# Chemistry Resources in the Electronic Age

*Judith A. Bazler*

**GREENWOOD PRESS**

# Chemistry Resources in the Electronic Age

# Chemistry Resources in the Electronic Age

Judith A. Bazler

Science Resources in the Electronic Age

An Oryx Book

GREENWOOD PRESS
Westport, Connecticut • London

**Library of Congress Cataloging-in-Publication Data**

Bazler, Judith.
Chemistry resources in the electronic age / by Judith A. Bazler.
p. cm.—(Science resources in the electronic age)
Includes bibliographical references and index.
ISBN 1–57356–379–X (alk. paper)
1. Chemistry—Computer network resources. I. Title. II. Series.
QD9.3.B39 2003
025.06′54—dc21 2002192824

British Library Cataloguing in Publication Data is available.



Library of Congress Catalog Card Number: 2002192824
ISBN: 1–57356–379–X

First published in 2003

Greenwood Press, 88 Post Road West, Westport, CT 06881
An imprint of Greenwood Publishing Group, Inc.
www.greenwood.com

Printed in the United States of America

The paper used in this book complies with the Permanent Paper Standard issued by the National Information Standards Organization (Z39.48–1984).

10 9 8 7 6 5 4 3 2 1

# Contents

# Acknowledgments

The author extends her appreciation to the graduate students at Monmouth University in West Long Branch, New Jersey. I acknowledge their assistance in researching and reviewing chemistry Web sites and their support and enthusiastic interest in this manual and in the larger process of infusing technology into their instruction and into their everyday lives. A number of students reviewed the first chapter for relevance and usability. In addition, three graduate assistants formalized the review process and suggested a number of the Web sites that the author reviewed for addition in the manual. Specifically, I wish to thank the following graduate students of Monmouth University: Mike Anderson, Nicole Barry, Fay Beale, Ruth Blouch, Patricia Caballero, Susan Cannon, Patricia Caufield, Maureen Collison, Heather Dahl, Michael DiClemente, James Dipalma, Katherine Dugan, Marc Dye, Aaron Edwards, Dorothy Farhy, Brian Farrell, Michelle Feldman, Elaine Feyereisen, Jami Fiasconaro, Rose Gordon, Amy Illiaria, Donna Jacobson, Allison Kellert, John Kelsey, Catherine Kornek, Carissa LaGuarina, Michelle Magliaro, Jennifer Margolies, Christine McClean, Colleen McGrath, Mary McMillan, Donna Mead, Tara Micciulla, Loren Miller, Michael Musumeci, James Nulle, John O'Shea, Merry Reilly, John Rooney, Jeff Sabella, Nicole Sansone, Gwen Schneider-Johnsen, Cheryl Scuorzo, Judith Shapanka, Philip Silva, Deborah N. Smith, Darren Spadavecchia, Leslie Sultan, Brenda S. Terrell Walker, Jill Tierney, Merita Tonuzi, Audra Trost, John Walby, Curtis Walker, Kim Wasserstein, Cheryl Whinna, Tracy Whitt, and Jennifer Willis. And I thank Mark Alfone for reviewing chapter one, as well as

graduate assistants Hasmukh A. Patel, Abdelghani Lakmini, and Jeff Portland.

My respect and admiration goes to Dr. Eleanora Von Dehsen, whose vision and leadership led to the development of this manual and the series that follows. Finally, I dedicate this book to my mother and father, who encouraged me to "get an education," and to my son, Kirk Melnikoff, who has always been my greatest friend.

# Introduction

*Chemistry Resources in the Electronic Age* is designed as a one-stop source for cutting through the chaos of the Internet to find authoritative information on topics covered in the chemistry curriculum. The book is divided into five chapters. In the first chapter, "The Basics," you'll find an invaluable introduction to the different kinds of electronic media. You might be surprised to learn that there's more than just the Web on the Internet. In addition to learning about the types of electronic resources, you'll also see how specific kinds of Web sites can be mined for your research projects. This chapter also provides basic information about the Web, search engines and other search tools, evaluating Web material, and copyright and plagiarism issues that are unique to today's electronic resources.

The heart of the book, chapter 2, "Resources in Chemistry," provides you with a treasure map to quality information on the Web, which will save you hours of your own research time. Here, we first point you to the Web's top-notch sites offering general information about science. Next, we have searched for and found the crème de la crème of Web sites providing specific information on key topics in chemistry. These topics are listed alphabetically rather than by name of Web site so that you can immediately go to the information you need without guessing if a site will be useful.

For each topic, you'll find reviews of several Web sites, giving you all of the information you need to know: the name, URL, appropriate grade range, and a thorough discussion of how to use the site for research. When you log on to the Web to find background information on Acids/Bases or to gain a fuller understanding of the Organic Chemistry,

you'll now have a number of handpicked sites, as opposed to the thousands that might turn up with a keyword search. In case you choose to conduct your own on-line search for a key topic, we let you know which search engine and key search words provide the best "hits."

The third chapter, "Supplies," reviews a number of excellent Web sites that offer materials and resources for parents and for science students, including sites of the premier science supply companies, such as Flinn Scientific, Sargeant Welch, and others.

The fourth chapter, "Museums, Science Centers, and Summer Programs," surveys Web sites offering unique on-line museum exhibits, interpretive centers, summer programs, and other interactive opportunities for students of science.

The final chapter of the book, "Careers," turns its attention to Web sites that provide students with career information in the field of science. Here, we've reviewed sites for professional associations, academic groups, conferences, workshops, programs, clubs, and other outlets for students interested in working or doing an internship in the subject.

## SCOPE AND CONTENT

We gathered the topics listed in chapter 2 from a detailed analysis of the science standards and leading chemistry texts. The index will lead you to topics not on the list in chapter 2.

The number of Web sites reviewed in each entry is determined by the number of good Web sites that look at different aspects of the topic, not the importance of the topic. We considered as many of the Web sites on each topic as possible and chose to review as many as possible. Most topics provided a number of excellent Web sites that are included in this book. Obviously, some topics had many Web sites to review, and only a few are included in this book due to space limitations. We did not limit the number of sites per topic, and we have chosen the Web sites based on how closely they mirror what is covered in textbooks and the national science curriculum.

## HOW TO USE THIS BOOK

There are three ways you can find information in *Chemistry Resources in the Electronic Age*. First, you can look at the detailed table of contents, which will quickly lead you to such topics as copyright and plagiarism or existing program sites. If you are researching a particular topic in chemistry, you can immediately go to the alphabetical listing of topics in

chapter 2. Finally, you can use the index, which expands our coverage significantly. Because we had to limit the number of topics in chapter 2, we added as much detail as possible to our site reviews. These include other topics covered in the Web site but not included in our topic list. All of these have been indexed. For example, *density* is not in the topic list, but if you look in the index, you will find that a site on analytical chemistry or inorganic chemistry discusses it. Therefore, if you don't find what you want in the topic list, go to the index.

So when you are desperate for a quick, reliable Web site for a report on proteins; need to know about Internet searching or citing electronic sources; or want to know what it's like to be a chemist, reach for *Chemistry Resources in the Electronic Age*. It will help you avoid the frustration of endless surfing and wasted time by taking you directly to the Web's best chemistry resources.

# 1
# The Basics

## INFORMATION IN THE ELECTRONIC AGE

Today, you are just as likely to turn to a computer terminal as to a book to answer your science reference questions. In fact, the Internet is considered by most to be the preferred reference tool. Unfortunately, many budding researchers use a hit-or-miss approach to their research strategy. This approach uses a lot of time and even more patience. If you love the challenge, this discovery approach may be exactly what you need to feel like an explorer. However, for the majority of researchers, who find the hit-or-miss approach time-consuming, this lack of a systematic process may lead to a high degree of frustration. The approach you choose to use is not the only barrier you must overcome in order to feel comfortable and confident in your searching. Even if you are successful using either a hit-or-miss search process or a more systematic process, the multitude of information gathered and the task of eliminating useless material without any standardization or guide may make the task of researching a topic on the Internet seem overwhelming and unachievable. More is not necessarily better, and you may wonder how it is that we evolved from using only the library card catalog indexes and typewriters to now using electronic computers and the Internet in our searching strategies.

The Internet initially provided information exchange among scientists. In the beginning, the Internet was owned and managed by the United States government. This governmental ownership changed in 1995 to a predominantly privately controlled organization. The Internet originally connected university-based research centers with governmental contractors, specifically military and defense centers. This initial network devel-

oped in 1969 was called Advanced Research Projects Agency Network of the Department of Defense (ARPANet). Early researchers concerned themselves with communication and information exchanges and resources. They were able to use different computers as long as each computer followed a set of rules for expressing the information. These rules are called protocols, and Telnet and Gopher are a few examples of early protocols of the electronic age. In these earlier protocols, graphics and illustrations were not easily transmitted. The Internet now commonly uses the transmission control/Internet protocol (TCP/IP). Where does the World Wide Web (WWW) fit into this picture? Is the Internet the same as the WWW? The Internet provides tools for communication, inquiry, and construction. It is much larger than just the WWW and includes newsgroups, chat rooms, mailing lists, videoconferencing, and e-mail, to name a few.

The Internet's versatility, combined with its multimedia capabilities, which include sound and graphics, places it as one of your research tools of choice. You would think that a tool that is so heavily used by so many people would have minimal problems or deficiencies. Even though a wealth of information can be found on the Internet, the lack of evaluative standards, the confusion of researching a topic, inactive or so-called dead Web sites, and the ever-changing product upgrades will plague you when searching the Internet. Yes, using electronic resources can be extremely exasperating to everyone.

Remember, currently the Internet provides access to only a small percentage (10%–15%) of all usable reference material. Since the Internet can only provide access to a small amount of all reference material available, you will need to know about other formats of science reference material and the availability and the value of these references. A science researcher uses all formats of reference material when fully exploring a science topic. How and where do you find answers to questions on specific topics taught in science courses? The *Science Resources in the Electronic Age* series should be the first reference before you begin your in-depth research of any science subject or topic.

*Chemistry Resources in the Electronic Age* is the first volume of an open-ended series that helps researchers quickly find reliable, age- or level-appropriate information on chemistry topics using the Internet. It is designed for students from junior high through the first years of college, as well as for the general reference audience, and it offers you an expert guide to the vast electronic information resources available. The series combines searching strategies and annotated sites to help you use electronic resources effectively. Because Internet information is often incom-

plete, the series also shows how other electronic media and print materials can supplement the Web.

Each volume in the series is divided into five distinct sections. The first chapter, "The Basics," contains a general overview of research in the electronic age and an introduction to electronic technologies. The chapter also includes information on different formats, Web basics and search strategies, and evaluation tools. The focus is on research on the particular discipline covered in the volume.

The second section, "Resources in Chemistry," is the heart of the book. It presents the resources available on key topics in the discipline. Each category begins with a quick-search feature, listing the most appropriate metasearch engine for researching the concept and suggesting the most useful key words to find the appropriate questions generated by the science curriculum and for their scientific accuracy. Emphasis is on the Internet, although other electronic media and print materials are discussed. Each source citation includes the name and URL of the site, its appropriate grade or age range, and a brief review of the site.

The remaining sections of each volume expand the scope of the book, s children, places from which to order scientific supplies, a complete list of museum sites, and information on careers.

## FORMATS OF RESOURCES

Science resources can be obtained in many different formats, including the Internet. In other words, science can be found in printed forms such as books, journals, and curricula, on CD-ROMs and videos, and in various professional organizations, science museums, and private corporations. The following discusses these formats and provides general resource addresses for further information.

### Library Electronic Services

There are a number of academic and professional directories that offer a collection of Internet resources. In addition, specific commercial portals, namely, gonetwork (http://www.go.com/) and open directory project (http://www.dmoz.org/), provide a reference directory that you can search using author, subject, or title. To obtain a list of libraries that have Internet-accessible catalogs, use LIBWEB at http://sunsite.berkeley.edu/Libweb. Another usable portal is the Library of Congress accessible at http://www.loc.gov/library.

### CD-ROM/Multimedia

A limited number of CD-ROMs, videos, and cassette tapes specifically concern themselves with science, and, more specifically, with chemistry. In addition, libraries use CD-ROMs in order to access large collections. Some CD-ROM indexes used by libraries are *Reader's Guide to Periodical Literature*, *Books in Print*, *InfoTrac*, *ProQuest's Periodical Abstracts*, and *Academic Search* or *Alternative Press Index*. You can also purchase CD-ROM reference materials, which contain videos, animations, pictures, and sound clips. *World Book Encyclopedia* is an example of a multimedia CD-ROM.

### E-mail

E-mail, which provides you with a quick method to exchange information with others, was the earliest function of the Internet. In order to use the Internet as an e-mail message tool, you simply need to have an e-mail account through an e-mail service provider. Once connected, you need to know the e-mail address of whom you are trying to send a message. Yahoo! People Search at http://people.yahoo.com or at http://ussearch.com can help you search for the address of a person. Various sites provide help and advice about science subjects. The Center for Improved Engineering and Science Education (CIESE) provides links to ask-an-expert sites at http://njnie.dl.stevens-tech.edu/askanexpert.html.

### Mailing Lists

Mailing lists are similar to e-mail; however, the contact in a mailing list is not a single individual but a group of individuals with similar interests. In order to participate in a mailing list, you must subscribe to one. Listserv@msu.edu is a mailing list on educational technology, listserv@unm.edu is a mailing list on integrating technology in schools, and listserv@postoffice.cso.uiuc.edu is a list on middle-school topics. For a complete list of mailing lists, use Liszt at http://www.topica.com. Once at the site, type in "science" at the search window. This leads you to a huge list of national and regional mailing lists in science.

### Usenet Newsgroups

A newsgroup maintains its messages on a bulletin boardlike server. Messages can be posted to the bulletin board by any one who has registered. In

order to obtain a directory of Usenet newsgroups, go to http://www.deja.com/usenet or http://www.cyberfiber.com/index.html and scroll to the "science" link. After accessing the science page, you will be given a list of groups with an indicator of the amount of activity occurring with the groups. You can read the messages, but in order to post a message you must simply register.

### Chat

Chat rooms provide you with real-time ability to communicate directly to people. Chat rooms differ in the ability to be synchronous and in real-time, whereas newsgroups and e-mail are not in real-time. Chat rooms are like face-to-face or telephone discussions. Science Live Chat from Western Canon University at http://mobydicks.com/commons/Sciencehall/live/chat.cgi is a live chat for one hour every day where people discuss great books of science. This classroom is active from 9:00 P.M. to 3:00 A.M. Eastern Standard Time. Other chat rooms can be found by searching using "science chatrooms" for the searching phrase.

### Videoconferencing

This format allows participants to see and hear each other. Cornell University originally designed the CU-SeeMe software. NASA uses this format to provide live feed during space shuttle missions. The Global SchoolNet Foundation maintains a list of CU-SeeMe schools at http://www.gsn.org/cu/index.html.

### Full-Text Magazines and Newspapers

A number of resources are available to the public that can be purchased or utilized through the library. Newspapers have become a wonderful resource for current science development. The Tuesday/Science Times section of the *New York Times* is my favorite resource for up-to-date science news. The *Los Angeles Times* also has an excellent science section. *CNN Science and Technology* is also an excellent resource for science research. Magazines (a list can be found at Enews: the ultimate magazine site), including *Discover, Popular Science, National Geographic World, Audubon,* and *Natural History,* provide current science written in a usable, friendly manner. A more ambitious researcher might look into the professional journals such as *Science* and *Scientific American*. A complete

list of professional journals can be found in the electronic journal index at http://www.e-journals.org.

### Digital Libraries

Libraries are busy storing whole collections on computers. The American Memory Learning Page provided by the Library of Congress at http://lcweb2.loc.gov/ammem/ndlpedu opens the door to collections, activities, and lessons and resources for you mostly in social studies but includes some inventions and technology. Single subject libraries exist such as the Banting Digital library found at http://newtecumseth.library.on.ca/banting. Other sites of interest are Canada's Digital Collections at http://collections.ic.gc.ca and Cornell's Digital Library Mathematics Collection at http://moa.cit.cornell.edu/dienst-data/cdimath-browse. html.

## TYPES OF WORLD WIDE WEB RESOURCES

The WWW contains numerous science Web sites that provide valuable information and tutorials, experiments and activities, science materials, and other reference materials. However, there are so many, you probably could use some help in choosing the best general science sites. Following are the names of science reference material sites, commercial and government resources, academic and educational resources, and existing science programs. In addition, I have included a brief discussion about practical activities and demonstration resources.

### Reference and Journals Web Sites

The Web contains a number of wonderful reference sites that contain not only resources that are found in dictionaries and encyclopedias, but also links to other great resources. These sites are usually well organized and updated regularly.

*Title:* StudyWeb
*URL:* http://www.studyweb.com/
*Grade Level:* Any grade level
*Review:* This site has over 162,000 URL sites listed. You search by selecting a topic from a specific topic list or typing in a topic. If you click on the "chemistry" link, for example, you are led to information about classroom resources, the history of chemistry, branches of study, teaching resources, and educational and professional development. I

clicked on the branches of the study topic "polymers," which led me to a list of URL sites rated for visual content (for example, a rating of four apples is excellent). The site has the approximate grade level, source, and contributor name. There is a brief review of the site included.

*Title:* InfoPlease
*URL:* http://www.infoplease.com/
*Grade Level:* Any grade level
Review: A wonderful reference tool. You can search the almanacs or the almanac index. The two entries that are directly appropriate to science are "health and science" and "weather and climate." You also can type in a topic at the search window. This site has a search window for topics and one for biographies. I typed in "Einstein" at the biography search window and was linked to encyclopedia, dictionary, and almanac links. The almanac link provided a picture, birth and death dates, and birthplace. The encyclopedia link provided information on his life, his contributions to science, his writings, and a bibliography. This site also has a pronunciation key link!

*Title:* Britannica.com
*URL:* http://www.britannica.com/
*Grade Level:* Any grade level
*Review:* A very easy site to navigate. You type in the topic at the beginning search window or locate it alphabetically, by subject, or by world atlas. I explored by typing in the term "acid rain," which lead me to Web site links that are rated (four stars is excellent and recommended), current event and magazine links, and a great encyclopedic reference complete with video and animation. There also is a [+] icon throughout the site to enable you to provide feedback to the site's developer. At the main menu is a link to Britannica School explaining that if you subscribe to this component of the Web site, additional curricular materials are available. I found the free component to be a worthwhile resource.

### Commercial and Government Web Sites

Do not avoid commercial sites because you think that these sites contain only science materials for sale. Carolina Biological, Pasco Scientific, Edmund Scientific, Educational Innovations, Inc., and Fisher Science Education On-line not only provide a source for you to buy a needed

piece of equipment, but these companies also offer practical information and activities. In addition, specific government programs from the National Science Foundation (NSF), and the United States Department of Education (USDE) provide the researcher with grant possibilities, program information, and other science resources.

### Academic and Educational Web Sites

Professional organizations are a wonderful resource for information, science activities, and science connections. The American Chemical Society (ACS), American Association of Physics Teachers (AAPT), National Science Teachers Association (NSTA), National Association of Biology Teachers (NABT), and National Council of Teachers of Mathematics (NCTM) are only a few of the academic and educational sites that are a must for the science researcher.

Many professional organizations maintain a national and/or international presence through group conferences and professional journals. Science professionals use both the journal and conference forum in order to share research and build collaborative partnerships. In science, the American Association for the Advancement of Science (AAAS) and the National Academy of Science (NAS) are considered to be the most prestigious science organizations. Both publish journals and information for those interested in science and act as a forum for science professionals to share both information and research.

*Title:* The American Association for the Advancement of Science (AAAS)
*URL:* http://www.aaas.org
*Grade Level:* Any grade level
*Review:* The American Association for the Advancement of Science publishes the journal *Science* and provides the forum needed for the development of Project 2061. The AAAS Web site links you to information about the following:

- National/international science conference and meetings dates
- Science policy
- Science workshops and programs (national and international) including radio programs that focus on science topics
- An index of science resources including science books, videos, and CD-ROMs and science products
- The latest research in science

- Science shows, including *Kinetic City Super Crew*
- A grant searchable database
- Links to on-line resources, including Project 2061, books, and CD-ROMs

*Title:* The National Academy of Science (NAS)
*URL:* http://www.nationalacademies.org/
*Grade Level:* Any grade level
*Review:* The National Academy of Science (NAS) is one of the branches of the National Academies organization that provides information on advisors to the nation on science, engineering, and medicine. The other organizations in the National Academies are the National Academy of Engineering, Institute of Medicine, and National Research Council. The NAS Web site links you to their publication, *Proceedings of the National Academy of Science* and to information on the following:

- Special science programs
- Science education
- International science policy
- Meeting dates of science conferences
- The latest science research

In addition, a quick review of the National Research Council (NRC) link leads you to the National Academy Press site, which has access to over 1,350 books on-line, including a table of contents for you to use to make your selection and ordering information. The NRC link also gives you access to both the NRC and NAS archives, providing you with information and access to past research.

Overall, both the NAS and AAAS sites provide the researcher with the latest science research and development. The best way to access them is directly through the above URLs.

*Title:* National Science Teachers Association (NSTA)
*URL:* http://www.nsta.org/
*Grade Level:* Any grade level
*Review:* Along with the NAS and NRC, both the National Science Teachers Association (NSTA) and the American Chemical Society (ACS) provide educators with the latest developments in chemistry education. A search of the NSTA Web site leads you to their journals (*Science Scope, The Science Teacher, Journal of College Science Teaching,*

*Quantum*, *Dragonfly*, and *Science and Children*) and information on the following:

- Position statements and policy on science education
- National student competitions
- Science clubs and organizations
- Science resources
- U.S. registry of science teachers
- Science workshops for educators
- Science awards
- Scilink, which is a free service that connects a Scilink textbook to the WWW
- A science video vault
- Science of energy
- A "Building a Presence for Science Education" discussion room

*Title:* American Chemistry Society
*URL:* http://www.jchemed.chem.wisc.edu/
*Grade Level:* Any grade level
*Review:* Even though ACS is an excellent resource for chemistry research, the *Journal of Chemistry Education* Web site is the best destination for chemistry information for the nonchemist. This Web site gives you links to chemistry software, to videos and CD-ROMs concentrating on chemistry, and to the *Journal of Chemistry Education* and other publications concerning chemistry.

### Existing Programs Web Sites

A number of existing science programs are available to the researcher. The government funds science programs, and a quick review of government resources will provide a list of these funded programs. The Jason Project is just one of these federally funded programs. In addition, publicly funded programs such as the Westinghouse Science Talent Search are useful to the researcher.

### Practical Activities Web Sites

My favorite resource to find practical activities is the Eisenhower National Clearinghouse for Mathematics and Science Education. Another useful tool is the Lesson Plan Search (from the Educational Resources Information Clearinghouse, or ERIC) or Ask ERIC.

## WEB BASICS

The WWW has enhanced the use of the Internet by using both multimedia and hypermedia. The multimedia capability allows you to communicate by integrating text, video, audio, and still images into a single product. The hypermedia capabilities of WWW allows you to experience the multimedia in any order. The WWW utilizes its multimedia and hypermedia capability and displays these as pages and links on a computer screen. Web pages can contain text, images, graphics, and video clips, and the links take you to other sources of information.

The WWW uses hypertext transfer protocol (HTTP) as its primary protocol. Other protocols are file transfer (FTP), network news transfer (NNTP), Telnet, Gopher, and simple mail transport (SMTP). The WWW utilizes a group of Internet servers. The Web browser is the forum that allows you to converse in these different protocols.

### Browsers

A Web browser provides the forum that you need to access the WWW and other information resources. Consider the Web browser to be like a workshop in which you use different tools to do different jobs. The two most popular Web browsers are Microsoft Internet Explorer and Netscape Communicator, in which Netscape incorporated Netscape Navigator. Like a workshop, Web browsers provide different tools to do different jobs while using the World Wide Web. For instance, most browsers have a "Forward" button that allows you to return to a page that you just visited. In addition, most browsers contain the following buttons:

- Back—allows you to go back to a page
- Home—returns you to your homepage or to your browser's home page
- Reload or Refresh—reloads the Web page
- Search—takes you to a list of search engines or directories that are specific to the Web browser
- Bookmarks or Favorites—helps you to store a URL for future reference
- Print—allows you to print a document

Under the tools, you will find a box labeled "Location," "Go To," or "Address." This is where you will type your specific Web site's address, which is called a Uniform Resource Locator (URL).

### URLs

You should think of URLs as addresses of Web sites that contain information. You probably have a home address, which usually includes your name, number of the building, street, city, state, and zip code. URLs are very similar to home addresses. Some of you may also have an e-mail address, which looks like the following: user@somewhere.domain. A typical Web site address looks like the following: a computer's name@somewhere.domain. An example of a URL address of a Web site for cyberspace law is: http://www.cs.csubak.edu.

- http://—hypertext transfer protocol, the beginning of a URL (in front of slashes), indicates either the resource or method of access. The most common research protocol for Web file transfers is http. Others are Gopher, gopher search tool; ftp, a file available for downloading; News, newsgroups; Telnet, another computer system; Wide Area Information Search (WAIS), a database; and File, your own file.
- www—World Wide Web, host computer name
- cs.csubak—specific computer or server
- edu—educational (domain designator). The last part (after the dot) of the URL contains the specific address or domain name system (DNS). The last three letters after the period of a URL beginning in "www" indicate the type of group that owns the server. In our example, the last three letters are "edu," which stands for University. Other words that you will need to know are as follows: com, business or commercial; org, organization; mil, military agency; net, network provider; aus, Australia; us, United States; ca, Canada; fr, France; uk, United Kingdom; K12__.us, public schools; and gov, government. The Internet Corporation for Assigned Names and Numbers (ICANN) sets up domain names.

Most research on the WWW requires you to learn how to find information through the process called a search.

### Metasearch Engines

In order to find URL addresses that are specific to the topic that you are researching, you need to use the appropriate computer tool. A searching tool that uses multiple search engines or directories is called a metasearch engine (also called multithreaded engines). Metasearch engines help speed up the process of a search. You can consider metasearch tools to be the Swiss Army Knife of search engines in that they provide many tools to do the job. Examples of metasearch engines are found in Table 1.1.

Metasearch engines are great to use when first researching a subject. You probably are now wondering which one or ones of the above to use in your search. Currently, high praise has been given to Metacrawler, MetaFind, and Dogpile from metasearch engine reviewers. My university students tend to use AskJeeves because it allows them to search with no specific searching rules, and once you do a search, the tool begins to ask you several questions to enable you to narrow your search. I use Metacrawler because it of its ease of use, its removal of duplicate sites, its ability to interpret Boolean search rules, and because it searches with the best search engines. After you have searched a topic and you find that you need more information, you may want to use an individual search engine in order to further refine your search.

### Search Engines

Search engines help you research various subjects or words. If the browser is your workshop, consider both metasearch engines and search engines to be your tools to obtain information. Generally, different search tools are available, depending upon the method that you choose to use in your search. There are directory search engines that find information by using subjects. There are also key word search engines that search by specific words. What is most confusing about the method of searching is that most will do both a search by key words and a search by subject. In addition, you may find that your information specifies that there are subject directories and search services. Most search engines will have a menu of subjects to click on or a space in which you provide the subject or key word. The problem should be which search engine to use and how to use it. There are more search engines on the WWW than are included in this book. Yahoo!, Alta Vista, Hotbot, Infoseek, LookSmart, and Excite are some of the more common ones. Table 1.2 lists search engines, their URLs, whether they use Boolean or limited logic, and the size of the search.

### Other Tools

A great Web site that provides more current information on the Internet is the Zen and the Art of the Internet Web site at http://www.cs.indiana.edu/docproject/zen/zen-1.0_toc.html. If the Web site that you are researching contains video, images, or sound, the Web site will direct you to a helper piece of software called a plug-in. The plug-in works with the Web browser, enabling you to use the multimedia required in the Web

**Table 1.1**
**Metasearch Tools**

| Metasearch Name | URL | Description |
|---|---|---|
| All-in-one | http://www.allonesearch.com/ | |
| Ask Jeeves | http://www.askjeeves.com/ | A simple tool. Very limited. |
| Cyber411 | http://www.cyber411.com/ | Uses 16 search engines. Uses Boolean logic for searching and eliminates duplicates. |
| Debriefing | http://www.debriefing.com | Searches Alta Vista, Infoseek, Excite, Webcrawler, Lycos, and Hotbot. Uses Boolean logic, ranks the sites, and eliminates duplicates. |
| Dogpile | http://www.dogpile.com/ | Searches 14 search engines, newsgroups, business news, and newswires. Uses Boolean logic for searching. |
| Highway 61 | http://www.highway61.com | Searches Yahoo!, Lycos, Webcrawler, Infoseek, and Excite. Uses Boolean logic and tends to be slow. |
| Inference find | http://www.infind.com | Searches Yahoo!, Alta Vista, Webcrawler, Infoseek, and Excite. Eliminates duplicates. |
| Internet Sleuth | http://www.thebighub.com/ | You determine which search engines it uses. |
| Mamma | http://www.mamma.com/ | Searches the Web, Usenet, news, stock symbols, company names, MP3 files, pictures, and sound; also Alta Vista, Excite, Infoseek, Lycos, Webcrawler, and Yahoo!. Uses implied Boolean logic (+/–). |
| Metacrawler | http://www.metacrawler.com | Searches Lycos, Infoseek, Webcrawler, Excite, Alta Vista, and Yahoo!; also searches computer products, Usenet, files, and stock quotes. Uses implied Boolean logic (+/–) for searching. |

*(Continued)*

**Table 1.1**
***(Continued)***

| Metasearch Name | URL | Description |
|---|---|---|
| Metafind | http://www.metafind.com/ | Searches Alta Vista, Excite, Hotbot, Infoseek, Planetsearch, and Webcrawler. Uses Boolean logic. |
| Profusion | http://www.profusion.com/ | Searches the Web or Usenet. Boolean logic used, tends to be slow. |
| Savvysearch | http://www.savvysearch.com/ | Uses many search engines. Boolean logic used, tends to be slow. |
| Verio Metasearch | http://search.verio.net/ | Uses many search engines. Tends to be slow. |

site. Files that require helper software are called Multimedia Internet Mail Extension (MIME) files. Adobe Acrobat Reader is a typical plug-in. It allows you to see portable document format (PDF) files. This plug-in is available for free at http://www.adobe.com/products/acrobat/readstep.html. Most plug-ins are available for free. Real Audio 4.0, Real Video 4.0, and QuickTime (WAV, MP3, and AVI are extensions) are more examples of helper software. Real Player and Real Jukebox allow you to see action or hear sounds live on the Internet. These plug-ins are available at http://www.real.com. Quick Time (http://www.apple.com/) is the plug-in to use for movies and videos.

Where plug-ins have expanded your ability to use the Web, new programming languages such as Java, Java Applets, JavaScript, virtual reality modeling language (VRML), and extensible markup language (XML) have expanded the Web abilities. Java is a programming language that would allow you to create and work independently on programs either singly or networked. JavaScript is a programming language that combines three intermingled languages.

Try some of the current tricks that are becoming standard in the Internet world. Try typing the word "Finger" and a DNS. For example, type "Finger@Monmouth.edu" or just "Finger" at the location window. This will get you information about users. You can also talk to someone without going into e-mail by typing Talk (Person's name)@DNS. For example, if you typed Talk Bazler@Monmouth.edu, and if I were on-line at the

**Table 1.2**
**Search Engine Researching Language**

| Web Site URL | Boolean Logic | Search Size |
|---|---|---|
| Google<br>http://www.google.com | AND assumed<br>No OR | Medium to large |
| Northern Light<br>http://www.northern.com | AND, OR, NOT | 140–160 million |
| Alta Vista<br>http://www.altavista.com | AND, OR, AND NOT,<br>NEAR | 140–160 million |
| Infoseek<br>http://infoseek.go.com | NO +/– | 30 million+ |
| FastSearch<br>http://alltheweb.com | NO +/– | 200 million+ |
| Librarians' Index<br>http://www.lii.org | AND implied, OR,<br>NOT | 5,000 |
| Infomine<br>http://infomine.ucr.edu | AND implied, OR | 16,000 |
| Britannica Web's Best<br>http://www.britannica.com | AND, OR, NOT | 150,000 |
| Yahoo!<br>http://www.yahoo.com | NO +/– | 1 million |
| Galaxy<br>http://galaxy.einet.net/ | AND, OR, NOT | 300,000 |

time, we could proceed to talk without accessing e-mail. This last development will help you with a search if you know the name of the person or if you know the domain of the institution. Type Whois at the location window. For example, if you are looking for the name of someone at the Massachusetts Institute of Technology (MIT), type Whois@MIT.edu. This will provide you with the names of registered users at MIT. Or if you know the name but not the domain, type Whois Bazler. If a user by the name of Bazler is registered, the appropriate Web site or domain will be recognized.

These are just a few of the latest new tools available for searching without a search engine. However, choosing the appropriate tool (metasearch or search engine) is only the first step of researching a topic. The follow-

ing suggested process will give you the steps you need to communicate your topic to the search engine.

## SEARCHING

One of the most difficult stages of a search occurs when you attempt to communicate your needs precisely to the search engine. The following is a suggested step-by-step process for refining your language for typing into the search window:

- Write a sentence or sentences stating what you want to research
- Identify key words in your sentence(s)
- List synonyms of key words
- Combine synonyms, key words, and so on with or/and/not or +/− and put parenthesis around "or" phrases
- Check spelling

For example, if you want to research the human heart, follow the above steps as in the following example:

1. Write a sentence stating what you want to research: I want to find out the parts of the human heart and the function of the parts.
2. Identify key words and underline those in your sentence: I want to find out the *parts* of the *human heart* and the *function* of the *parts*.
3. List synonyms of key words: parts = components, members, subdivisions; human heart = cardiac organ, vascular organ; function = capacity.
4. Combine synonyms and key words with or/and/not or +/− and put parenthesis around "or" phrases: (parts or components or members or subdivisions) and (human heart or cardiac organ or vascular organ) and (function or capacity).
5. Check spelling.

## EVALUATING WEB MATERIAL

In the past, the experts in their fields evaluated most reference material. Written science material such as that found in journal articles, reference materials, and books are scrutinized by an editorial process that includes a review by science experts. Even films, CD-ROMs, and audiovisual materials are reviewed by a standardized process before being made available to the public. In addition, librarians evaluate most materials

found in academic libraries. However, there is currently no standard evaluation practice in place for review of Internet material. You, the Internet user, are the evaluator. Since there is no evaluative process and since the Internet is accessible to anyone for uploading information, evaluating each Web site for accuracy, content completeness, and up-to-dateness is a critical part of the researcher's job. The following guidelines and questions will help you with this task:

- Who is the author? Is the author or organization one you recognize or one who others recognize positively? Is the author's résumé included? Can you contact the author?
- Who is the publisher? Has the document gone through peer review?
- What is the author's bias? Is the article based on logic or logically obtained data?
- Is the article referenced? Are the references and links current? Do the links work? Is the site updated? Does the site list the date of the last time updated?
- If educational, is the material truly at the accurate readability level stated?

In addition, you should evaluate the site for its ease of use, technical availability, and timeliness. In order to make this process easier, I have developed the following checklist (Table 1.3) for your use.

## BEYOND THE WEB

There are other sources of information not on the WWW that should be mentioned. These resources include WAIS, Gopher (an older, menu-based information system), Telnet (on-line library services), FTP (a comprehensive listing of anonymous sites), Experimental Metamap, and Experimental Search Engine Meta-Index. Interesting sites for science are the Los Alamos Physics Papers (available on the Web) and the White House Papers (available on WAIS).

## COPYRIGHT AND PLAGIARISM IN THE ELECTRONIC AGE

Information is now readily accessible and at your fingertips. After you have evaluated a Web site's credibility and usability, learn the rules governing the use of this information. Information concerning Internet materials usage varies from source to source. According to http://www.cs.csubak.edu, Cyberspace Law for Non-lawyers, "ideas, facts, titles, names, short phrases, and blank forms cannot be protected by copyright."

**Table 1.3**
**Web Site Evaluation Form**

Name of Web site _____
URL _____
Web site author _____
Date of last update _____

Web site contains:
Tutorial _____
Laboratory activities _____
Resources _____
Professional information _____
Teacher information _____
General science information _____

| | 1 (poor) | 2 | 3 (average) | 4 | 5 (excellent) |
|---|---|---|---|---|---|
| 1. Article is referenced | | | | | |
| 2. References are current (within 5 years) | | | | | |
| 3. Author's résumé or e-mail is included | | | | | |
| 4. Article is based on research and/or data analysis | | | | | |
| 5. Links are current and operational | | | | | |
| 6. Article is peer reviewed | | | | | |
| 7. Navigation is easy | | | | | |
| 8. Easy to print, clear design | | | | | |
| 9. Web site is interactive | | | | | |
| 10. Updates are listed | | | | | |
| 11. Information is easy to follow | | | | | |
| 12. Appropriate readability level | | | | | |

From a safe user position, consider everything that is written to be eligible for copyright. Therefore, if it has a copyright (which conservatively we assume everything written has), and you have decided to make a copy and you did not get the permission of the author, you may have violated copyright law. The exceptions to this are outlined by the Fair Use Doctrine. Legally, if when you copy a piece and you can answer yes to most of the following, you are allowed to copy legally as long as you site the author:

- Is the piece for noncommercial use—you are not going to sell it?
- Is the piece for criticism, comment, parody, news reporting, teaching, scholarship, or research use?
- Is your use of the piece mostly factual?
- Is your use of work that was published?
- Are you using only a small part of work?
- Are you using only an insignificant part of work?
- Are you adding significantly to original work?
- Does your use affect any profits that the original owner makes?

Remember, to not acknowledge the author and to use writings unchanged is called plagiarism. Use the following Web sites to clarify style and for additional guidance:

**Online! Citation Styles**
http://www.bedfordstmartins.com/online/citex.html
Modern Language Association (MLA), American Psychiatric Association (APA), the *Chicago Manual of Style*, and Kate Turabian

Electronic Styles: A Handbook for Citing Electronic Information
http://www.uvm.edu/~ncrane/estyles/apa.html
http://www.uvm.edu/~ncrane/estyles/mla.html
Style guide for electronic material.

**Library of Congress: Citing Electronic Sources**
http://lcweb2.loc.gov/ammem/ndlpedu/cite.html
Provides examples of citations for MLA and Chicago/Turabian style.

**The Columbia Guide to Online Style**
http://www.columbia.edu/cu/cup/cgos/idx_basic.html
A guide for MLA, Chicago/Turabian, or APA style.

# 2
# Resources in Chemistry

This chapter is devoted to the Internet and specific Web sites. The first section contains general science information including reference, commercial, and government sites, academic and educational sites, and existing programs and demonstration sites. The second section presents general sources for chemistry, such as safety information, glossaries and dictionaries, and tables, charts, and formulas. The third section contains chemistry topics listed alphabetically and gives relevant sites for each topic.

## TYPES OF GENERAL SCIENCE RESOURCES

Following is an alphabetical list of general science resources. Each listing provides the URL, grade level, search engine, key search word(s) used, and a brief review of the site.

### Reference

*Title:* CNN Science and Technology Page
*URL:* http://www.cnn.com/tech/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry resources
*Review:* This site contains the current and archived science news. The site has links to videos and audio archives. Type the name of your topic or subject in the search window provided on the home page. You can then further refine your search in another search window.

The resulting article summaries can be sorted by date or by relevance. If you sort by relevance, the key search word will be highlighted in yellow in the summary, and the article summaries will be ranked according to relevance. Clicking on the article link leads you to the complete article as well as to links to related stories and sites.

*Title:* ERIC Clearinghouse for Science, Mathematics, and Environmental Education
*URL:* http://www.ericse.org/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science resources
*Review:* A component of the Educational Resources Information Center sponsored by the U.S. Department of Education. This resource was designed to provide information about learning science and the environment. It has links to science and environmental science resources, resources for parents and children, a bookstore, on-line publications, a conference calendar, and other science links.

*Title:* Electronic Journal Index
*URL:* http://www.coalliance.org/ejournal/
*Grade Level:* High school to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* educators sites + science + journals
*Review:* This Web site contains journals, magazines, newsletters, and other publications available over the Internet. The site lists the electronic journals alphabetically, by subject, by publisher, or titles published in the state of Colorado. The site contains a search window for you to use to facilitate your search. When you use the search window option, the site provides you with a list of matches with a star indicator that ranks the listed Web sites by appropriateness. For instance, a four-star ranking indicates a better match. When you click on the alphabetical or subject links you reach a screen where you can click on an alphabet (a, b, c . . . ) or type into a search window. Once into a specific electronic journal, complete address, peer review status, and subject list index is available. This is an excellent resource for you to begin your search for information.

*Title:* Enews: The Ultimate Magazine Site
*URL:* http://www.enews.com
*Grade Level:* All grade levels

*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science magazines
*Review:* This site provides information concerning over 900 magazines. You can search by title, category, interest area, or alphabetical listing. A brief review of the magazine including subject area and grade appropriateness is included. Access to information about purchasing popular science magazines including *Discover, Popular Science, National Geographic World, Natural History, Audubon, Science News, Mother Earth News, Animals,* and *American Heritage of Invention and Technology* is also provided in this site.

*Title:* LA Science Page
*URL:* http://www.latimes.com/news/science/science
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science resources
*Review:* The home page of this site provides a link to the archive depository. Clicking on the archive link leads you to a search window and to other search tools. You can type a topic into the search window and further narrow your search to a specific period or a specific section of the paper. There are two additional search tools that help you narrow your search by relevance, publication date, and amount of stories retrieved. This service gives you access to all the articles on a specific topic published in the *Los Angeles Times* since 1990. Archive stories older than 14 days cost $2/story or $6/month for up to 10 stories.

*Title:* Martindale's Health Science Guide
*URL:* http://www.sci.lib.uci/edu/~martindale/hsguide.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science reference
*Review:* A great reference tool for any age. This site is divided into large links to specific disciplines, such as science tables or chemistry. Scroll down to the specific center or click directly on the center. This leads you to an elaborate listing of science topics in each center. This is a great resource to links for any topic in science.

*Title:* Nature
*URL:* http://www.nature.com
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com

*Key Search Words:* chemistry reference
*Review:* Access to *Nature* magazine. Includes a trial, on-line copy of the magazine. Has a search icon but you must register and pay to access. Has a product link to new products advertised in *Nature*.

*Title:* On-Line Encyclopedia of Chemical Terms
*URL:* http://www.scimedia.com/chem-ed/scidex.htm#top
*Grade Level:* High school to adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry encyclopedia
*Review:* This electronic encyclopedia is an excellent resource for tutorials and information. At the home page, you will find links to equilibrium problems, an index, an encyclopedia, and an alphabetical listing of topics. A click on a topic in the alphabetical listing leads you to information pages that are cross-linked to other relevant topics. The visuals in the pages are clear, accurately labeled, and easily followed. The equilibrium tutorial problems and answers are excellent but limited to this specific topic and still in development. This link includes a pretest on basic math and chemistry concepts, a review of math and basic chemistry, and problems and solutions to the problems. The link is subdivided into seven basic concepts concerning equilibrium: buffers, precipitation, advanced acid/base, weak acid/base, review, introduction/general solutions, and gas-phased equilibrium. Only the sections of review, introduction/general solutions, and weak acid/base are accessible. Each problem has a link to a page that allows you to type in your answer and a link to check the answer. Below this is a hints section, which provides tutorial advice and help to accomplish the problem. In addition, a section called pop-up tools includes links to physical constants, quadratic equations, and a calculator.

*Title:* Science
*URL:* http://www.sciencemag.org
*Grade Level:* Upper grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science reference
*Review:* This site has an alphabetical science term listing, which you access through the browse link. Clicking on the browse link leads you to a long listing of articles on specific subjects. Each article is briefly described, and links to the complete article or abstract are provided for each article. Therefore, you can print directly off the Internet, or you can order an article or issue.

*Title:* The Philadelphia Inquirer Health & Science Magazine
*URL:* http://sln.fi.edu/inquirer/inquirer.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science magazines
*Review:* This site contains articles with teacher and student resources on the most current science developments. The Franklin Institute Museum maintains the site and offers materials for students and teachers.

*Title:* The Why Files
*URL:* http://whyfiles.news.wisc.edu/oldstorylist.html
*Grade Level:* All grade levels
*Review:* This site is maintained by the University of Wisconsin. You can navigate through the Web site using a topic index (biology, physical science, etc.) or using the provided subject search window. Basically, the Web site tries to answer the question "why?".

### Commercial and Government Sites

*Title:* National Science Foundation (NSF)
*URL:* http://www.nsf.gov/
*Grade Level:* College and above
*Review:* Congress established the National Science Foundation on May 10, 1950, in order to "promote the progress of science, to advance the national health, prosperity and welfare, to secure the national defense, and for other purposes." At the home page, you can access science programs and science highlights or search by word, phrase, or specialization area. Clicking on the "Mathematics, Physical Science" link on the home page leads you to another specific link to Chemistry, which leads you to the newly designed Chemistry Division page. Kids can click on "for kids only" to find answers to various questions such as "What is fire made of?". The other links provide information on funding opportunities and funded projects.

### Academic and Educational Sites

*Title:* American Association for the Advancement of Science (AAAS)
*URL:* http://www.aaas.org/
*Grade Level:* All grade levels
*Review:* The AAAS was founded in 1848 in Philadelphia, Pennsylvania. It is the largest science organization and publishes the peer-reviewed

journal *Science*. At the home page, you are invited to explore more about AAAS, browse the on-line products, access the latest data of science and society, study the science educational programs for the future, or explore careers in science. The on-line products link explores present and past research on various topics. There are three levels of data retrieval, two of which require you to pay a fee. However, after registering for free, you can retrieve, for free, full-text of articles published in the past year, staff-written summaries of research, abstracts of current or new research, and the tables of contents of all back issues. You can also perform a science search by author and key word, in addition to accessing other resources to numerous to mention.

*Title:* American Chemistry Society (ACS)
*URL:* http://www.acs.org/
*Grade Level:* All grade levels
*Review:* The ACS is a professional organization in the field of chemistry. The Web site includes information on membership, educators and students, policy, and professionals. It is the portal for *The Chemistry Journal*.

*Title:* Journal of Chemistry Education
*URL:* http://www.jchemed.chem.wisc.edu/
*Grade Level:* High school to college
*Review:* The best destination for chemistry information for the non-chemist. This Web site gives links to software, to videos and CD-ROMs, and to the *Journal of Chemistry Education* and other publications.

*Title:* National Science Teachers Association (NSTA)
*URL:* http://www.nsta.org/
*Grade Level:* Any grade level
*Review:* Links to NSTA journals (*Science Scope*, *The Science Teacher*, *Journal of College Science Teaching*, *Quantum*, *Dragonfly*, and *Science and Children*) and information on the following: position statements and policy, national student competitions, clubs and organizations, science resources, U.S. registry of teachers, workshops, awards, Scilink (Scilink is a free service that connects a Scilink textbook to the WWW), a video vault, science of energy, and building a presence for science education discussion room.

### Demonstration Sites

*Title:* Twinkies Project
*URL:* http://www.twinkiesproject.com
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* science projects
*Review:* This is the most humorous yet well-researched and well-written site on scientific method and research. Twinkies stands for "Tests with Inorganic Noxious Kakes in Extreme Situations." All of these tests were done at Rice University during finals week, obviously after much time spent studying for final exams. At the main menu, you are led to a number of different tests that you can do with a Twinkie as your chemical.

## GENERAL SOURCES OF CHEMISTRY INFORMATION

### Safety

*Title:* Safety in the Chemistry Laboratory
*URL:* http://chemlabs.uoregon.edu/safety/generalinstructions.html
*Grade Level:* High school and above
*Review:* This is an informational Web site updated regularly by the University of Oregon. It contains information about attire, conduct, and proper handling of chemicals. The site has direct links to the Material Safety Data Sheet (MSDSz) Web site and the National Fire Protection Agency (NFPA) Web site. It is written clearly and could be used in a high-school class.

*Title:* Occupational Safety and Health Administration
*URL:* http://www.osha.gov
*Grade Level:* College and above
*Review:* OSHA's mission is "to save lives, prevent injuries, and protect the health of America's workers." The OSHA home page presents you with either an alphabetical search tool or a search window to type in your search words. For example, clicking on the "M" leads you to a list of services and materials including the MSDS that is a must for all chemists. These sheets provide valuable information about every chemical. Unfortunately, more information is obtained directly from the OSHA site than is generally needed. It will take you time to download the MSDS guidelines and information for even one chemical.

*Title:* Laboratory Safety: Department of Chemistry
*URL:* http://www.che.ilstu.edu/chemsafety/chemsafety.htm
*Grade Level:* High school and above
*Review:* This site, published by Illinois State University, explains the information found on the MSDS sheet and provides direct links to all Web sites in the United States working with chemistry and health safety. At the home page, you will find links to regent handling, chemical spills, waste disposal, emergencies, safety training, and chemical hygiene plans.

### General Sites

*Title:* General Chemistry Online
*URL:* http://antoine.frostburg.edu/chem/senese/101/index.shtml
*Grade Level:* All grade levels
*Review:* This is a site provided by Professor Fred Senese, who is in the Chemistry Department at Frostberg University. It contains a searchable glossary, frequently asked questions, hyperlinked notes and guides for first-semester chemistry, a searchable database, tutorials, and a toolbox containing formulas and charts. It also contains quizzes and test sections, and a link called Just Ask Antoine, which allows you to ask a question and have scientists respond to it. This is a very general and user-friendly Web site for students in beginning chemistry courses.

### Glossaries and Dictionaries

*Title:* Your Dictionary.Com
*URL:* http://www.yourdictionary.com/
*Grade Level:* All grade levels
*Review:* This Web site is an on-line dictionary Web site. At the home page you can type your word in either the dictionary or thesaurus search window. On the left of the home page is a list of specialty dictionaries; click on "80 or more" and over 90 specialty dictionaries will appear on the Web page. Clicking on the chemistry link leads you to a number of specific chemistry dictionaries and glossaries including links to a chemistry dictionary and chemistry glossary.

*Title:* Links for Chemists
*URL:* http://www.liv.ac.uk/chemistry/Links/links.html
*Grade Level:* All grade levels

*Review:* Links for Chemists is the chemistry section of the WWW Virtual Library copyright by the University of Liverpool, U.K. At the home page, scroll through the topics on the left until you get to Chemical Information. Click on Dictionaries and Encyclopedias and you will be led to a long list of chemistry links, such as Chemistry-Glossary@NorthCarolinaUS and Chemcyclopedia@ ACS.com. This Web site provides you access to a number of excellent resources for references.

### Standard Tables and Charts

*Title:* ROBORR
*URL:* http://www.periodictables.com
*Grade Level:* All grade levels
*Review:* RobOrr offers exciting, innovative periodic tables for high school science students. At the main menu, click on "chemistry," found on the left side of the page. The periodic table is large enough for your use on-line. This company sells their tables through Flinn Scientific, Wards, and Carolina Biologicals, to name of few of the supply stores. You can order direct from RobOrr at this site.

*Title:* The International Union of Pure and Applied Chemistry (IUPAC)
*URL:* http://www.iupac.org/dhtml_home.html
*Grade level:* College and beyond
*Review:* The International Union of Pure and Applied Chemistry serves to advance chemistry worldwide. This Web site provides you access to the international journals *Chemistry International* and *Pure and Applied Chemistry*. Even though only the abstract is available, a direct link to the source is available for you to obtain the original article.

*Title:* Tom Lehrer's Elements Song
*URL:* http://dcbwww.unibe.ch/groups/ward/pictures/ELEMENTS.ALF
*Grade Level:* All grade levels
*Review:* This Web site plays Tom Lehrer's Elements Song for you. It is a must-hear for all chemistry students. In order to have a copy of the lyrics, go to http://paul.merton.ox.ac.uk/science/elements.html.

*Title:* Periodic Table
*URL:* http://www.ch.cam.ac.uk/sgtl/elements/
*Grade Level:* All grade levels

*Review:* J. M. Goodman, of Cambridge, UK, developed this interactive periodic table of elements. When you click on the element in the periodic table you are provided with the element's name, atomic number and weight, and melting point. You also can click on a button in order to change the table based upon relative atomic weight, atomic number, number of isotopes, and so forth. This is a very interesting resource.

*Title:* Element Story
*URL:* http://www.smallfry.dmu.ac.uk/chem/periodic/elements.html
*Grade Level:* Middle school to high school
*Review:* A most unique Web site providing you with the history of each element. It is worth a look; however, it is not complete.

*Title:* Periodic Table of Poetry
*URL:* http://superdeluxe.com/elemental/
*Grade Level:* Grade 7 to adult
*Review:* This is a Web site that connects poetry and chemistry. A click on every element in the periodic table leads you to a wonderful poem.

**Formulas**

*Title:* Wilton High School Conversion Formulas
*URL:* http://www.chemistrycoach.com/conversi.htm#Conversion Formulas
*Grade Level:* High school and above
*Review:* This Web page provides direct access to conversion formulas for length, area, mass, time, force, energy, momentum, power, number, volume, density, velocity, pressure, acceleration, frequency, angles, action, charge, current, resistance, electromotive force, and mass-to-force. This would be a very usable conversion table.

*Title:* Fundamental Physical Constants
*URL:* http://www.chemie.fu-berlin.de/chemistry/general/constants_en.html
*Grade level:* High school and above
*Review:* This page was developed by the biology, chemistry, pharmacy departments of Freie Universität (FU) Berlin. It contains an alphabetical list of physical constants, their symbols, and their numeric values with appropriate units, including Avagadro's number, the Boltzmann constant, and Planck's constant, to name a few.

## CHEMISTRY TOPICS

This section is designed for you to easily use. Chemistry topics are listed alphabetically. Additional cross-listed topics are included in the appendix for ease of use. Each review contains the name of the Web site, URL, appropriate grade level, search engine used, key search word(s) used, and a review of the site.

### Acids/Bases

*Title:* High School Chemistry Resources on the Web
*URL:* http://w3.nai.net/~bobsalsa/high.htm
*Grade Level:* Grade 7 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry + acid + base + high school; educators sites + acid + base
*Review:* This site provides problems and definitions concerning acid/base topics. Unfortunately, there is no search tool available in order for you to type in acid/base and directly take you to the material; however, a complete index is provided, accessed through the "whs tutorial" link. After clicking on this link, scroll to the acid/base topic. Once you are there, the site has grouped other topics related to acid/base chemistry, such as electrolytes, Arhennius theory, Bronsted theory, and Lewis theory. A click on any of the above subjects provides definitions, problems, and answers for the learner to actively find out more about these topics. This Web site and recommended links are updated on a consistent basis. The site contains an e-mail address that is responded to very quickly.

*Title:* The pH factor
*URL:* http://www.miamisci.org/ph/
*Grade Level:* Grades 4 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry + acid + base
*Review:* This site was designed by the Miami Museum of Science and is a wonderful, easy-to-use site! The links are in writing and with pictures. There are links for more information and for activities. What is great about this site is its consistent use of visuals for quizzing and for laboratory simulations. For instance, at the main menu, if you click on the "excite" link (boy with tongue sticking out), you go to a tutorial page dealing with tongue tasting. You are asked to click on the

part of the tongue that allows you to taste a lemon and other sour tastes. If you make an incorrect guess, you are told to try again. This site provides a link to suggestions for the teacher. This is a great site for laboratory simulations!

*Title:* General Characteristics of Acids and Bases
*URL:* http://www.science.ubc.ca/~chem/tutorials/pH/section0/content.html
*Grade Level:* Grade 7 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* acid/base tutorials
*Review:* This site contains both information and tutorials. The site is divided into twenty units, with a multiple-choice quiz with each unit. Some of the units are basic acid/base concepts, such as weak acids, strong bases, pH, solubility, and precipitation. The site does not have an index or a search window; therefore, you have to click on the "forward" link to see what units are covered. Each unit quiz has a recall link that provides you with reestablished information about the unit topic. Although you are provided with the correct answer, the quiz is limited, never providing you with the steps needed to arrive at the answer. This site is maintained at the University of British Columbia by chemistry professors.

*Title:* On-Line Encyclopedia of Chemical Terms
*URL:* http://www.scimedia.com/chem-ed/scidex.htm#top
*Grade Level:* High school to adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* acid/base tutorials
*Review:* This electronic encyclopedia is an excellent resource for tutorials and information. At the home page, you will find links to equilibrium problems, an index, an encyclopedia, and an alphabetical listing of topics. The equilibrium tutorial problems and answers are excellent. This link includes a pretest on basic math and chemistry concepts, a review of math and basic chemistry, problems, and solutions to the problems. The link is subdivided into seven basic concepts. Only the review, the introduction/general solutions, and the weak acid/base sections are accessible. Each problem has a link to a page that allows you to type in your answer and a link to check the answer. Below this is a hints section that provides tutorial advice and help to accomplish the problem. In addition, there is another section called pop-up tools, which includes links to physical constants, the quadratic equation, and a calculator.

*Title:* The pH–Acid/Base Tutorial
*URL:* http://jeffline.tju.edu/CWIS/Dept/biochemistry/pH_tutorial
*Grade Level:* High school to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* acid/base tutorials
*Review:* This tutorial site contains problems, definitions, and examples. It covers basics, logarithms, equilibria, pH, solutions, strong and weak acids and bases, buffers, titration curves, and polyprotic weak acids (amino acids). It is maintained at the University of Wisconsin by Dr. Zeiger.

### Analytical Chemistry

*Title:* Analytical Chemistry
*URL:* http://www.scimedia.com
*Grade Level:* High school to adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* analytical chemistry
*Review:* This is a commercial site that contains information and tutorials about analytical chemistry. There is an index of analytical chemistry basics and an encyclopedia of analytical chemistry. Some of the indexed terms also have tutorials included.

*Title:* Chemistry Education
*URL:* http://www.netaccess.on.ca/~dbc/cic_hamilton/chemed.html
*Grade Level:* All age levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* analytical chemistry tutorials
*Review:* This site contains information, resource lists grouped by grade level, journals, a chemistry dictionary, software, societies, and tables. Click on the Main Chemistry Index for links to analytical chemistry subdivided into the following categories: chemometras, chromatography, colorimetry, electrophoresis, microscopy, and spectroscopy. Some of these topics include tutorials and abstracts. Unfortunately, there is no search window at the Web home page to help you search more easily. This is a hit-or-miss site. However, the information available is excellent, the tutorials are good, and the resources are current.

*Title:* Chemistry Hypermedia Project
*URL:* http://www.chem.vt.edu/chem-ed/vt-chem-ed.html

*Grade Level:* Grade 7 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for analytical chemistry
*Review:* This Web site has a cross-listing alphabetical guide that provides tutorials for specific topics. An example would be to click on the link to titration. This link explains what titration is and how it is used. Other links are provided within the explanation in order to give you more information defining the process. The graphics used are extremely clear and help to explain the concept. In addition, real-life pictures are provided; for example, a picture of a pH meter is provided when discussing any instrumentation. This site also included some self-paced problems. What is great about this site is that the problems have step-by-step procedures for solving them. There is also a warm-up section including a unit pretest and unit math test.

*Title:* B. O'Neil's Home Page
*URL:* http://infoweb.magi.com/~douglas/lab.htm
*Grade Level:* Grade 7 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for analytical chemistry
*Review:* This Web site contains two links to analytical chemistry and analytical chemistry instrumentation. Neither of the links will take you directly to the Web sites indicated. However, two of the links to problem sets and quizzes are current and provide wonderful problem sets with a button that allows you to hide or show the answers to the problems. General chemistry problem sets and chemistry concept tests links are active and provide excellent problem sets and quizzes. In addition, a number of tutorial links are provided at the beginning of the Web site. Chemistry I and Chemistry II links are excellent and provide worksheets, demonstrations, and laboratory experiments. The Chem Team link is a good one for advanced placement chemistry information. The Chemical Concept FAQs link poses the most frequently asked questions in chemistry with answers to the questions. This also provides a link to Radioactivity: Historical Figures for in-depth historical reviews.

*Title:* CHE 221/223 Analytical Web Sites and Tutorials
*URL:* http://www.campbellsvil.edu/~e . . . ton/courses/analyt/c221web.htm
*Grade Level:* Grade 12 to college
*Search Engine:* http://www.metacrawler.com

*Key Search Words:* tutorials for analytical chemistry
*Review:* This is a great Web site for tutorials on analytical chemistry. The Web master labels those sites that are active and excellent by adding the word "hot" to them. I agree that those Web sites labeled "hot" were the best. Each site listed is current and maintained. Some of the nonlabeled sites are not found, so click on the hot sites. This site also lists new magazines or services such as the "chemcyclopedia" site, which lists commercially available chemicals made available by the American Chemistry Society.

*Title:* ChemicalAnalysis.com
*URL:* http://www.chemicalanalysis.com/
*Grade Level:* High school to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* materials for analytical chemistry
*Review:* This Web site is a resource for books, videos, products, and services.

*Title:* Umega University–Analytical Chemistry
*URL:* http://www.anachem.umu.se/eks/pointers.htm
*Grade Level:* High school to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* experiments for analytical chemistry
*Review:* This site provides links to analytical resources. At the main menu, click on "curriculum material," which leads to a long list of Web sites with brief descriptions of what is found in each. A number of the sites are tutorials, the best of which are (1) chemistry tutorials—at the main site, click on "analytical chemistry" for tutorials for analytical chemistry, spectroscopy, and mass spectroscopy, and how to identify an unknown substance using analytical chemical instruments; (2) The Chemistry Place—once into the site, you have a choice of high-school or university-level material, and this tutorial site requires a subscription fee; (3) the Towson University chemistry tutoring centers home page, which has some free tutorial aid sheets on-line (the analytical chemistry tutorial sheet is being designed); (4) World Chemistry Interactive Web site—a free service with tutorials that are easy to find and easy to use. Type in the words analytical chemistry at the chemsoc site window. This site also has links for demonstrations and experiments, resources, and other chemistry information. This is a great resource due to the brief review of each Web site listed.

*Title:* Chemistry Collection of Infostead Australia
*URL:* http://www.zip.com.au/~sswans/chemistry-6.html
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* analytical chemistry
*Review:* At the main menu, click on "section 1—analytical chemistry and laboratories." Clicking on the third link, "methods, procedures and techniques," leads you to a list of resources. The first link leads you to a university site called analytical chemistry webbed. This is an intense site directed at analytical chemistry research and development. The next site provides a list of chromatography sites found by the search engine Yahoo!. I recommend this site for students who are doing research and who are interested in the latest analytical chemistry research development.

*Title:* About the Human Internet
*URL:* http://chemistry.about.com/msu . . . ical
*Grade Level:* Grade 12 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* analytical chemistry
*Review:* At the main Web site, click on "analytical chemistry" on the left alphabetical listing. Then click on "analytical chemistry coursework and notes." This leads you to a number of options. The lecture notes of James Hardy are an excellent supplement for information on various analytical chemistry topics. The lecture notes from James Plambeck of Virtual University North are also great supplemental material on the subject of analytical chemistry. The two-electrophoresis simulation sites are a must for those of you in advanced placement chemistry. The on-line learning site is a must for college students, especially those in either an instrumental course or those who need help with the concepts behind chromatography or spectroscopy. *Zellmer's Survival Guide to Analytical Chemistry* is also a great resource for, well, those who need to survive basic chemistry. Even though there are few tutorials at this site, the basic information and the great simulations make it a must-peruse site for advanced students.

### Atomic Structure

*Title:* High-school Chemistry
*URL:* http://members.aol.com/ChemSample/highschl.htm
*Grade Level:* High school

*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for atomic structure
*Review:* Even though this tutorial chemistry program for high-school students is not free, some good tutorial summaries are free for your use. Part four contains a tutorial on atomic structure that is worth your time. Also, there is a free sample of the course that can be downloaded.

*Title:* Wilton High School Chemistry
*URL:* http://www.chemistrycoach.com/home.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for atomic structure
*Review:* At the main menu, click on "Wilton original tutorials." You then have a menu of tutorials from "Bohr theory of the atom: assumptions" to "electron configurations." The tutorials contain both assumptions and derivations. A link to a worksheet is found at the top of the tutorial. A worksheet with answers is found at the end for you to check your answers. When there is a need for further clarification, additional links are provided to give you more information. This site is excellent.

*Title:* Chem Team: Main Menu
*URL:* http://dbhs.wvusd.k12.ca.us/ChemTeamIndex.html
*Grade Level:* Grade 7 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry + atomic structure
*Review:* This Web site is extremely easy to use. There is a complete index at the main Web site in which you choose a topic and click to go to a more specific list of topics. If you click on "atomic structure," for example, you are then presented a list of topics including topics with the historical perspectives, such as "the origin of the atom concept in Greek philosophy." This Web site includes pictures, maps, and concepts and is extremely well written and very interesting. At the end of each topic, there are more links to further delve into the topic including historic pictures and writings of the scientists. The Chem Team has been on the WWW since 1996 and has won several well-deserved awards for excellence. At the main Web site, there is also a link to classic papers that deserves a visit. There you will find translations of Thomson, Nagaoka, Kelvin, Arrhenius, Rutherford, and Bohr, to name a few. The classic papers, the excellent presentation of

the topics, and the other links makes this one of the sites you need to use. Other links at the main menu provide you with the National Olympiad test questions and answers for various years, a photo gallery of chemists, and last but not least, a link to chemistry humor.

*Title:* Frank Potter's Science Gems
*URL:* http://www-sci.lib.uci.edu/SEP/SEP.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials in atomic structure
*Review:* Even though you search in this site by subject, for example, physical science or biological science and then by topic, once you have chosen a topic, the links are identified as to grade level from kindergarten to college. For example, atomic structure lies in physical science part II. You can then click on "atomic physics." At the end of the main menu, you will find a search window. If you type in "atomic structure," you are presented with a list of graded (percentages) resources from the Martindale Desk reference materials. I clicked on the 100% Martindale Chemistry Center, which led me to a bunch of choices. I could view the material in English, Spanish, French, or Italian. There is a section of Chemistry overview, which provides information on symbols, constants, and so on. Then, there is a huge section on chemical databases. There is also a section called What's New in Chemistry, with current information on safety and research. The final section on chemistry courses and curricula is worth reviewing for tutorials and information about atomic structure. You should scroll down to "courses and tutorials" and click on "atoms and bonds," which leads to a huge section of curricula and tutorials. This is a wonderful resource for tutorials and simulations.

*Title:* Web Index for General Chemistry
*URL:* http://www.sfu.ca/~lower/genchem.html
*Grade Level:* Grade 7 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for atomic structure
*Review:* This is a general resource site that contains a long list of Web sites for you to use to find information about chemistry. It provides general resources, tutorials, software resources, and other miscellaneous items. Of the two sites found under atomic theory, one is dead and the other is "a primer on quantum theory of the atom," which provides questions and answers about the atom and atomic structure. "Just Ask Antoine"

is an excellent resource for questions that are frequently asked about chemistry, and it is easy to use. For example, in the search window, type "atomic structure," and a list of question-and-answer informative slides appear. Each slide series is graded by stars according to appropriateness to the topic "atomic structure." This is a great Web site for you to use for further information. If you require a personal tutor, click on Academic Assistance Access, which provides free tutorials in a number of subjects at the high-school or college level.

**Atoms**

*Title:* Atoms and Elements
*URL:* http://www.karentimberlake.com/atomsand.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials on atoms
*Review:* This Web site provides PowerPoint tutorials on atoms and elements. A quiz is provided to test yourself after you have learned the information from the modules. This site is written and maintained by Karen Timberlake. In order to use the site, you will have to download the PowerPoint module.

*Title:* ChemTeam: Main Menu
*URL:* http://dbhs.wvusd.k12.ca.us/ChemTeamIndex.html
*Grade Level:* Grade 12 to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* atom tutorials
*Review:* The ChemTeam provides study resources in all standard topics for students in high school and advanced placement chemistry. This Web site is extremely easy to use. There is a complete index at the main Web site in which you choose a topic and click to go to a more specific list of topics. If you click on "atomic structure," you are then presented a list of topics, including topics with historical perspectives, such as "the origin of the atom concept in Greek philosophy." This Web site includes pictures, maps, and concepts and is extremely well written and very interesting. At the end of each topic, there are more links to further delve into the topic including historic pictures and writings of the scientists. The Chem Team has been on the WWW since 1996 and has won several well-deserved awards for excellence. At the main Web site, there is also a link to classic papers that deserves a visit. There you will find translations of Thomson,

Nagaoka, Kelvin, Arrhenius, Rutherford, and Bohr, to name a few. The classic papers, the excellent presentation of the topics, and the other links makes this one of the sites you need to use. Other links at the main menu provide you with the National Olympiad test questions and answers for various years, a photo gallery of chemists, and last but not least, a link to chemistry humor.

*Title:* About/Science and Nature for Kids
*URL:* http://kidscience.about.com/ms . . . ms = %2Btutorials+%2Bon+%2Batoms
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* atoms
*Review:* Information and resources pertaining to chemistry. Click on "chemistry" on the menu on the left side of the screen. Scroll down to the "atoms family" and click on the link. A number of icon choices appear, such as "The Phantom's Portrait Parlor," which provides other resources to learn about the atom and molecules. Once you click on any of the icon links, you are provided with topics and grade levels. This site is well done and informative and created with a whimsical adventuring spirit. A great resource for chemistry and other science topics.

### Biochemistry

*Title:* Biochemistry Resources
*URL:* http://www.usm.maine.edu/~rhodes/biochem
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials on biochemistry
*Review:* This Web site was developed by Gale Rhodes at the University of Southern Maine for other teachers of biochemistry and is packed with useful information on biochemistry. Begin by scrolling to and clicking on "topic list for a one-year biochemistry course." You then click on the topic of choice. Back at the main menu, scroll down to "learning biochemistry with a deep view." Clicking on this link leads you to all the graphics files that you may need in a biochemistry course. You are provided with not only the graphics but with additional information about each graphically displayed molecule. At the main menu is also a link to "Rasmol," which comes from raster display of molecules. This link is a tutorial to designing Web molecules

but does require the Rasmol software. There also is a direct link at the main menu to the protein database where you can obtain three-dimensional macrobiological structure data on proteins.

*Title:* Metabolic Pathways of Biochemistry
*URL:* http://www.gwu.edu/~mpb/index.html
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry tutorials
*Review:* This is a Web site of Karl J. Miller, who has a B.S. in Chemistry from George Washington University. The Web site is an "online reference about metabolism for students, scientists, and the world." The reaction pathways presented are carbohydrate, lipid, amino acid, energy, and coenzymes, in two- and three-dimensional formats. The pathways are easily followed and printable. The three-dimensional versions allow you to interact with the molecules by clicking on the molecule and manipulating the molecule with your mouse. This Web site is a must for you if you need biochemical metabolism pathway diagrams. The Web site is not yet completed, which is very frustrating, but the author is working on finishing it.

*Title:* Biochemistry Teaching Program
*URL:* http://www.chem.su.se/biochemteach
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry tutorials
*Review:* This Web site was designed by the Department of Biochemistry at the Arrhenius Laboratories at Stockholm University. At the main menu, you can either click on the link to learning and teaching resources or use the "click and select" search window provided at the top of the page. Clicking on "assignments and tutorials" leads you to a limited menu of biochemical tutorials. Some of the topics are easily accessed, some are not readily viewable but must be downloaded to a disk, and finally, some are not accessible at all.

*Title:* The Biology Project
*URL:* http://www.biology.arizona.edu
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry

*Review:* The biology project is an interactive and informative site for middle school and high-school students and teachers. The University of Arizona Department of Biochemistry and Molecular Biology created this site to support and stimulate student and teacher exploration of science and technology. The Web page is divided into three sections. The upper right side of the Web page contains numerous interactive lesson plans and activities and ideas for classroom projects. The lower half of the right side is called The Kids Corner and offers The Manduca Project, which is based on the tobacco hornworm. This would be a terrific project for a middle-school classroom. This research project is very comprehensive and offers the teacher extensive advice on developing this thematic unit. The lesson plans for this project are interdisciplinary and very complete. You can also order all the necessary materials to recreate this project in one's own classroom. The center of the Web page is a site map that categorizes problem sets and tutorials ranging from biochemistry to molecular biology. I clicked into the biochemistry section and explored the chemistry of life, large molecules, energy reaction, and photosynthesis. The left side of the Web page lists activities concerning biochemistry, cell biology, chemicals and human health (CHH), human biology, and immunology. This site also encourages teachers to share their ideas and experiences. Overall, I found this site to be very informative and a must-see for middle-school and high-school science teachers.

*Title:* Biochemical Reviews–Online
*URL:* http://www.biochemj.org/bj/subjects/reviews.htm
*Grade Level:* Undergraduate, graduate, and postgraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* The Web site I researched was Biochemical Reviews–Online. The Web site gives the latest reviews, forthcoming reviews, current year reviews, and free reviews from past issues from 1995 to 2000. The home page allows you to pick any of the above categories and go directly to that selection. From there you can navigate to the specific topic you are looking for. The reviews are approximately one page in length. Once you have read the review, as a subscriber, you have the option to receive the full article. Lastly, the home page states the journal's purpose (to fill the gap between Mini-Reviews and Annual Reviews), lists the many different topics (modern biochemistry, molecular biology, and cell biology), and explains that the articles are highly cited and well referenced. The top of each review pages lists

topic boxes such as Site Map, Links, Contact Us, Biochemistry Society, and Search This enables the reader the opportunity to further research or investigate other areas of interest with one click of the mouse. There was one part of the Web site I found fault with. The home page had an icon to click on for subscriptions, but the price was not listed. The reader had to send an e-mail to receive that information. In closing, however, I found this Web site to be a valuable tool for people who are in the biochemical industry or biochemical education field. To the ordinary person who does not have a strong background in biochemistry this site would not be as beneficial.

*Title:* Biochemistry
*URL:* http://www.nyu.edu/pages/mathmol/textbood/elem_home/_html.
*Grade Level:* Elementary school to grade 3
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* This is an excellent interactive sight for any classroom! Once I had entered the search engine and clicked onto Biochemistry, the actual site that I entered was "Click on Hypermedia Textbooks." You have an option to select the level you are looking for: elementary school or middle school/high school. I selected Elementary, the lowest level offered, third grade. You may then select your topic. I selected Water In the Air. Information is given at the child's level. Questions are posed and instructions are given for simple experiments and demonstrations to prove answers. A self-check, a review, and extended-activity experiments are given. This is a great way to infuse technology into the classroom. Check it out!

*Title:* Biochemistry
*URL:* http://www.jbc.org
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review: Journal of Biological Chemistry* was found with the key word "biochemistry." This site offers many different sections on the topic of biochemistry. The left side shows info on subscriptions, instructions to authors, and other basic info. There are archived journals to use dating back to January 1980. The blue oval to the right titled "reflections" shows six articles from past publications. Clicking on this will show an outline of choices to pick from. "Remembering Our Teacher" is an article written by Arthur Korrberg that was published in 2001. It

reflects on past scientists who've made significant breakthroughs in the field. Click onto "full text" and the articles will follow. It focuses on Carl and Gerty Cori, scientists who recognized and named the Cori cycle and the Cori ester. This was a great site for students looking to find out more about the innovators of science as we know it today.

*Title:* Biochemistry Job Postings, Salary Information and Job Search Tips
*URL:* http://resumegenie.com/jobs.asp?job = Biochemistry Grade
*Grade Level:* High school, college undergraduate
*Search Engine:* http://metacrawler.com
*Key Search Word:* biochemistry
*Review:* This is a free informational site for students who are exploring the opportunities, salary prospects, and career-related tools related to the scientific field of biochemistry. Links on this site provide current job postings, salary information, and job-searching models. High-school students may gain incentive to pursue this field of science, while the college student may use this site as part of a specific job search.

*Title:* Biochemistry
*URL:* http://www.Chem4kids.com or http://www.Kapili.com
*Grade Level:* Upper elementary/intermediate
*Search Engine:* http://www.askjeevesforkids.com
*Key Search Word:* biochemistry
*Review:* This is a relatively new site, which appears to be under construction in some areas. There are three subjects to choose from: biology, chemistry, and geography. All three subjects and sites can be accessed from any page on the site. Clicking on "Chem4kids" brings you a detailed but simplistic site for chemistry topics broken down into the following subgroups: matter, reactions, elements, atoms, et cetera, and biochemistry (all can be accessed from any page). Clicking on "biochemistry" brings you to a detailed overview, with links on the left side for specifics in the topic such as carbohydrates, lipids, amino acids, and structure. All descriptions contain definitions, highlighted words for additional vocabulary, and examples for basic understanding. There is a search box available on each page to take you to another area. The home page offers links to activities, such as quizzes and flash cards, wallpaper for your desktop, examples containing chemicals and reactions with pictures and definitions, and an extensive bibliography. This is a very simple site to navigate and understand and is designed for students just being introduced to the topics.

*Title:* Biochemistry
*URL:* http://www.molecularmedicine.medscape.com
*Grade Level:* Grade 12 and above
*Search Engine:* http://www.lycoszone.com
*Key Search Word:* biochemistry
*Review:* This is a commercial Web site with a enormous amount of information. The company, Digital Health Record Solutions supports, an "Online magazine with articles, events and news" focusing on molecular medicine resources. The Web site includes over thirty areas in which you can retrieve information. I selected the Journal Room, which includes current articles ranging in topics from AIDS to wounds. In addition to the journal articles there are textbooks, professional publications, and medical news periodicals for reference. This Web site is updated daily and is an informative medical reference resource for upper-level high-school students, college students, and medical professionals.

*Title:* Biochemistry
*URL:* http://pubs.acs.org/journals/bichaw/index.html
*Grade Level:* Higher education
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* Biochemistry is a Web site created by the American Chemical Society with the purpose of publishing the results of research regarding mechanisms of biological phenomena. Biochemistry presents a weekly journal that covers topics such as structure, function, and regulation of molecules, protein folding, and others. The left side of the Web page provides information about the journal, sample issues, hot articles, supporting information, author index, and licensing information. It also gives you information on how to subscribe to on-line services in order to obtain articles. On the left side, you can also find ways to contact the editorial office, customer service, technical support, and webmaster. In addition, the Web site offers some free hot articles and the option for authors to electronically submit their manuscripts.

*Title:* Interactive Biochemistry–Hot Topic
*URL:* http://www.harcourtcollege.com/chem/biochem/Campbell/HotTopics/Love/Love.html
*Grade Level:* High school to college
*Search Engine:* http://www.ask.com

*Key Search Word:* biochemistry
*Review:* This Web site takes a twist on biochemistry, trying to explain that biochemistry can aid humans by figuring out what love really is. Researchers have done studies on voles, small mouselike rodents that live in the midwestern United States. The prairie vole is monogamous. A pair will share the small burrow, raise young, and stay faithful to each other even after one dies. The montane vole is promiscuous. The voles were given oxytocin and vasopressin shots and then studied to see if they were monogamous or promiscuous. The shots made the prairie voles more monogamous and had no affect on the montane voles, except that it made the male montane voles more aware of self-grooming. The site concluded that biochemical understanding of love may aid physicians in understanding aspects of love, such as obsession, withdrawal, and depression, but that humans are the true creators of their own lives.

*Title:* MedBioworld
*URL:* http://www.ScienceKomm.at/index.html
*Grade Level:* Undergraduate and postgraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* MedBioworld is a Web site created to provide access to medical and bioscience journals, associations, and databases. The Web page is set up in three columns. The first column provides journals by specialty, the second column provides journals by field, and the third column contains general resources and reference tools. The left side of the Web page provides information on specialty journals, which encompass medical, pharmacological, and clinical resources. The center column provides access to Bioscience Databanks, biological science libraries, abstracts, articles, biological statistics, and surveys. The right column of the Web page is a general resource section, which provides references tools such as dictionaries and glossaries, as well as on-line encyclopedias, scientific news, and abstract sources. In addition, it provides information on how to locate articles on-line, translation services for articles, and research in foreign languages. At the top of the Web page are additional links that allow the user to order books and materials and obtain articles.

*Title:* The Journal of Biological Chemistry
*URL:* http://jbc.org

*Grade Level:* Undergraduate/graduate/postgraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* *The Journal of Biological Chemistry* (*JBC*) has a Web site that allows the user to search all of its issues from January 1980 through January 2002. The *JBC* provides scientists with over 49,000 pages of highly cited biochemical research each year. This Web site itself is easy to navigate. The user may select to browse the current issue, select an issue from the archive, or search the *JBC* with the options of entering key words, authors, or dates. It also provides a link to search High Wire Press journals. The left side of the Web page provides a subscription area, a member sign-in, a members-only area for the American Society for Biochemistry and Molecular Biology (ASBMB), instructions for authors, and editorial policies. On the left side, you can also find ways to provide feedback, get 'Net tips, and navigate your way to the ASBMB Web site and the High Wire Press. One must register at a cost of $8 for seven days to gain access to a single, full-text article. Without a subscription the user has access to tables of contents and abstracts at no cost and without having to register. The 2002 rate for *JBC* On-line is $1,500 for institutional subscribers, $300 for an individual license (nonmembers), and free for ASBMB members. This site is a fast and easy but an expensive resource if you need access to this type of information.

*Title:* General, Organic, and Biochemistry
*URL:* http://ull.chemistry.uakron.edu/genobc/
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* This site is for a college-level introductory class for student teachers or teacher assistants, but students could use it as a reference. This Web site is a guide for a teacher or professor teaching a course in general chemistry, organic chemistry, and biochemistry. The information is broken down into two semesters by subject area. There are also examples of different subject areas with animations, where you click on the area and a picture pops up and shows a quick movie of the topic you picked. A student poll asks various questions about you and what Web sites you have tried in addition to theirs. Last but not least is a periodic table, which you can click on and get information about a certain element. This site was very interesting and could assist science teachers with their lesson plans and other activities.

*Title:* Innocentive—Mind Over Matter
*URL:* http://www.innocentive.com/
*Grade Level:* Organic chemistry background
*Search Engine:* http://search.metacrawler.com/
*Key Search Word:* biochemistry
*Review:* Innocentive is a free Web site created by Eli Lilly and Company, which is a leading innovation-driven pharmaceutical corporation. This Web site gives the user an opportunity to earn money if he or she is able to solve scientific challenges. However, the user must find the best solution to the problem in order to receive any money. As the Web site states, there may be more than one way to solve a challenge, but only the best solution will get the money. Solvers are able to submit more than one solution at a time. One must first register to become a solver by clicking the "register" icon at the top of the Web page. Then the user must enter specific information such as his or her name, e-mail address, user name, and password. It is free to register. This is a great site for students and adults who have a profound interest in biochemistry. This Web site benefits all those involved; the companies searching for solutions to their problems are able to review many solutions to the challenge and are possibly able to find new solutions, while the solvers are able to conquer a challenge and receive a nice reward.

*Title:* Chem4kids
*URL:* http://www.chem4kids.com
*Grade Level:* Grades 7 to 9
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* Chem4kids is a great Web site for kids interested in learning biochemistry. This Web site could be used to supplement classroom instruction or as a tutorial. This site explains everything about biochemistry in a clear and humorous way. The site has a flash card feature whereby students can see how much they have learned about a particular topic. In addition, once students have completed the tour, they can take the on-line quiz and get immediate feedback. Students in grades 7 to 9 would really enjoy this site. Students can access and navigate around the Web site by doing the following: Type in www.chem4kids.com. The home page has several icons that the student can choose from. In this case, the student would select the biochemistry icon. A page containing the definition of biochemistry appears. On the sidebar is a list of topics that would be covered under this section (biochemistry). Select a topic in the sidebar or click on

the button "The Next Stop on Tour." Keep selecting a topic from the sidebar or click "The Next Stop on Tour" button until you get to the end of the tour. Once the tour is complete, select activities located at the bottom of the screen. The activity page allows the student the choice of taking a quiz or utilizing the flash card feature. Students can continue to maneuver around the site by pressing an icon, selecting a topic from the sidebar, or choosing one of the items listed on the main menu at the bottom of the page. Students can select "Home" to get back to the home page, located on the main menu at the bottom of the screen.

*Title:* Beginning Biochemistry
*URL:* http://www.worthington-biochem.com
*Grade Level:* High school
*Search Engine:* http://www.dogpile.com
*Review:* This is an educational Web site geared toward high school–aged biochemistry students. This site is primarily focused on the introduction of enzymes and their overall use in the field of biochemistry. The subject of enzymology is broken down into terminology that can be easily understood by high-school students. There are three sections to this particular site: Introduction, Enzymes and the Life Processes, and Enzyme Kinetics. Each part contains subsections that can be clicked with the mouse and read by the student. This site is an effort by the Worthington Biochemical Corporation to make complex subjects, such as enzymology, easily understood and accessible.

*Title:* Biochemistry
*URL:* http://www.chem4kids.com/files/bio_intro.html
*Search Engine:* http://www.ipl.org/youth/
*Review:* This site is geared toward elementary to lower middle-school children. The site offers a general explanation of biochemistry as well as the basic chemical and molecular compounds that comprise biochemistry. The links within the main biochemistry page include Carbohydrates, Lipids, Amino Acid Structure, Amino Acids, Proteins, Enzymes, Nucleic Acids and Metabolism. Other site links include Matter, Atoms, Elements and Reactions. The site offers both interactive quizzes and flash cards. The page offers other site links for kids. The other links include geography (Geography4kids.com), biology (Biology4kids.com), and general science and technology (Kapili.com). Overall, this would be a great starting place for creating introductory lessons on biochemistry and/or related science topics.

*Title:* Biochemistry and Molecular Biophysics at Caltech
*URL:* www.its.caltech.edu/~biochem/
*Grade Level:* College and graduate students
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* biochemistry
*Review:* This site gives an overview of the biochemistry program at Caltech. It provides a link for the courses in biochemistry, information on graduate study, faculty research areas, graduate information, a biochemistry handbook, and instructions on how to apply to the institute. This site also provides an overview on the study and research in biochemistry. This overview explains that "biochemistry has been established as an interdisciplinary program and it is the interface of bio and chemistry that seeks to understand the chemical of life." Biochemistry addresses the principles through which each individual cell combines to produce its form, its function, and its dynamic behavior. This is an informative site for those students who are looking to further their education and study biochemistry. This institute offers a Master's program and a Doctoral program. This information can be found at the Graduate Program link.

*Title:* Interactive Concepts in Biochemistry
*URL:* http://www.boyerbiochem.com/index.htm
*Grade Level:* High school
*Search Engine:* http://www.google.com/
*Key Search Words:* biochemistry and interactive
*Review:* This site is an interactive multimedia companion to the textbook, *Concepts in Biochemistry, 2d edition* (Boyer). It is an instructional resource designed to supplement key concepts presented in the Boyer text. In this resource, students and instructors explore biochemistry through multimedia. The seven areas available to the user are the chapter index, a concept review, interactive animation, structured tutorials, cutting-edge topics, Web links, and quizzes.

*Title:* Expertise Search, Guide to Consultants, Specialists and Experts
*URL:* www.expertisesearch.com
*Grade Level:* Professional level
*Search Engine:* http://www.dogpile.com
*Key Search Word:* biochemistry
*Review:* Expertise Search is a wonderful, easy-to-navigate Web site. The company's Web page layout is also quite user-friendly. The main purpose of this Web page is to find a specialist in almost any area to an-

swer your personal questions. I find this interesting because years ago, when a person was unfamiliar with a certain topic, they would research it at a local library. Now all you have to do is go to this Web page. Click the specialist you need, and the computer gives you a list of specialists in that area. I can't say I am completely against this Web site because if I was in the need of a biochemist to answer a question, I would pay the money to save the time. This Web site is not only to find biochemists, but rather for any specialist you might need.

*Title:* High School Web Sites: Experiments and Demonstrations
*URL:* http://jchemed.chem.wisc.edu/HS/WWWED.html
*Grade Level:* Advertised as high school, but also included is four-year college material and K to 12 sample laboratory protocols
*Search Engine:* http://www.google.com
*Key Search Words:* teaching + biochemistry+ high + school
*Review:* This Web site was most addictive because each subdivision not only provided what was advertised but also held some delightful surprises. In order of presentation, the first item selected was "Biochemistry Teaching Resources by Barry Ganong." The information located here centered around three major course descriptions: organic chemistry and biochemistry (general education science majors), introduction to biochemistry (nutrition majors), and biochemistry (science majors). A course description and rather inclusive list of regular and custom-modified labs were provided, as well as a summary of the laboratory protocols. Mr. Ganong's emphasis was on citing and sharing labs that were instructive, workable, and inexpensive. The next topic chosen to explore was "Chemistry Experiments You Can Do At Home." Instructions were provided for the following categories of experiments: gases, reactions with oxygen, solutions, tests for substances, and miscellaneous. "Bizarre Chemistry Experiments" was the tantalizing title of the next selection chosen. The focus of this section was some well-known, and some obscure, demonstrations and experiments guaranteed to grab student interest on topics ranging from atomics, chemistry, life, temperature, and gases and liquids. Another selection chosen was "Frontier High School Chemistry Class." It was advertised as illustrating materials for a chemistry class, including skills tests, instructions for demonstrations, notes on various chemical concepts and more, but failed to materialize, despite several futile attempts to connect with it. The "Wilton High School: Tutorials and Other Things" selection contained many topics typical of a general chemistry course but also

included a few offbeat and decoratively illustrated items. Note the following blurb, excerpted from "The Christmas Story" entry: "In a little back street in Wilton, we find chemistry teachers Ebeneezer Jacobs, Ebeneezer Blizman, Ebeneezer Karas and Ebeneezer Gregory licking their tungstens with mercurial delight as they count their gold and silver collections from their students' fees for broken glassware. 'Praise, O Dimium!' the Ebeneezers shout. 'Poor Marie Osmium, usually warm and iridium, has collapsed and is lying phlatinum from our titanium final examination, yet we am not dysprosium to become good samariums.'" The next section, "Science is Fun in the Lab of Shakhashiri," written by University of Wisconsin at Madison Chemistry Professor Bassam Z. Shakhashiri, features science experiments you can do at home, chemical of the week fact sheets, supporting materials for general chemistry courses, and links to related chemistry sites and on-line journals The last selection presented by this Web site was Project Labs, which contains lesson plans and hands-on activities for grades K–12 and is produced by Project Learning about Basic Science (LABS), a cooperative program for science teachers. The activities are grouped into three categories: general, physical, and biological sciences. In summary, this Web site was fairly well diversified and included a humorous element to the study of biochemistry. Its designers employed interesting graphics while still retaining the integrity of the subject matter. Further, the Web site provided a comprehensive list of additional links for its browsers to employ, as follows: High School Resources for JCE Subscribers, Journal, JCE Software, JCE Internet, Chem Ed Today, JCE Books, About JCE Home, Subscriptions/Orders, Service/Support, Authors, Reviewers, and Site Info.

*Title:* Biochemistry
*URL:* www.bioch.ox.ac.uk
*Grade Level:* College and graduate students
*Search Engine:* http://www.google.com
*Key Search Word:* biochemistry
*Review:* This extremely extensive site is the main site for the Department of Biochemistry at the University of Oxford. The home page of the Department of Biochemistry provides many links. These links include: What's New in Biochemistry, the Department, Research, Teaching, Units, Services, Administration, Links, Search, and Help. Each link is filled with information for each of the mentioned areas. The search link is restricted to students accessing the site from the

University of Oxford. It allows students to search through other search engines that may be restricted to members of specific organizations. The search link also has links to complete an external search on the Web, Medline, or Genbank. This was a very well-organized site. It provided great deal of information for those interested in the field of biochemistry.

*Title:* Expertise Search, Guide to Consultants, Specialists and Experts
*URL:* http://www.expertisesearch.com
*Grade Level:* Professional level
*Search Engine:* http://www.dogpile.com
*Key Search Word:* biochemistry
*Review:* Expertise Search is a wonderful, easy-to-navigate Web site. The company's Web page layout is also quite user-friendly. The main purpose of this Web page is to find a specialist in almost any area to answer your personal questions. I find this interesting because years ago, when a person was unfamiliar with a certain topic, they would research it at a local library. Now all you have to do is go to this Web page. Click the specialist you need, and the computer gives you a list of specialists in that area. I can't say I am completely against this Web site because if I was in the need of a biochemist to answer a question, I would pay the money to save the time. This Web site is not only to find biochemists, but rather for any specialist you might need.

*Title:* EXTOXNET—The Extension Toxicology Network
*URL:* http:/ace.orst.edu/info/extoxnet/
*Grade Level:* High school and above
*Search Engine:* http://www.dir./yahoo.com/science
*Key Search Word:* biochemistry
*Review:* This is a colorful Web site devoted to informing the public about toxicology and environmental chemistry. EXTOXNET is a consortium comprised of University of California at Davis, Oregon State University, Michigan State University, Cornell University, and University of Idaho. The best link is the first one, which is frequently asked questions (FAQs). Here you can find answers to questions related to nine different topics, including Diet and Cancer, and Indoor and Household Hazardous Waste. Consumers might find this information very valuable. There are additional links to areas about technology, fact sheets, newsletters, and so on. In addition, there is a direct link to an e-mail address for direct written correspondence. Connection to EXTOXNET Global Search and Browse page is avail-

able as well. This site would probably be useful to consumers and/or college students who needed to research related topics.

### Bonding

*Title:* General Chem Tutorials
*URL:* http://gaia.fc.peachnet.edu/tutor/
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* bonding tutorials
*Review:* This Web site tutorial was developed at Fullerton College by Professor Harvey Moody. At the main menu, scroll down and click on "Chemical Bonding, Molecular Structures and Covalent Bonding Theories." You now will have to choose between Lewis Structures, Writing Lewis Structures, VSEPR Theory II, and VSEPR III. Each one of these topics has been subdivided into specific topics. The tutorials are well written in a step-by-step manner and easy to follow.

*Title:* Aufbau1: A Teaching Resource for 14–16 Year Old Chemistry Students
*URL:* http://www.wissensdrang.com/auf1con.htm.
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* bonding tutorials
*Review:* This Web site was written and is maintained by Dr. Roger Peters. At the main menu, scroll down and click on either 01, 03, 04, 05, or 06 in the Selected Principles section. Dr. Peters maintains a slightly humorous but effective tutorial throughout his discussions. This site, though intense, is well written and very comprehensive.

*Title:* Chemistry About
*URL:* http://chemistry.about.com/?once = true&
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* experiments on bonding
*Review:* The About.com network provides an expert guide who builds the topic environment including the best content, how-to's, forums, and answers to any topic questions. For instance, type in the words "hydrogen bonding" in the search window at the chemistry home page. You will then be led to a number of links to Web sites that discuss

"hydrogen bonding." The About expert leads you to various Web sites that specifically discuss chemistry bonds.

*Title:* News and Communication Page
*URL:* http://www.textileweb.com/content/hubs
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what is chemical bonding
*Review:* Textileweb.com is a resource for professionals in textiles and fabric industries. It is sponsored by Mac Sales, Inc., of Greenville, South Carolina. This is a company that designs machinery for various industries including plastics and textiles. The News and Communication Page supplies you with current information in the field. "Current Headlines" provides links to articles in the news that are related to textiles. Through one of the links, I learned that Lee Jeans will be coming out with a new line of khakis that will be stain resistant! "Supplier News" provides links to articles about specific suppliers. In the "Download Library" you can download free software tools and resources. "Discussion Forums" currently has ten forums. The "Events Calendar" lists upcoming industry events, and you can post your own relevant events as well. This Web site can be a good resource for people in the field of textiles and for students who might be researching related topics.

*Title:* Chemical Bonds, Molecular Shapes, and Molecular Models
*URL:* http://www.eosc.osshe.edu/chemweb/molmodel/mmp.html
*Grade Level:* Undergraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical bonds
*Review:* This Web site is a hypermedia-based tutorial on chemical bonds, molecular shapes, and molecular models. It was designed to supplement lecture material from an Eastern Oregon University class and to prepare students for model building in the laboratory, classroom, or at home. As is stated in its description, "it provides not only the material fundamental for chemical model building, but contains more basic information to reacquaint students with topics in which they need to strengthen their foundation." Upon entering the main page, the user must click on the contents button to reach the Table of Contents. The Table of Contents includes definitions, demonstrations, specific examples, and a self-assessment quiz—which I could not reach. The site also contains "hyperactive molecules," which are

three-dimensional structures that students can rotate and manipulate. All in all, it is a rather simple site to get through. Besides undergraduate students, I feel that high-school students and perhaps even middle-school students interested in the subject would benefit from viewing this page.

*Title:* Chemical Bonding/Table of Contents
*URL:* http://www.okstate.edu/jgelder/bondtable.html
*Grade Level:* Upper high school and college undergraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical bonding
*Review:* This Web site originates at Oklahoma State University. It was designed to be used a support area for both students and teachers. A table of contents provides an overview of the subjects, complete with placement in curriculum and performance objectives. I clicked into the Concept/Skills Development area and discovered an abundance of laboratory activities, demonstrations, group activities, and tips for teachers including a glossary of terms relating to chemical bonding. There is also a chemistry review that goes into great detail about covalent bonds, hydrogen bonds, and hydrophobic interactions complete with examples. You can also click onto a page that lists the biographies of various pioneers in the field of chemical bonding. The creators of this Web site also offer a look at their humorous side and included an area filled with riddles, rhymes, limericks, and word searches. For example, "What is the name of 007's Eskimo cousin?" Answer: "Polar Bond." In conclusion, I found this site to contain a plethora of information that students and teachers alike could put to good use.

*Title:* Chemical Bonding K–12
*URL:* http://www.nyu.edu/pages/mathmol/textbook/bonding.html
*Grade Level:* Grades 7 to 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical bonding
*Review:* The page begins with an image of a water molecule with a simple explanation and a three-dimensional image link. Scrolling down, you see descriptions of covalent bonds, ionic bonds, and hydrogen bonds. All had links to click to view images as well as more in-depth descriptions for vocabulary or phrases (although some were not accessible). The bottom of the page offered more advanced lessons for chemical bonding. The link at the bottom for an advanced lesson on

the structure and bonding of atoms takes you to the University of Illinois at Chicago's Department of Chemistry. The MIT Hypertext book link shows you multiple diagrams of various types of bonds from basic to complex. The site is simple and basic and easy to navigate. There is not a wealth of information, but the images are good. This site would benefit the beginning chemist.

*Title:* 1001 Periodic Table Quiz Questions
*URL:* http://www.1001-periodic-table-quiz-questions.com/abouthtml
*Grade Level:* Grades 3 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical bonding Web sites
*Review:* This Web site was designed by Alwyn Botha from South Africa. He researched and developed it along with many other Web sites for middle-school and high-school students. The Web site contains curriculum-based chemistry quizzes starting at grade 3 (age 8) to grade 12. It also includes periodic table reference information and chemistry links. This Web site can be of value to science teachers in need of creative ideas for quizzes.

*Title:* Chemical Bonding
*URL:* http://www.fh.huji.ac.i/~guy/ChemBond/
*Grade Level:* Graduate
*Search Engine:* http://www.msn.com/
*Review:* Introduction to Chemical Bonding is a basic course in quantum chemistry presented by Professors Ronny Kosloff and Guy Ashkenazi. On the left side of the page, you can find the lesson index. There is a total of twenty-four lessons that include topics such as wave particle duality, matter waves, free particle, angular momentum, measurements, and others. Lessons are presented in English (text) and in Hebrew (slides). Some lessons also include images to better illustrate the topics. In the center of the page are the programs you need to have installed in your computer in order to be able to download the lessons. At the bottom of the page, you have the possibility to obtain a compressed archive of the content. It seems to be a very informative page for those who enjoy and understand chemistry.

*Title:* Chemical Bonding
*URL:* http://users.senet.com.au/~rowanb/chem/chembond.html
*Grade Level:* Middle school and high school
*Search Engine:* http://www.ajkids.com

*Review:* This is an incredible Web site on chemical bonds. It includes pictures and diagrams, something every science student needs when learning about chemical bonding. The site starts out by explaining general chemical bonding and then continues with information on metallic, ionic, and covalent bonding. Each section has tables with the bond properties and explanations of each. I liked this Web site because it had diagrams of confusing bonds, such as shared bonds.

*Title:* Chemical Bonding K–12
*URL:* http://www.nyu.edu/pages/mathmol/textbook/bonding.html
*Grade Level:* High school
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemical bonding
*Review:* This Web site provides a basic introduction of chemical bonding to high-school students. The site claims to be for K–12, but the content is very advanced for elementary school–aged students. In the opening section, the three basic bonds are explained for the student. These bonds are covalent, ionic, and hydrogen. Each section has windows to click for visuals or further explanation. At the bottom of the page, more advanced lessons can also be clicked. One of windows is the MIT Hypertext book on chemical bonds. It is a much more involved introduction of chemical bonding. It contains basic, black-and-white visuals and explanations of other more advanced bonds. This Web site can be a good resource for working on a project or just for giving a student a basic background in chemical bonds.

*Title:* Chemical Bonding
*URL:* http://students.washington.edu/manteca/Grade
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Review:* This Web site shows which chemicals can bond with each other: "The significance of the Colored Periodic Table is that the colors elucidate the method in which particular elements bond together." The Web site could help someone who needs a reference to chemical bonding. It discusses three types of chemical bonding and the processes involved in it.

*Title:* Types of Chemical Bonding
*URL:* http//www.beyondbook.com/psc92/3.asp
*Grade Level:* All levels above elementary school
*Search Engine:* http://www.dogpile.com

*Review:* "Types of Chemical Bonding" is the page that appears when clicking on the search results that appear from Dogpile. This site goes into detail about several types of chemical bonds, including covalent, ionic, and metallic bonds. You can click on either of these choices and get more information on them. There is also a "molecule of the month" link that you can click on to visit. On the right is a blocked-out section with four focus topics, and on the left margin is a dictionary look-up section. Type in a topic or word for information on it. This is a great site for the student needing information for school reports or projects or someone looking to broaden their knowledge on this topic.

*Title:* An Introduction to Atomic Structure and Chemical Bonding
*URL:* http://www.wissensdrang.com/aufascb.htm
*Grade Level:* Grades 9 to 11
*Search Engine:* http://www.google.com
*Key Search Words:* chemical bonding
*Review:* This Web site provides the following synopsis: "This document provides conscientious 14–16 year old students with an unorthodox introduction to atomic structure, chemical bonding, and reactivity; its unusual feature is its degree of concordance with both high-school Physics and advanced studies in Chemistry." Although there was not great evidence of unorthodoxy, the site was unique in that it provided a comparative and well-documented theoretical discussion approach to the various bonding theories. The graphics were fairly simple to interpret and supported the text appropriately. Nontext examples were also interwoven to further compare and contrast the bonding theories. Caveats to bonding rules were discussed also, something not usually seen in most text sources at this level. A helpful list of terms and their definitions were provided before proceeding into the actual chemical bond types. The covalent bonding section mentioned localized bonding, mechanics of bonding, and polarity of covalent bonds and discoursed on both pi and sigma bonds. Further, it presented charts of bonding energies, broken down by bond types. The metallic bonding portion grew ever more complex, being rather detail-oriented with few diagrams to clarify or to sustain interest for the casual browser. Lastly, the redox portion included extensive charts of both oxidation and reduction half reactions and concluded with a clever so-called courtroom contest pitting the challengers, Mr. Lithium and Mr. Potassium, to a reactivity and rate comparison. The argument ensued as different data emerged to support the points

made by the two combatants. The Web site concludes with the student being asked to continue to weigh data evidence before making sweeping generalizations about bonding in general. This Web site was very informative and well documented but might be too challenging for most 14- to 16-year-olds, except for the most capable students. The format was entirely presented in black-and-white, which sufficed, but could be more visually compelling if brighter colors or animation were used. The use of humor, toward the end, brought levity to a complex topic and made me glad to have persevered to its end.

*Title:* Chem Source—Chemical Bonding
*URL:* http://www.okstate.edu/jgelder/bonding.html
*Grade Level:* High school through adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical bonds
*Review:* This outstanding site is designed for those who teach chemistry at the high-school level. It can be accessed through Metacrawler. The main page lists the topics covered on the site: Content in a Nutshell, Place in the Curriculum, Central Concepts, Related Concepts, Related Skills, and Performance Objectives. Included tools for the teacher are notes on lesson planning and background of the subject matter, two laboratory activities, multiple demonstrations, group and discussion activities, tips for the teacher, and links to other Web resources. Especially interesting is the link to chemical-bonding humor, that includes: jokes, limericks, rhymes, chemtoons and cartoons, and many other motivating tools that the teacher might want to utilize in her classroom. The best Web site that I could find on chemical bonding using the search engine Megacrawler is entitled Atomic Orbitals and is at the following address: http://www.imsa.edu/~ishmael/bonding. The introduction page automatically brings you into the body of the Web site. There are several ways to maneuver around the Web site; however, the easiest way is to use the "Forward" button to go through each page of information on the site. Each click of the "Forward" button changes the three-dimensional pictures and illustrates what the text on that page is talking about. If you need to go back through the site, use the "Back" button to do that. The other way to maneuver around the site is to click directly on one of the three topics that you want information on at the bottom of the page: Atomic Orbitals, Chemical Bonding, or Hybridizations. Click on "Chemical Bonding," and once in that section, use the "Forward" button to take you through

all the pages on chemical bonding. Again, there are three-dimensional pictures for each page that provides a visual for what the text is discussing. I feel that this page is for an honors level or advanced placement chemistry high-school class because of the language used on the page.

*Title:* Chemical Bonding
*URL:* http://www.nyu.edu/pages/mathmol/textbook/bonding.html
*Grade Level:* Grades K to 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical bonding
*Review:* This Web site provides a detailed description of chemical bonding for students. The site describes covalent, ionic, and hydrogen bonds. At the bottom of the page, four additional links are listed. The links include a hypertext book, structure and bonding of atoms, and chemical bonding. This site would be beneficial to students who are having difficulty in their classes understanding chemical bonding.

*Title:* Ray's Educational Software "Atoms, Bonding and Structure"
*URL:* http://www.rayslearning.com/bonds.htm
*Grade Level:* Four units are targeted at middle-school students (grades 6 to 8), and four units are targeted at high-school students (9 to 12)
*Search Engine:* http://search.metacrawler.com
*Key Search Words:* chemical bonding
*Review:* "Atoms, Bonding and Structure" is interactive teaching software for home and school. The user can download a free version of the program. This program tests students as they learn the different concepts about chemistry. Starting from very basic principles, the program guides students through all the concepts required for understanding atomic structure and various types of chemical bonding. This program is intended for class use, however, parents can download this program to their home computer. Also, this program could be used for parents who homeschool their children. It is user-friendly and provides a hint icon to help the user if he or she becomes frustrated.

*Title:* Chemical Bonding
*URL:* http://users.senet.com.au/~rowanb/chem/chembond.htm
*Grade Level:* High school
*Search Engine:* http://www.aol.com

*Key Search Words:* chemical bonding
*Review:* This Web site gives general, metallic, ionic, and covalent information regarding chemical bonding. The information is displayed through diagrams, definition tables, and formulas. The Web site is very basic. There are no fancy illustrations or pictures, nor are there links to other Web sites. The only link is to a site called Chemistry Central, where there is much more information about chemistry topics. It seems to be a site created by a chemistry teacher (Rowan Beckworth). This site would mainly be used by a beginning chemistry student in high school. It gives basic definitions from the topics listed.

*Title:* Chemical Bonding
*URL:* http://www.nyu.edu/pages/mathmol/textbook/bonding.html
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical bonding and preschool
*Review:* This Web site is a very basic introduction to chemical bonding. The construction of the site is simple for new computer users looking to learn about chemical bonding. I liked this site because it showed three-dimensional pictures of various bonds. This site could be best used in a school classroom to show what bonds look like in a simple way.

### Carbohydrates

*Title:* Chemodule Tutorials
*URL:* http://www.karentimberlake.com/carbohydrates.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials on carbohydrates
*Review:* This Web site, which must be downloaded onto a disk, provides you with two PowerPoint tutorial presentations: one on monosaccharides and one on disaccharides and polysaccharides. The site has been designed for students in basic chemistry or allied health courses. There is also a quiz link for carbohydrates.

*Title:* Tutorials at the Biozone—Biological Sciences 101 William V. Glider
*URL:* http://www.libfind.unl.edu/wglider/tutor/tutor.htm/
*Grade Level:* High school

*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials on carbohydrates
*Review:* These tutorials are interactive learning modules that cover specific topics in biology. At the main menu, click on the word "carbohydrates." The module requires you to fill in the flowchart with the appropriate word. If you are wrong, the word will go back to its original position at the bottom of the chart. This interesting technique for learning about carbohydrates could also be used as an on-line quiz for a student.

*URL:* http://www.biology.clc.uc.edu/courses/biology/carbon.htm
*Grade Level:* High school to college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials on carbohydrates
*Review:* This Web site was developed by J. Stern Carter at the Biology Department at the University of Cincinnati, Clermont College. At the Web page you will find a discussion about carbon-based compounds including carbohydrates and their functions. The site is well written and easy to understand.

*Title:* Fun with Food Science
*URL:* http://www.aces.uiuc.edu/~Whitesid/4-H/carbintr.html
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* experiments for carbohydrates
*Review:* This Web site was developed by the University of Illinois Cooperative Extension Service and the Illinois 4-H Office. The Investigating Carbohydrates activity contains both the content, the activity, and a report sheet for the student data. It also has a link to explain the results and to add another demonstration. This is a simple but well-written activity in carbohydrates study designed for the middle-school student.

*Title:* The Doctor's Medical Library
*URL:* http://www.medical-library.net
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* The Doctor's Medical Library is a Web site that contains the page "Carbohydrates in Nutrition," presented by Dr. Ron Kennedy. The center of the page offers opportunities to find a doctor, a den-

tist, or information about basics of physical and spiritual health. Then, it proceeds to describe what carbohydrates are, where can they be found, and the results of excess carbohydrate intake. At the bottom of the page it shows other related links for topics such as nutritional medicine, macronutrients, and fats in nutrition. On the left side of the page, you can find a library tour, articles, specialties, symptom correlation, and a feature called "Ask Dr. Kennedy." It seems to be a very interesting page for those interested in nutrition and health.

*Title:* The Doctor's Medical Library
*URL:* http://www.medical-library.net/carbohydrates-nutrition.html
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* carbohydrates in nutrition
*Review:* This Web site is based on articles of study written by Ron Kennedy, MD, from Santa Rosa, California. The site is written in very comprehensible form so that high-school students can gain a tremendous understanding of carbohydrates and their affect on human health and nutrition. The site explains the different types of carbohydrates, the foods they are found in, and how the body breaks them down. There are related links such as "Reorganizing the Way You Eat," "Nutritional Medicine," and "Nutrition," which were very informative and enlightening. The "Nutrition" link goes into much detail about human evolution and how we have strayed away from the way we were physically and biologically designed to eat. The site is very fascinating and extremely informative.

*Title:* Carbohydrates—The Energy Foods
*URL:* http://www.healthlibrary.com/reading/weight/chap17.htm
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* This Web site would be appropriate for middle- and high-school students and those individuals wishing to become more knowledgeable about nutrition. At the top of the page a series of files can be accessed with just a click. My favorite was the Help Reading Room because I found a virtual on-line library of twenty-five full-text unabridged books plus numerous magazine articles on health, nutrition, and medicine. The main body of this page explains what carbohydrates are and how our body uses them as energy. I decided to

explore the index, which was under the heading "How to Lose Excess Weight Permanently." The contents page has articles you can access and it answers every question you could possibly want answered regarding carbohydrates, obesity, health, nutrition, vitamins, exercise, and all-around good health. Students as well as health teachers wanting to broaden their base knowledge about good health would benefit from this Web site.

*Title:* Think Quest—Teenage Health Interactive Network
*URL:* http://library.thinkquest.org/29500/
*Grade Level:* Middle school and above
*Search Engine:* http://www.webcrawler.com
*Key Search Words:* carbohydrates and interactive
*Review:* This Web page would be suitable for a health or a science classroom. It answers questions for teenagers that deal with topics such as nutrition, fitness, and personal care. Once on the site, you are able to search the site for different categories. The search on carbohydrates was successful and offered many choices such as facts, nutritional quizzes, and other related topics.

*Title:* Kids Health
*URL:* http://kidshealth.org/kid/stay_healthy/food/protein_carb_fat.html
*Grade Level:* Grades 3 to 9
*Search Engine:* http://www.askjeeves.com
*Key Search Word:* carbohydrates
*Review:* This is a highly developed and very informative site encompassing a variety of health topics for children, from basic nutrition, to general first aid, to what to expect in surgery. The site is written in a fun, upbeat manner, for elementary school children through adults looking for basic but thorough information. The left side of the opening page has a list of topics: Feelings, Fitness, Childrens' Illnesses, How the Body Works (which the user needs Macromedia Shockwave to access, and there is a link to install), Growing Up, Games, Glossary, and Watch Out, all of which have many individual links with subtopics that cover many situations. The bottom of the opening page has an area to print any article, e-mail the site, or e-mail something on the site to a friend. The opening page also begins by defining protein and discussing why the body needs it and which foods provide it. The user may either jump to another article, set up in the same manner, about carbohydrates, fats, and calories, by clicking on the particular link or going through a page-by-page tour. Although the site is not focused solely on carbohydrates,

enough information is supplied to provide a basic understanding of carbohydrates and how they work in conjunction with the body and nutrition.

*Title:* BNF Information—Carbohydrates
*URL:* http://www.nutrition.org.uk/facts/energynut/carbo.html
*Grade Level:* High school to college
*Search Engine:* http://www.lifebytes.gov.uk/
*Review:* This is a good site for those looking for information on carbohydrates and diseases that correlate with eating carbs. The site is colorful with circle graphs on the sources of total carbs in a British diet. Then it presents a figure of the structure of glucose. The last part of the site mentions different carbs and the diseases that are caused and helped by eating them. For example, dental caries is believed to be caused by high intakes of carbohydrates, while large bowel cancer is seen in lower incidences with people who have a high intake of carbohydrates.

*Title:* Carbohydrates: The Structure and Function of Carbohydrates
*URL:* http://www.biology.about.com/library/weekly/aa040501a.htm?iam = dpile&terms = carbohydrates
*Grade Level:* Grades 7 to 12
*Search Engine:* http://www.dogpile.com
*Key Search Word:* carbohydrates
*Review:* This Web site comes from http://www.about.com. It is a complete introduction to the subject of carbohydrates. The carbohydrates are broken down into its three basic parts for the student. These parts (monosaccharides, disaccharides, and polysaccharides) are defined, and images of the bonds are given for each example. A discussion board is available with a new question posted each week. Related resources such as lipids and proteins are also available. Other subjects such as botany, cell anatomy, and marine biology can also be accessed. This site also has a homework help section, a teacher's section, and a virtual dissection area. About.com provides a very in-depth and easy to follow Web site for students of all ages.

*Title:* Fast Food for a Fast Generation
*URL:* http://coe.west.asu.edu/students/jklein/janwebquest.2.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* carbohydrates Web sites

*Review:* This is a Web quest designed by Jan Klein. Fast Food for a Fast Generation describes eating habits for a healthy long life. The Web site is colorful and user-friendly, which is appealing to adolescent students. The site is broken up into six sections: Introduction, Task, Process, Resources, Evaluation, and Conclusion. There are links to other Web sites including the American Heart Association. The Fast Food for a Fast Generation Web site focuses on restaurant eating guidelines, cyber diets, and dietary guidelines, all which encourage proper nutrition and a healthy lifestyle of eating.

*Title:* Carbohydrates in Nutrition
*URL:* http://www.medical-library.net/sites/carbohydrates_in_nutrition.html
*Grade Level:* College or adult reference
*Search Engine:* http://www.webcrawler.com
*Key Search Word:* carbohydrates
*Review:* This Web site talks about carbohydrates, which come in two basic forms: "complex and simple. Simple carbs are one, two, or at most three units of sugar linked together in single molecules. Complex carbs are hundreds or thousands of sugar units linked together in single molecules. Simple sugars are easily identified by their taste: sweet. Complex carbs, such as potatoes, are pleasant to the taste buds, but not sweet." In addition, you can find information on the results of excess carbohydrate intake, and the site has related hyperlinks wherein you can find other sources (e.g., Nutrition, Macronutrients, Fiber in Nutrition, Fats in Nutrition, Proteins in Nutrition, Reorganizing the Way You Eat, Nutritional Medicine, Nutritional Medicine Approach).

*Title:* How Stuff Works
*URL:* http://www.howstuffworks.com/food.htm
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* This is another section of the How Stuff Works main Web site for children. It is a fantastic children's resource that explains in excellent terms the workings of many of the things we all use every day and yet don't quite know the reasons or scientific explanation behind the phenomena. This site tells about your body's use of food and explains everything from the basics of food to carbohydrates, proteins, fats, vitamins, minerals, water, and fibers. For children, it answers the ques-

tion of: Why am I starving? There are excellent graphics and many links to additional information so that a student could answer just about any question she might have. This site is excellent for the intermediate or middle-school student.

*Title:* Lifeclinic: From Spacelabs Medical
*URL:* http://www.lifeclinic.com
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* Lifeclinic.com is a Web site that offers numerous health topics such as cholesterol, diabetes, nutrition and fitness, senior care, and blood pressure. By choosing one of these topics on the home page you can research articles, find fitness programs, and look at cholesterol charts. Lifeclinic.com also has many other sections on its home page. The first area that caught my eye was the Highlight section. Each week three topics are featured that offer detailed information (i.e., nutritional foods in your diet). Two other customer-orientated sections are "Ask an Expert" and the on-line rating poll where you may to rate all the features the Web site has to offer. On the left side of the page is a resource section, which contains links such as medication, cookbooks, and health news. Lastly, the home page offers a terrific nutrition and fitness-tracking system to its members. You can track everything from your blood pressure to your eating habits. In closing, Lifeclinic.com covers a well-balanced variety of health-care issues. It is very user-friendly and provides information in a professional way. The free membership makes it even more appealing. The search of carbohydrates led me to numerous subtopic areas where you could find a variety of information. Lifeclinic.com would be a valuable tool for any individual concerned with their health and well-being.

*Title:* Carbohydrates—The Energy Foods
*URL:* http://www.healthlibrary.com/reading/weight/chap17.htm
*Grade Level:* Grades 6 to 12
*Search Engine:* http://search.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* This site is about the carbohydrates that are found in the foods we eat. Carbohydrates—The Energy Foods begins its site by defining what is a carbohydrate. Carbohydrates are the principal source of energy for the body. Next the site explains the two types of carbohy-

drates and what foods they can be located in. The two types of carbohydrates are simple and complex. Simple carbohydrates are found in sugar and white flour and complex carbohydrates are found in whole grains and vegetables. Finally, the site explains which carbohydrate is better between the two. Complex carbohydrates are better for you because refined carbohydrates are enriched with sugars and fat, which may lead to obesity. The Web site seems to be based from Indian collaborators because most of the information is based on what Indian people used to eat compared to today. Also, there is a link marked "INFO"; it provides the user with information on medical schools, colleges, hospitals, and pharmaceutical companies in India. This Web site is informative because it tells the user what food will help him or her lose weight and maintain a balanced diet.

*Title:* Carbohydrates
*URL:* http://www.medicallibrary.net/sites/carbohydrates_in_nutrition.html
*Grade Level:* Undergraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* My search led me to a page entitled Carbohydrates in Nutrition by Ron Kennedy, MD, of Santa Rosa, California. It is part of The Doctor's Medical Library. The introduction states that this Web site network was designed to introduce people to the way doctors think of illness and health, to allow the user to understand the pressures doctors are under to conform, and the courage they have to remain true to the welfare of their patients. It is also a tool to allow people to locate the kind of doctor who can help them achieve the health they deserve. Upon entering this page the user will see an explanation of different types of carbohydrates and what they are. There are four tabs at the top of the page. The first will get the user help in finding a doctor. The second will help in finding a dentist. The third is a link to reading a guide on the basics of physical health. The fourth tab is a guide on the basics of spiritual health that is really just a link to a publishing company. There are also a variety of choices on the left-hand side of the screen to choose from. There is a tour, an introduction, and library articles to read. There are also buttons that will take the user to specialty areas such as book orders and free course sign-ups offered by the site. At the bottom are related hyperlinks to: Nutrition; Macronutrients; Fiber in Nutrition; Fats in Nutrition; Proteins in

Nutrition; Reorganizing the Way You Eat; Nutritional Medicine; and Nutritional Medicine Approach. Be sure to click on the "Basics of Physical Health" tab, it made me want to change my diet!

*Title:* Carbohydrates in Nutrition
*URL:* http//www.medical-library.net/sites/carbohydrates_in_nutrition.html
*Grade Level:* All grade levels
*Search Engine:* http//www.metacrawler.com
*Key Search Word:* carbohydrates
*Review:* This was the first option on my list of choices from Metacrawler. It offers a variety of info on carbohydrates. The author is Ron Kennedy, MD, from Santa Rosa, California. He makes learning about carbohydrates very easy and interesting. He discusses the two basic forms of carbs—simple and complex—then explains how those are differentiated. On the left side are links to related articles, Q and A's, and other library info. Along the top are boxes to click on if you are looking for a doctor or dentist. This site is very educational and easy to read for younger students. I recommend it to anyone wishing to learn more about carbs and any other nutritional information.

*Title:* Elementary School Nutrition Education: a Teaching Curriculum for 1st Grade
*URL:* http//www.amsa.org/pdf/elemnutrition.pdf
*Grade Level:* First grade (but probably could be used for K to 3)
*Search Engine:* http://www.google.com
*Key Search Words:* teaching + carbohydrates + elementary
*Review:* This Web site is a curriculum guide, which was created by a medical school professor, Andrew Tershadovec, who is affiliated with the Childrens Hospital of Philadelphia and the University of Pennsylvania Medical School. It was intended to be used for teaching first-graders about nutrition at inner-city elementary schools. It has been used by Dr. Tershadovec and first-year medical students. These medical students volunteered to teach a total of thirteen lessons in the schools. The entire program is sponsored by AMSA—American Medical Students Association Task Force on Nutrition and Preventative Medicine. When you enter the Web site you see the title and some colorful graphics of food items. I thought these would lead to links about the various food groups. But there are actually no links at all on this site. The entire Web site is fifty-two pages! It is designed like a book. There is an acknowledgment page, a table of contents, and then curriculum

pages. The Table of Contents displays an Introduction, Suggestions and Guidelines, Lesson outlines, Description of Props, and detailed lesson plans for thirteen lessons. When scrolling down to lesson plans, it is evident that each lesson is carefully designed with the same format. That format consists of "Subject, theme, duration of lesson, objective, materials, lesson presentation including starting lesson, lesson sequence and ending the lesson." Each lesson plan includes "teacher actions" and "student actions." "Teacher actions" consist of prescribed verbal scripts of actions, statements and questions and descriptions of material to be used. "Student actions" is the expected student response. At the end of the site is an address and phone number if you want permission to copy this program. Copies are permitted with no fees. This site could be valuable to new teachers who want to teach kindergartners through third-graders about various aspects of nutrition. It is almost a cookbook recipe. If you can gather the materials, all you have to do is follow the lesson sequence. There are no handouts or graphics that can be used. But there are plenty of ideas about how to teach this topic to children.

*Title:* Carbohydrates
*URL:* http://www.react.ie/Health/Nutrition/Carbohydrates.htm
*Grade Level:* High school and above
*Search Engine:* http://www.google.com
*Key Search Word:* carbohydrates
*Review:* The initial page of this Web site included a "type-written" text summary of carbohydrate function in the body, a classification of carbohydrates into simple and complex types, a comparison of the merits of refined and unrefined carbohydrates and examples of foods that typify each type. There was also advice "For the Athlete" on this page, advocating the uptake of certain types of carbohydrates prior to exercise, depending on the intensity and duration of the exertion anticipated. This page was informational, but not inspirational. Fortunately, the sidebar choices proved to be much more exciting and interactive. The first option selected, "Eating Habit Assessment," offered a quiz-style format to query the number of servings per food group per day a person consumes and then utilizes this data to rate one's responses and offer advice accordingly. The next option selected was the "Body Mass Index (BMI Calculator)." When height, weight, and wrist size data was entered, the BMI was calculated and then compared to separate standards established for men and for women. "Recommended Body Fat Levels" followed next, allowing

one to assess his/her BMI result and read the accompanying analytical commentary. One could also choose to visit the "Are You Overweight?" and the "If You Need To Lose Weight" choices from the sidebar, or not! Also provided here were "ideal weight" projections and calorie counters. Another text-oriented option was entitled "Body Type or Somatotype," which listed and defined the following genetic somatotypes: ectomorph, mesomorph and endomorph. The "Target Heart Rate" option was also interactive. Participants are asked to input their age and in return are provided with formulas to calculate their safe maximum heart rates for light and moderate-to-heavy intensity exertion. This information can also be selected to be calculated on screen. Concluding the sidebar choices was "Health Checks," which analyzed one's resting heart rate data and offered a "step test" heart rate rating, too. This site then links to a myriad of other sidebars, whose choices include nutrition basics and guidance, disease and cancer prevention by diet, food additives, individual nutrients, minerals, and vitamins! The plethora of information at one's fingertips, at this one site, literally exemplifies the scope and realm of the Web. The material presented was well within the grasp and reading level of most high-school students and adults. It is a very informative site with several valuable interactive modules for those determined to get a handle on their overall fitness ranking and those looking for a quick way to gauge their fitness progress.

*Title:* Biores
*URL:* http://bioresearch.ac.uk/browse/mesh/detail/c0007004L00070004.html
*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Word:* carbohydrates
*Review:* Biores is a site that provides information for biological and biomedical research. The carbohydrates page contains information about hypertext books and on-line books that go into great detail about carbohydrates. Each of the main topics mentioned on the home page have links to other sites for further information. The information found on this site seems quite advanced. This information would probably be most useful for college-level students who were studying these specific areas.

*Title:* PBS Teacher Source: Classroom Currents—Food Pyramid
*URL:* http//www.pbs.org/teachersource/thismonth/mar01/index2.shtm

*Grade Level:* Middle-school and high-school students (Grades 6–12)
*Search Engine:* http://www.yahoo.com
*Key Search Words:* teaching and carbohydrates and elementary
*Review:* This Web site was a teacher resource to assist teachers in enabling and empowering students to check up on their nutritional habits by maintaining three-day food journals to record everything that they eat and drink. The Web site also explored helpful activities to conduct with students to explore the issues of body image and the nutritional value of teens' favorite fast-food restaurants. For the first activity students would maintain a three-day journal to track their nutritional intake and at the conclusion, students would be able to tabulate their dietary entries, for example, calculating the number of fruits, vegetables, dairy products, and bread according to the food pyramid. The journal activity would expect students to record their nutrition intake and draw a food pyramid for each day of the process. Students would then compare their food pyramids with actual/real food pyramids online at the USDA Web site. The Web site provided a series of questions that the teacher would provide for the students so that they could assess their progress through this three-day food journal. This Web site offered activities to engage students in a survey activity to determine body image. In addition, it offered teachers activities for Health students to work in a group to develop a "typical" teen fast-food meal from popular fast-food establishments. Each group would choose a different fast-food restaurant by using nutritional pamphlets from the various fast-food restaurants or by accessing restaurant Web sites. Students would then find the nutritional information for fats, carbohydrates (minus fiber), and sodium. At the conclusion of this nutritional fact-finding activity, it offered the suggestions for teachers to include a scientific investigation to determine the nutritional value of fast foods. It stated the following: "Since most nutritional information available for fast foods is given in grams, science classes could be involved in measuring representative amounts of fat (shortening), carbohydrates minus the fiber gram(s) (sugar) and sodium (salt) to create visual displays. Students should be made aware of the number of grams needed to equal measurements with which they are familiar such as teaspoons, tablespoons, and cups." This was an excellent Web site for teachers, especially those that instruct Health Education and Science. This Web site offered helpful and user-friendly Web links.

*Title:* Carbohydrates
*URL:* http://www.successlink.org/great2/g644.html

*Grade Level:* Grades 10 and 11
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* teaching, carbohydrates, 9–12
*Review:* This link suggests an activity for high-school students in grades 10–12: a performance event that requires that students show an understanding of carbohydrates and indicators to determine if a food contains carbohydrates in the form of starch or simple sugars. The student will have to plan an experiment that will test a new product for the presence of starch and simple sugars. Students will need the prerequisite knowledge of the chemical makeup of carbohydrates in the forms of starch and simple sugars, how Benedict's solution and iodine react with starch or simple sugars, and how to plan a scientific experiment.

*Title:* Food and Nutrition for Grades Preschool through 6
*URL:* http://www.nal.usda.gov/fnic/pubs/bibs/edu/preschool.html
*Grade Level:* Prekindergarten to grade 6
*Search Engine:* http://www.askjeeves.com
*Key Search Words:* carbohydrates and preschool
*Review:* This Web site is a little lengthy, but I feel it is worth reading. As teachers, we are always searching for ideas on ways to teach concepts. This site gives tons of curricula/lesson plans for teaching, activities for children, and even audiovisuals to help teach a concept. Another aspect of this site that is exciting is the link for resources for teachers. This Web site is probably best for districts searching for new units to implement in the district.

*Title:* KidsHealth
*URL:* http//kidshealth.org/kid/stay_healthy/food/protein_carb_fat.html
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Review:* This Web site requires reading but may be too elementary for high school. It appeals to the humor in science, provides real-life pictures to demonstrate meanings, and provides pronunciations and definitions for hard words. The Web site features a variety of health-related articles located on the left sidebar, such as Dealing with Feelings, Staying Healthy, Everyday Illnesses and Injuries, My Body, Growing Up, Kids' Talk, People, Places and Things That Help Me, Watch Out, The Game Closet, Kids' Health Problems, and a Glossary. In order to get to the section containing information on carbo-

hydrates, select Staying Healthy from the left sidebar. After the article comes up, scroll down until you see the section titled "Fabulous Foods." Here is where you will find information on carbohydrates. There are links to other Web sites: the American Dietetic Association and the U.S. Food and Drug Administration's Children and Tobacco Web sites. Overall, the KidsHealth Web site is easy to get through. Either read the entire page and then click on "next page" to get through the entire article, or choose the page directly that you want to read.

**Chemical Engineering**

*Title:* C&EN's Top 75 Profile Glenn Seaborg: A Towering Figure in Chemistry
*URL:* http://pubs.acs.org/hotartcl/cenear/980112/seaborg.html
*Grade Level:* Middle school through college
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemical engineering
*Review:* This site is an article found in *Chemical & Engineering News*, January 12, 1998, containing a biographical sketch of the life and work of Glenn Seaborg, who received the third highest number of votes in the balloting process of C&EN's Top 75 Distinguished Contributors to the chemical enterprise. Glenn Seaborg, one of the pioneers of nuclear chemistry, has devoted his life to chemistry, government service, and academe. After his discovery of plutonium, Seaborg worked on the government-sponsored Manhattan Project, the project in which the production of plutonium was aimed at development of the atomic bomb. Later, President John F. Kennedy appointed Seaborg to the chair of the Atomic Energy Commission, which he maintained for the next ten years. Seaborg is an author and Nobel Laureate, whose life and accomplishments are described on this Web site. This site is a good resource for the student who is looking for biographical information concerning this famous and legendary name in chemistry. It provides a brief glimpse into this scientist's accomplishments.

*Title:* K–12 Grade Lessons
*URL:* http://www.chemindustry.com/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials on chemical engineering

*Review:* This is the major directory and search engine for chemical engineering. It provides lists of chemical engineering Web sites, experts, chemical names, and jobs. It also has a global list of chemical manufacturers. Two search windows are provided, one that searches for an expert in the field and the other that searches generally. In addition, the site has a listing of chemical manufacturers, resources, equipment and software, career and personal pages, organizations, industry services, academic institutes, and events. In addition, there is a direct link to the journal *C & E News*.

*Title:* Chemical & Engineering News
*URL:* http://acsinfo.acs.org/cen/
*Grade Level:* Grade 3 to college
*Search Engine:* http//www.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* The Web site is formatted as an on-line magazine, providing a comprehensive table of contents, namely, articles, editorials, and job opportunities. In the education section of the site, there is an Internet-based K–12 educator link. There are weekly featured articles, many of which are suited for most grade levels. Parts of the site require a subscription. This site is easy to navigate and quite interesting for most ages.

*Title:* The World-Wide Web Virtual Library: Chemical Engineering
*URL:* http://www.che.ufl.edu/WWW-Che/index.html
*Grade Level:* High school and undergraduate
*Search Engine:* http://www.aol.com
*Key Search Words:* chemical engineering
*Review:* This Web site was referred to as a virtual Web site in the aol.com search I conducted. This site is basically a resource page and can be used to further research chemical and process engineering. At the top of the page just under the title, "Chemical Engineering," I noticed "Chemical and Process Engineering" typed in blue characters and decided to click on it. I discovered a half-a-dozen more headings I could click on to get an explanation of chemical engineering. Most of the sites were not accessible. However, I kept at it and found a terrific page titled, "History of Chemical Engineering." The author of the page, Wayne Pafko, wrote a disclaimer in the beginning of his page. Briefly he stated that the page should be viewed as a brief tour with the hope that it will stimulate the reader to further explore the field of chemical engineering. He goes on to explain what chemical engi-

neering is and is not. As he put it, "Chemical engineering is not intended to describe the type of work the Chemical Engineer performs, but it refers to the branch of engineering that is being employed." He whets the reader's appetite by listing the ten greatest achievements in the field of chemical engineering, such as the ability to split the atom, plastics, diagnostic devices and artificial organs, increasing the yield of antibiotics, bullet-proof vests, nylon stockings, tires, running shoes, catalytic cracking, and biotechnology. Next, I decided to return to the home page and explore some of the subtopics listed on the sidebar. The subtopics are listed in alphabetical order and range from analytical methods to water technology. I checked out the education resources and discovered numerous listings for general information regarding catalogs, quarterly journals, directories, and classified ads all relating to chemical engineering. I clicked on "Instructional Software for Chemistry" and found a resource with an emphasis on lessons, digital textbook chapters, and other alternative methods of instruction. Next, I checked out "Teaching Topics and Resources" and realized that it repeated just about every resource that I found listed in the section entitled "Education Resources." I scrolled down the home page and found another heading that listed organizations. The organizations are subdivided into academic, professional, research, labs, and providers. The academic organizations are listed geographically and alphabetically. The next heading on the home page was "Relevant Informational Resources." It gives a review of the virtual catalog, information indexes, news groups, bulletin boards, periodicals, publishers and the WWW virtual libraries. This page lists about a dozen topics to explore in the virtual library. Wow! I was up for the adventure of exploring them. However, every site I clicked on could not be accessed. I found this very disappointing. Even though I could not access the virtual library I found this site to be worth a visit if only to gain a better understanding of what chemical engineering is and how it has benefited humankind over the years.

*Title:* Chemical Engineering
*URL:* www.engin.umich.edu/labs/mel/index.html
*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Words:* chemical engineering
*Review:* The Multimedia Educational Laboratory (MEL) is part of the Chemical Engineering Department at the University of Michigan. This site creates computer-based modules for the advancement of

chemical engineering understanding. These modules include the following: The Visual Encyclopedia of Chemical Engineering Equipment, Materials and Energy Balances Multimedia, and Chemical Engineering and Biological Systems. This is a great site for college students; however, there is a registration fee.

*Title:* New ChE in Every Day Life Article: Chemical Engineering around the House
*URL:* http://www.cheresources.com/aroundhouse.shtml
*Grade Level:* Intermediate through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical engineering information
*Review:* The site contains many articles that you can click on depending on interest or need. I clicked on Christopher Haslego's article "Chemical Engineering around the House" because as an educator, I like to see how a subject that seems scary, and at first impression, irrelevant to learn by students, can be connected to everyday life. The author, utilizing a simple example of a soda bottle that had collapsed simply because his wife had sealed it tight after cleaning it with hot water, explained how the same is true in industry when an operator cleans a tank or process vessel and seals it too soon after cleaning it, thereby destroying it. It helps makes a connection and foster understanding of this phenomena. Other articles at this site are handled much the same way. Sites like this help answer the question most asked by students: "Why do I need to learn this?"

*Title:* History of Chemical Engineering 9–12
*URL:* http://www.lycoszone.com/dir/Homework/Science/Engineering
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Review:* This Web site written by Wayne Pafko. The history of chemical engineering begins with its conception in 1888 in Great Britain. The goal of this Web site is to start at the beginnings of chemical engineering and discuss its contributions over the past 100 years. Answering some of the important questions pertaining to what chemical engineering is and some of the problems of the profession, the Web site includes a table of contents broken up into the following sections: Background, Past and Present, Charts and Tables, Case Study, Appendix, and World Wide Web. Each of these areas has significant amounts of information that would be useful for students. The site

can be displayed in PDF format. Links to other chemical engineering Web sites are also provided.

*Title:* ChemIndustry.com (Search Engine)
*URL:* ChemIndustry.com
*Grade Level:* Advanced high school and above
*Search Engine:* http:/www.askjeeves.com
*Key Search Words:* chemical engineering
*Review:* My search in Ask Jeeves delivered a search engine of sites for everything one could ever want to know about chemicals and the industry. This search engine has been operating since April 1999 and has over 65,000 listings available to the user. The home page offers tabs across the top: Submitting a Site, Affiliate Programs, Login (to make purchases of equipment), About Us, and Home Page. Clicking on the About Us tab explains the goal and mission of the engine itself: a comprehensive directory for chemical and related-industry professionals that maximizes the use of the WWW as an information source for any professional working in any part of the chemical industry. It is available in English, Chinese, French, and German. Tabs within the About Us section are Key Personnel, Editorial Staff (both have photos and minibios), Job Opportunities, and Partners. There are also tabs for Submit a Site, Chemical Name, and Expert, where, for $250, one can search for and arrange a chat with an expert in the chemical industry; there is also a "Featured Expert," complete with a photo and short biography. While on the home page, scrolling down a bit, you will find a Search Box and Help button (available anywhere in this engine). The opening page has links to topics such as chemical suppliers, equipment, software, lab suppliers, resources, organizations, academic Institutes, and resources. Each topic is broken down to over twenty subdivisions with links to specific Web sites dealing with that particular topic. Each site itself lists its name, description, country it is derived from, and its URL. The topic of resources in this area has a link for Chemical Engineering. Clicking on that brings you to links to sites for subtopics such as Technical Information, Industry Services, Dynamics, and Job Opportunities. The right side of the opening page lists information about the chemical industry with links to What's New, Facts/Figures, Newsletter Sign-up, and even a Best Chemical Site Contest. This search engine is very easy to navigate through because everything is broken down thoroughly. College students, perhaps advanced high-school students, and any professional in the chemical industry will find this site extremely useful.

*Title:* The Chemical Engineer Resource Page
*URL:* http://www.cheresources.com/indexzz.shtml
*Grade Level:* High school and above
*Search Engine:* http://www.google.com
*Key Search Words:* chemical engineering
*Review:* The Web site is in sections and menus. The ChE Services menu will guide you through the Web site. ChE Assist, ChE Systems, and ChE Surplus are the three sections that you can use. "ChE Assist can be used to solicited professional assistance for a chemical processing problem, it also gives you advice from someone experienced in your area of need or if you're seeking the help of a licensed professional engineer." ChE Systems is a service designed to help you gather and evaluate bids for modular chemical processing equipment. "ChE Surplus is a one stop shopping center for visitors looking to buy or sell used equipment." In addition, there are articles on various subjects that are posted for people to see.

*Title:* The Newsmagazine of the Chemical World Online
*URL:* http://pubs.acs.org/cen/
*Grade Level:* Undergraduate and graduate students
*Search Engine:* www.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* The Newsmagazine of the Chemical World Online is an in-depth site for individuals interested in the field of chemical engineering. A cover story and top story are found on the home page as well as many links to other sites. The main links on this site include News of the Week, Cover Story, Business, Government, and Science/Technology. All of the links provide a wealth of information about chemical engineering. This site seems to be updated on a weekly basis so that it stays current with the most recent information. In order to get the most out of this site, you need to be able sit down and take a look at all of the information and links found on the home page.

*Title:* Sprocket Works
*URL:* http://www.sprocketworks.com
*Grade Level:* Middle school to high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* children + chemistry
*Review:* This Web site provides a wealth of information on various topics surrounding science. From the home page, you can click on which-

ever topic is of interest to you. Other topics include Oceans, Biology, and Space. Once you click on Chemistry, it will bring you to a page that offers various choices of subtopics. This section includes an interactive periodic table of elements, a build-a-molecule feature, games, trivia, and a glossary. The glossary provides many terms relating to chemistry, including inorganic chemistry, and detailed definitions of each. The Web site offers interesting graphics and an eye-pleasing layout that would hold the attention of any student. Many of the subtopics offer animations and interactive experiments, which further help explain certain areas of chemistry. The only drawback to this site is that it takes quite a bit of time to load each section. When you click from the main topic to a subtopic, it takes a while for all of the graphics to pop up, but if you have the patience, it's well worth it.

*Title:* Career Choices for Chemical Engineers
*URL:* http://www.aiche.org/spins/careers/
*Grade Level:* College undergraduate, graduate, and professional engineer
*Search Engine:* http://www.google.com
*Key Search Words:* chemical engineering
*Review:* Although some Web sites do not live up to expectations, this site delivers not only a comprehensive view of the many employment opportunities available in the chemical engineering field, but also posts job listings and educational trainings. The home page, or "Overview," provides brief summaries of job descriptions within the field and outlines the necessary entry background knowledge or interests throughout the scope of chemical engineering. The colorful sidebar contains the options listed below, in sequence. The first sidebar is entitled "Job Descriptions." This choice proved to be most interesting as it provides a QuickTime movie of an employee to accompany each job function and description. The job descriptions ran the gamut from process engineering to the sales and marketing of the product. A QuickTime program download is available at this site, if the browser does not already have a subscription to QuickTime. The next sidebar in the sequence is "Industry Profiles," where employment in the chemical-processing industries is explored. As quoted from this section's introduction, "The CPI's focus is on the development, extraction, isolation, combination, and use of chemicals and chemical by-products." "The Workplace" is the next sidebar. In this section, average starting salary offers are noted,

between the dates of September 2000 and January 2001, for recently graduated chemical engineering students as well as for more seasoned chemical engineers with advanced degrees and years of experience. The site was last revised in April 2001. The "Products Available" sidebar addresses the amazing number of items manufactured or produced by chemical engineers. After viewing this compilation, it was difficult to isolate any product that was not in some way affected by chemical engineering, at some point in its design, development, or packaging. In the "On-line Resources" section, journals and Web addresses (URLs) are provided for general career planning and guidance. Additional information sites for related topic information or for more specific searches are also referenced. Information concerning conference dates and locations, related publications, membership, career and employment opportunities, education and training sessions, a summation of the key issues in the industry, and government regulations are all included when the AIChE home page sidebar was chosen. There was also a section here that was dedicated to the student and/or young engineer. The last sidebar, "AIChE Career Services," offered job listings and conference information, but also included sections entitled, "Tools for Engineers," "Tools for Employers," and "Tools for Students," a "Members Only" option, and a FAQs selection. It is difficult to imagine any concern related to chemical engineering that was not touched upon, or referenced to, by this Web site. Its comprehensive approach, its substantial documentation of resources, and its video interview and imaging should provide the interested browser with a reasonably complete view and perspective of the interest areas and the employment possibilities and probabilities in the field of chemical engineering.

Title: Chemical Engineering Learning Resources
*URL:* http://www.svce.ac.in/~msubbu/
*Grade Level:* Undergraduate/graduate/postgraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* This time my search led me to Chemical Engineering Learning Resources. This site was started in July 1999 by M. Subramanian of the Department of Chemical Engineering, Sri Venkateswara College of Engineering (SVCE), Tamil Nadu, India, with the help of Dr. V. Ravichandran and Mr. B. Muthukumaran of the Molecular Chemistry department. Encouragement was given by Mr. B. Nedu-

maran and the students of chemical engineering. The infrastructure was provided by SVCE. The page is set up with what I call hover buttons. These are buttons that light up when the mouse passes over them. Some of the hovers take the user to a brief history of the site, to a section of lecture notes, or a section of downloadable material, which includes some of the recent software developed by this page designer. The "Solved Problems" hover button offers solved problems for chemical engineering subjects. Presently, problems for fluid mechanics, process calculations, chemical reaction engineering and mass transfer, and thermodynamics are available. A ChE-Hints button leads you to useful hints on chemical engineering topics and some definitions of chemical engineering terms. A question bank is offered, which contains a collection of questions for various chemical engineering subjects. You may also venture to "Useful Links," "ChemQuiz," or "Tutorial Links," which contains links to on-line tutorials for various chemical engineering subjects and other related subjects such as chemistry, math, and computers. Finally, there is a link called Higher Study Information. You may also choose to search the site using Google at the bottom of the first page.

*Title:* Chemical Engineering
*URL:* http://www.che.com/
*Grade Level:* Chemical engineering background
*Search Engine:* http://search.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* Chemical Engineering is a site to serve chemical engineers and related technical people in the chemical process industries (CPIs). On this site you can find articles that contain such topics as: chemicals, including petrochemicals; drugs and cosmetics; explosives and ammunition; fats and oils; fertilizers and agricultural chemicals; foods and beverages; leather tanning and finishing; lime and cement; synthetic fibers; metallurgical and metal products; paints and coatings; petroleum refining and coal products; plastics; rubber; soap and detergents; stone, clay, glass and ceramics; wood, pulp, paper and board; and other chemically processed products. You can use this site to find practical information that pertains to the field of chemical engineering that you are interested in. Chemical Engineering receives their articles from engineers and other technical persons in the CPIs. However, these articles are carefully reviewed on different standards and are related to education and job function. In order to receive these ar-

ticles, you must subscribe to Chemical Engineering, which makes this a pay site. However, once you subscribe, you can browse the site to find articles that interest you, or you can simply use the search engine to find certain articles.

*Title:* Hands on Activities (For Chemical Engineering)
*URL:* http://www.sme.org/memb/neweek/hpact.htm
*Grade Level*: Elementary school through high school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical engineering + elementary
*Review:* This page is actually a link that originates form the Society of Manufacturing Engineers. At first, I was confused as to where it came from because there was no headline other than "Hands on Activities." Following the links, I learned there was a National Engineers Week from February 16 to 22 in 1997. This page was designed to give teachers ideas for experiments to perform that are related to chemical engineering. A brief statement at the top of the page states, "The National Engineers Week Committee is providing engineers, teachers, parents and children with fun engineering-related hands-on activities." Each activity can be accessed by clicking on its name in the table of contents. There are sixteen activities, with titles such as "Electricity Transfer" and "Design a Product (Design Engineering)." Each activity has a grade level listed, and in most cases the topic within chemical engineering is listed as well. Some of the activities are related to television shows, such as "Make an Oscilloscope (Sound Patterns)" (*Beakman's World*). Several of these activities that have television show names in the titles have links to the Web pages for these shows. However, I tried to access two different television show links and was unsuccessful, which was disappointing. Each activity page is set up slightly different, but they all seem to have a format that includes indication of school level, purpose of activity, a list of materials, procedure, and questions for students. Activities are arranged in the following groupings of grade levels: grades 6–12, grades 5–10, grades 1–5, grades 6–8, grades 5 and 6, and grades 6–9. This site could be valuable to teachers, especially of grades 6–8. Some good ideas for experiments and activities to do with their students are presented. One drawback is that there are not a lot of links from this page, though one can get to the Society Of Manufacturing Engineers page, if need be.

*Title:* The World-Wide Web Virtual Library: Chemical Engineering
*URL:* http www.che.ufl.edu/WWW-CHE/index.html

*Grade Level:* Undergraduate/graduate/business world
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* This Web site is a resource Web site. The home page has subject catalog lists for information resources relevant to chemical and process engineering. The home page is broken up into three sections. The first section is subtopics. Here you can choose a specific topic, and it will bring you to multiple Web site listings regarding that topic. A few examples are Biotechnology, Energy & Conservation, and Polymers. The second section is organizations. Here you can get U.S., geographical, professional, and research organization listings. Again, you can click on one topic and it will bring you to several Web sites. The last section is relevant information resources. Some topics you can choose from are catalogs, patents, and periodicals. Lastly, the Web site has an e-mail address for questions or comments. This site is definitely a useful tool for the person in the chemical engineering field. The site is easy to navigate and provides a broad range of topics.

*Title:* Chemistry
*URL:* http//www.southern.edu/academics/departments/acad-dep-chemistry.html
*Grade Level:* High-school students (grades 11 and 12)
*Search Engine:* http://www.yahoo.com
*Key Search Words:* teaching and chemical engineering and career planning
*Review:* Due to the subject matter/concept search, I decided to explore chemical engineering from the prospective of a graduating high-school student who is pondering a career in chemistry prior to his or her entrance into college. This Web site is provided by Southern Adventist University and lists the various academic departments at Southern U., from Allied Health to Technology. On the topic of chemical engineering, the Web site provides an overview of the field of chemistry and described it as "Chemistry . . . a career of discovery." The Web site summarized the advantages of attending Southern U. and pursuing a career in chemistry: "Southern's chemistry program centers on quality instruction from professors who are dedicated to achievement from a Christian perspective. A knowledge of up-to-date techniques and the latest equipment helps our instructors prepare students for graduate or professional exams such as MCAT, DAT, OCAT, and VAT." In addition, the Web site provided information and a description of the degree

programs that a student could pursue and a perspective of the job market by choosing a career in chemistry, or chemical engineering. I found this site's use of terminology was user-friendly and not too technical for graduating high-school seniors that are exploring a career in chemical engineering.

*Title:* Why Become a Chemical Engineer
*URL:* http://www.cheresources.com/whyzz.shtml
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical engineering, career
*Review:* This is a link for students in high school that promotes the benefits of becoming a chemical engineer. It explores the different avenues you can take after obtaining your chemical engineering degree. The site gives the student some background on chemical engineering as well.

*Title:* Journal of Chemical Engineering
*URL:* http://pubs.acs.org/journals/jceaax/
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* This is a Web site designed by American Chemical Society (ACS) Publications. The left side of the Web page gives you access to information about the journal (sample issue, masthead, supporting info, author index, and licensing info). If you click on the "how to subscribe" button, you get to a page with a "members-on-line" button that provides rates and subscription information. If you click the "info for authors" button, you will get information on how to submit manuscripts. Clicking on the "advertising information" button gives you information for individuals and magazines. You can select a journal, and if you click on its button, it will give you pricing and publishing schedules. It also provides information on advertising specifications, for example, production specification for journals and magazines and general information for chemical engineering news classifieds. Going back to the home page, and still on the left side, you can find the "copyright" button and the "contacts/help" button. By clicking on the latter, you can contact the editorial office, customer service, and technical support and access the site map. On the center of the page, you can see the "what's new" title offering authors the opportunity to electronically submit their manuscripts. Right below that, there is a large list of articles that you can access on-line with your subscription to the journal.

*Title:* Chemical Engineering
*URL:* http://www.che.com
*Grade Level:* Chemical engineering students
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical engineering
*Review:* This is an on-line publication dedicated to the field of chemical engineering. The top of the page displays all the options of the Web site. Your options are article archives, a buyers' guide, preferred suppliers, advertisers, registration information, and subscription information. The current subscription rate is $39.50/year (twelve issues). The highlighted article was called "Terror-proofing CPI plants." Part of it was excerpted, and you can click on it for more info. Overall I think this site is very user-friendly and extremely easy to navigate.

*Title:* History of Chemical Engineering
*URL:* http://www.pafko.com/history/h_intro.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* teaching chemical engineering
*Review:* This site is a very helpful tool for students learning about chemical engineering. The layout is simple and student friendly. In addition, the site gives the goals of the site and what you should gain from researching more within the site. Also, the site states that although it is a good site, it only provides a basic overview of chemical engineering, and if you want to learn more, you should visit more sites. I would recommend this site to any student looking into learning the basics of chemical engineering.

*Title:* Chemical Engineering
*URL:* http://www.chemistry.about.com/cs/engineering2/index.htm
*Grade Level:* College (undergraduate)
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemical engineering
*Review:* This Web site provided by About.com is from their homework help section. The subject is titled Chemical Engineering, and the Web site contains two pages of articles and topics, including biomedical engineering, fluid dynamics, corrosion, distillation, and heat and mass transfer. There is also a site that focuses on the basics of this topic called The Introduction to Chemical Engineering. About.com has provided a thorough look at this topic with its assortment of the different subjects that can be researched by students.

### Chemical Reactions

*Title:* Chemistry About
*URL:* http://chemistry.about.com/
msu . . . +%2Bon+%2Bchemical+%2Breaction
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for chemical reactions
*Review:* At the home page search window, type in the words "chemical reactions." This will lead you to a list of topics and activities that you can perform. The list includes chemistry experiments, soap and saponification, how to create an exothermic reaction, chemistry—medical, and safety, to name 5 of the 806 different topics that are available. You can also refine your search by clicking on the following links: Chemistry, Chemical Reactions in a Bag, Types of Chemical Reactions, Chemical Reactions in the Classroom, Chemical Reactions Equations, Explosives Chemical Reactions, Reaction, and others.

*Title:* Chemtutor
*URL:* http://www.chemtutor.com/
*Grade Level:* High school through college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for chemical reactions
*Review:* Basic chemistry help for high-school and college students. At the main menu, either click on "chemical reactions" or "oxidation and reduction reactions." You now must choose from a list of topics, which will further discuss chemical reactions. The information is clear and well written and provides examples, and this is a good tutorial Web site for basic chemistry information.

*Title:* Chemistry 100
*URL:* http://www.piedmont.tec.sc.us/CHM100/equations.html
*Grade Level:* High school through college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* tutorials for chemical reactions
*Review:* At the main menu, choose either "types of chemical reactions" or "types of reaction exercises." If you click on "types of chemical reactions," you will be led to information with examples and more importantly practice problems that allow you to work and check your

answers. This is a well thought-out tutorial site, and it has been selected by science educators to put in their Sci Link Web site.

*Title:* Grade Six Science—Chemicals and Reactions
*URL:* http://www.sasked.gov.sk.ca/docs/chemistry/chem20.html
*Grade Level:* Grade 6
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical reaction experiments
*Review:* This tutorial comes from the Saskatchewan Education Department in Canada. Click on "Chapter VI, Chemical Reactions." This leads you to the curriculum, including objectives, activities, and assessment suggestions. The activities are found under the "suggested activities and ideas for research projects" section.

*Title:* ChemWeb 2000: Balancing Eq. & Types of Reac.
*URL:* http://library.thinkquest.org/19957/
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical reactions + high school
*Review:* ChemWeb 2000 is a Web site containing a comprehensive list of links to topics in chemistry. The page dedicated to chemical reactions can be accessed by clicking on the "Balancing Equations and Types of Reactions" link, located on the left side of the page. This will bring you to a page entitled "Balancing Eq. & Types of Reac." The left side of this page has links to three topics: What Are Chemical Equations?, Balancing Equations, and Types of Reactions. Each link leads to a good summary of the topic that also contains sample chemical equations. Located directly under the title of the page are three more links: Questions, Search, and Glossary. The questions section contains several self-correcting sample problems. The titles of the other two sections are self-explanatory. Overall this Web site offers a good introduction to the topic of chemical reactions but lacks real depth in the subject.

### Chromatography

*Title:* LCGC Magazine Online
*URL:* http://www.lcgcmag.com/
*Grade Level:* Adult
*Search Engine:* http://www.metacrawler.com

*Key Search Words:* chromatography tutorials
*Review:* This chromatography reference magazine enables you to browse their author or subject index, access their peaks of interest page, search their job-posting section, and directly link to chromatography resources and buyers' guides.

*Title:* Chemdex
*URL:* http://www.shef.ac.uk/~chem/chemdex/chemdex/education.html
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chromatography tutorials
*Review:* This Web site is the chemistry directory on the Internet. At the main menu, you can choose from a list of links, including Key Lists, Bad Science, Chemistry On-line Calculations, Chemistry Education Resources, Chocolate, On-line Books, On-line Resources, and Popularizing Chemistry, to name a few. Clicking on any of the above links leads you to a list of resources with direct click-on links to the resource. Chemdex.org has existed on the WWW since 1993 and has over 5,000 links to the latest chemistry resources. It is updated on a regular basis and is maintained by the Royal Society of Chemistry and the Department of Trade and Industry in the United Kingdom. This is an excellent resource.

*Title:* The Gene School—Experiments
*URL:* http://library.thinkquest.org/19037/experiments.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chromatography experiments
*Review:* This Web site contains various chromatography experiments, games, and quizzes, including DNA extraction protocols, a section detailing how enzymes work, and a section on paper chromatography. The experiments contain directions and explanatory pictures. The quizzes allow you to interact on-line and check your answers. The games also provide keys at the end of the game. These are very user-friendly. This site is a great resource for activities with a plus added.

*Title:* Science Connection—Crime Lab
*URL:* http://student.biology.arizona.edu/sciconn/crime/teacher_crime.html

*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chromatography experiments
*Review:* This Web page contains an experiment on paper chromatography. It begins with the explanation of the lab activity written for the teacher. The activity spells out the materials needed, the preparation needed, and the experimental procedure. This lesson could be used by a student at home or by a teacher for a class. It is very well written with meticulous directions.

*Title:* Chemistry Experiments
*URL:* http://www.geocities.com/Heartland/Acres/6690/chmistry.htm
*Grade Level:* Grade 6
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chromatography experiments
*Review:* This Web page includes two chromatography activities: coffee filter chromatography and bottled rainbows. The activities are extremely simple and well explained.

*Title:* About Chromatography
*URL:* http://search.about.com/fullsearch.htm?terms = Chromatography&Site = home&SUName = home&TopNode = %2F&PM = 59_100_S
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chromatography experiments
*Review:* At the home page, you will be provided with ninety-two Web sites in which to explore the world of chromatography. Clicking on any of the ninety-two links leads you to again another list of excellent resources in chemistry. The links are current, and I found none that led me to a dead end.

*Title:* Kitchen Chemistry
*URL:* http://personal.cfw.com/~rollinso/SciFood.html
*Grade Level:* Elementary school (to grade 6)
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chromatography experiments
*Review:* This is a Web site developed by a woman from her home. Either click on the "candy" link or scroll down to "candy chromatography." This is a simple lab activity that can either be done at home or at

school. It is well written; however, even though the references are provided, the "science content" is missing in the activity. No direct link to the references is provided.

*Title:* Chromatography Forum
*URL:* http:www.chromatographyforum.com
*Grade Level:* Undergraduate/graduate/postgraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* chromatography
*Review:* This Web site is a public discussion group where you can post questions and news, answer questions, or just browse new postings for information. There is another section for new postings and archived postings that dates back to 1999. The Web site is overseen by a panel of advisors who moderate the forum. The Web site is very easy to navigate. There are sections for help, tools, and discussions. The help section consists of how to get started, formatting a message, and troubleshooting. The "tools" section allows you to search a specific day, keyword, or contact name. The last section, "discussions," allows you to locate postings from the previous day or week. The Chromatography Forum seems to range from average to highly technical questions. This site is definitely useful for a person who is involved in this field. It also enables you to make contacts with other professional in your field. I would recommend this Web site. It is very easy to navigate and can be a great tool for finding answers to questions you may have regarding chromatography.

*Title:* Intro to Chromatography
*URL:* http://www.rpi.edu/dept/chem-eng/Biotech-Environ/CHROMO/chromintro.html
*Grade Level:* College undergraduate
*Search Engine:* http://www.google.com
*Key Search Word:* chromatography
*Review:* This Web site opened with a text format, accented by chromatographically inspired multicolored lines. The introduction page provided a definition of chromatography and briefly asked and answered questions about the general techniques involved and why the process was important. When the "Do You Want to Know More?" selection was chosen, the following highlighted choices were brought into view. This browser chose to proceed, sequentially: The Equipment Used, Basic Operation, The Output: The Chromatogram, Different Types of Chromatography, Another Overview of Types of Chro-

matography, Scale Up, Preparative Chromatography, List of References, and See Prof. Cramer's Chromatography Course. The first option, "The Equipment Used," listed the necessary components for a column chromatography setup, differentiating between the packed bed and the open tubular methods. It also presented a diagram of a column chromatography, labeling the stationary and mobile phases. Gas and liquid chromatograms were mentioned here also. The "Basic Operation" module could be accessed independently but could also be reached by continuing along with the first selection. A text review section outlined the basic laboratory protocol most chromatographs follow and was supplemented by animation that could be triggered to show, via red and green dots, a model of the molecular dispersion of a mixture, as it passed down through a column. "The Output: The Chromatogram" option displayed an artistic rendition of a separating column sample chromatogram, whose peaks designated its component molecules. This information was then analyzed to determine the identity of the molecules involved. Gas, liquid, ion exchange, and affinity types of chromatography were presented in the selection entitled, "Different Types of Chromatography." Each of these general categories was then subdivided into more specific protocols. Gas chromatography, for example, listed three different methods: gas adsorption, gas-liquid, and capillary gas procedures. Liquid chromatography offered four varieties; ion exchange offered two; and affinity offered one, based on one specific molecule's attraction for another. "Another Overview of Types of Chromatography" included a simplified yet thorough comparison of the basic types of chromatography. Sketches and explanations were done by a former student, Kevin Yip. Modifications to increase the size of the chromatography column usually suggest either lengthening or widening the column to allow for greater separation. In the "Scale Up" section, equations are given to calculate a scaled diameter and to then relate and equate linear flow rate between the scaled and unscaled conditions. The "Preparative Chromatography" section was advertised but was not obtainable. An apologetic note was provided that directed the browser to use other suggested URLs instead to reach this information. A list of references was given to acknowledge and credit sources contributing to this Web site. The final selection, "See Prof. Cramer's Chromatography Course" listed chromatographic separation procedures planned for a Spring 2002 semester course. Also provided were instructors' and teaching assistants' locations and office hours schedules, a course outline, course materials, a student work outline and grading schedule, a

laboratory demonstration section, and computer simulations. Based on the reading level and topic selection options, this Web site presents the uninitiated undergraduate college student with a general overview of the complex topic of chromatography in its various forms. The information is presented in a professional yet nonthreatening fashion for the student contemplating taking this type of course, either as an extension of or follow up to an introductory college chemistry or biochemistry class. The diagrams are helpful and user-friendly. The syllabus outline allows the prospective student to view, assess, and anticipate the intensity and scope of the topic prior to registration for an actual course. This Web site yielded a wonderful, exploratory view of chromatography and its valuable applications to the scientific world.

*Title:* Western Carolina Chromatography Discussion Group (WCCDG)
*URL:* http://www.members.aol.com/chromgroup/index.html
*Grade Level:* Undergraduate/graduate college level
*Search Engine:* http://www.aol.com
*Key Search Word:* chromatography
*Review:* This Web page was formed in 1987 and was designed to provide chromatographers with opportunities to dialogue with other professionals in the field. Directly below the title was a brief introduction to the page and a bulleted table of contents. The first bullet was titled "Upcoming Events," so I clicked on to it. I discovered an out-of-date listing of local meetings, other chromatography related events, and past meetings and conferences, which listed past symposiums, workshops, meetings, and discussion programs that had taken place all over the country between the years 1996 and 2000. I was surprised this page had not been updated in two years. I began to feel this was a waste of time and started to shut it down and look for a new site to review when I decided to explore one of the past meetings. I chose a seminar that took place back in July 1998 in Spartanburg, South Carolina, titled, "Forensics and Chromatography." The subject matter caught my interest. However, this page was not found. Red flag! Next, I checked out the bulleted title, "Membership Information," and discovered that for a mere $10 a year, you too can become a member of WCCDG, just be sure to include your name, address, phone number, fax, and e-mail address in your application for membership. This page was last updated on January 22, 1999! Where are all the chromatographers? Next, I checked out "Links & Chromatography Related Web Sites." This section offered five sections: Chro-

matography, Other Discussion Groups, Chemistry, Local Chemistry Departments, and Commercial Sites. I clicked on the Chemical Separations Tutorial under the title "Chromatography" because it was labeled in bright yellow as being NEW. To my disappointment it was not to be found! Next, I tried "Another Intro. to Chromatography," hoping to garner a better understanding of the process of chromatography and what a chromatographer does and discovered another dead end. I decided not to waste my time and instead changed my focus to another section titled "Other Discussion Groups." I chose to click on North Jersey Chromatography Discussion Group (http://njacs.org/chroma.html ) to see what was cookin'. This was a terrific site! It offered up-to-date information. The discussion was "AN Intro. to LC-MS and Its Applications," by Philip Tiller of Merck & Co. and Mark Hail of Novatia, LLC. This site offered an abstract of that discussion, biographies of the speakers, registration forms for meetings, notification of future meetings, and a list of officers of the organization. Great site! At the end of my exploration I returned to the home page and noticed at the bottom a request that visitors to the page leave comments. Mine were as follows, "Web site discussion groups are always a great idea, but they must be maintained and up-dated to really promote technical and professional growth in the field they designed for, otherwise they become a waste of the visitor's time." I returned or tried to return to the WCCDG site this morning before posting this review and to my surprise I couldn't access it! Maybe someone is checking out the comments! All-in-all, I wish I hadn't spent so much time checking out this site. On a more upbeat note, I did discover the North Jersey Chromatography Discussion Group and it is worth a visit.

*Title:* Paper Chromatography
*URL:* http://chemistry.rutgers.edu/genchem/chrompap.html
*Grade Level:* High School (advanced class), and college
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* chromatography
*Review:* Use of this Web site requires some prior knowledge of chemical solutions. I found it to be very clear in instruction for the experiment to be performed. Background information and reasons for using the specific materials in the experiment were given. Step-by-step instruction was given, along with a picture illustration of what results should be seen. There were comprehensive questions asked at the end, where the answers could be found by clicking on "answers." I particu-

larly liked the fact that this experiment was related to the tarnish found on a silver key ring or silverware. This Web site takes a scientific topic and relates it to an everyday experience, helping the learner connect the concept for better comprehension.

*Title:* Chromatography
*URL:* http://home.att.net./~GCresources?GCmain.html
*Search Engine:* http://www.lycos.com
*Key Search Words:* chromatography Web sites
*Review:* After looking for over an hour for a chromatography Web site that would be interesting for students of any level, it was extremely refreshing to find this site. The entire site is choreographed to different songs. When you enter this Web site, the Smashmouth song "Walking on the Sun" plays. This is somewhat refreshing when looking up this subject. I found this Web site to be most informative in educating the learner on what chromatography is. Paul Adams created this Web site for his own pleasure in educating others on chromatography. He uses gas chromatography in the field of refining and petrochemicals. The home page offers four educational resource links: Gas Chromatography, Kids Chromatography, The GC Files, and Sea Monster or Shark? I opened Sea Monster or Shark? first. It begins with a Devo song, which was very cool. This is a true story about how scientists used ion-exchange chromatography to identify a large carcass (4,000 lbs.) found by Japanese fisherman in 1977. I don't want to spoil the story for you so you'll have to read this one for yourself. Next I traveled around this Web site and found some useful information to use with small children. There was a page on chromatography and the color of leaves. There is some useless material on this site along with useful information for students of all levels. The music adds some creativity on this Web site, which helps to make the learning fun.

*Title:* What Is Chromatography?
*URL:* http://www.eng.rpi.edu/dept/chem-eng/Biotech/Environ/CHROMO/chromintro.html
*Grade Level:* College undergraduate majors/graduate
*Search Engine:* http://www.askjeeves.com
*Review:* The entire site provides the biology or chemistry major an overview of the chromatography process. The first page explains what chromatography is, how it works, and why it is special. The bottom link, Want to Know More?, takes you to a page of nine links

to choose from, all subsidiaries of the chromatographic process. The first link, Equipment Used, shows a somewhat fuzzy but labeled diagram of laboratory equipment used in the separation process, and each labeled part has an explanation of what it is and how it works. The next link, Basic Operation, shows the user a different diagram and explanation, with a link to an animated separation process. The third link to a chromatogram shows the user yet another diagram (a little blurry but readable), with detailed information on the process. The fourth link, Different Types of Chromatography, lists links to four types, with each link giving a detailed explanation. The fourth type listed, Affinity, has its own link called The Works, which provides the users with an additional three-page explanation to this type of chromatography. Cute little links at the bottom of each of these pages help you return to the home page if "you have had enuff." There are also informative sketches by scientist Kevin Yep to help with understanding. The fifth link in the main menu, Another Overview of the 4 Types, is one page of one-paragraph explanations and mini-diagrams. The Scale Up-link, the sixth, explains a ratio formula that can be used with a chromatography column when the amount needs to be enlarged. The seventh link, Preparative Chromatography, was not accessible. The eighth link to references lists the manuals from which the information was gathered. The final link to Professor Cramer's Chromatographic Course gave Professor Cramer's class information for the Spring 2002 semester, complete with office hours.

*Title:* Chromatography
*URL:* http://www.rpi.edu/dept/chem-eng/Biotech-Environ/CHROMO/chromintro.html
*Grade Level:* Undergraduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* chromatography
*Review:* Using Metacrawler and the key search word "chromatography" returned many different hits of companies that were either in the chromatography field or manufacturers of chromatography-related products. I did finally come across a rather nice page describes chromatography and tells what it is, how it works, and why it is special, and if you want to know any more, it gives a couple of Web sites. The Web site that started off simply with a definition ("it is a

broad range of physical methods used to separate and/or to analyze complex mixtures"). The components to beseparated are distributed between two phases: a stationary phase bed adn a mobile phase, which percolates through the stationary bed. This was good because I really had no idea what it was. It went on to further explain that "the components to be separated are distributed between two phases: a stationary phase bed and a mobile phase which percolates through the stationary bed." I would have to read on from this point! The second heading was "How Does It Work? Like Magic!" This section describe simply how the process works. Basically, a "mixture of various components enters a chromatography process, and the different components are flushed through the system at different rates. These differential rates of migration as the mixture moves over adsorptive materials provide separation." The third section was entitled, "So, Why Is It So Special?" According to this page, it is special because it can separate complex mixtures with great precision and it can be used to separate delicate products. The final section was labeled "Do You Want to Know More?" This section states that because chromatography has so many wonderful applications in the biotech industry, they want to offer links to the following topics: The Equipment Used; Basic Operation; The Output: The Chromatogram; Different Types of Chromatography; Another Overview of Types of Chromatography; Scale Up; Preparative Chromatography; and List of References. This page was good yet simple. It is a perfect starting point for someone with little or no knowledge on the subject.

*Title:* Chromatography Forum
*URL:* www.chromforum.com/
*Grade Level:* chromatography background
*Search Engine:* http://search.metacrawler.com
*Key Search Word:* chromatography
*Review:* Chromatography Forum, a free site, is a public discussion group where you can post questions, news, or messages of interest to chromatographers everywhere. To use this Web site, simply click on a topic of interest on the message board. Once you have clicked on a topic, you can respond by scrolling down to the bottom of the screen and entering a message in the "Add a Message" area. If the message is a public posting, then you do not need an account. To start a new conversation or post a question, click on the "Create New Conversa-

tion" button. In order to obtain a password, you must contact the moderator by e-mail (info@LCResources.com) and send the serial number of your DryLab program.

*Title:* Chromatography Technology Service Corporation (CTS)
*URL:* http://ctshplc.com
*Grade Level:* College and adult
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* chromatography
*Review:* The CTS is a Web site created by the Chromatography Technology Services Corporation. This corporation provides services for those using high-pressure liquid chromatography (HPLC) instruments. Both the left side of the page and the center of the page offer the same buttons: Links lead you to information about the corporation and how to reach products and services offered. If you click on "Free Printed Catalog," you can get an order form to obtain the catalog. If you click on "Browse On-line Catalog," it takes you to a page that shows manufacturers, gives general info, allows you to place an order, and directs you to other helpful pages. Clicking on the third button, "Repair Instruments" will take you to a page that describes key benefits, instruments the corporation repairs, custom repair work, rebuild/exchange services, pricing, and warranty information. If you click on the button below this button, you will get to a page that contains a description and pricing of the reconditioned used instruments for sale. Following, you can click on the "Purchase Instruments and Parts" button to obtain a list of the instruments the corporation may be interested in buying. The button below will provide you with useful hints for troubleshooting common problems. The last button takes you to a page that provides information about different ways to place an order and provides a phone number, fax number, and e-mail address.

*Title:* Color Matters
*URL:* http:www.colormatters.com/entercolormatters.html
*Grade Level:* Grade 5 and above
*Search Engine:* http://www.yahoo.com
*Key Search Word:* color
*Review:* This is the most thorough site on color I have come across. It has many different areas that explore color. Some areas include color and how it relates to science, the brain, the body, vision, de-

sign, and art. It also includes areas that present factoids, surveys, other links, and books, and it even has a section where you can post questions. The site is user-friendly and is a great resource for both teachers and students.

*Title:* Introduction to Chromatography
*URL:* http://www.phys.virginia.edu
*Grade Level:* High-school physics
*Search Engine:* http://www.dogpile.com
*Key Search Word:* chromatography
*Review:* This Web site was created by students at the University of Virginia Physics Department. It could primarily be used as a lesson for high-school physics students. The objective of this lesson is to apply basic chromatography to the separating of mixtures. The materials and procedures are listed in a step-by-step process. Background information and a brief history on chromatography are given. The language is very easy to understand. Different materials and safety issues are also mentioned on the Web site. A student activity and assessment can be printed for classroom use. This Web site is a useful teaching tool for an introductory experiment on basic chromatography for high-school or undergraduate college students.

*Title:* MEDTEC Analytical Products
*URL:* http//www.medtec.co.nz/analpro.html#99schrom
*Grade Level:* Adult
*Search Engine:* http://www.yahoo.com
*Key Search Word:* chromatography
*Review:* This Web site has links to several companies that deal with chromatography and chromatology. It was difficult to find a Web site on this topic. Most sites were from colleges and basically listed courses that were offered. After using several search engines, I finally did find this site using Yahoo!. It has two basic types of links: links to pages where consumers can purchase products and links to other companies that sell related products. The general headings on the home page are "Consumables," "Environmental Testing," "Gas Chromatography," "Liquid Chromatography," "Radiochemistry," and "Spectroscopy and Spectometry." I did follow some of these links, but since I am not familiar with chromatography, I did not really understand what I was looking at! Nowhere did I find a definition of "chromatography"!

*Title:* Austin Science Fun Guide: Home Activities
*URL:* http://www.utexas.edu/cons/funguidchromo.html
*Grade Level:* Elementary school to high school
*Search Engine:* http://www.yahoo.com
*Review:* This site is submitted by the Science and Technology Center of the University of Texas at Austin. This activity demonstrates chromatography to students using materials that are typically available to everyone. It is well organized and includes diagrams of the activities. It provides directions and poses simple questions for the reader to consider as the process unfolds. It explains the basics of what is happening. This particular page is only part of a science-related Web resource. If you scroll to the bottom of the page you will find a link: Back to Fun Guide Table of Contents. This link brings you to a table of contents that lists the links to Science Centers in Austin, Science Associations & Interest Groups, Austin's Nature Trails, Educational Resources in Austin, and Science Activities You Can Do at Home. This last link may be the most valuable for students everywhere, while the others may be most valuable to the resident of Texas.

*Title:* Grape Soda Chromatography
*URL:* http://http://www.accessexcellence.org/AE/ATG/data/released/0351-ErnieNicol/index.html
*Grade Level:* Grades 10 to 12
*Search Engine:* http://www.yahoo.com
*Key Search Words:* teaching, chromatography, K–12
*Review:* This Web site is a link to an activity on chromatography. Its a lab activity in which the students are asked to separate and analyze dyes from different brands of soda using liquid chromatography. This site lists the equipment needed and provides a step-by-step procedure on how to complete this experiment.

*Title:* A Journal of Chromatography
*URL:* http://www.elsevier.nl/inca/publications/store/5/0/2/6/8/8/
*Grade Level:* High school to graduate school
*Search Engine:* Overture.com
*Key Search Word:* chromatography
*Review:* This site gives a detailed description of a chromatography journal entitled *A Journal of Chromatography*. It describes this magazine as including research papers on all aspects of separation science, including

theory and instrumental development. Audience and bibliographic information are included. Ordering information and a free journal sample offer are part of this site. This is a user-friendly Web site.

*Title:* Candy Chromatography: Colorful Feats of Tasty Treats
*URL:* http://www.owu.edu/~mggrote/mist/chemistry/chromatography.html
*Grade Level:* Middle school to high school
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chromatography and teaching
*Review:* This Web site provides a fun way to learn about chromatography through an activity. As I searched and searched through the Internet, nothing was very exciting that related to teaching, and then I found this site. This can be used to further understand chromatography for students who learn through hands-on methods rather than verbal communication. The site gives the materials needed, the procedure, and even extension activities for your class. Great site!

### Crystals

*Title:* Kiwi Web-Chemistry and New Zealand
*URL:* http://www.chemistry.co.nz/crystals_defined.htm
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* crystal tutorials
*Review:* At this Web page, you will see a menu of chemistry topic links. Click on the "Crystal" link and information including definitions, examples, and diagrams becomes available. In addition, embedded within the text are a number of direct links to crystal experiments and more in-depth information concerning how crystals are formed and different types and shapes and colors of crystals. This is a very well-written and useful Web site.

*Title:* FAQs on Crystals for Students
*URL:* http://laue.chem.ncsu.edu/student_faq_xtal.html
*Grade Level:* Middle school and high school students
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* crystal tutorials
*Review:* This page developed by college students at North Carolina State University defines crystals, explains the different types of crystals, how they are formed, and how they grow. It also explains what a per-

fect crystal is, how light affects the color of a crystal, and why crystals have different shapes and sizes. This Web site is written informally and provides information in a precise, clear form.

*Title:* Crystal Growing Experiments; Rockhounding Arkansas
*URL:* http://www.rockhoundingar.com/pebblepups/growcryst.html
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* crystals experiments
*Review:* A wonderful resource, including activities with pictures and information about crystals. The activities include growing alum crystals, growing stalactites and stalagmites, growing a crystal garden, and rock candys. The table of contents contains the following links: Mineral ID, Let's Go Rocking, Rock Crafts, and Collecting Tools. This site was designed for projects for Weebelos, Cub Scouts, and Boy Scouts and contains information for their projects in geology.

*Title:* British Crystallographic Association
*URL:* http://bca.crystl.bbk.ac.uk/bca/index.html
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* crystallography
*Review:* This is the professional Web site for the British Crystallographic Association. Scroll down and click onto one of the four groups within the association—Biological Structure, Chemical Crystallographic, Physical Crystallographic, or Industrial—to obtain information concerning their latest conferences, including other vital research news. Scroll further on the main page and access links to publications, resources, and databases and software. This site maintains a variety of resources on crystals that are easily available.

*Title:* Crystallography Sites
*URL:* http://xtal.pharm.nwu.edu/crystal/CrystSites.html
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* crystallography
*Review:* This site directory lists the numerous Web sites concerned with crystals with direct click-on access to each site.

*Title:* International Union of Crystallography
*URL:* www.iucr.ac.uk/

*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* crystallography
*Review:* The International Union of Crystallography (IUCR) is the world's professional organization for crystallographers. This Web site gives you direct access to the *Journal of Crystallography,* international tables of crystallography, the IUCR newsletter, teacher pamphlets, and other publications. In addition, the Web site provides links to a database of crystallographers, crystallography news on-line, SINCRIS information on-line, book reviews, crystallographic information file (CIF), and other resources. Clicking on the CIF file leads you to a list of crystal dictionaries that you can download including a core dictionary, a macromolecular dictionary, and a powder dictionary, to name a few.

*Title:* Minerals, Crystals, and Gem Resources
*URL:* http://educate.si.edu/resources/lessons/siyc/gems/info.
*Grade Level:* Grade 3
*Search Engine:* http://www.metacrawler.com
*Key Words:* crystals in education
*Review:* Minerals, Crystals, and Gem Resources is an educational Web site designed by Smithsonian in Your Classroom. This Web site focuses on three lesson plans for third-grade students. This is a well-organized Web site that is easy to follow. The first lesson is "Creating a Classroom Exhibit: Investigating Rocks and Minerals." The children are asked to find rocks and minerals in their surroundings and bring them to school. The lesson is designed with questions and a form for the children to fill out on completing an investigation. The second lesson plan, "Watching Crystals Grow," is an experiment that the children will conduct using petri dishes, food coloring, Epson Salts, and found objects. There is an activities page with samples on the questions the children are to answer when they make their observations. Over a period of a week, children will watch crystals grow or not grow on their found objects. The third lesson is titled "Look for Mineral Products at Home, School, a Pharmacy, or in a Hardware Store." This is a mineral scavenger hunt. It includes a chart for the children to fill out. Looks like fun! All three lesson plans are creative and excellent for third-grade students. In addition to the lesson plans, the Web site has a resource page. Traveling through this section I discovered a section called "Minerals A–Z," which is an excellent reference guide to be used with these lesson plans. The photographs of the

minerals are of the highest quality, brilliant in color and definition. The children will enjoy these visual beauties. This Web site (http://www.minerals.net/mineral/index) is a must-use when identifying minerals with third-graders and above.

*Title:* Crystals—Info
*URL:* http://www.ruidomain.com/amulet/crystal_info.htm
*Grade Level:* Middle school to high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* crystals
*Review:* The site contains fascinating information on crystals and is arranged in alphabetical order. There is a picture of the crystal, detail of its composition, and interesting facts about its history with regard to the belief that they possess certain curing powers. The delivery of information is set up in such a way that it will hold the interest of those who read it. Everyone has a certain fascination and curiosity with the suggestion of its magical powers. By providing such a format, I believe it engages the reader and encourages a student to research further. Any site that accomplishes that is worth utilizing in the classroom.

*Title:* Liquid Crystals Today—The Newsletter of the International Crystal Society
*URL:* http://www.liquidcrystalstoday.com
*Grade Level:* College and adult
*Search Engine:* http://www.google.com
*Key Search Word:* crystal
*Review:* This Web page is an on-line version of a journal entitled *Liquid Crystals Today*. The home page is a nice color graphic. If you click "enter," it takes you to the first page of the journal, which is an editorial. On the left side of the editorial page there are (1) links to "archives," which connects to volume 10 (issues 1–2), (2) a graphic in a box announcing this new on-line version of the journal (since March 2001), and (3) a photo of the front page of the journal. On the bottom of the editorial page and pages linked to it, you can follow links to the following: (1) Articles—currently it links to only two articles; (2) News-links to Society News—this has links to new and old products; (3) Conference Information—links to recent and past conferences; (4) Comments and Feedback—currently this page is blank; (5) Book Reviews—currently there are three very long book reviews; (6) Contacts—two names with addresses, phone numbers, and e-mail

addresses, twenty-eight other names with e-mail addresses. This site might be valuable to someone who is involved in the field of crystals. There didn't seem to be much educational material, other than book reviews. In all, it is not a very exciting Web site.

### Electrochemistry

*Title:* Electrochemical Society
*URL:* http://www.electrochem.org/
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* electrochemistry
*Review:* The Electrochemical Society (ECS) is the leading professional organization concerning solid state and electrochemical science and technology. This Web site provides you with sample articles from Electrochemical Society journals, meeting information, and information concerning the various ECS divisions.

*Title:* Electrochemistry Facts
*URL:* http://chemistry.about.com/msu . . . &terms = %2Belectro+%2Bchemistry
*Grade Level:* Middle level through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* electrochemistry
*Review:* Type the word "electrochemistry" at the main search window. This will take you to four links, including Electrochemistry Facts, Electrochemistry, Electrochemistry Journals, and Electrochemistry Software. Clicking on Electrochemistry Facts leads you to a number of links to tutorials, databases, and other functional information. I liked the electrochemistry refresher link developed by Adrian Fisher at the University of Bath. The electrochemistry dictionary link provided by Argonne Laboratories was also a great resource.

*Title:* Experiments in Electrochemistry
*URL:* http://www.funsci.com/fun3_en/electro/electro.htm
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* electrochemistry experiments
*Review:* The review for this site is found in the review of the site Links about Energy and Water, below.

*Title:* Links about Energy and Water
*URL:* http://www.snopud.com/education/funlinks.htm
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* electrochemistry experiments
*Review:* At the main menu, scroll down and click on "Electrochemistry." This brings you to the Web site called Fun Science Gallery. You then have a choice of a number of topics, such as Conductors, Batteries, Measuring Potentials of Reduction, and Galvanic Deposition. Each topic contains activities that are well written with explanatory diagrams and pictures. In addition, an extensive explanation is provided that gives not only the pertinent information but also additional extenders. Excellent site. This Web site also has links to a number of other sites on electricity and electrochemistry.

*Title:* On Electrical Decomposition by Michael Faraday
*URL:* http://www.d.k12.ca.us/Chem-History/Faraday-electrochemical.html
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* electron chemistry history
*Review:* This Web site contains the lecture that Michael Faraday presented to the Philosophical Transactions of the Royal Society in 1834. It includes both text and diagrams. This was Web site was developed by Chemteam.

**Electronic Structure**

*Title:* Discovery of the Electron
*URL:* http://www.aip.org/history/electrons/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* electrons
*Review:* This site was designed by the Center for the History of Physics of the American Institute of Physics. It contains complete pictures and explanations including information and links about J. J. Thomson, mysterious rays, 1897 experiments, corpuscles to electrons, legacy for today, and exhibit information. Links to the actual paper written by Thomson and his legendary Nobel Prize address of 1906, as well as links to other papers written by Thomson, are provided. This is a wonderful

site including photos of the drawings of the equipment designed and developed by scientists working on different aspects of atomic structure research and is well worth a visit by any science student. Also, the provided list of additional resources is extremely valuable.

*Title:* Life, the Universe, and the Electron
*URL:* http://www.iop.org/Physics/Electron/Exhibition/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* electronic structure tutorials
*Review:* This Web site is a collaborative effort of the Science Museum of London and the Physics Institute. It contains links to the following: What Is an Electron, Discovery, 1897, Electrons in Atoms, Seeing Atoms, Electrons in Our Lives, Electron Events, and links to other information as well. Clicking on any of the above links leads you to more information designed with both written format and diagrams and pictures. This site is well researched and very well designed.

*Title:* Jefferson Lab/Science Education
*URL:* http://www.education.jlab.org/atomtour/
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* atoms
*Review:* At the main Web page, click on continue. This leads you to a diagram of an atom. If you click directly on the electron in the drawing, you will learn about different uses of the electron. If you scroll up to the links at the top of the page, click on "teacher resources" and you will find a number of hands-on activities, worksheets, puzzles, games for your use. There are some on-line games, including "looking for the top quark," that provide both information and fun at the same time.

### Energy

*Title:* The Energy Story: Chapter 1—What Is Energy?
*URL:* http://www.energy.ca.gov/education/story/story-html/chapter01.html
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what is energy

*Review:* This Web site provides very concise information about energy. If you scroll to the bottom of the page you have a choice between the Energy Quest table of contents or a link to the Energy home page. The table of contents lists the following: Chapter 1, Energy, What Is It?; Chapter 2, What Is Electricity?; Chapter 3, Generators, Turbines, and Power Plants; Chapter 4, Geothermal Energy; Chapter 5, Fossil Fuels; Coal, Natural Gas, and Oil; Chapter 6, Hydropower; Chapter 7, Nuclear Energy—Fission and Fusion; Chapter 8, Ocean Energy; Chapter 9, Solar Energy; Chapter 10, Wind Energy; Chapter 11, Electricity Transmission System; Chapter 12, Natural Gas Distribution System; Chapter 13, Energy for Transportation; Chapter 14, Biomass Energy; and Chapter 15, Saving Energy and Energy Efficiency. The Energy Quest home page also provides a number of different resources available. This Web site provided by Energy Education from California is an excellent resource for the beginning science students.

*Title:* Energy and the Earth
*URL:* http://kids.infoplease.lycos.com/ipka/A0775713.html
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what is energy
*Review:* At the main page you can either read information about energy and the planet Earth or click on the links (Almanac, Science, and Energy and Environment) provided above the material. There also is a search window for you to type in a word(s) to search for more specific information. At the top right of the page, you will find links to Almanac, Dictionary, and Encyclopedia. If you click on Dictionary, you will obtain links to dictionary resources concerning the word(s) that you are seeking. The encyclopedia is the *Columbia Encyclopedia, 6th edition*, and contains over 57,000 articles for you to search in the provided search window.

*Title:* KIDS Report March 25, 1998: Science Experiments
*URL:* http://scout18.cs.wisc.edu/KIDS/KIDS-980325txt.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* simple energy experiments
*Review:* This site reviews other science Web sites for kids. For example, the site Energy and Science Projects for Students is great for finding science experiments on energy. This site was developed by kids for kids.

*Title:* About the Human Internet
*URL:* http://home.about.com/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* simple energy experiments
*Review:* At the home page, type in the word "energy." You can narrow the search at the search window or just click on one of the links provided, such as Solar Energy, Wind Energy, Nuclear Energy, Tidal Energy, Alternative Energy, Free Energy, Geothermal Energy, Department of Energy, or Energy Conservation. If you want experiments on energy, type that into the search window. The About.com site is a great way to narrow your search and to focus on the specific topic that you want to research.

*Title:* Grade Three Science—Simple Machines
*URL:* http://www.sasked.gov.sk.ca/docs/elemsci/gr3uhesc.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* simple energy experiments
*Review:* The Evergreen Education/Saskatchewan Education site is an educational site with curriculum on many disciplines at a number of different educational levels in both English and French. In order to search the other curricular areas, go to the top of the page and click on the Curriculum Menu. This will lead you to the elementary science curriculum. If you are interested in middle school or high school, click on the Evergreen Menu link and scroll to select "By Subject." The curriculum provides a general overview, objectives, and a number of suggested activities for each objective. This is a well thought-out resource for students and teachers. Even though the standards that are keyed to each objective are standards for Canada, they could easily be converted to either national or regional standards.

*Title:* Motion Energy and Simple Machines
*URL:* http://www.necc.mass.edu/MRVIS/MR3_13/start.htm
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* simple energy experiments
*Review:* This Web site was the culmination of research by the Merrimack River Valley Investigations in Science project. It includes both information about Newton's laws of motion pertaining to potential and kinetic energy including suggested experiments. The experiments also

have a pictorial representation of how to set up the experiment to help those students who require not only the verbal but visual information and help. The project leaders were also attentive to the needs of finding the materials and therefore provide a list of supplies needed plus a suggested resource for obtaining the materials.

### Environmental Chemistry

*Title:* Welcome to the Atmospheric Sciences Division
*URL:* http://www.ecd.bnl.gov/
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* environmental chemistry for kids
*Review:* This site developed at Brookhaven National Laboratory is an excellent one for atmospheric science. Click on either the Environmental Science Division (ESD) home page or the BNL home page. The ESD home page leads you to a list of programs that will link you to the current research programs and information about each of the programs of ongoing research. Clicking on the Program link leads you to a brief summary of the research with another link to learn about the project leader. There is also a link to other publications in scientific journals and book chapters that might be of interest for those students interested in an in-depth research project.

*Title:* Environmental Chemistry Facts
*URL:* http://chemistry.about.com
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* environmental chemistry
*Review:* This is the About.com site. At the home page type in "environmental chemistry." Clicking on any of the links provided leads you to information, journals, and other resources that have been researched by the about.com researchers. When you type in only "environmental chemistry," you are provided with over 350 resources; however, if you go back and narrow the search further, perhaps by expanding the search to "environmental chemistry experiments," you then narrow the search to forty resources. I checked a number of the links and they were excellent. For instance, when I typed in "environmental chemistry," I clicked on the Chemistry—Environmental link that was reviewed to contain "environmental chemistry notes, lectures and articles are listed." From there I clicked on "Acid Rain" and was led to

an excellent review of acid rain, which included a definition of acid rain, the causes of acid rain, the effects of acid rain, explanations about the formation of acids in the atmosphere and reducing emissions, and gave links to other acid rain sites and a list of useful resources.

*Title:* BC Education—Grade 7 Physical Science (Environmental Chemistry)
*URL:* http://www.bced.gov.bc.ca/irp/sciencek7/7phyenv.htm
*Grade Level:* Grades K to 7
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* environmental chemistry experiments
*Review:* This is a Web site designed by the BC Education Department. This part of the Web pages brings you to the curriculum for seventh-grade science in environmental science. It includes learner outcomes, suggested instructional strategies, suggested assessment strategies, and recommended learning resources. If you scroll to the bottom of the page, you will find the link to the table of contents. Clicking on that leads you to the curriculum for grades K to 7. The curriculum is separated into life science, physical science, and earth and space science. Scroll down to seventh-grade science, and you will find environmental science under applications to physical science. Look through the other grade levels to determine if there is anything else of interest to your research.

**Enzymes**

*Title:* Sounds Like Science—Listen to Radio Science News
*URL:* http://www.npr.org/programs/science/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what are enzymes
*Review:* NPR on-line is a free Web site produced by the National Public Radio. The Sounds Like Science Web page offers a number of science programs to listen to and all require Real Player 2.0 (free link). The left side of the Web page also lets you listen to the latest show and shows in their archives, and you can also access Fun Factoids, Science Quiz, Contact Us, and Tapes and Transcripts. The archives are listed by year, month, and day. Factoids are indexed by animalia, space, and technology. Each index is subindexed and, a click on the search window provides you specifics about the factoid; for instance, within an-

imalia is the factoid "wild shrimp." Clicking on that leads you to an article on wild shrimp. The Science Quiz link provides you an on-line science quiz that is interactive. You can order tapes and transcripts through that link. This is a great resource, especially for those students who have a vision impairment. A wonderful way to listen to science.

*Title:* Introduction to Enzymes
*URL:* www.worthington-biochem.com/introBiochem/introEnzymes.html
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what are enzymes
*Review:* This Web site is provided by Worthington Biochemical Corporation. There is a brief introduction to enzymes followed by two main categories: "enzyme and life processes" and "enzymes and kinetics." The enzyme and life processes section is subdivided into four links; specifically, Early Enzyme Discoveries, Chemical Nature of Enzymes, Specificity of Enzymes, and Naming and Classification. Clicking on any of these links gives you both information and appropriate diagrams for explanation where needed. The enzymes and kinetics section is subdivided into three links; specifically, Basic Enzyme Reactions, Energy Levels, and the enzyme Substrate Complex. This Web site also provides a number of resource links, catalog price lists, and a search tool. If you click on the Web Directory link, a number of useful links appear, such as Courses and Tutorials and Databases and Tools. Clicking on Courses and Tutorials leads you to list of content areas like biochemistry, biology, and so forth. Choosing "biochemistry" leads you to thirteen university links with a brief description of the course or tutorial provided at each specific university. The databases and tools are well worth the look. Dictionaries, glossaries, encyclopedias, and on-line search tools are well identified and briefly reviewed per link. For the professional researcher, the conference and societies link identifies both the international and national professional societies with a link directly to them and a brief discussion of the mission of the society. Other links on the Web Directory are academic departments, companies, indices and links, institutes and organizations, journals and bibliographies, labs and research projects, products, protocol and on-line papers, and specific topic sites. This Web site is well-written, easy to use and follow, and filled with important biochemistry/molecular biology information.

*Title:* Enzyme Kinetics
*URL:* http://jeffline.tju.edu/CWIS/DEPT/biochemistry/kinetics/HTML/INDEX.HTML
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what are enzymes
*Review:* This Web site is the property of Thomas Jefferson University and is a tutorial on enzymes. The tutorial includes both written information and explanatory diagrams. There is no self-check. The specific topics are Introduction, Activation Energy, Change in Free Energy, Equilibrium Equations, Michaelis-Menten Equation, Briggs-Haldane Equation, Plot of V vs. [s], Discussion of [s] Values, the Importance of Km, Derivation of Kcat or Turnover Number, Discussion of Kcat or Turnover Number, Enzyme Kinetics in Medicine, Temperature, pH, Competitive Inhibitors, Competitive Inhibition, Competitive Inhibition—Practical Examples, Competitive Inhibition—Ki, Noncompetitive Inhibitors, Uncompetitive Inhibitors, Irreversible Inhibitors, and Irreversible Inhibitors—Practical Examples.

*Title:* The Gene School—Experiments
*URL:* http://library.advanced.org/19037/experiments.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* enzymes experiments
*Review:* Think Quest Web site is a virtual library designed and developed by teachers and students worldwide. The Gene School includes general information, applications, interactive, glossary, and About links. The About link lists the names of the students and teachers who developed the Gene School and also provides a bibliography of resources used to develop the site. The interactive link leads you to experiments, games, quizzes, a message board, polls, and teacher links. The experiments are designed to be printed out and can be done at school or at home. The experiments include pictures of the students and of the equipment, give a brief description of the purpose of the experiment, list the supplies needed, provide detailed instructions including pictures, have a list of results and answers in italics, and end with applications. These are extremely well-written and easy to follow. The quizzes and games are interactive. The games are in PDF format and require Adobe Acrobat Reader (free to download). This Web site is a joy to use and very informational. Good job!

*Title:* Recent News in Genetics
*URL:* http://www.pbs.org/gene/resource/716_links.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* enzymes experiments
*Review:* This is a free service provided by public broadcasting systems. The recent news list contains a list of current genetic research articles with a brief description of the article and a direct link that allows you to read the complete article. On the left of the home page are other links to "Program Reviews, Genetic Testing," Find Out More, Surveys, Educator Resources, Careers in Genetics, What Do You Think, and Discussion forum. The Recent News list included articles from *Scientific American, Discover, Fortune* magazine, *New York Times,* and *Time* magazine. You can request a copy of an educator's guide to *A Question of Genes: Inherited Risks* for free by clicking on the Printed Educator's Guide link and telling them a little about yourself. You can also order videotapes of *A Question of Genes: Inherited Risks* for $29.95 plus shipping.

*Title:* Access Excellence
*URL:* http://www.accessexcellence.org
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* enzymes experiments
*Review:* This Access Excellence site is provided for health and bioscience teachers by Genentech Corporation. Eight links are available at the home page, including What's New, About Biotech, Classrooms of the 21st Century, Resource Center, Health Headquarters, Let's Collaborate, Activities Exchange, and bio. Ed. Online. Science updates link provides the current news worldwide on science. All you do is to click on the link that also provides you a brief description of the article and you can either read the entire article or print it. The About Biotech link enables you to review past chronicles of biotech, review current projects, access interviews with scientists on the Career link, and access the Graphics link, which provides diagrams and charts. Let's Collaborate is a great resource for interacting with others with similar interests. There is a Town Hall link for teachers interested in sharing research, a Teacher Community-Sharing link for team sharing, a Mentor link, and a bio. Ed. Online link that provides peer-reviewed, on-line publication. The Activities

Exchange is the place to find a multitude of classroom experiments and activities.

### Equations

*Title:* Mrs. Glosser's Lesson on Writing Algebraic Equations
*URL:* http://www.mathgoodies.com/lessons/vol7/equations.html
*Grade Level:* Grade 6 through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* equations
*Review:* Mrs. Glosser's Math Goodies, Inc., was founded in 1998 in order to provide on-line math resources and software following NCTM guidelines. At the Algebraic Equation page, you are provided with a number of sample problems with elaborate explanations. New terms are linked to definitions of a term. Following the sample problems are the problem exercises, which are interactive, providing you immediate input with the correct answers. At the bottom of the page you will find links to math puzzles, challenge exercises, and other exercises on different aspects of algebra. In addition, there are links to Mathchat, Lessons, Homework, Newsletter, Articles, Bookstore, and Homeroom. The resources available on this Web site are excellent and extremely user-friendly.

*Title:* Chemical Equations: A Way to Represent Chemical Reactions on Paper
*URL:* http://pc65.frontier.osrhe.edu/hs/science/cequa.htm
*Grade Level:* Grade 6 through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* equations
*Review:* This is a great tutorial Web site for balancing equations designed by Frontier High School. The information is logically organized, beginning by answering the question of why you have to balance chemical equations and continuing on to explain the parts of a chemical equation, then on to the actual step-by-step method to balance the equation. The designers use graphic hints—basic happy faces and "no" signals for important information. The page ends with ten practice problems with answers provided by clicking on the "check" icon. At the bottom of the page, you will find a link to the Diamond Bar High School Chem Team—Equation Balancing, which connects you to another Web site that provides more on balancing equations, more worksheets (identified by whether there are answers provided), and

other links for more information. This is a great tutorial for balancing equations.

*Title:* Interactive Tutorial on Balancing Chemical Equations
*URL:* http://www.wfu.edu/~ylwong/balanceeq/balanceq.html
*Grade Level:* High school and beginning college
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* equations
*Review:* This Web site was designed by Dr. Yue-Ling Wong of the Department of Chemistry, Wake Forest University. At the home page click on "Interactive exercises on balancing equations" or "online practice." For the interactive exercises, first click on the link then click on the blackboard to start the program. (Make certain that you click directly on the "done" button when you complete the exercise.) I had some difficulty with this program; however, it is a great resource.

**Equilibrium**

*Title:* Kapili:Chem4Kids.com:Reactions:Equilibrium
*URL:* http://www.chem4kids.com/reactions/equilib.html
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* equilibrium tutorials
*Review:* This is a Chem4Kids Web site. It includes information on equilibrium, reactions, acid base, thermodynamics, reaction rates, and catalyst-inhibitors in "normal language." For instance, the heading for equilibrium is "What the Heck is Equilibrium." The information is presented informally, with diagrams to aid comprehension.

*Title:* Chemical Equilibrium
*URL:* http://antoine.frostburg.edu/chem/senese/101/index.shtml
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* equilibrium tutorials
*Review:* General chemistry on-line presents this Web site. At the home page, type in "equilibrium" in the search window on the left. There are fifty-seven matches with the word "equilibrium" in the document. Each document has been reviewed and rated with stars; the more stars, the better the document. This Web site has consistently been reviewed and received high praise and a visit to it and using the resource will make you one of those advocates. The fifty-seven matches

are rated with the best first and the others following. The brief review of each link is well-written and complete. For instance, General Chemistry Online: FAQs, Acids and Bases link includes sublinks to "specific pH, Calculating pH, How does hydrolysis enter in to pH equations?, How do I calculate pH for a strong acid after dilution, and Equilibrium constants." When you click on the General link, you will find question links like the ones written in the brief review, and you can scroll down to the Equilibrium link on equilibrium constants. Or, if you click on the highlighted (blued) link within the review, you will be taken immediately to the links—no need to scroll. Each one of the fifty-seven links has "equilibrium" highlighted to direct you to the information concerning equilibrium that you are seeking.

*Title:* WWWolfe CHM1046 Chemistry Course Links
*URL:* http://www.mindspring.com/~drwolfe/WWWolfe_hcc_1046_links.htm
*Grade Level:* High school through college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* equilibrium tutorials
*Review:* This Web site is maintained by Drew H. Wolfe, a "long-time professor of chemistry." At the home page, click on either chemical equilibria, acid-base equilibria, or solubility equilibria. This will lead you to a number of links with brief reviews of each. If the links are old, when you click on them there is a message from the designer telling you that the material is out-of-date and to return to the other links. Generally, most of the links are current and very valuable. On the left of the home page, you will find a list of resources under "chemistry pages," including periodic tables, databases, structure, ACS, chemists, and others. You will find some excellent resources with suggestions as to the best resources available. This is a great reference resource site.

### Ethics

*Title:* Ethics in Science
*URL:* http://www.chemistry.vt.edu/ethics/ethics.html
*Grade Level:* College level
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* ethics tutorials
*Review:* This Web site was developed by Virginia Polytech Institute and State University. It is not currently being updated; however, the links

are extremely valuable and worthy of your review. The site provides resource links including a science ethics bibliography and a course outline for a physical science ethics course. In addition, the site includes a number of links to essays on ethics, including ethics in science, ethics-related issues in forensic science, misconduct in science, on being a scientist, and the chemists' code of conduct.

*Title:* Ethics Updates Home Page: Moral Theory, Relativism, Pluralism, Religion
*URL:* http://ethics.acusd.edu/index.html
*Grade Level:* College level and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* ethics tutorials
*Review:* This Web site is for ethics teachers and students and is provided to keep researchers current in the field of ethics. At the Web home page type in the words "chemistry ethics" in the search window or scroll down to environmental ethics and click on the link. If you typed "chemistry ethics," you will find two articles on environmental ethics. Clicking on the environmental ethics link leads you to real video interviews with Dr. Dale Jamieson on animal rights and Dr. Baird Callicott on the ethical legacy of Aldo Leopold. In addition, there are direct links to the centers for environmental studies at the University of North Texas and in British Columbia, Canada. Included on this page is a listing of environmental ethics links, government and legal resources on environment, links to NPR's "Talk of the Nation," a list of on-line articles on environmental ethics, and a survey of selected philosophical literature on environmental ethics. This is an extremely inclusive Web site for the serious researcher.

*Title:* The Online Ethics Center for Engineering & Science
*URL:* http://onlineethics.org/
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* ethics tutorials
*Review:* This Web site was established in 1995 by a grant from the National Science Foundation. Its mission is to provide science and engineering ethics information to scientists, engineers, and science and engineering students. There is a "search" link at the top of the home page for your use. The home page has been designed like a research book, with tabs on the left side of the page instead of on the right. Each tab leads you to a different area of ethics, including main, biology, help-line, research,

cases, leaders, problems, corp., codes, diversity, essays, and education. The search tool allows you to type in your topic in English or Spanish. Type in the words "chemistry ethics" and you will be led to ten links, including "online ethics center: bad chemistry," "online ethics center: ethics in the science classroom," and others. There also are other links on the left of the home page screen; one of the links, "pre-college," includes information on materials for instruction in science and engineering ethics in the secondary school level, studies on children's ethics, and other educational resources available for students K–12. Other links on the left provide you access to a topic index, glossary, bibliography, conferences, organizations, other sites, and a Spanish-only resource. This is an invaluable resource for students researching science and engineering ethics.

*Title:* Center for Applied Ethics
*URL:* http://www.ethics.ubc.ca
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* ethics tutorials
*Review:* The Center for Applied Ethics Web site is maintained by the University of British Columbia. The home page has six links: About the Center, Education, People, Research, Resources, and the Colloquium Series. The timetable of the Colloquium Series provides the time and date of the colloquium as well as a link to the paper presentation. If you add "/resources/computer/" to the URL, you will be led to the computer ethics resources; from there you should click on "ethics institutes and organizations." At this page you will be able to choose from a number of international resources dealing with ethical issues in computing, including cyber angels, the Internet-safety organization, or Peacefire, the teen net anticensorship organization.

### Formulas

*Title:* NIST Chemistry Web Book
*URL:* http://webbook.nist.gov/chemistry/form-ser.html
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* formulas
*Review:* The NIST (National Institute of Standards and Technology) Chemistry Web Book is just one of the databases provided by NIST

for scientists and engineers for over thirty years. Also available are databases in analytical chemistry, atomic and molecular physics, biotechnology, chemical and crystal structure, industrial fluids and chemical engineering, thermo chemical, materials properties, and surface data. On the "Search for species data by chemical formula" page, you enter the formula, scroll down to the rules if you need help, and it provides you with possible formula. For instance, if you type in "C6H12" in number 1 and press the "search" key, you will be provided with thirty-eight matches and the chemical name and formula for each species. Clicking on any of the chemical names leads you to a page that provides the name, formula, molecular weight, CAS registry number, chemical structure, other possible names,and more data. This is the resource you will need for chemical formulas.

*Title:* Chem Tutor
*URL:* http://www.chemtutor.com/
*Grade Level:* High school and college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry formulas
*Review:* This site has been developed to provide tutorial help to high-school and college students studying chemistry. At the home page scroll down to "compounds" and click on it. This will lead you to a list of possible links, including "writing ionic compound formulas" and "checklist for writing compounds." Clicking on any of the links provides you with a precise tutorial with examples. At the end of the tutorials you will find a worksheet with answers to each of the questions. This is a good tutorial for basic chemistry.

*Title:* Chemistry Homepage
*URL:* http://gonzoga.K12.nf.ca/academics/science/chem/index.htm.
*Grade Level:* High school through college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry formulas
*Review:* This Web page provides information concerning chemical formulas in an interactive tutorial, with a worksheet with answers following the tutorial work. At the home page, click on "chemistry 2202," then click on "compounds and nomenclature" or "chemical formulas, naming compounds, naming acids." The compounds and nomenclature link provides the interactive tutorial, and the chemical formula, naming compounds, naming acids link leads you to work-

sheets for further assessment. The interactive tutorial provides a multiple-choice question and gives you feedback on your selected answer. For instance, the first question asks, "When combining Co and I, the Co atoms transfer 3 electrons to the I. The resulting formula would be _____." You are then provided four choices; if you choose the wrong one, you are told to try again. If you are correct, you are told so. The worksheets give you thirty questions on chemical names and chemical formulas that you have to write the names/formulas for. You check your answers with a check link.

*Title:* Measurement Formulas
*URL:* http://library.thinkquest.org/library/index.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* formulas
*Review:* Think Quest library contains over 5,000 Web sites that have been produced by students competing against each other for inclusion in the library. Think quest materials have been produced by kids for kids. At the home page, type in the words "chemical formula" in the search window. Scroll down to Chemistry Tutor and click on the link, then click on the "click on to view this site" link. Click on the "chemistry calculations" icon and find grams to moles, moles to grams, ideal gas, and temperature conversions.

*Title:* Science Help Online-Chemistry—Writing Chemical Formulas
*URL:* http://fordhamprep.pvt.k12.ny.us/gcurran/sho/sho/lessons/lesson53
*Grade Level:* Grades 6 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical formulas
*Review:* This is actually a section of the Fordham Pre Chem help page. Brief definitions of chemical formulas, ionic compounds, and molecular compounds are given to familiarize the student with the task at hand. After the definitions there is a section that teaches how to write ionic formulas and what they are. An explanation is given along with many examples, using step-by-step procedures. The next section explains how to write molecular formulas and what they are. It is also step-by-step, with examples provided. At the end of the section there are links for the student to print out practice worksheets on binary ionic compounds, ternary ionic compounds, and the stock system. All of these are explained in the text. Another group of links provides the student with an opportunity to take an on-line quiz

based on the learned information. Overall, the information provided by Fordham Prep seems easy enough to understand, provided that the student has had some prior knowledge of the elements.

*Title:* The School for Champions
*URL:* http://www.school-for-champions.com/default.htm
*Grade Level:* Middle school, high school, and college
*Search Engine:* http://www.google.com
*Key Search Words:* what are chemical formulas
*Review:* The School for Champions Web site is a very motivational and positive Web site. Carried by the slogan "A better you, a better society, a better world," the Web site provides extensive lessons and tips to help a student become "a champion." The site consists of thirty-six different subjects that range all the way from getting good grades in school to different chemistry items. Within each subject there are items that provide more detailed information, exercises, and mini quizzes. Several of the topics include an audio portion that adds to motivation with inspirational words on how to succeed. The site is easy to navigate, and the search function helps you to quicken your search of a particular topic or subject. The site lacks the aesthetic appeal that other sites have, but it is sufficient for its intended audience of older students. It is a great vehicle to either introduce or deepen your understanding of many subjects (both academically and personally).

*Title:* Chemical Formulas—Succeed in Physical Science
*URL:* http://www.school-for-champions.com/science/chemformulas.htm
*Grade Level:* Middle school, high school, and college
*Search Engine:* http://www.askjeeves.com
*Key Search Words:* what are chemical formulas
*Review:* This is a free Web site produced by Kurtus Technologies for both teachers and students. The Web page immediately begins with giving the definitions and explanations of chemical compounds and chemical formulas along with how to write them. At the end of each section the site gives a mini on-line quiz. The Web page contains links to different experiments, notes, quizzes, tests, and study and homework guides, as well as possible homework assignments. Clicking on the hyperlink to "experiments" leads you to a number of different hands-on and computer-based experiments that can be done at home as well as at school. Another feature that I found to be very beneficial to students is "keys to getting good grades." This hyperlink takes you to another page, where hints and tips for doing homework, studying,

and taking a test are given. This is a great resource because it not only gives information on what chemical formulas are but also gives ways to test that information along with follow-up exercises for those who are ready to advance.

*Title:* Journey into Science
*URL:* http://www.sciencebyjones.com
*Grade Level:* High school
*Search Engine:* http://www.yahoo.com
*Key Search Words:* teaching chemical formulas
*Review:* This Web site is produced by a teacher, Mr. Larry Jones, at Daniel High School in Pickens County, South Carolina. When searching under "teacher topics" you can journey to different areas of interest. There are many topics available with a variety of subtopics. Each one is rich with information about the topic of your choice. There are various details and examples completing each section. By clicking on Nomenclature you will enter the section on chemical formulas. There is a list of things that are covered within the topic, each one being sectioned off and easily located with a click. Besides demonstrating how to write chemical formulas, the section teaches how to name inorganic compounds and acids. Although this is a Web site from one teacher in one school, I found it extremely effective and easy for any student to understand.

*Title:* Chemistry
*URL:* www.spacesciencegroup.nsula.edu
*Grade Level:* Grades 5 to 10
*Search Engine:* http://www.yahoo.com
*Search Words:* chemical formulas for kids
*Review:* This is a pretty cool site that has a space theme. It is very easy to navigate and has the basics for many different chemistry topics. On the left is a pull-down menu of science topics ranging from combustion to atoms and molecules to nuclear fission (all in layman's terms). Once you pick a topic you are led to a short summary page consisting of very basic information. I clicked on Chemical Formulas and the page came up explaining why we use symbols like $H_2O$ and what the different parts mean. Some of these topic pages have pictures included. For instance, when you click on Elements, there is a small picture of the periodic table that you could download to your computer. The pictures would certainly aid a child in understanding the basics of chemistry and understanding the terminology. There is even

a quiz given by an alien character named Larry. Click on the student menu page and you'll find anything from summer science camps, student labs (which require Adobe Acrobat), and even a dictionary of terms used in the site, as well as videos on science (for Real Player). Some of the video titles listed are "Liquid Crystals," "Infrared Thermometers," and "Metallized Materials." This site is very user-friendly and has a lot of interesting information for kids who are into science, whether it is for a school project or just for fun. The basic information, pictures, and bright colors will keep kids browsing on this site for awhile till they find something that catches their eye; if they like science, then this site is a sure thing.

*Title:* Elements
*URL:* www.chem4kids.com/chem4kids/Grade
*Grade Level:* Grades 4 to 8
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry for kids
*Review:* This Web site explains what elements are, the basic elements, and why elements are important. It gives details about the first eighteen elements. It is written for kids and the graphics are attractive. It does not include activities or related Web sites.

*Title:* NIST Chemistry Web Book
*URL:* http://webbook.nist.gov/chemistry/
*Grade Level:* High school and college
*Search Engine:* http://www.webcrawler.com
*Key Search Words:* chemical formulas
*Review:* This is a reference database that allows you to search by formula, name, or structure. The site includes a physical property search as well. The formula search allows for many options, including thermodynamic data (gas or condensed phase, ion energetics or clusters, etc.). It gives the student specific formula search help, including examples. I did a search on the formula "C6H" and received sixteen matches that included chemical name, formula, and structure image. The site isn't pretty, but it is informative and free.

*Title:* Chemical Formulas—Succeed in Physical Science
*URL:* http://www.school-for-champions.com/science/chemformulas.htm
*Grade Level:* Middle school
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemical formulas

*Review:* This is a good site. It explains the definitions of chemical formulas and how to read the formulas. It tells you how to figure out how many atoms are in a molecule and how many of each molecule there are in the formula. It is pretty straightforward and easy to understand, even for those who don't like chemistry. There is also a little quiz at the end to see how much of the information you actually understood.

*Title:* Rader's Chem4kids
*URL:* http://www.chem4kids.com/index.html
*Grade Level:* Grades 4 to 6
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemistry, children
*Review:* This Web site seems like it would be very useful. It provides a ton of information on elements, matter, atoms, chemical compounds, reactions, and so forth. The language that is used to explain various science topics would be easy for children to understand. The site map makes it easy to navigate through all of the information to find just what you are looking for. Also, a link on the bottom on the home page will take you to some activities. They provide some on-line quizzes and on-line activities such as figuring out the elements by their symbols.

*Title:* Chemical Formulas—The Physical Science Series
*URL:* http://www.physicalscienceseries.com/chemformulas.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical formulas
*Review:* This Web site, a segment of The Physical Science Series, is an interactive HyperStudio program written specifically for high-school chemistry students. It is attractively designed and most informative. Colorful, well-illustrated drawings, located along the left portion of the page, enhance the basic information about writing chemical formulas as well as writing chemical formulas of compounds with a transition metal, two nonmetals, or polyatomic ions. Examples of common compounds are shown. Ionic and covalent compounds, the use of Roman numerals, and when to use parenthesis with compounds containing a polyatomic ion are explained in detail. Students are given practice exercises after learning the facts, followed by three quizzes at the end of the program. This is a great resource.

*Title:* Formulas of Binary Compounds
*URL:* http://pc65.frontier.osrhe.edu/hs/science/cforms.htm
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical formulas
*Review:* The "Formulas of Binary Compounds" Web page consists of one week's worth of chemistry lessons and a skills test. The objective is to "use oxidation numbers to write the chemical formula for any binary compound and write chemical formulas containing polyatomic ions." Definitions include chemical formulas and binary compounds. Detailed explanations are provided for oxidation number and polyatomic ion. A simple way to learn to write chemical formulas is listed. Subsequent links provide additional practice and a skills review test is also available. This site provides simple and concise instructions for constructing a chemical formula. It is ideal for students who are chemistry-phobic.

*Title:* Rader's Chem4kids
*URL:* http://www.chem4kids.com
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry and kids
*Review:* This Web site is an offshoot of Kapili.com, a service that provides informational and educational Web sites for all grade levels. The site is set up with the following indexes: Reactions, Elements, Atoms, Matter, Biochemistry, and Et Cetera. Each topic has a subset of pages that goes deeper into each subject. At the bottom of each page is a "next page on tour," which takes the viewer to the next page and deeper into the topic picked. It is in Et Cetera where one will find information on chemical formulas. This Web site is a great site for kids of all ages to view with their parents or as an aid in the classroom. The site is easy enough for kids yet informative enough for even the adults.

*Title:* Chemical Formulas
*URL:* http://www.zuniart.com/Mole.html
*Grade Level:* Grades 9 and 10
*Search Engine:* http://www.google.com
*Key Search Words:* chemical formulas for kids
*Review:* This site was created by a high-school chemistry teacher who has had difficulty in the past trying to explain what a "mol," or mol-

ecule, is to her students. In an effort to make her students understand, she compares the concept of a molecule to the animal, the mole. She explains that a mol is the chemist's version of a dozen, only our mole is equal to 6.02 × 1023. Because of this difficult concept, a National Mole Day Foundation was started to promote the celebration of National Mole Day on October 23 from 6:02 A.M. to 6:02 P.M. Get it?! On her Web site, she also showcases her collection of fifty-one carved Zuni moles. It seems that her passion for teaching in a novel way would be beneficial to students and that a difficult concept can be simplified.

*Title:* Chemical Formulas and Chemical Equations
*URL:* www.st-agnes.org/~lstinson/webpages/chemform.htm
*Grade Level:* Middle school and high school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical formulas
*Review:* "Chemical Formulas and Chemical Equations" is a Web site for chemistry beginners. It starts with an introduction to chemistry. It defines chemical formulas and chemical equations very clearly. It then goes on to the two types of chemical formulas; molecular and empirical. The site asks common questions about chemical formulas and answers them. In addition it gives examples. The periodic table, in color, is provided. After discussing chemical formulas it continues discussing chemical equations in the same format as stated above. As a whole the site is very straightforward and explains things very clearly and well. As far as being exciting—well, it's not. There are no links to any other sites. It does, however, serve its purpose.

*Title:* Formulas of Binary Compounds
*URL:* http://pc65.frontier.orshe.edu/hs/science/cforms.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.metacrawler.com
*Review:* This Web page is another part of a comprehensive chemistry unit that can be found on the Internet. This page, unlike the other, is not quite as interesting to read or to review. The information contained on the page is a bit more like reading a textbook than some of the other pages that were located. The benefit of this particular page, or series, is the students' ability to work on difficult concepts in real time and to receive feedback, and a grade, almost immediately. The bulk of the work is dedicated to understanding how chemical formulas are created and written. At the beginning of each day's activities is a se-

ries of student objectives and what the outcomes should be for each student as they complete the problems and experiments on-line.

*Title:* Chemical Formulas
*URL:* http://www.school-for-champions.com/science/chemformulas.htm
*Grade Level:* College, high school, and middle school
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemical formulas
*Review:* The level stated was taken from the School for Champions home page; however, I believe this Web site would be too simple to be of any use to a college student beyond the point of simple chemistry. This site is very basic and easy to navigate and understand. The definitions and analogies were simple enough that I felt I had a basic understanding of the concept. The Chemical Formulas site starts with four sentences defining the subject, which are clear, complete, and understandable at the simplest level. Next, there is a list of questions that the student "may have." I found this helpful, because if I were a student looking for something specific, I wouldn't have to waste time trying to navigate around the site; I could just read these questions to find out if the answers I'm looking for are contained within this Web site. There is a brief lesson following this short introduction, which covers all the main points, very simply. The three main points are Chemical Compounds, Chemical Formulas, and Complex Formulae. Within Chemical Formulas, the Web site investigates three more topics: Shorthand for Elements, Number of Atoms in a Molecule, and Number of Molecules. Finally, there is a conclusion to the lesson just covered. Again, I found this Web site easy to understand because everything was so basic. There is a need for understanding simple algebra, and if a middle-school student hadn't gotten that far, this Web site would be of no use to him or her. I was also expecting a list of chemical formulas, which wasn't there, just a handful of examples to explain the concept being taught. After the lesson, there is a mini quiz to check your understanding. I liked the quiz; it touched on all the main points and I felt it would keep students interested in the Web site by being informative and interactive. You can e-mail the author of the Web site with questions, comments, and opinions and he'll write back to you. I think this is great. Students who need help or whose questions aren't answered can go to the source directly. Students and researchers have an opportunity to contribute to the Web site as well. Finally, there are a number of links at the bottom of the Chemical Formulas Web site that allow you to navigate and search

around the School for Champions Web site, including other physical science topics, homework exercises, and definitions. If a student needed help with other science homework in other topics, this might be a nice place for them to start; however, if a student needed more information on chemical formulas, they'd have to start from scratch with their search for another, more detailed Web site.

### Gas Laws

*Title:* Gas Law Tutorial Index
*URL:* http://chemistry.ohio-state.edu/betha/nealGasLaw/
*Grade Level:* High school through college and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* gas laws
*Review:* This Web page is a section from the Betha page at Ohio State University. What is extra special about the page is that you have a choice either to listen to the tutorials or to read them. To listen you need a Shockwave plug-in. If you choose to read you need to scroll to the second table of contents and choose a topic to research. This is a complete topic listing on gas laws, including "What is a gas?," "A gas fills its container," "Physical characteristics of gasses," "The Ideal Gas Law," "What's behind the Ideal Gas Law?," "Solving a problem using the Ideal Gas Law," "Mixtures of gasses," "Solving a Gas Mixture Problem," "Processes with two changing variables," "Solving for two variables," "Derived Gas Laws," "Reactions in the gas phase," and "A gas stoichiometry problem."

*Title:* Gas Laws
*URL:* http://www.matchrockets.com/air/airmain.html
*Grade Level:* Grades 7 and 8
*Search Engine:* http://www.google.com
*Key Search Words:* gas laws for kids
*Review:* This site is great for seventh- and eighth-graders because they can access it themselves and find out about the gas laws like the Perfect Gas Law, Boyle's Law, Dalton's Law, Avogadro's Law, and more. There is also a gas law tutorial that is linked to the page and the graphics are excellent. The best part about this Web site is that it has safe and effective experiments that teachers can use in the classroom to demonstrate the gas laws. A classic example is crushing a can with air. Another example is building a very safe, nonflammable "bomb"

that demonstrates gas laws. There are plenty more on the Web site to click on, and directions are available.

*Title:* Gas Laws
*URL:* http://science.widener.edu/svb/tutorial/gaslawsfinal.html
*Grade Level:* High school and college
*Search Engine:* http://www.askjeeves.com
*Key Search Words:* what are gas laws
*Review:* This site is excellent for a review once gas laws and other chemistry related topics have been taught. The Web page is designed to test students on questions that vary enormously, depending on how well the previous question was answered. The students are immediately able to understand if they are doing the equations correctly because the Web site tells them whether they are correct or incorrect right after they put in the answer. This is a helpful study tool because students will not move on to a more difficult question without making sure that they know how to answer the easier questions first. The Web site also offers links to other chemistry sites that include different lab experiments and environmental issues. All in all, I think it is a great site . . . but it is definitely designed for a more advanced chemistry class.

*Title:* Kinetic Molecular Theory and Gas Laws Table of Contents
*URL:* http://dbhs.wvusd.k12.ca.us/GasLaw/KMT-Gas-Laws.html
*Grade Level:* Upper high school and college
*Search Engine:* http://www.yahoo.com
*Key Search Words:* gas laws and tutorial
*Review:* This is an excellent Web site for the upper-level student looking for information about gas laws. The Web site has many key indexes that break down each of the gas laws, the kinetic molecular theory, and the four gas law variables. Each description gives an in-depth discussion of the law and the equation for each law. At the bottom of each page there is a worksheet to put the laws into use. Again, this site is for the higher-level student.

*Title:* Gas Laws and Their Behaviors
*URL:* www.geocities.com/chemistyvillage/gases/gases.htm
*Grade Level:* High school
*Search Engine:* http://www.dogpile.com
*Key Search Words:* gas laws

*Review:* This site was created by a student with close cooperation of his chemistry professor. It gives simple, easy-to-understand explanations of gas laws and the characteristics of some gases. There are detailed diagrams and charts, along with sample formulas to give the student an example of how these gases should be written. The laws that are explained on this site are Avogadro's Principle, Dalton's Law of Partial Pressures, Grahm's Law of Diffusion, and the Thread.

*Title:* Gas Laws
*URL:* http://library.thinkquest.org/12354/
*Grade Level:* Grade 6 through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* gas laws
*Review:* This is a Think Quest Web site made by kids for kids. Scroll to the "Gas Laws Click Here" link and click on it. This takes you to the Web site Gas Laws. Scroll down and click on "First a Few Basic Concepts," "Some Basic Conversions," "Common Abbreviations," "Glossary," or "Periodic Table," and find lots of information on gas laws. Or scroll down and click directly on each formula and find information, diagrams, and pictures and sample problems and other problems. Answers to the problems are on a separate link that you will find at the end of the page. What is nice about this Web site is the format. The type size is large and distinct, and there seems to be double space between each line.

*Title:* The Laws List: I
*URL:* http://www.alcyone.com/max/physics/laws/i.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* ideal gas laws
*Review:* This Web site is the laws list of Erik Max Francis. It contains laws, rules, and so on, of physics. Under the letter "I" for ideal gas laws, find formulas and constants for the ideal gas constant, ideal gas equation, Charles's Law, Boyle's Law, and pressure law. Included is a little history. This is a convenient site for use by beginning students.

*Title:* The Gas Laws and Anesthesia Tutorials
*URL:* http://www.4um.com/tutorial/science/gas1.htm
*Grade Level:* High school and college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* gas laws

*Review:* This Web site was designed by Pat Neligan. This contains a brief overview of gas laws, including Boyle's Law, Charles's Law, the Third Gas Law, Dalton's Law of Partial Pressures, Avogadro's Hypothesis, and the Universal Gas Constant. It also includes a section on the Solubility of Gases including Henry's Law, Determination of Gas Solubility in Liquid, the Ostwald Solubility Coefficient, and Partition Coefficients. You are not allowed to reproduce this material; however, the information is available and can be used as a brief tutorial.

*Title:* Gas Laws
*URL:* http://www.chemistry.ohio-state.edu/betha/nealGasLaw/
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* gas laws
*Review:* This is an excellent site, providing detailed information and examples on the following topics: 1. What is a gas? 2. A gas fills its container. 3. Physical characteristics of gasses. 4. The Ideal Gas Law. 5. What's behind the Ideal Gas Law? 6. Solving a problem using the Ideal Gas Law. 7. Mixtures of gasses. 8. Solving a Gas Mixture Problem 9. Processes with two changing variables. 10. Solving for two variables. 11. Derived Gas Laws. 12. Reactions in the gas phase. 13. A gas stoichiometry problem. The information is presented in a text-read format, or if sound is available and the Shockwave plug-in is loaded the information is presented to the user in discussion format as well.

*Title:* Scuba Physics: Buoyancy and Gas Laws
*URL:* www.aquaholic.com/gasses/laws.htm
*Grade Level:* Grades 6 to 9
*Search Engine:* www.yahooligans.com
*Key Search Words:* gas laws
*Review:* This search engine is used very widely in the middle school in which I work. Many students use it for homework help, while others use it to research topics. The topic of gas laws is covered in full on this Web site. There are eight subtopics under the main topic. When entering each one, there is a detailed explanation of the topic, along with formulas and examples to better illustrate what is being said. Many of the gas laws are covered, such as Boyle's Law, Charles's Law, and Dalton's Law.

*Title:* Gas Laws
*URL:* http://www.chem4kids.com/files/matter_gas.html

*Grade Level:* Grades 3 to 6
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* gas laws for kids
*Review:* I have researched several search engines (Google, Metacrawler, Lycos) and used various words (gas laws, gas laws for kids). Upon review, the Chem4kids site is the most readable and best laid-out site for grade levels 3 through 6. It has interesting headings ("Looking for a gas," "So you want to be a gas") and important concepts about gases appear in boldface. Each Chem4kids site concludes with a short biography of a scientist important to that particular field of study. Chem4kids also refers other sites for Earth sciences, biology, and general science.

*Title:* The Chem Team
*URL:* http://dbhs.wvusd.k12.ca.us/ChemTeamIndex.html
*Grade Level:* High school
*Search Engine:* http://www.yahoo.com
*Key Search Words:* children, science
*Review:* This Web site provides some tutorials for high-school students in different areas of science. The home page provides a number of different topics to choose from. If you click on "Kinetic Molecular Theory and Gas Laws," it will take you to the section involving gas laws. In that section there are various other links to click on that explain things such as gas law variables, Charles's Law, Boyle's Law, and so forth. This Web site is pretty much just text and is not very interesting in its presentation of the information. It does, however, seem to contain a fair amount of information for a student who is studying this topic.

*Title:* Chemical Elements.com
*URL:* http://chemicalelements.com/
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* children, on-line, chemistry
*Review:* This Web site provides an interactive periodic table of elements. It also contains a breakdown of various chemical groups and information on each element within. It allows you to click on each individual element and takes you to a page containing information specific to that element, including a picture of the atomic structure. It also includes facts about each element and it has discovery. This Web site is

fairly informative and provides many links for further exploration of the topic.

*Title:* Gas Laws—The Physical Science Series
*URL:* http://www.physicalscienceseries.com/gaslaws.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* gas laws
*Review:* This Web site, another segment of The Physical Science Series, is an interactive HyperStudio program written specifically for high-school chemistry students. Its colorful graphics and easy-to-read blocks of information introduce the students to the scientists and their gas law formulas. It also contains Web links to find additional resources. Throughout the program students work out gas law problems. The program shows them how to rearrange formulas to solve for a variable. In one lesson, the pressure gauge breaks when the student clicks on it too hard. They are then forced to calculate the new pressure using Boyle's Law. Throughout this program, the students are required to make calculations and then graph their data. This hands-on approach helps the student to discover whether the variables in question are either directly or inversely proportional. This is an excellent resource! The attractive, colorful presentations, coupled with the hands-on activities to determine the relationships of pressure, volume, and temperature is an effective tool for learning or reinforcing the understanding and application of this more difficult concept.

*Title:* Gas Laws
*URL:* http://library.thinkquest.org/12354/
*Grade Level:* Upper middle school through high school
*Search Engine:* http://www.webcrawler.com
*Key Search Words:* science, gas laws, education
*Review:* I liked this site because it was created by high school-students under teacher supervision. It explains what the relationships and properties are, as well as ways to calculate equations. It has separate pages for a glossary, abbreviations, basic concepts, conversions, and a periodic table. At the end there is a sample test (with answers included) that the Web-researching student can work on. The students did a nice job creating the site (there is even a cheesy Casio version of a song by Garbage for your background enjoyment); it is easy to understand and hopefully beneficial to others.

*Title:* Gas Laws
*URL:* antoine.frostburg.edu
*Grade Level:* Grades 5 to 9
*Search Engine:* http://www.yahoo.com
*Key Search Words:* gas laws and children
*Review:* This Web site was great and very neatly laid out. The introduction page showed the main gas topics on the Web site. Those listed were Avogadro's Law and gas densities, empirical gas laws, mixture of gases, molecular weight of gases, reaction stoichiometry and real gases each with subtopics. I clicked on "empirical gas laws" and up came some more listings, such as Charles's Law complete with an easy-to-understand explanation of what the law was and a few examples of Charles's Law in action. The best example given is how a turkey plunger pops out when the turkey is done because the volume of trapped air under the plunger increases as the temperature rises. The site provides excellent examples that children can immediately relate to. The next thing listed under "empirical gas laws" was Boyle's Law: doubling the pressure on a gas halves its volume as long as the temperature of the gas and the amount of gas aren't changed. It goes on to explain how a deep-sea fish dies when brought to the surface of water because the pressure decreases and the volume of gases in their bodies increases and pops bladders, cells, and membranes. Then it explains in as much detail Amonton's Law and and Avogadro's Law. I loved the examples given because they are interesting and made me want to read on. The most important thing about this site is that it forces children to think about science not as experiments and projects but as an everyday occurrence.

*Title:* Gases and Their Behaviors
*URL:* http://www.geocites.com/chemistryvillage/gases/
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* gas laws
*Review:* When I first looked at this Web site to determine whether it was worthy of reviewing, I found that it was created by a college student at Miami-Dade Community College to help as a study guide for a group project. However, it turned out to be one of the best Web sites I've ever encountered. Since the group project, the student has updated the study guide to a complete lesson with diagrams, explanations of how the mathematical equations work, and simple examples

of each law. The site is ten pages total, with links only from one page to the next, vice versa, and back to home. The only fault I found with the site was the lack of links to other Web sites concerned with the same topic. The Web site begins with a short history of how the Web site came to be, which initially deterred me from wanting to read further. I read on, however, and found the most detailed and complete Web site I've ever navigated. After the history begins an introduction. The first page is called "The Physical Behavior of Matter in the Gaseous State." This includes the Kinetic Theory of Gases, which is in complete detail and has great examples to help clarify. Every concept and term that may not be clear to the reader is defined. The second page is "A Brief Introduction to Some Gas Laws and Equations." There is an introduction to pressure. Then he goes into each of the following briefly, which he also goes into in greater detail later in the site: Boyle's Law, Charles's Law, Pressure Law, General Gas Equation, Ideal Gas Equation, Avogadro's Principle, Dalton's Law of Partial Pressures, Graham's Law of Diffusion, and the Concept of Molar Volume. Each includes the law stated clearly and separated into the parts that make these laws whole. The third through tenth pages go into detail of each of the above listed, including a more detailed explanation of the law restated, examples of each, the law or equation mathematically restated, simpler, but useful diagrams, and how the Kinetic Theory explains each law if this applies. The pages on diffusion include a short introduction and explanation of the rate of diffusion. Graham's Law of Diffusion is represented mathematically. Here we come to the end of the site, which allows you to start all over if you'd like. Again, the only thing this Web site lacks is links to other sites for further information.

*Title:* Gas Laws—By George McBane, D. Neal McDonald, Zil Lilas, Midori Kitagawa-De Leon, and Sherwin J. Singer
*URL:* http://www.chemistry.ohio-state.edu/betha/nealGasLaw/
*Grade Level:* Middle school and up
*Search Engine:* http://www.google.com
*Key Search Words:* gas laws
*Review:* This Web site is small and self-explanatory. When a question is clicked on, a page opens up with an animated picture explaining the answer. If there are speakers with the computer, there is a discussion with the explanation, though the man's voice is very monotonous. The pictures are clear, labeled, and descriptive. At the

bottom of the page, there are links to the Betha home page on balancing chemical equations, gas laws tutorial, and introduction to quantum mechanics.

*Title:* Gas Laws
*URL:* http://wine1.sb.fsu.edu/chm1045/notes/Gases/GasLaw/Gases03.htm
*Grade Level:* Grade 5 and up (introductory level)
*Search Engine:* http://www.google.com
*Key Search Words:* gas laws
*Review:* This Web site is a free Web site that is basically for anyone beginning the study of gas laws. It begins by defining the gas law variables, then goes into Boyle's Law, Charles's Law, and Avogadro's Law. A very brief history of each law is given, and diagrams and sample equations are provided for all three laws. This site is very basic. There are no links to any other sites. It is, however, to the point and would be good to use as reinforcement or a study guide for students who may need further explanation outside of text and class. I clicked on "to find out more about the simulation," and it explained what was happening in the simulation. The colors are the four molecules, and when they collide, they react to form a pair of green or blue molecules. Then it explains how to write the formulas for these reactions. This site gives a lot of information, some of which I didn't understand but that would be good for someone taking a class on the topic. What I like about this site is that it asks a lot of questions throughout the explanations. For example, what would happen if you changed the density of the reactants? How does the reaction rate change? It gives the answer right after the question. And it has numerous questions throughout the explanation.

*Title:* Gas Law Tutorial Index
*URL:* www.chemisrty.ohio-state.edu/betha/neal/GasLaw/
*Grade Level:* Grades 7 to 12
*Search Engine:* http://www.yahoo.com
*Key Search Words:* gas and law
*Review:* This Web site offers discussions on different topics of gas laws. It has a computerized voice discussion if your computer has Shockwave. If it does not, the Web site still has the discussion in a written format along with animations. The animations show colored gases in bottles to help describe how it takes up space. This Web site is good in help-

ing to explain step-by-step, and no prior knowledge is needed on gas laws before viewing the Web site.

### Groups

*Title:* Periodic
*URL:* http://www.newi.ac.uk/buckleyc/periodic.htm
*Grade Level: High school and above*
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table groups
*Review:* This Web site contains links to Chemistry, the Periodic Table, Electronic Configuration, and Bonding; it was developed by David Harrison at the School of Science and Technology in North Wales. At the home page you will find an excellent tutorial on the periodic table, including tables and diagrams as well as distinct and basic information. The site is well written in large type, with clear tables and diagrams.

*Title:* Chemical Groups
*URL:* http://www.lcc.ukf.net/Chem13/groups 1234&8.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical groups
*Review:* This Web site, sponsored by Loreto College, Coleraine, Ireland, Chemistry Department, offers the browser a variety of choices. Included on this site are specific chemistry topic hyperlinks to additional useful sites, a clipart page, brainteasers, chemistry demonstrations, a "Chemistry Clinic" link, and an invitation for people with similar interests to share written resources. This site has an eye-pleasing pattern of color attractively displayed in the background as the reader digests large quantities of factual information. The general properties of the main groups of the periodic table are presented. The text begins by giving a brief summary of chemical groups I, II, III, IV, VII, and VIII. Group I and II elements are identified as the s-block elements. They are characterized by their reactivity, low density, and softness. Further discussion identifies and explains the physical and chemical properties of these groups. The elements of each group are listed and their reactivity, proper handling and storage, relative abundance in nature, and practical uses for man are discussed. Additional information is provided for the chemistry student regard-

ing valence states, engineering properties, such as electrical and thermal conductivities, and items of special interest to the chemical engineer and reaction kinetics for commercial production.

*Title:* BioChemLinks—General Chemistry
*URL:* http://biochemlinks.com/bclinks/chem.cfm
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* teaching + chemistry
*Review:* This Web site begins with several subdivisions such as Introduction to Chemistry, Periodic Tables, Molecules, Ions, Solutions, Acids, Bases, pHs, Chemical Reactions, Analytical and Environmental Chemistry, Questions, Problem Sets, Quizzes, and Laboratory Experiments. There is also a smaller subdivision, Inorganic Chemicals, which is where I clicked on the three different choices of Baking Soda, Bleach, and Ozone. When I looked through all three of those sections I found experiments teaching high-school students about inorganic chemicals. The Baking Soda experiment is done to teach students about the leavening process and how to produce the gas that makes cakes, muffins, and breads rise. They learn that baking soda and the liquid acid in the recipe results in leavening. They also learn that when the liquid ingredients are mixed with the dry ingredients you get leavening, or when the product is heated you will also get leavening. The Bleach section of this Web site discusses the bleach cycle, the manufacturing process, safety and environment, recycling, and the Risk Management Program (RPM). The Ozone section discusses how CFCs destroy the ozone and how the ozone is destroyed naturally. It supplies measurements, pictures and movies, effects, and sources of destroyers. Students can learn a great deal about these various inorganic chemicals through this Web site. I found it very easy to follow and understand what the creator of the Web site was trying to show. The Web site also provides learning activities and quizzes, which are extremely helpful.

*Title:* None
*URL:* www.chemicalelements.com
*Grade Level:* Advanced middle school and above
*Search Engine:* http://www.aol.com
*Key Search Words:* chemical elements and families
*Review:* This site is mainly composed of several links where you can find basic explanations of most elements-related topics, such as atomic numbers, atomic mass, electron configuration, melting and boiling

point, and crystal structure. The part of this site that attracted me for the purposes of this assignment was the links for the element groups. They are: Alkali Metals, Alkaline Earth Metals, Transition Metals, Metalloids, Non-metals, Halogens, Noble Gases, and Rare Earth Elements. Each of these links for the groups provides general information as well as what element is included in each group. Each element is also a link to a page that gives very specific information for each element. The periodic table illustrated is also interactive, allowing you to click on whatever element you want in order to get the important information. This site provides the same information however a variety of ways to find it. You can search from the groups, or the elements' names, or by the symbols on the table. I think this is great, because we all know that we find things in many different ways. Students can find the information they need any way they look!

*Title:* Web Elements—Chemical Groups
*URL:* http://www.webelements.com
*Grade Level:* All ages
*Search Engine:* http://www.askjeeves.com
*Key Search Words:* what are chemical groups?
*Review:* This site is a great reference for all chemical groups and, more specifically, the individual chemical elements. The site is primarily made up of the periodic chart of elements. By clicking on each element in the chart you are given a very thorough report of the element. The weight, symbol, group number, group name, and several more specific details are given. A brief description is provided along with a description of the isolation of the element. The site includes descriptions of the elements properties, history, uses, and several other categories that I wasn't even familiar with. A picture of the element is also included. Some descriptions of the elements even include a movie of different chemical reactions. Overall, the site amazed me! I will definitely use this site in the future, and I think that it is a great reference for all ages!

*Title:* Chemical Groups
*URL:* www.chem4kids.com
*Grade Level:* Grades 5 to 9
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemistry for kids, chemical groups
*Review:* This Web site is designed with colorful, large block letters that are easily accessible to children to simply click on the topic they are

interested in studying. The language is geared toward children and uses phrases like "this is the deal" to get its point across, which I think is important. It is very easy to navigate; the main home page consists of a list of the main science topics on the site. The sections that can be explored are Elements, Reactions, Atoms, Matter, and Biochemistry. I clicked on Biochemistry and an introduction to biochemistry came up on how scientists study this field and why it is important. It explains how a biochemist must understand "both the living world and the chemical world to be best at their jobs." All the key words in the introduction are bolded for kids, and each paragraph is broken down into further sections. For example, under carbohydrates we see subsections of "what is a carbohydrate?", "what is it used for?", "what do they contain?". Then on further inspection we learn about saccharides, regular sugars, and polysaccharides. Click on "enzymes" and learn all about catalysts and pH levels. The example of a lock and key really does a good job of explaining how an enzyme acts as a lock and the compound acts like a key. There is an activity section listed on this site, which mostly contains quizzes for teachers, and there is a great section of examples. The exceptional thing about this site was the "quick cards" that could be printed out of the symbols and the atomic numbers. I thought that would be really helpful for those having to memorize this information like I had to in seventh grade!

*Title:* All about Meteorites
*URL:* http://www.meteorite.fr/en/classification/ironchem.htm
*Grade Level:* Middle school and high school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical groups
*Review:* Why the heck did I choose a site about meteorites? I wanted to find something that might interest the students while they were learning about chemical groups. What student wouldn't be interested in massive rocks that fall from the sky? The site is a little stiff as far as design is concerned, but the content is what makes it a worthwhile visit. Meteorites are broken down into different categories (classifications), depending on what chemical groups the meteor is made of. Stony, iron, and stony-iron meteorites and their subcategories are represented here, each type containing different chemical elements. Did you know that Earth, Venus, and Mars are the only planets that are geologically active? Did you know that there is a specific type of rock that is called a Martian Meteorite? No? Well

maybe you will want to visit this site. There is also a link to a chart of the largest meteorites to have landed on Earth. This gives you the location, weight, year, and chemical groups contained in the meteorite. In 1891 a stony meteorite of the Chondrite class weighing 564 kg landed on Long Island. I believe this is a fact that students will find interesting. Maybe while they are at it they will learn about chemical groups as well.

*Title:* FRAC Fungicide Group Names and Codes
*URL:* http://www.gcpf.org/frac/chemical%20group.html
*Grade Level:* College or advanced placement (AP) high school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical groups
*Review:* I've spent hours searching for a better chemical groups Web site but have found nothing. Therefore my first comment would be that there is a strong need for a good chemical groups Web site because it is an important topic. However, this Web site, although it specializes in fungicide chemical groups, is useful in providing excellent definitions of chemical groups, chemical names, and common names. There is also an excellent explanation of resistance. The Web site has been developed by the Fungicide Resistance Awareness Committee to "classify active components of commercial fungicide products." There is a chart of fungicides, by common name, stating, group code, chemical group, chemical name, and comments on resistance. The chart is very clear and straightforward; if this was something you were researching it would be helpful. There are links to the FRAC home page, the Purpose of FRAC page, the Organization page, the Working Groups page, publications page, and archived reports page. If you were concentrating on fungicide chemical groups, this Web site is excellent. However, if you are searching for your basic chemical groups Web site, the only positive aspect of this site is the very basic definitions.

*Title:* Exxon Chemical
*URL:* http://www.exxonchemical.com/chemical/education/kids/index.html
*Web Site:* ExxonChemical.com: Just For Kids specifically Chem-O-Home
*Grade Level:* K to 3
*Search Engine:* http://www.lycos.com

*Key Search Words:* chemical groups and kids

*Review:* This Web site has three sections. The Who Is Exxon Mobile? section is basic corporate propaganda. It contains everything you can find in their media kit. The Super Science Links section contains a great list of science Web sites for people of all ages. It is broken down into the following subsections: Kids Stuff, Teen Sites, and Science Pages for All Ages. It is quite a diverse list of links that is good for an hour or two of fun science surfing. The section that I liked and that is most pertinent to the subject, chemical groups, is the Chem-O-Home. This is a Shockwave-driven virtual house that is broken up into the basic rooms of the house: bedroom, attic, bathroom, kitchen, and living room. You can also search the garage. The purpose is to show young kids that the things they take for granted are all made up of chemicals. Each room has a scrolling list of common items that the child (or adult) can click on. Then, a description of the item pops up and tells what that item is made of. For example, the living room has clear tape, crayons, a chocolate bar, birthday candles, and CDs and a videotape. If they are clicked, it will tell you each of the chemicals that are used in the production of the item. For example, if clear tape is chosen, it gives a description of what it is used for and says that it is made from polypropylene and adhesives. If you want to delve further into what those are (it is geared for younger minds, mind you) you can click on one of the many links on the links page. This is a fun site to go on with a younger child. It is great to introduce kids to the fact that the things we use are in fact made up of "things"; they do not just fall out of the sky.

*Title:* Chemical Elements.com—An Interactive Periodic Table of Elements

*URL:* www.chemicalelements.com

*Grade Level:* All grade levels

*Search Engine:* http://www.infoseek.com

*Key Search Words:* chemical groups

*Review:* This Web site is a free interactive periodic table which is very easy to use. It is very bright and colorful, which makes it very easy to see and understand its different parts. Down the left side of the Web page are a number of links that lead you to different ways to learn about chemical elements and groups. The left column leaves you with a number of ways to view the periodic table on the right based on what you are learning or want to learn. For example, it allows you (by just clicking on the hyperlink) to view the table by

name, atomic number, atomic mass, electron, configuration, number of neutrons, melting point, boiling point, date of discovery, and crystal configuration. Below these links, the Web site gives the list of different chemical groups by name (Alkali Metals, Alkaline Earth Metals, Transition Metals, Other Metals, Metalloids, Non-Metals, Halogens, Noble Gases, and Rare Earth Elements). By clicking on one of these hyperlinks the right side of the page removes the picture of the periodic table of elements and gives you information on that particular chemical group as well as the elements that make up that group. That list of elements is also hyperlinked so that you can click on one of those elements and then be taken to a page with all of the information of that particular element. This Web site also allows the student to learn more by having a hyperlink to other chemistry links such as links for chemists, pictorial periodic table, and chemical associations. Overall, I found this to be the best Web site I have found so far. This Web site can be beneficial to all age groups because it is very easily understood and accessible.

*Title:* Important Chemical Functional Groups—By Robert J. Huskey
*URL:* http://www.people.virginia.edu/~rjh9u/IntroBio/functgrps.html
*Grade Level:* Grade 8 and above
*Search Engine:* http://www.google.com
*Key Search Words:* chemical groups
*Review:* This Web site led me to one page of a chart of chemical functional groups. At first it was not that interesting, though for what is was, it was helpful. The chart, separated by various colored columns is labeled functional group, class of components, structural formula, and example. The chart was easily identifiable and comprehendible. Other links are at the bottom of the page. When I clicked on them, I realized that this Web page was a part of a Biology 121 class at the University of Virginia. At this point there were many other topics of conversation that ranged from cloning, genes and chromosomes, hormones, enzymes, and the cell cycle. Again there were descriptive pictures and clear explanations with every topic. The reason I suggest this for eighth grade and higher is for the sole purpose of the other topics found with the Bio 121 class. The chart was clear and perfectly fine for younger grades as well.

*Title:* Chemical Elements
*URL:* http://www.chemicalelements.com/

*Grade Level:* Grade 3 and above
*Search Engine:* http:///www.hotbot.com
*Key Search Words:* chemical + elements
*Review:* This site is an on-line, interactive periodic table of elements. Each chemical element is shown, then when clicked on, it opens and its basic information is available. For example, here's Osmium: Name: Osmium. Symbol: Os. Atomic Number: 76. Atomic Mass: 190.23. amu Melting Point: 3045.0 °C (3318.15 °K, 5513.0 °F). Boiling Point: 5027.0 °C (5300.15 °K, 9080.6 °F). Number of Protons/Electrons: 76. Number of Neutrons: 114. Classification: Transition Metal. Crystal Structure: Hexagonal. Density @ 293. K: 22.4 g/cm$^3$. Color: silvery. This site even tells you the date of discovery of the element. There's also an explanation of all the items on the fact sheets that defines the terms such as atomic number, mass, melting point, boiling point, number of protons/electrons, and so forth. Overall, this is a great site that I will save for my children to refer to when they take chemistry.

*Title:* Parent Chemicals
*URL:* www.pesticideinfo.org/documentation 3/ref_parent.html
*Grade Level:* Grades 7 to 12
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemical grouping
*Review:* The Web site above breaks down chemical grouping. It offers information on "Logic behind Grouping Chemicals," "About Compounds," and "Toxicological Similarities." It also offers definitions of a vast array of words to assist in understanding chemical grouping. There also are diagrams and animations to help explain the information. This Web site is good to use as a review, because the students should have some understanding of chemical grouping before going to the Web site.

### Inorganic Chemistry

*Title:* Inorganic Chemistry Resources
*URL:* http://www.wsu.edu/~wherland/
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry tutorial
*Review:* This Web site was designed by Washington State University for inorganic chemistry teachers seeking resources. In order to view and

manipulate the structures you first have to download and register for the free Chime software. Follow the easy, straightforward directions. After registration click on either the 3-D periodic table of radii or the structure database links at the top of the Web page.

*Title:* American Chemical Society Publications: Inorganic Chemistry
*URL:* http://pubs.acs.org/journals/inocaj/index.html
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry tutorial
*Review: Inorganic Chemistry* is the professional journal of the American Chemical Society. It is the top journal for inorganic chemists, containing "experimental and theoretical reports on quantitative studies of structure and thermodynamics, kinetics, mechanisms of inorganic reactions, bioinorganic chemistry, and some aspects of organometallic chemistry, solid-state phenomena, and chemical bonding theory. Emphasis is placed on the synthesis, structure, thermodynamics, reactivity, spectroscopy, and bonding properties of significant new and known compounds." At the home page, click on the "search the journals" or "back issues" links. This links you to a search window, which enables you to type in a topic and/or author and to search in all journals or one specific journal. For instance, if you type in the words "inorganic chemistry," you will be given a list of ten articles that you can purchase or, with a subscription to the journal, you can download and print. Subscription rates for ACS members and nonmembers is $50/year to access the Web subscription, and the print subscription rate is $140/year for members and $304/year for nonmembers (for North American subscriptions). Full-text articles are available free after accessing the "hot articles" link on the left of the home page. Also on the left is a complete author index. This Web site is an important resource for those of you who are researchers and are looking to share information through publishing your articles. The link on the left, "info for authors," provides all the necessary details.

*Title:* Chemistry: A History
*URL:* http://www.nidlink.com/~jfromme/history2/chemist.htm
*Grade Level:* Grade 6 and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry tutorial
*Review:* This is a wonderful history of chemistry Web site developed by James Fromme. It includes information on Early Chemical Arts,

Breaking the Chemical Barrier (Boyle, Priestley, Lavoisier, and Scheele), Identifying the Invisible (Dalton and Cavendish), Secrets of the Gases (Gay-Lussac, Avogadro, and Berzelius), Trail of the Elements (Sir Humphrey Davy, Bunsen, Moissen, Mendelyeev, and Ransay), Living Chemistry (Kekule), A New Age of Chemistry (Moseley and Curies), Achievements of Chemistry in Industry (Hall, Frasch, Haber, and Langmuir), and reference notes. This Web site is easy to use.

*Title:* Chemistry Central
*URL:* http://users.senet.com.au/~rowanb/chem/
*Grade Level:* Grade 6 through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry tutorial
*Review:* This page was designed and maintained by Rowan Beckworth. It contains links to Basic Atomic Information, Information on the Periodic Table of Elements, Information on Chemical Bonding (metallic, ionic, covalent), and Information on Organic Chemistry. It includes information, color diagrams, and tables on each of the topics. There are also embedded links at the beginning of each topic that will take you directly to the linked information. For instance, Chemical Bonding has three links: one to metallic, one to ionic, and one to covalent. Clicking on one of the links zooms you to that part of the document directly, saving you time. Following the tutorials is a list of other chemistry links.

*Title:* Exploratorium: Skateboard Science
*URL:* http://www.exploratorium.edu/skateboarding.index.html
*Grade Level:* Grade 6 through high school
*Search Engine:* http://www.worldnet.att.net
*Key Search Words:* inorganic chemistry for kids
*Review:* This amazing site is filled with outstanding graphics and information that children will be eager to learn about because of its theme: skateboarding! Live Web casts have been available in the past (and can be viewed in their archives by clicking on the link). These Web casts demonstrate the physics behind this sport. Two physicists explain and provide pictures of a skateboard trick called an "ollie." This maneuver is one in which a skater jumps from one place to another in the air with the skateboard staying intact under the skater's feet. This is just one of the many tricks that are explained through physics on this Web site. The flight of the ollie is depicted in seven photographs, and a clear description of each step is given. The three forces of

physics are explained: the skateboard's gravity, the skater's downward force, and the ground's upward force. This site is truly fun and informative. I would highly recommend this site to any physics teacher—especially one who may have trouble getting his or her students interested in physics.

*Title:* Inorganic Chemistry
*URL:* http://science.ntu.as.uk/chph/netchemteach/netpap1.html
*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Words:* inorganic chemistry + teaching + high school
*Review:* This site seemed to make the most sense about teaching a subject that I know nothing about. I initially had to look up the scientific definition of the term, which basically refers to all chemistry that does not include carbons. The title of this is "The Network for Chemical Teaching." The introduction talks about helping students to understand and apply underlying principles, rather than stressing factual material. "There needs to be increased emphasis on applications and industrial importance in order to make this area of chemistry relevant to students." This teaching-paper recommends activities for teaching this subject, as follows: "Group presentations—research by 3 or 4 persons about an element or group of materials and presented to the class. Assessment by peers has been found to work well. Mini-tests—a short test of approximately 5 questions to assess students understanding of material. Scientific papers—familiarizes students with the literature about a topic. Can give students the opportunity to explore their own interests in the subject. Crosswords—adds variety to the format of the course." I searched several times to find Web sites on this topic for elementary students, my area of interest, and was unsuccessful.

*Title:* Inorganic Chemistry
*URL:* http://www.aolsvc.worldbook.aol.com/wbol/wbPage/na/ar
*Grade Level:* High school
*Search Engine:* encyclopedia.com
*Key Search Words:* inorganic chemistry
*Review:* This site gives a brief overview of what inorganic chemistry actually is. It was easy to understand. When I finished reading it, I actually knew what inorganic chemistry was (well, more than I knew before I read it). It explained why inorganic chemistry is important for everyday life, for example, the stop of the growth of cancer cells or

for the use for glass fibers to transmit telephone messages with light. It gives examples that everyone can relate to. This is good to do with a topic that most people don't know much about. This was a good explanation of inorganic chemistry for beginners who might be afraid to learn about this topic.

*Title:* Organic and Inorganic Chemistry
*URL:* http://www.epa.gov/region02/desa/lab/labchem.htm
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.google.com
*Key Search Words:* inorganic chemistry for kids
*Review:* This Web site's "Organic and Inorganic Chemistry" section analyzes environmental samples in all types of media. It has a subject index and a search function. It helps kids learn about environmental topics, link to other helpful sites, and find assistance for teachers. This site is easy to access and very user-friendly.

*Title:* Cyber Chem
*URL:* http://www.angelfire.com/md/mzh
*Grade Level:* Grades 6 to 12
*Search Engine:* http://www.aol.com
*Key Search Words:* inorganic chemistry for kids
*Review:* After searching for a very long time, I finally found a Web site on inorganic chemistry that was more than just a bunch of definitions. I actually found a site that is a great tool for students that love to use the computer and want to interact with a Web site. This Web site is very pleasant to the eye . . . in fact, it allows you to choose the colors you want the screen to be before you even begin. The Web site comes with three main links for inorganic chemistry. The three main hyperlinks are periodic table with data, periodic table with more data, and virtual chemical lab. Both hyperlinks for the periodic table take you to a virtual periodic table whereby clicking on the element of your choice you can find out all of the information on that particular element. Now, for the student who can't get enough of being in the science lab, by clicking on the hyperlink to the virtual chemical lab you are a brought to a number of different new hyperlinks that will get you started in doing your own experiments on the computer! One such experiment deals with the Structures of Simple Inorganic Solids. These experiments start out by giving you background information on the topic, along with other information you might need to understand your experiment. The site then gives other hyperlinks to get

you on your way to a virtual lab experience. This Web site is a great way for a student to gain new knowledge on inorganic chemistry while also expanding their laboratory skills by following the computer through a virtual experiment.

*Title:* Welcome to Structure World
*URL:* http://www.ilpi.com/inorganic/structures/
*Grade Level:* Students in introductory inorganic chemistry courses
*Search Engine:* http://www.askjeeves.com
*Review:* This Web site introduces students to the basic structures that are involved in inorganic chemistry. Vivid pictures in bright colors display the structures. Students can view a variety of 3-D inorganic structures. These include models that can be manipulate by the students. Vital statistics of the structures are also included. This is an excellent Web site with colorful resources. However, the only downfall of Structure World is that the Chime Netscape Navigator Plug-In must be downloaded. Nonetheless, it is downloaded for free. So enjoy this hands-on Web site!

*Title:* Chem4kids
*URL:* http://www.chem4kids.com
*Grade Level:* K to 8
*Search Engine:* http://www.google.com
*Key Search Word:* chemistry
*Review:* Chemistry is explored on this wonderful Web site designed specifically for kids. This is an interactive site that includes the periodic table of elements, molecules, matter, biochemistry, chemical reactions, and atoms. This site even teaches kids how math is utilized in chemistry. This is a great site because it actually offers the students a chance to search a keyword or term, unlike many Web sites that I had researched. A site map is also included in this colorful resource. Chem4kids also includes quizzes and activities so students can test their knowledge. And since chemistry is such a difficult topic, hints are given to help students answer the questions. There are also flash cards sets to help kids remember what they have learned. In conclusion, this is absolutely the best Web site that I have found on chemistry and chemical groups for children!

*Title:* Inorganic Chemistry Facts
*URL:* www.rod.beavon.clara.net/chemistry_contents.htm
*Grade Level:* High school or college

*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry for kids
*Review:* I found it difficult to find a Web site about inorganic chemistry that I enjoyed enough to tell you about. There are few chemistry Web sites that go into detail or even explain what inorganic chemistry is. It took an afternoon, but I eventually stumbled across this one. It isn't the best, but answers many questions about inorganic chemistry. The home page provides a number of links to research inorganic chemistry. Once you begin clicking on the categories, all the facts are right there. It also posts frequently asked questions and gives you all of the answers. The Web site itself can be difficult to get around if you don't know what you want to look for. But when it is found—the information is endless. It gives many examples and goes into much detail—even giving you other places to look for information. Overall—it was OK. There needs to be more Web sites that have easy access to this topic.

*Title:* Inorganic Chemistry
*URL:* http://www.snowbirdsoftware.on.ca/index-old.htm
*Grade Level:* Grades 9 to 12, junior college
*Search Engine:* http://www.google.com
*Key Search Words:* inorganic chemistry
*Review:* This Web site is a Windows version for inorganic, physical, and atomic chemistry. It contains animated chemistry simulations for high-school and junior college-level students. It is set up to be used by either the regular (standard) or the visually impaired student. In the inorganic chemistry section, students can choose from over 170 chemicals in a storeroom, take them to a bench, and run their own experiments using their own choice of apparatus. The animated graphics are presented in a series of three pictures: bench with flask, crucible, and gas apparatus. The student is directed to click on the pictures to view larger images and then proceed with the experiment. In the physical chemistry section, students have a choice of four types of apparatus. The experiments include those that take up a lot of time and are often difficult for the students to complete: titration, thermo chemistry, gases, and electrochemistry. In the atomic structure section, students can write electron configurations, see atomic orbitals, and plot atomic properties. The atomic orbitals can be mixed to show the shapes of the functions. A listing of available teacher workshops is included at the end of the site, as well as

additional contact information from the author. A very interesting and fun site! It makes learning this aspect of chemistry painless and enjoyable. It is student-friendly, using the inquiry approach to learning.

*Title:* Inorganic Chemistry
*URL:* www.ilpi.com/inorganic/
*Grade Level:* Any grade level
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemical groups + inorganic
*Review:* This Web site is pretty good and can be utilized practically for any grade as an introductory lesson. The Web shows many different pictures and gives a little bit about inorganic statistics. It's an OK Web site.

*Title:* Inorganic Chemistry
*URL:* http://virtualsciencecenter.com/halloforganicchemistry/inorganicchemistry.org/
*Grade Level:* All grades, all students, all ages
*Search Engine:* http://www.google.com
*Key Search Words:* inorganic chemistry, kids
*Review:* This site takes a while to become familiar with, although the information seems vast and useful. It is a student publishing site, where student papers, photography, drawings, and art can be submitted. There are guidelines and certain stipulations. A student from either the primary, secondary, college, graduate, or technical level can submit. Once I figured out how to get around on the Web site, I found that, for example, inorganic chemistry had an immense list of resources and reviews for various topics pertaining to inorganic chemistry were given. It was quite expansive and impressive. There were not simply science-based inorganic chemistry sites; there were art, music, and math links and so on.

*Title:* Kaboom!: Pyrotechnics—It's Elemental
*URL:* http://www.pbs.org/wgbh/nova/kaboom/elemental/
*Grade Level:* Any grade level
*Search Engine:* http://www.lycos.com
*Key Search Words:* inorganic chemistry and kids
*Review:* This is a simple site that is contained on the PBS program *Nova*'s Web site. Its purpose is to provide information about the makeup of

fireworks. The site provides a periodic table that has all the elements highlighted that make up the big fireworks like they show on television. Once each element is clicked, it tells what the element is, what its use in the firework is, and the family it belongs to and gives a description of what we actually see it do when the firework explodes. This is a fun site to view with kids and students during the summer, obviously during the Fourth of July holiday. All of us, at one time or another, have wondered how fireworks explode; this site answers the question. And it is part of the *Nova* Web site, so if a question is raised that you cannot answer, most likely the answer will be found somewhere else on the site. This site was found using the cool4kids links page at http://cool4kids.com/c4k/Science/Chemistry.

*Title:* General Chemistry Online
*URL:* antoine.fsu.umd.edu/chem/senese/101/intro/faq/What-is-Chemistry.shtml/
*Grade Level:* Grades 7 to 12
*Search Engine:* http://www.yahoo.com
*Key Search Words:* inorganic substances
*Review:* This Web site gives a general description of chemistry and all of its characteristics. It has a table of contexts that offers a tutorial Index and Glossary for chemistry. It also allows you to type in search words to assist you in your finding. This Web site provides a quiz for the student to take. The Web site is an excellent source for all components of chemistry including inorganic substances. The Web site can be used before, during, and after the lesson is taught.

*Title:* Inorganic Chemistry
*URL:* www.infoplease.com
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.msn.com
*Key Search Words:* inorganic chemistry
*Review:* I had a very hard time finding any information on inorganic chemistry. There was plenty on organic, however. I finally found this site, which basically gave an explanation of what exactly inorganic chemistry was and how it differs from other areas. The terms used are quite understandable although it appears to be a more advanced chemistry site. It tells the user that inorganic chemistry is the study of all elements and their compounds except carbons and its compounds, which fall under organic chemistry. Inorganic chemistry studies non-

living matter and minerals found in the Earth's crust. The branches of inorganic chemistry include organic chemistry, bio-organic, coordination, geochemistry, inorganic technology, nuclear science and energy, organometallic compounds, reaction kinetics and mechanisms and solid state chemistry and synthetic organic chemistry. I understand the basics of what inorganic chemistry is from this site, but there aren't any examples to aid in understanding, which is so important to drive it home.

*Title:* Inorganic Chemistry Facts
*URL:* http://chemistry.miningco.com/msub16.htm
*Grade Level:* High school or college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry facts
*Review:* This home page has a list of links in alphabetical order that link the user to related course work and notes. The page includes more than just inorganic chemistry facts, but it is the most helpful Web site I've encountered in this particular search. This was actually the first Web site recovered in the search, and I chose to look for another site because of the amount of advertisements and flashing things on the home page. Once you sort through all the stuff, you realize that this is a good, factual site. Along with the links, there is also a search option, which leads you through the entire about.com database. There is also a list of chemistry essentials in the top left corner which may be helpful to students of all ages searching for something quickly, including Periodic Table of the Elements, Chemistry How-To Guide, Chem 101: Introduction and Study Tips, Chemistry News, and Chemistry Glossary. There is also a list of other science-related links within the about.com pages, including Analytical, Biochemistry, Engineering, Environmental, General Chemistry Geochemistry, Inorganic, Organic, Physical Chem, Spectroscopy, Clip Art, Convert/Calculate, Databases, Dictionary, Education Employment, History, Home Experiments, Homework Help, How Things Work, Humor, Legal Issues, Industry, Medical and Safety, Periodic Tables, Professional, Software, Suppliers, Weird Science, Subject Library, and All Articles on This Topic. And, of course, there is the option to subscribe to their newsletter, which I'm sure would also allow you to receive plenty of e-mails from people you don't know and don't want to know. Aside from all of the advertisements and annoying flashy things, this is a really useful

Web site with almost too much information. But I believe that if a student were searching for something, they'd be able to find it here.

*Title:* Inorganic Chemistry Resources
*URL:* http://www.wsu.edu/~wherland/
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* inorganic chemistry education
*Review:* This site, created at Washington State University, was designed to assist the science teacher in the quest to teach students about inorganic chemistry. Its contents include a 3-D periodic table of Radii, as well as a structure database. The structure database is rather large, containing 330 different structures, so the student can view and study different molecular shapes and dimensions. So if you want your students to study Tetrafluoborate, Buckminsterfullerene, Carbon tetraiodide, or any Metaloprotiens, all formulas and structures are included here. The site also gives lesson ideas for the teacher to better utilize the information presented.

*Title:* Making Matter—The Atomic Structure of Atoms
*URL:* http://www.ill.fr/dif/3D-crystals/
*Grade Level:* High school and college
*Search Engine:* http://www.yahoo.com
*Key Search Words:* inorganic chemistry
*Review:* This site is very comprehensive, and I found it very easy to follow. The home page separates the categories of bonding all the way to superconductors. I particularly found useful an introductory question next to the topic to give you a brief overview of what would be covered. It also provides a free download of 3-D crystals. I found that the site was very comprehensive but in a way that was interesting and simple. The descriptions included real-life examples and examples of compounds that everybody is familiar with (e.g., salt).

*Title:* Inorganic Chemistry
*URL:* http://www.compusmart.ab.ca/plambeck/che/struct/s060x.htm
*Grade Level:* High school and above
*Search Engine:* http://www.google.com
*Key Search Words:* inorganic chemistry
*Review:* This site is a great introduction to the subject of inorganic chemistry. In several paragraphs the subject is explained in a language that is easily understood by non–chemistry majors. Detailed

explanations on the following subtopics is further explored: Inorganic Chemistry of Hydrogen, Inorganic Chemistry of the Oxygen Group, Inorganic Chemistry of the Halogens, Inorganic Chemistry of the Carbon Group, Inorganic Chemistry of the Main-Group Metals, Inorganic Chemistry of the Transition Metals, and Inorganic Industrial Chemistry. The information contained in this site was prepared by Dr. James A. Plambeck, Department of Chemistry, University of Alberta, Edmonton, Alberta, Canada, for the VUN (Virtual University North).

**Kinetics**

*Title:* Chemical Kinetics
*URL:* http://www.millsaps.edu/www/chem/chem1223/ckinet1/index.htm
*Grade Level:* College level
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* basic chemical kinetics
*Review:* This Web site has links to Chemical Kinetics, Chemical Kinetics, The Law of Mass Action, Terms that Seem to Conflict, Balanced Equations and Rate Express, Basic Rate Expression, The Rate of a Reaction Depends On, Effect of Concentration on Rate, First Order Kinetics, First Order Kinetics Problems 1 and 2, Second Order Kinetics, Zero Order Kinetics, Zero Order Reactions, and Chemical Kinetics. The Web site was developed in 1996 by Cord Corporations. It contains a thirty-nine-slide, PowerPoint presentation covering the topic of chemical kinetics.

*Title:* Chemical Reactions and Kinetics
*URL:* http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch22/react.html
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* basic chemical kinetics
*Review:* This Web site developed by Purdue University's chemistry department covers: The Mechanisms of Chemical Reactions, The Relationship Between Rate Constants and Equilibrium Constants, Determining the Order of a Reaction from Rate of Reaction Data, The Integrated Form of First-Order and Second-Order Rate Laws, Determining the Order of a Reaction with the Integrated Form of Rate Laws, and Reactions that are First Order in Two Reactants. It contains both the information and a few practice problems with the answers.

*Title:* Chemical Kinetics Database
*URL:* http://kinetics.nist.gov/index.php
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical kinetics
*Review:* This Web site is maintained by the National Institute of Science and Technology (NIST). It contains a searchable kinetics database and a searchable bibliographic database. At the home page, click on either of the database links. Either searchable database asks you to type in either the title, author, book title, journal, volume, year, or ISBN. Search windows have Boolean logic buttons to choose from.

*Title:* Chemistry Class the Internet Science Room
*URL:* http://pc65.frontier.osrhe.edu/hs/science/creact.htm
*Grade Level:* Grade 6 through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* basic chemical kinetics
*Review:* This Web site is a great tutorial for students developed by Frontier High School in Red Rock, Oklahoma. At the top of the weekly lesson plan, you will find the following objectives: Recognize when a chemical reaction is taking place; Know the four basic types of inorganic reactions; Know the characteristics of a neutralization reaction; Know the characteristics of an oxidation-reduction reaction; Know the characteristics of a combustion reaction; and Given the reactants, predict the products of a reaction. The question that follows appears when you place the arrow on the picture. For instance, there is a beaker with a red substance giving off a gas that appears on the right of the page. Placing your arrow on the beaker, the question "what can you see that tells you a reaction is taking place?" appears followed on the screen by the answer to the question. Included on the Web site are page links to more information and to virtual lab experiments. Included with the virtual lab experiments are lab keys and self-scoring rubrics pages. There are sample problems and practice problems with check sheets included. At the top of the Web page, you will also find a skills test and sample experiment form.

*Title:* Chemical Kinetics Simulation (Instructions)
*URL:* http://www.chem.uci.edu/education/undergrad_pgm/applets/sim/simulation.htm
*Grade Level:* Grade 12 through college
*Search Engine:* http://www.google.com

*Key Search Words:* chemical kinetics
*Review:* This Web site is an extension of the University of California Chemistry Web page. This is a great Web site to see the simulation of chemical kinetics. Students have the opportunity to change the initial concentrations (number of molecules per box) and reaction rate constants (probability). This hands-on approach involves the students more deeply in the simulation process of chemical kinetics. Throughout this program students can make calculations and figure out reaction rates with each entry. This site explains that kinetics is whether equilibrium is reached quickly or slowly. This site also offers great examples of how to get specific reactions with formulas. The colorful simulation on the first page is an attractive presentation that leads to hands-on activities and calculations. Overall, this site is great for seniors in an advanced chemistry class and college-age students.

*Title:* Chemical Kinetics
*URL:* http://grandmac.calpoly.edu/docs/science/chem/kinetics.html
*Grade Level:* Grade 12 (requires calculus)
*Search Engine:* http://www.google.com
*Key Search Words:* chemical kinetics for kids
*Review:* This site, developed by California Polytechnic State University, connects engineering and the physical sciences with mathematics. The example of chemical kinetics begins with a hypothetical accident at a nuclear power plant. The task is to plot the first- and second-order reactions and integrated rate laws to determine when (and if) classes can resume at a nearby university. The process is well-described and there is some humor in it, also. I think that this would be an interesting activity for an AP science or calculus class.

*Title:* Chemical Kinetics
*URL:* http://gaia.fc.peachnet.edu/tutor/index12.htm
*Grade Level:* All grade levels
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemical kinetics
*Review:* This Web site is very bright and easily assessable and understandable for all students. By clicking on a number of hyperlinks, students are able to find out different information on chemical kinetics such as factors that affect rate, average rate, the dependence of rate on concentration, temperature and rate reaction, catalysis, mechanism, and collisional theory of reaction rates. By clicking on any of these hyperlinks you are taken to a new page, which gives you definitions and

equation examples of the selected topic. I did find this site to be very easy to understand and use; however, I think it would be more beneficial to a student as a study guide than as an initial way of learning the subject matter. This site also gives links to find other chemistry topics, which I find to be very helpful since the Web site itself is very easy to follow.

*Title:* Combustion Simulations
*URL:* http://www.chem.leeds.ac.uk/Combustion/Combustion.html
*Grade Level:* AP grade 12 and college
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemical kinetics
*Review:* I had quite a difficult time trying to find a Web site that wasn't trying to sell chemical kinetic software, so this site is a little more advanced than I intended. I was originally trying to find something for middle-school students, but I found this one that would only be appropriate for AP chemistry students. This site is from the University of Leeds in the UK (Dainton Laboratory in the School of Chemistry and the Department of Fuel and Energy). What the site lacks in aesthetic cohesion, it makes up for in information about chemical kinetics. This site offers links to several other areas such as combined mechanisms, combustion mechanisms, thermodynamics, the methane oxidation mechanism, simulation software, and kinetic analysis. There is also a link to recent publications related to chemical kinetics. What I liked most about the site was that it was easy to navigate and it offered a variety of simulations. Unfortunately, I believe that a lot on this site is far too advanced for high-school students to understand, so several of the resources on the page would be left untapped.

*Title: Chemical Kinetics Simulation*
*URL:* http://www.chem.uci.edu/education/undergrad_pgm/applets/sim/simulation.htm
*Grade Level:* High school and college
*Search Engine:* http://www.google.com
*Key Search Words:* chemical kinetics
*Review:* This page is part of the chemistry department Web site at the University of California, Irvine. It provides a real-time interactive simulation of a chemical reaction. Basically it is an animation of four different colored molecules floating around in a box on the screen. You are given a control panel that enables you to change various at-

tributes of the molecules in the box in order to see what type of reaction may occur if some of the variables were altered. For example, you can change the number of molecules in the box or you can change the reaction rate. Each time you change something in your control panel, you can click on "restart simulation" to see what the result would be if that change were made in the experiment. Above this interactive experiment box is a link to a page containing information about this particular interactive experiment as well as chemical kinetics as a whole. The information provided is really quite technical and advanced and would be best suited for older students. The interactive animation, however, is colorful and interesting enough that it might lend itself to usage in the lower grades—provided the teacher has the ability to explain the topic in more simple terminology to the class than what is provided on the site.

*Title:* Chemical Kinetics
*URL:* http://gaia.fc.peachnet.edu/tutor/index12.htm
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical kinetics
*Review:* This Web site is very colorful and easy to access. It describes what chemical kinetics is and the different parts associated with it. Within each subtopic there are various examples, including formulas and definitions. Each subtopic reviews what was already stated and goes on with the new information. The breakdown of the topic is very helpful in understanding what is being taught. I think that the way things are described and the words that are used would be more beneficial and easy to understand for a high-school student, but a student in junior high school that is more advanced may find this site to be useful.

*Title:* Chemical Kinetics
*URL:* http://www.science.uwaterloo.ca/~cchieh/cact/c123/chmkntcs.html
*Grade Level:* Grade 6 and above
*Search Engine:* http://www.hotbot.com
*Key Search Words:* chemical kinetics
*Review:* The Web site Chemical Kinetics enables you to explain the term chemical kinetics, to describe factors that influence rate of chemical reactions, and to define and use proper units for chemical reaction rates. It gives top conditions for homogeneous and heterogeneous reactions. It starts off by explaining its goals, then by defining the term chemical

kinetics, which is the study and discussion of chemical reactions with respect to reaction rates, effect of various variables, rearrangement of atoms, formation of intermediates, and so on. The site then defines terms such as chemical reaction rates, thermodynamics and kinetics, and kinetic factors, and then it goes into factors that influence reaction rates. The Web site then gives you a test they call "confidence building questions." For example: What drives chemical reactions? a. energy b. activation energy c. electrons d. physical conditions. You can then click on Reaction Mechanisms, for example, and it then explains reaction mechanism and derives a rate law from a given mechanism. This site is very interactive and easy to use.

*Title:* Chemical Kinetics
*URL:* www.chem4kids.com
*Grade Level:* Grades 6 to 9
*Search Engine:* metacrawler.com
*Key Search Words:* chemical kinetics
*Review:* This site is great. It is so easy to navigate, and if you can't find what you are looking for right off the bat you can hit the "search" button and it will find what you are looking for. This is how I found "kinetic energy." It was not under any of the large sections but just a small dollop of information was given and it was under Thermochemistry. The site explains how thermochemistry deals with the temperature from chemical reactions and how some reactions give off a lot of heat. A great example was given discussing the hot and cold packs in a first-aid kit and how many chemicals go into those bags and how the chemcial reaction they go through create the heat or the cold needed. We also learn that scientists use the Greek letter delta to say there has been a change in something, such as temperature. All of this has to do with kinetic energy and how when we think of heat we think of fire and when we think of cold we think of ice. Heat has a lot of kinetic energy and gives it away. The cold doesn't have as much and absorbs energy from the area. Scientists measure heat in units called joules. There are two kinds of heat. The first is caused by physical energy. The more kinetic energy there is, the more activity. Extra activity makes more collisions occur thus producing more heat. The second type of heat is caused by chemical processes and the heat and energy around us. This is a detailed yet easily broken down overview of kinetic energy. It was the best I could find after my extensive search. The Web site also mentions Lord Kelvin.

*Title:* Chemistry at UC Irvine—Chemical Kinetics Simulation
*URL:* http://www.chem.uci.edu/education/undergrad_pgm/applets/sim/simulation.htm
*Grade Level:* Undergraduate
*Search Engine:* About.com
*Key Search Words:* chemical kinetics
*Review:* When I logged onto this site, the first thing that popped up is a screen with red, blue, yellow, and green balls moving around inside a box. Then in the corner of my screen was a little box where you could change the amount of colored balls. This was the simulation control panel. And then you could click on button to display a graph of concentration versus time. This all seemed very interesting and fun to play with.

*Title:* Chemical Sciences
*URL:* compusmart.ab.ca/plambeck/che/struct/s50x.htm
*Grade Level:* High school and above
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemical kinetics
*Review:* This is a very informative site. It is detailed and actually understandable and is perfect for a student who may have missed class the day this topic was covered. It lists the Terms and Concepts of Chemical Kinetics with links in each category giving a more detailed description. The main categories are Extent of Chemical Reaction, Rate of Chemical Reaction, Order and Rate Constants, Integrated Rate Laws (this link had an actual page for each law), Elementary Reactions, Mechanisms of Chemical Reactions, Catalysis of Chemical Reactions, Applications of Chemical Reactions, and Problem Sets in Chemical Reactions. I found just about any information a student would need on this topic. It seems to cut out the garbage that most textbooks provide and gives the student the important information they really need.

*Title:* Chemical Kinetics Simulation
*URL:* http://www.chem.uci.edu/education/undergrad_pgm/applets/sim/simulation.htm
*Grade Level:* Any level studying chemical kinetics
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical kinetics

*Review:* This is soooooo cool! When I clicked on the link to this page and the little frozen dots appeared, I was at first disappointed, thinking that I'd again clicked on a link that led me nowhere. Then I clicked on the image and the little dots started dancing all around the page and forming reactions, and I realized these are molecules and they are reacting! The first page is the *greatest* example I've come across so far. Along the top of the page are links to Chem Home, where I discovered that this was a Web page sponsored by UC Irvine; Education, which is a list of all of their undergraduate and graduate chemistry programs; Undergraduate, which is a list of undergraduate programs and resources; Applets, which is a list of cool links described as a list which "give you a chance to explore some scientific principles the same way a professional scientist does: by messing around with a system that exhibits the principle"; and Sim, which although I clicked on, I didn't understand. After I reviewed all of the links, I clicked on the button that said "Instructions." This took me to a page that explained in perfect detail what was happening in the simulation. (There are four molecules represented in the box by four colors; when you click on the simulation, the molecules bounce into each other and react.) The Instructions page covered a number of topics: What's Happening, explaining the simulation, including this is a binary chemical reaction, with a written reaction, which is explained; Take Command, explaining that you can control the simulation, which is occurring in real time by changing the concentration and reaction rate as well as viewing the strip chart; Notes on Performance, providing some simple tips for any problems you may have running the simulation off of your computer; Notes on Chemistry, explaining how to change certain things within the simulation to see what happens, going into detail about the chemistry of the experiment and asks more of the students; and a list of References for these pages. Again, this is so cool and fun to play with. I spent too much time playing with the simulation and watching the red and yellow molecules make blue and green and vice versa!

*Title:* Chemical Kinetics
*URL:* http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch22/rateframe.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical kinetics education

*Review:* A thorough if not completely boring site. Explanations of chemical kinetics and examples are provided, as well as practice problems (with solutions and formulas) for each topic covered. Those topics include rate laws and reactions, different ways of expressing the rate, and order and molecularity. Also included are a periodic table and a glossary to answer any questions that I—I mean, the student—may have.

*Title:* Potential and Kinetic Energy
*URL:* http://ofcn.org/cyberserv/academy/ace/sci/cecsci/cecsci187.html
*Grade Level:* Grades 5 to 6
*Search Engine:* http://www.msn.com
*Key Search Words:* lesson plans, science, chemical kinetics
*Review:* I had a very difficult time trying to find a Web site containing lesson plans on chemical kinetics. This Web site dealing with kinetic energy was the closest one I could find. The section of the Web site on kinetic energy gives a lesson plan focusing on comparing and contrasting potential and kinetic energy. The students are expected to already know the definitions of work and mechanical energy. Students will observe and record the amount of work done by the three different marbles rolling down an inclined plane and hypothesize about the reasons for the differences. The objectives of this lesson are that students will be able to discover that the larger the mass, and the higher an object is raised, the more energy is stored. Also they will be able to measure work in centimeters, compute the average distances, make predictions, record observations, and create hypotheses. For the actual experiment, the students will set up a demonstration of rolling three different sized marbles down an inclined plane. Then they will place the bottom section of a milk carton at the bottom of the ramp to catch the marble and measure the distance that it moves the carton. Some questions that are asked during this process are: Which marble has more mechanical energy (sitting on a flat plane)? If I put the marbles up on the inclined plane, would they have energy? Why? Something to ask the students to do during the experiment is to predict how many centimeters each marble will move the milk carton and which marble will move it the most and write their predictions on a piece of paper. To tie it all together, in the end this lesson plan suggests having the students discuss some examples of storing and using energy in our environment (teeter-totter, wrecking ball, hydroelectric dam, elevators) and what factors affect the amount of work an object can do (mass and height). Also, after the experiment, this lesson suggests having students explain on the

paper that they wrote their predictions why their predictions were right or wrong. I think this is a pretty good lesson plan on kinetic and potential energy. It is appropriate for the grade level suggested because it does not seem too advanced, but at the same time it involves enough to be pushing the students to really be thinking. I would definitely use a lesson like this in my classroom; it is fun for the students because it has them being active and using marbles which most kids that age like to do. If this Web site is appropriate for what you were looking for, then I believe it is a good one.

*Title:* Chemical Kinetics—Simulation
*URL:* http://www.chem.uci.edu/education/undergrad_pgm/applets/sim/simulation.htm
*Grade Level:* Middle school through college
*Search Engine:* http://www.google.com
*Key Search Words:* what are chemical kinetics
*Review:* This may perhaps be my favorite site yet. The link put me through to a chemical kinetics simulation where you could click to begin the simulation. It shows different molecules moving and colliding with one another to form reactions. More importantly, the site does provide a link that gives instructions and details of what is being shown. The instructions were particularly useful and gave details on how to manipulate the simulation through the use of the control box. A control panel will pop up somewhere on your screen. Using this control panel you can change the initial concentrations (expressed as the number of molecules "per box") and the reaction rate constants (expressed as a probability between 0.0 and 1.0). I thought that this site was incredibly useful and was even clear enough in its explanation for middle-school students. I think that the students would like the simulation!

*Title:* Chemical Kinetics
*URL:* http://chem.uci.edu/education/undergrad_pgm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.metacrawler.com
*Review:* This Web page is great. The first thing you see is a box with a bunch of yellow and orange balls. The page prompts you to hit the start button, which begins to excite the balls turning them into other colors, blue and red, and forcing them to move faster and faster. It gets crazy. At the top of the box there is a small box that says "directions." This link takes you to a very comprehensive document that

explains in very specific detail, exactly what is going on on your computer screen. I have absolutely no chemistry background and I was able to understand most of what the Web site had to offer. This page is part of UC Irvine's chemistry program, and it looks like the students use the Web page to share experiments and actually do some of their course work on the Internet.

*Title:* Chemical Kinetics
*URL:* http://www.chem.uci.edu/education.undergrad-pgm/applets/sim/simulation.htm
*Grade Level:* All grade levels
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemical + kinetics
*Review:* What a colorful Web site! This site has a few places you can click on for some information on this particular topic. I wouldn't recommend it for the younger ones; it's too advanced. The Web is very well-organized and vivid as well. The way it's presented really makes you want to explore it.

*Title:* Chemical Kinetics
*URL:* http://www.chem.uci.edu/education/undergrad-pgm/applets/sim/simulation.htm
*Grade Level:* High school and undergraduate
*Search Engine:* http://www.google.com
*Key Search Words:* chemical kinetics
*Review:* This site is a simple, color-coded simulation of a binary chemical reaction. The viewer can control the initial concentrations and the chemical reaction rate constants. You get a live picture of the reaction and, if you desire, a ticker tape showing the concentrations moment by moment. By clicking "for instructions" after viewing the simulation, the viewer is taken to a series of pages that explain what is happening in the simulation and how to activate and freeze the simulation and experiment with the velocities of the molecules. The simulation runs in real time. From the control panel, the viewer can turn on and off a "strip chart" that records the instantaneous concentrations of the four species of molecules as the simulation proceeds. Additional notes on the performance of the simulations, detailed notes explaining the chemical reaction, equilibrium constant, fluctuations and equilibrium constant, reaction rates, kinetics and thermodynamics, as well as references are included in the site. This Web site is an enjoyable way to learn more technical chemical information! It

is most effective for use by senior high-school or college-level chemistry students. Experimenting with the simulation was enjoyable. I was thankful the author took the time to explain what was happening in the simulation and the theory.

*Title:* Chemical Kinetics—By Harvey Moody, PhD
*URL:* http://gaia.fc.peachnet.edu/tutor/index12.htm
*Grade Level:* Middle school and above
*Search Engine:* http://www.google.com
*Key Search Words:* chemical kinetics
*Review:* I found this site to be full of information that seemed easy to locate. The home page had links for into, rate, concentration, time, collisions, temperature, mechanism, and catalyst. They all have subcategories, with formulas, charts and graphs, and examples. This site was self-explanatory and easy to follow. The language used was simple but detailed and made the concepts comprehensible.

*Title:* Chemical Kinetics
*URL:* http://www.compusmart.ab.ca/plambeck/che/struct/s050x.htm
*Grade Level:* High school and above
*Search Engine:* http://www.google.com
*Key Search Words:* chemical kinetics
*Review:* This site is a great introduction to the subject of chemical kinetics, and it is presented in a language that non–chemistry majors can understand. Terms and concepts, such as the extent and rate of a reaction, are explained in detail. Several paragraphs are devoted to each of the following subtopics: Integrated Rate Laws, Elementary Reactions, Mechanisms of Chemical Reactions, Catalysis of Chemical Reactions, Applications of Chemical Kinetics, and Problem Sets in Chemical Kinetics. The information contained in this site was prepared by Dr. James A. Plambeck, Department of Chemistry, University of Alberta, Edmonton, Alberta, Canada, for the VUN (Virtual University North).

### Lab Techniques

*Title:* EME—Science—Chemistry—Video
*URL:* http://www.emescience.com/chem-video-chemistrylabtechniques.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com

*Key Search Words:* laboratory techniques tutorial
*Review:* EME corporation sells software, videos, and overhead sheets in a variety of science topics. They produced a video that can be purchased for $69 that is "a valuable pre-lab program to help students master basic experimental procedures. Covers use of the beam and electronic balances; filtration, including Buchner and separatory funnels; handling the crucible; methods for collecting and testing gases; distillation with a condenser; and titration skills. Emphasizes safety by showing consequences of improper techniques. 25 minutes."

*Title:* Basic Laboratory Techniques
*URL:* http://www.sunderland.ac.uk/~hs0bcl/techvids.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* laboratory techniques tutorials
*Review:* This Web site from Chemistry and Pharmaceutics at the University of Sunderland in the UK contains links to Chemistry Pages, Summary of Research Interests, Chemistry Modules, B.Sc. (Hons) Chemical and Pharmaceutical Science, Chemistry Teaching Pages, Chemical Data, Historical Notes, Kilcoyne's Glossary, Chemistry Web Tests, Basic Lab Techniques on Video, and Trivial Nomenclature. At the home Web page click on the Basic Lab Techniques on the Video link. This leads you to a page that provides a video on an introduction to the use of the pipette. In order to view the video, you must have a RealPlayer viewer, which is obtainable at no cost from the RealAudio/Video Web site (http://www.real.com/).

*Title:* NIST Chemical Science and Technology Laboratory
*URL:* http://www.cstl.nist.gov/
*Grade Level:* College through adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* lab techniques tutorials
*Review:* CSTL's vision is "to be a world-class research laboratory recognized by the Nation as the primary resource for chemical, biomolecular, and chemical engineering measurements, data, models, and reference standards required to enhance U.S. industrial competitiveness in the world market. CSTL's Mission as the Nation's Reference Laboratory for chemical measurements, is to provide the chemical measurement infrastructure to: enhance U.S. industry's productivity and competitiveness; assure equity in trade; and improve public health, safety, and environmental quality." CSTL is grouped into

five divisions: Analytical Chemistry Division provides "reference measurement methods and standards to enhance U.S. industry's productivity, assure equity in trade, and facilitate sound decision-making regarding human health, safety, and the environment"; Biotechnology Division provides "the measurements, standards, and data needed for advancing the commercialization of biotechnology"; Physical and Chemical Properties Division provides "physical and chemical data needed for industrial processes and environmental protection"; Process Measurements Division provides "measurement standards and tools to help U.S. industry control processes and maximize efficiency"; and Surface and Microanalysis Science Division provides "research reference materials, and data to support accurate, sensitive and selective analysis of the spatial distribution of chemical species relevant to industrial and environmental processes." Clicking on the Analytical Chemistry Division link leads you to information on spectrochemical, organic analytical, gas metrology and classical, molecular spectrometry and microfluidic, and nuclear analytical methods. Further information concerning each method is provided. For instance, if you click on the Gas Metrology and Classical Methods Link you will be led to an information page with the following: "The Gas Metrology and Classical Methods Group conduct research in gas metrology and classical analytical chemistry including: titrimetry, gravimetry, the thermodynamic basis for pH, wet chemical and electroanalytical methods. The group applies this research to the development and certification of Standard Reference Materials for primary chemical reagents and the determination of gaseous species and major elements in a broad spectrum of matrices; develops and critically evaluates new techniques and provides standards for real-time measurement of automotive emissions; establishes the infrastructure for the establishment of NIST traceability for secondary reference materials; maintains and develops pH and electrolytic conductivity standards and techniques; provides advice and services to government agencies, scientific organizations and American industry, and interacts with international standards organizations." On the left of the page you will find links to the following references: Gas Cylinder Mixtures, Anion Standards, Electrolytic Conductivity, Ion Activity/pH, Standard Reference Ozone Photometer, Stoichiometry, Quantitative Infrared Database, NTRM Activities, International Collaborations, Research Opportunities, Publications, Staff, and a Virtual Tour. This is an excellent resource for the adult student and practitioner.

*Title:* NIEHS Kids Pages—Getting Your Own Lab Coat
*URL:* http://www.niehs.nih.gov/kids/labcoat.htm
*Grade Level:* Grades 6 to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* lab techniques tutorials
*Review:* The NIEHS Kids Pages are "produced by the Office of Management, National Institute of Environmental Health Sciences (NIEHS), as an informational and educational resource for all ages." At the home page you will find articles on Getting Your Own Lab Coat Why Study Environmental Health?, Epidemiology—What is That?, Talk to a Microbiologist, Talk to a Wetland Ecologist, Talk to a Lung Doctor, Talk to a Growth Biologist!, and What Is an "Environmental Analyst?". Clicking on any of these links leads you to a discussion about the topic with links to other resources. In addition links at the upper left of the home page provide useful resource information on Science Projects Help, Hot Topics in Science, People Doing Science!, and Science/Health Kids Links.

*Title:* Chemistry Lab Techniques by Harvard Science Web site
*URL:* http://www.hwscience.com/smarden/mlab.htm
*Grade Level:* Grade 11 through college
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry lab techniques
*Review:* I was very impressed with this Web site; however, it is geared for higher levels. This Web site gave lab techniques and instrumentation for various topics such as chromatography, ionization, distillation, and thermodynamics. Each topic lists its format, file size and the source used. Once an experiment is clicked on, it brings you to an automated play-by-play movie of the experiment. You do have the option of jumping ahead to a certain section of the explanation. Great links are provided on this informative Web page. It is clearly labeled and understandable. Along with links, the element chart and various lectures can be accessed.

### Lipids

*Title:* Lipids
*URL:* http://bioweb.wku.edu/courses/BIOL115/Wyatt/Biochem/Lipid/lipid1.htm
*Grade Level:* Grade 12 through college
*Search Engine:* http://www.metacrawler.com

*Key Search Word:* lipids
*Review:* This tutorial concerning lipids contains information and diagrams. Topics include lipids, saturated and unsaturated fatty acids, energy storage, Olestra, and polar and nonpolar molecules. Not only are the molecules in color but they are interactive and allow you to twist and turn them with your mouse.

*Title:* Lipids
*URL:* http://www.encyclopedia.com/articles/07511.html
*Grade Level:* Grade 7 through adult
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* lipids
*Review:* This Web site was developed by the *Columbia Electronic Encyclopedia, Sixth Edition,* Columbia University Press. Even though this Web site is a pay service, there is some great topic information with links to more specific resource information within the encyclopedia reference information found on the left of the page. Not only are you provided with basic information concerning lipids, but links to further information concerning fatty acids, phospholipids, fats and oils, steroids, waxes, cells, lipoproteins, vitamins, liposomes, and lipases are only a click away. In order to find other information about chemistry subjects return to the page and type in your word in the search window found at the top of the page. Below the search window you will find a link to search in *Encarta* encyclopedia. All of the above is free.

*Title:* Lipids.html
*URL:* http://www.utc.edu/~sprtnutr/lipids.html
*Grade Level:* Grade 12 through college
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* lipids
*Review:* This Web site was developed at the University of Tennessee at Chattanooga in the sports nutrition department. The site reviews the chemistry of different dietary lipids including saturated and mono- and poly-unsaturated fatty acids, trans fatty acids, essentials, and omega classification. Within the text, you will find links to chocolate, olive oil, canola oil, avocado, margarine, and eggs Web sites. The "chocolate information center" contained more information about Flavonoid-Containing Foods, Fact Sheets, Presentation Slides, and New Research About Chocolate's Contributions to Heart Health. The only thing that would have added to the excellence of this Web site would have been a link for free chocolate!

*Title:* Biochemistry of Lipids
*URL:* http://www.indstate.edu/thcme/mwking/lipids.html
*Grade Level:* Grades 8 to 12
*Search Engine:* http://www.google.com
*Key Search Word:* lipids
*Review:* This Web site is an extension of a medical biochemistry page. This is a great Web site about the biochemistry of lipids. This Web site is very useful for students conducting research on lipids. On the first page, a table of contents is conveniently displayed offering visitors a map for this wonderful Web site. This site is such an easy read that anyone who knows how to use the Internet can easily find their way. This site can be accessed by people of all ages interested in identifying the biological roles of lipids. The major roles of biological lipids and fatty acids are identified. In addition, there is a wonderful chart on physiologically relevant fatty acids. This chart includes the numerical symbol, common name, chemical structure, and overall comments. This amazing Web site also illustrates the basic structures of triacylglycerides, phospholipids, plasmalogens, and sphingolipids, which are all types of lipids. Overall this is a wonderfully informative site that has an immense amount of information to offer students.

**Liquids**

*Title:* CyberChem—Liquids
*URL:* http://www.ultranet.com/~kristoff/teaching/liquids/liquids.html
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* liquids
*Review:* The introduction link on the left of the home page explains the purpose of the Web site by its author, Eric Kristoff. Specifically, "The goal of this hypertext is to inform the average reader about different areas of chemistry. As it develops, I hope it will be of use to students, teachers, as well as a casual reader. A lot of information is contained here. Some of it can get very in depth, but I hope it is presented in a fairly simple and easy-to-understand way. If you find anything confusing, please let me know. While reading through this hypertext, you will come in contact with text images, animations, sounds, and VRML, and possibly other forms of media. For this reason, I suggest using Netscape 3.0 or a similarly compatible browser. Most of all, have fun!" The topics links listed on the left of the home page are Atoms, Nuclear Chemistry, Compounds, The Mole, Reactions, Stoichiome-

try, Gases, Liquids, Solids, Acids and Bases, Redox reactions, Electrochemistry, Equilibrium, Thermodynamics, and Organic. Clicking on "liquids" will lead you to an outline. Hopefully by the time this book is in print the links for further information will be completed. Even if they aren't, the complete outline of topics could be useful for a researcher to focus their searches.

*Title:* Liquids
*URL:* http://encarta.msn.com/index/conciseindex/4E/04E41000.htm?z = 1&pg = 2&br = 1
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* liquids
*Review:* This is the *Encarta Reference Library 2002*. Scrolling down to the guide to using *Encarta* provides the following information about *Encarta*'s capabilities: "Encarta.com features a reference library (including a dictionary and atlas), a homework help section, precollege and graduate-school departments, a section especially for parents, a center filled with online course offerings, and a shop stocked with great deals on educational products. . . . Encarta Online Encyclopedia is the online version of our award-winning CD-ROM encyclopedia."

*Title:* Chemistry Experiments Dictionary
*URL:* http://www.uq.edu.au/Chemistry_Dictionary/
*Grade Level:* High school through adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* liquids experiments
*Review:* This Web site was developed by the School of Education at the University of Queensland, Brisbane, Australia. By clicking on the "enter" link you are then led to a list of links including Chemistry Dictionary, UNESCO Science Education Section Physics Dictionary, UNESCO Resource Kit for Science and Technology Education, UNESCO Teaching and Learning for a Sustainable Future, Agriculture for the Tropics, Food Gardens for the Tropics, Golden Key Research Center (Education for the Visually Impaired in Rural China), Understanding Food Plants, Young Scientists of Australia, Primary Science Lessons, and United Nations Youth Association. Clicking on the Chemistry Dictionary leads you to a table of contents of nineteen different topics, which are then further subdivided, into a number of specific subtopics. For instance, one of the nineteen topics is chemical solutions which then has information subtopic links including

Mole, Preparing Stock Solutions, Ammonia, Calcium Hydroxide, Caustic Potash, Caustic, Soda, Lime Water, Potassium Hydroxide, Sodium Hydroxide, Dilution of Acids and Alkalis, Dilute Acids, Dilute Bases, Bromine Water, Making Chemical Indicators, Litmus Solution, Universal Indicator, Cobalt(II) Chloride Paper, Heat Sensitive Paper Preparation Instructions, Molarity, Acetic Acid, Ammonium Molybdate Solution Calcium Hydroxide Solution, Di-potassium Hydrogen Orthophosphate Solution, Di-sodium Hydrogen Phosphate Solution, Ethanoic Acid, Ethanedioic Acid, Hydrochloric Acid, Hydrogen Peroxide Solution, Iodine Solution, Lime Water, Nitric Acid, Oxalic Acid, Sodium Chlorate Solution, Sodium Dihydrogen Phosphate Solution, Sodium Hydrosulfite Solution, Sodium Hydroxide Solution, Starch Solution, Sulfuric Acid Tin(II) Chloride Solution, Different Concentrations and Volumes, Series Dilutions, Alloys, Solder, Bronze, and Brass. Each link provides information on specifically how to make the solution. The dictionary alone provides so much needed information that this is indeed one of the finest Web sites for the chemist.

### Matter

*Title:* What Is Matter?
*URL:* http://www.nyu.edu/pages/mathmol/texbook/whatismatter.html
*Grade Level:* Grades 3 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical matter
*Review:* This is a great Web site for tutorials on molecular modeling. Click on A K–12 Guide to the World of Molecules. Now you are faced with a Web site, which has two links to hypermedia textbooks: Elementary School version for grades 3–5 and Middle/High School version for grades 6 to 12. Click on Elementary School, and you'll find three icons (at the bottom of the page) labeled Grade3, Grade4, and Grade5. By clicking on Grade4, you'll get to a page that has five links (chapters). Chapters 1 and 2, "What Is Matter?" and "States of Matter," cover the matter subject. Each chapter has its own site. Both sites are extremely clear and help to explain the concept. In addition real-life pictures are provided.

*Title:* Matter
*URL:* http://antoine.frostburg.edu/chem/senese/101/matter/
*Grade Level:* High school through college

*Search Engine:* http://www.google.com
*Key Search Words:* chemical matter
*Review:* This is a great Web site for tutorials on matter. The information available is excellent and the tutorials are very good. Great features of this site include the following:

- Free tutorials
- Clear and easy to use
- A worksheet with the most frequently asked questions about matter, with answers to the questions
- A quiz for each unit topic

This site is excellent.

*Title:* Classification of Matter
*URL:* http://dept.physics.upenn.edu/courses/gladney/mathphys/subsubsection1_1_3_1.html
*Grade Level:* Grade 12 through college
*Search Engine:* http://www.google.com
*Key Search Words:* chemical matter
*Review:* This Web site provides a wonderful tutorial on classification of matter. It starts with a definition of chemical change and physical change. After that, it generalizes the classification of matter under a diagram; also, it defines each diagram branch with examples. The most important thing in this site is that the different examples of problems have step-by-step procedures for solving the problem with a comment.

*Title:* Kid's Corner Matter Lessons
*URL:* http://users.etown.edu/B/BOWDENAM/matter_lesson.html
*Grade Level:* Grades 5–8
*Search Engine:* http://www.aol.com
*Key Search Words:* matter lessons
*Review:* Kid's Corner Matter Lessons is a free Web site produced from Elizabethtown, Pennsylvania. This Web page offers you information about the three types of matter: solid, liquids, and gas. At the top of the Web page you can click on the type of matter you would like to learn about. By clicking on one of these topics you will see a list of links about each topic. Clicking on Solid as a Rock brings you down the page to a paragraph introducing the definition of solid and giving an example that would be relatable to all (e.g., the floor). Then you will see a colored illustration of a solid at a smaller hand. A paragraph precedes that illus-

tration, giving you a simple explanation of it. After reading about a solid, there are four lively illustrations and you are to choose which picture shows the solid form. Underneath, the answer is given along with an open-ended question, "What state are the others?" Scrolling down to the bottom of the page you are able to click on activities, quizzes, or lessons. You can follow up on matter by clicking on Quiz 2. This link quizzes you about the different states of matter with interactive graphics. It also provides motivating words. By clicking on your answer it will constructively tell you if you are correct or to try again. Clicking on Activity 1 brings you to a link that has a secret recipe for you to make at home. It includes the ingredients, instructions, and a follow-up question. After mixing the ingredients but before cooking, you have to make a prediction of whether it is a solid or liquid. Lastly, by clicking on Activity 3 you can observe the changes in matter in a fun way by making ice cream. This link provides you with an overview, resources/materials, activities, procedures, and connection questions. Kids would be making ice cream and not even realize they were learning from it! The language used to describe the information about solids is fun and exciting. The activities presented are a wonderful way to involve parents at home or integrate into a lesson at school. This is a great site for kids.

*Title:* The Structure of Matter
*URL:* http://www.compusmart.ab.ca/plambeck/che/struct/index.htm
*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Words:* chemical matter
*Review:* This Web site has eleven links to different topics related to chemistry. Click on The Structure of Matter and you'll find a Web site that takes you deeper into the structure of matter. This site contains links to different states of matter, such as Electrons in Atoms, the Nature of Gases, and Liquids and Solids. For example, when you click the Nature of Gases link, you find four major parts labeled: The Empirical Gas Laws, The Ideal Gas Law, The Kinetic-Molecular Theory of Gases, and Application of the Kinetic-Molecular Theory of Gases. Each part has a number of links. In general, this site is very good for students who are doing research on structure of matter.

*Title:* Some Problems in Chemical Evolution of Matter in Space
*URL:* http://www.endeav.org/evolut/text/spcems/spcems.htm

*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Words:* chemical matter
*Review:* This Web site describes some problems in chemical evolution of matter in space. The reader should have a good background to understand to material because it has complex formulas and tables.

*Title:* What Is Matter?
*URL:* http://www.usoe.k12.ut.us/curr/science/core/chem/main.htm
*Grade Level:* Grade 8
*Search Engine:* http://www.google.com
*Key Search Words:* chemical matter
*Review:* This Web site contains links to different grades level. Click on 8th Integrated Science link, and you'll face a site that has—under Core Resources—a link labeled Eighth Grade Sci-ber Text. After you click on it, you'll find a site that has five icons, labeled Matter, Energy, Forces, Machines, and Earth. Click on Matter icon, and you'll find a good Web site that has a chapter about changes in matter. Features of this Web site include:

- It is clear and easy to use
- The information available is excellent
- It has a good tutorial
- It has real-life pictures, which aids comprehension
- It has animator pictures, which look like you're watching a demonstration on TV
- It has a diagram that represents a common type of classification system used for matter

*Title:* Matter
*URL:* http://www.uen.org/utahlink/lp_res/TRB001.html
*Grade Level:* Grades 2 to 5
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical matter
*Review:* This Web site is developed by and for the teachers of Utah. Under Grade Overviews and Topic Background, you will see links labeled Kindergarten Overview, First Grade Overview, Second Grade Overview, . . . Sixth Grade Overview. The second and fifth grades have a link to Matter. If you click on Matter under Second Grade Overview, you'll get a Web site that covers physical properties of various materials such as weight, texture, flexibility, size, and shape. Also

it has the effects of physical changes by cutting, bending, heating, freezing, and so on. If you click on Matter under Fifth Grade Overview, you'll get a Web site that covers physical and chemical properties, chemical reactions, and states of matter. Both sites have activities to do by students.

*Title:* Matter and Chemical Bonding
*URL:* http://educ.queensu.ca/~science/main/concept/chem/c07/c07main.htm
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical matter
*Review:* This is a Web site developed by the Queen's University Faculty of Education. It includes Concept Development, Demos, Tips, and Labs/Activities. Because this is such an excellent resource the complete list of topics are included. Concept Development includes Dyes and Dying, Chemistry of Cosmetics, Emission Spectra; Discussion and Relation to Atomic Model, Crystals; Ionic, Molecular, Network and Metallic Crystals; Ions and Ionization Energy, Comparing Ionic and Covalent Bonding; Introduction to Periodic Table—How It Developed?; Atom is Mostly Empty Space; Theories, Laws and Relationships, Atomic Particles; Introduction to Matter; Contribution of Scientists to Nature of Matter; Variation of Atomic Properties, Concept Development; It's a Chemical Life; Go Rust Your Nail, Consumer Chemistry Product Portfolio; Helping Students Visualize Atom Size; Concept Mapping: Relating Atomic Structure and Spectroscopy; Particle Theory of Matter; More Particle Theory of Matter; Introduction to the Elements and Trends in the Periodic Table; Atomic Theory—Analogies, Demos and Tips; Meet the Periodic Table; Changes of State; and Early Atomic Theories. Clicking on any of the above links leads you to a tutorial on that topic. I clicked on Contribution of Scientists to Nature of Matter and was led to information on John Dalton, J. J. Thomson, Ernest Rutherford, James Chadwick, and Neils Bohr. The Demos topic link includes links to Lift an Ice Cube with Salt, Take the Challenge—Density, The Floating Soap Bubble, Density, Law of Conservation of Mass, The Black Box—Model Building, Boiling Water in a Syringe, Hand Boiler—Particle Movement, Sandcastles and Van der Waal Forces, Ball and Ring Trick, Attraction of Water, Underwater Explosion, Balloon Models, Chemical vs. Physical Properties Demo, Atomic Spectra, Flame Test, Energy Levels

Demo, Periodic Table: Missing Pieces, Periodic Table: Organization, Flame Tests, Guessing Food Labels, Periodic Table Activity, States of Matter, Discovering Electrons Using a Gas Discharge Tube, The Size of Sugar and Starch, Reactivity Trends in the Periodic Table—Alkali Metals, Reactivity Trends in the Periodic Table—Halogens, Demos to use with Particle Theory, and Rutherfords's Gold Foil Experiment. Each Demo (laboratory activity) includes Purpose, Materials, Safety, Procedure, Key Questions: To Be Asked before Demo, Explanation, and Reference. The Tips topic link provides links to tips on Inorganic Nomenclature, Diatomic Elements—Mnemonic, Analogies to Explain Ionic, Covalent, and Polar Covalent Bonding, The Atomic Clock, Ionization Energy, Shielding Effect, Atomic Theory, Atomic Theory Hund's Rule, Particle Theory, Electro negativity, Mnemonic for Oxy Acids, Electron Orbitals, Shielding Effect, Chemical Clock, Glow Sticks and Chemiluminescence, Movie—The Elements, Aurora Borealis, The Interactive Websites, Alphabet Periodic Table, Movie—Invention: Elements and Compounds, Electron Shells, Noble Gases, Elemental Bingo, Orbital Analogy, Making Electrostatics Memorable, Campfire Analogy for Electron Shielding, and Atoms: Mostly Space. Clicking on any of the tips links indeed provides tips for further understanding of the specific concept. Finally, the Labs/Activities topic link provides a number of laboratory activities, including Elemental Advertising—twist on typical element project, Elemental Report—another element project, Mastering the Elements #1, #2, #3, #4, #5, and #6, Trends in the Periodic Table #1, #2, and #3, Organization of Periodic Table Activity—Nuts and Bolts, Lab—Reaction and Properties of Group VIIA, Cl, Br, I, Properties of Metals and Non-Metals, and Physical and Chemical Properties of Groups IA, IIA, and Comparing Physical Properties of Ionic and Covalent Compounds, Valence Electrons and Bonding—A Student Activity, Students Design Their Own Periodic Table, Ju-Ju Lab, Lab on the Activity Series, First 20 Elements of the Periodic Table Activity, Classification of Elements Activity, Emission Spectra Lab, Basic Chemical Concepts, A dry ice investigation lab, Edible atom project—help students learn about atomic mass and atomic number as well as basic structure of the atom, Boil Water in a plastic bottle or paper cup, Atoms and Elements, Graphing Practice, Old Scientists and History Assignment, Identifying Matter Lab, Autobiography of an Element Activity, Rubric for Autobiography of an Element Activity, Density Graphing Activity, Density Lab, Physical vs. Chemi-

cal Properties Lab, Separating Metallic Iron from Cereal, Chemical Change: Wine to Water to Milk, Variation of Atomic Properties, Household Chemicals, Design a Lab—Fill a Tub with Gelatin, Chemical/Physical Change Station Lab, Rusty Nails Lab, The Day the Earth Lost Its, Create Your Own Element, Austin Powers's Mo-Jo Caper, Element Bingo, Classifying Household Products, War with Bohr, Creating the Periodic Table, ELEMENTary My Dear Watson, Consumer Guide to the Periodic Table, Candy Molecular Models, Ionic Bonding Lab, Periodic Table Reactivity Trends, Investigating the Periodic Table, Element Job Assignment, Constructing Bohr Models and Determining Trends, Explaining Periodic Trends Using Electron Configuration, Reactions of Magnesium and Calcium, Reactions of Group I and II Metals, Particle Theory Activity, Particle Theory Questions, and Pith Ball Experiment. Each lab/activity is subdivided into purpose, materials, procedure, observations, and conclusions. This is an excellent resource for middle-school and high-school students and could be used in beginning college courses. I like the catchy titles of the lab/activities and the well-written format of the exercises.

**Measurement (Chemical)**

*Title:* Units of Measurement
*URL:* http://www.unc.edu/~rowlett/units/
*Grade Level:* Grade 7 and above
*Search Engine:* http://www.google.com
*Key Search Word:* measurement
*Review:* This Web site provides a wonderful tutorial on measurement. On the top of this Web site, you'll find two lines of letters from A to Z. To get information on a specific unit, click on the first letter of its name. Also, this Web page has two columns: (1) Commentary and Explanation and (2) What's New. On the bottom of Commentary and Explanation, you'll find seven principal links, such as The International System (IS) and The Metric System and IOS and IOC Country Codes. But the most important link is Links to Related Sites. After you click on this link, you'll get more than forty links related to the home site.

*Title:* Interactive Measurements Calculator
*URL:* http://www.convert-me.com/en/
*Grade Level:* Grade 7 and above
*Search Engine:* http://www.google.com

*Key Search Word:* measurement
*Review:* This Web site provides an interactive calculator for many measurement systems, some that are commonly used, like metric and U.S., Avoirdupois, and some that are quite exotic, like ancient Greek and Roman. This Web site has different measurements that are available for conversions, such as Weight and Mass, Distance and Length, Capacity and Volume, Area, Speed, and Time. After you click on the Weight and Mass link, you'll find a Web page that has combo box to select or enter a significant figure, and a convert button on the right side of each unit converter, such as Metric, Avoirdupois, Troy, Apothecaries, Japanese, Old Russian, and Old German. On the bottom of this page, you'll find links to useful books on units and measures available from Amazon.com.

*Title:* Glossary of Measurements Terms
*URL:* http://www.hemweb.com
*Grade Level:* Grade 6 and above
*Search Engine:* http://www.google.com
*Key Search Word:* measurement
*Review:* This Web site provides a basic glossary of terms used in educational testing. At the home page, you'll get a Web page that has nine icons on the top. Then click on the fifth icon, Library, and you'll get a Web page that has seven links. Next, click on the Glossary of Measurement Testing link, and you'll get a Web page that has a basic measurement concepts.

*Title:* Dictionary of Units
*URL:* http://www.ex.ac.uk/cimt/
*Grade Level:* Grade 6 and above
*Search Engine:* http://www.google.com
*Key Search Word:* measurement
*Review:* This Web site provides a wonderful summary of most of the units of measurement to be found in use around the world today (and a few of historical interest), together with the appropriate conversion factors needed to change them into a "standard" unit of the SI. After you enter the URL, you'll find a Web page that has a link called A Dictionary of Units. Click on that link, and you'll get a Web page that has a summary of most the units of measurement. The units may be found either by looking under the category in which they are used (such as length, mass, density, energy, etc.), or else by picking one unit from an alphabetically ordered list of units.

*Title:* General Tables of Units of Measurement
*URL:* http://ts.nist.gov/ts/htdocs/230/235/appxc/appxc.htm
*Grade Level:* High school and above
*Search Engine:* http://www.google.com
*Key Search Word:* measurement
*Review:* This Web site provides the following: Tables of Metric Units of Measurement, Tables of U.S. Units of Measurement, Notes on British Units of Measurement, Tables of Units of Measurement, U.S. Units and Metric Units, Units of Length—International Measure, Units of Length—Survey Measure, Units of Area—International Measure, Units of Area—Survey Measure, Units of Volume, Units of Capacity or Volume—Dry Volume Measure, Units of Capacity or Volume—Liquid Volume Measure, Units of Mass Not Less than Avoirdupois Ounces, Units of Mass Not Greater than Pounds or Kilograms, Tables of Equivalents, Units of Length, Units of Area, Units of Capacity or Volume, Units of Mass, and Links to the Metric Program Conversion Sites.

**Mole**

*Title:* Index
*URL:* http://www.chemistrycoach.com
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* mole
*Review:* This is the Web site for the science department at Wilton High School in Wilton, Connecticut. At the home page scroll to the Chemistry Test Bank and click on the link "Sample Early Mole Test" to find a test with answers on the concept of the mole. Scroll further down the home page until you reach the section called Mole Unit, which includes the following links for further information: Candy Lab: A Wilton High School Lab Event, Christmas Story: A Wilton High School Chemistry Competition, Elementary Crossword Puzzle, The Magnesium Oxide Lab Data and Results Sheet, Potassium Chlorate Lab, Mole Lecture Lab, The Mole Lecture Lab Notes, The Moles, Moles and Mass Worksheet with Spreadsheet, Hydrate Lab Experiments, Hydrate Lab Conference, Hydrate Lab Event Contest, Stoichiometry 1: The Mass Ratio, Stoichiometry 2: The Mole Ratio, Stoichiometry 3: The Reactant in Shortest Supply, Stoichiometry 4: More, Return of the Yellow Lab, The Return of the Yellow Lab Contest, Winner: Blood of a Scarlet Rose by Matt

Horowitz, Return of the Yellow Lab Fiction, Contest, and Sample Early Mole Test.

*Title:* Mole Calc
*URL:* http://defoort.free.fr//molecalc/
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* mole
*Review:* Very easy to use free software for Windows, which calculates the molecular weight of all your chemicals. Mole Calc by David Defoort is advertised to be "the desk calculator you need for all chemicals!" Mole Calc calculates the molecular weight of all your chemicals by using a Windows (95/98/NT) tool that is very similar to a classical calculator but that recognizes the atomic compounds from the Mendeleev table and knows their weight. Features of Mole Calc: "Very easy to use interface, Accurate results, Accepts long and complicated chemical formula, Knows the atomic weight of unusual compound, Easy installation and un-installation, Very useful for chemists, researcher, engineers, students."

**Molecules**

*Title:* Chemistry Tutorials and Resources Page
*URL:* http://c4.cabrillo.cc.ca.us/
*Grade Level:* College and above
*Search Engine:* http://www.google.com
*Key Search Words:* molecules tutorials
*Review:* This is a Web site designed by Cabillo College students. At the home page find links to "Molecular Library 2.0—A set of over 400 molecular models, plus three Java-enhanced viewers: the Mono Viewer, DuoViewer, and MacroViewer. The old version is still available as well; A Chime Tutorial—How to use Chime, a Netscape plug-in which renders molecular structures within a web browser. Includes problem set; Chime Student Exercises—Sets of chemistry problems incorporating Chime models. Assigned as student homework in 5 different undergraduate courses; Insulin: Structure of a Protein Hormone—A Chime-based tutorial examining the structure of the protein insulin; Chime Toolbox—A package of Java applets for educational developers to use in making their own Chime web pages. Includes online documentation and examples; Download C4 Software—You can download our completed tutorials or

other projects here, for use offline; About the C4 Project—We are developing visualization and instructional software for chemistry instructors and students; Chime Help Center—How to get set up with Chime and a compatible browser; Molecular Modeling Links—Recommended internet resources for molecular modeling information and models; and, Molecular Playground—A selection of eight different sample molecular models for Chime. This site REQUIRES Netscape Navigator 3.04 or later and the Chime plug-in."

*Title:* Molecular Library
*URL:* http://www.nyu.edu/pages/mathmol/library/library.html
*Grade Level:* College and above
*Search Engine:* http://www.google.com
*Key Search Words:* molecules tutorials
*Review:* This Web site was developed by New York University Scientific Visualization Center. At the home page, scroll down and click on "molecules of life." You now have a choice between Amino Acids (A–N), Amino Acids (O–Z), Nucleotides, Lipids, Photosynthetic Molecules, and Sugar Molecules. "The MathMol library contains three different file formats: GIF, PDB and VRML. PDB (Protein Data Bank) files require that you install a PDB viewer such RasMol or WebLab. Alternatively, files can be downloaded and read from any PDB viewer. VRML files are best viewed using the latest version of Netscape." This Web site is currently being designed and developed, so it is incomplete; however, it is worthy of a look-see.

*Title:* National Chemistry Week—Experiments Atoms and Molecules
*URL:* http://www.cheminst.ca/ncw/experiments/eatoms.html
*Grade Level:* Grades 4 to 5
*Search Engine:* http://www.google.com
*Key Search Words:* molecules tutorials
*Review:* This Web site contains two experiments modeling molecules and crystals using gumdrops. The Web site was developed by the Chemical Society of Canada. Explanations for each of the experiments tell you what you need and what to do. Both experiments include diagrams for you to follow as well as written directions.

*Title:* Chemmybear's Resources
*URL:* http://www.spusd.k12.ca.us/chemmybear/
*Grade Level:* Grade 12

*Search Engine:* http://www.google.com
*Key Search Words:* molecules tutorials
*Review:* This Web site was developed by Paul Groves, who is an AP chemistry teacher at South Pasadena High School. At the home page, you can access the following links: "Student drawn moles to add to your handouts, Copper + Nitric Acid—A Lecture Experiment. The gas produced both dissolves in water and cools producing a surprising ending to this demonstration, Animate Molecules—Animated GIF files of the common molecular shapes by Robyn Rindge, An Element of Interest, A Review of Study Guides—One student's review of six available AP Chemistry study guides, Liquid Oxygen—A Lecture Experiment Using liquid nitrogen, we liquefy some oxygen and observe its unique properties, AP Chemistry Study Cards. Here are Adobe Acrobat versions of Groves' Chemistry and AP Chemistry study cards used at SPHS, Classifying Reactions Predicting Reactions—Here are some ideas about how to classify and organize the reactions you see in the Predicting Reactions portion of the AP Chemistry Test." In addition, there are a number of extra resource links provided, including links to the ACS Exams Institute, the ChemTeam, Steve Marsden's ChemistryPage, the Chemistry Animation Project, OSU Chemistry Department, Online Resources at UCR, Flinn Scientific, College Board Online, Science Is Fun, Educational Innovations, Inc., and Chem4Kids. This is a great resource for any high-school student in advanced chemistry.

### Nuclear Chemistry

*Title:* Chemistry Resources
*URL:* http://nuchem.iucf.indiana.edu/
*Grade Level:* College through adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* nuclear chemistry/tutorials
*Review:* This Web site has been developed by the Many-Body Nuclear Dynamics Group at the Indiana University Cyclotron Facility. The following is a statement of the research interest of the many-body nuclear dynamics group: "The focus of our research is heavy-ion reaction dynamics at intermediate energy (between 20A and 200A MeV) and studying light-hadron-nucleus collisions from to 15 GeV. Our research emphasis are: probing the nuclear equation of state (EOS), the liquid-gas phase transition of nuclear matter and the interplay between the statistical and dynamical break-up of nuclei under extreme conditions of density, temperature, shape, and isospin (neutron-

proton asymmetry). Our experimental research program requires the continual development of sophisticated detectors and associated electronics. We are involved in development of silicon strip technology (LASSA, HiRA) to provide isotopically resolved identification of reaction products formed in nuclear reactions." On the left of the home page, there are links to Research, Instrumentation, Publications, What's New?, Seminars, Contact Us, and Useful Links.

*Title:* Journal of Nuclear Materials
*URL:* http://www.elsevier.com/inca/publications/store/5/0/5/6/7/1/
*Grade Level:* College through adult
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* Nuclear chemistry/tutorials
*Review:* As stated on this site, "The Journal of Nuclear Materials publishes high quality papers in materials research relevant to nuclear fission and fusion reactor technologies, and in closely related aspects of materials science and engineering. Both original research and critical review papers covering experimental, theoretical, and computational aspects of either fundamental or applied nature are welcome. The breadth of the field is such that a wide range of processes and properties is of interest to the readership, spanning atomic lattice defects, microstructures, thermodynamics, corrosion and mechanical and physical properties, for example." The following topics are found in the journal: Fission reactor materials, including fuels, cladding, core structures, pressure vessels, moderator and control components; Fission product behavior; Materials aspects of the fabrication and reprocessing of fuels; Performance of nuclear waste materials, glasses and ceramics; Immobilization of wastes; Fusion reactor materials, including first walls, blankets, insulators and magnets; Neutron radiation effects in materials, including defects, microstructures, transmutations, phase changes and macroscopic properties; and Interaction of plasmas, ion beams, electron beams, and electromagnetic radia-tion with materials. At the home page click on ScienceDirect in the upper right. ScienceDirect is the world's largest supplier of scientific, technical, and medical (STM) information, covering more than 1,200 journals from Elsevier Science, together with an array of journals from other leading STM publishers and societies. "If your library subscribes to journals via ScienceDirect you will have the following benefits: Browse issues and tables of contents, Access and download articles (HTML & PDF format), Links from references to other articles on ScienceDirect or other publishers' platforms,

View abstracts of non-subscribed journals on ScienceDirect, Access several years of archived materials, Search on title, full text, author, keyword, year, etc., Save a search, Receive email alerts, or Set up a Personal Journal List. This is the journal for all researchers of nuclear chemistry."

*Title:* American Nuclear Society
*URL:* http://www.ans.org/
*Grade Level:* College and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* nuclear chemistry/tutorials
*Review:* This site states, "The American Nuclear Society is a not-for-profit, international, scientific and educational organization. It was established by a group of individuals who recognized the need to unify the professional activities within the diverse fields of nuclear science and technology. December 11, 1954, marks the Society's historic beginning at the National Academy of Sciences in Washington, D.C. ANS has since developed a multifarious membership composed of approximately 11,000 engineers, scientists, administrators, and educators representing 1,600 plus corporations, educational institutions, and government agencies. It is governed by three officers and a board of directors elected by the membership." At the home page, you will have access to member services, constituencies, meetings, standards, career center, honors and awards, publications, public information, ANS store, resources, advertising, and nuclear links. If you click on "publications," you have access to handbooks and dictionaries, monographs, magazines, textbooks, proceedings, technical journals, nuclear plant wall maps, special publications, standards, and public information. Below these links are links to nuclear news, radwaste solutions, ANS news, nuclear science and engineering, nuclear technology, and fusion science and technology. Most of these documents must be purchased through the ANS store, or you can obtain them by becoming an ANS member. If you are a serious nuclear power researcher, this group is a must-join for access to current information.

*Title:* Nuclear Reaction: Frequently Asked Questions
*URL:* http://www.pbs.org/wgbh/pages/frontline/shows/reaction/etc/faqs.html
*Grade Level:* Grade 12 and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* nuclear chemistry/tutorials

*Review:* These Q & A's are from a *Frontline* interview with Dr. Charles Till, a nuclear physicist and associate lab director at Argonne National Laboratory West in Idaho. *Frontline* is an association within National Public Radio. The original transcript of show number 1511 is available by clicking on the "about this report" link found at the top right of the page. If you click on Dr. Charles Till's name within the document you will be linked to an interview with Dr. Till on the subject of nuclear power.

### Organic Chemistry

*Title:* Organic Chemistry Help
*URL:* http://www.chemhelper.com/
*Grade Level:* Grade 12 and college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* organic chemistry/tutorials
*Review:* This is a chemistry help page developed by Frostburg State University Chemistry Department. It contains the following tutorials: Alkane Tutorial, Covers common and IUPAC nomenclature and properties of alkanes; Alkene Tutorial, Covers properties, common and IUPAC nomenclature, cis-trans isomerism, and orbital theory of alkenes; Alcohols Tutorial, Covers properties, structure and classification, and common and IUPAC nomenclature of alcohols; Alkynes Tutorial, Covers properties, orbital theory, structure and classification, and IUPAC and common nomenclature of alkynes; Benzene Tutorial, Covers orbital theory, structure and classification, and nomenclature of benzene; Amines Tutorial, Covers common and IUPAC nomenclature, structure, and properties of amines; Ketones and Aldehydes Tutorial, Covers properties, IUPAC and common nomenclature, and structure and classification of ketones and aldehydes; and Carboxylic Acids Tutorial, Covers properties, IUPAC and common nomenclature, and structure and classification of carboxylic acids. Each link provides tutorial information including diagrams, practice problems, and a scoring link with correct answers for those that you miss. In addition to the listed organic tutorial links, there are other links to organic help, organic practice tests, basic organic mechanisms, and other organic links. This is a great resource for beginning organic chemistry students.

*Title:* Chemistry Online Help for High School Students
*URL:* http://members.tripod.com/chemistryhelp/

*Grade Level:* Grade 12 through college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* organic chemistry/tutorials
*Review:* At the home page, scroll and click on the "enter" link. Click on the "organic Chem" link at the top of the page. You now can choose from the following topics: saturated hydrocarbons, unsaturated hydrocarbons, branched hydrocarbons, cyclic hydrocarbons, alkyl halides, alcohols, aldehydes and ketones, and carboxylic acids. Choosing any of these links leads you to a well-written tutorial on the topic. This site is well-written and easy to navigate. A great resource for the organic student.

*Title:* The Learning Matters for Chemistry
*URL:* http://www.knowledgebydesign.com/tlmc/tlmc.html
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* organic chemistry/tutorials
*Review:* This page and the materials in this page were developed and maintained by Yue-Ling Wong, PhD. It includes links to "Computer Graphics, Visualization of molecular models and atomic orbitals, and computer animation QuickTime, MPEG movies, GIFs, VRML, and Macromedia Shockwave files; On-line Exercises, Interesting on-line interactive exercises to increase your chemical common sense; instant feedback; Software Library, Downloadable computer-aided learning an interactive multimedia chemistry programs, for Mac and Windows, that were developed by her. The interactive multimedia CD-ROM, Atomic Orbitals CD is now available; Interactivity: Interactive technology that we applied to chemical education on the net, including a Periodic Table game and titration applets; Other Chemistry Sites on the Net, Listings of other chemistry sites. Keyword search is available for finding information from this long listing; and, Safety: Ever wonder what is the color-coding for the hazardous material."

*Title:* Organic Chemistry Labs
*URL:* http://www-class.unl.edu/chem253a/Index.htm
*Grade Level:* Grade 12 through college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* organic chemistry/tutorials
*Review:* This Web site was developed at the University of Nebraska at Lincoln to assist students in the organic chemistry laboratories. On the Web page there are links to Emergency and Safety Procedures,

Syllabus, Safety and Good Lab Practices, and Organic TAs. Below these general information links you will find fifteen laboratory links. For example, Lab 2 concerns itself with Melting Points and Recrystallization. First, the site provides background information. This laboratory link tells you, "The experimental techniques involved in organic chemistry can be loosely divided into three types: 1) techniques for executing chemical reactions; that is, the techniques, apparatus and conditions required for converting some set of reactants into the desired products; 2) techniques used for purifying and equipment for determining the purity of the organic product; and 3) spectroscopic techniques and instrumentation for determining the structure of the organic product. Recrystallization is a technique for purifying crystalline organic compounds, and the melting point range of a crystal is useful for verifying its structure and/or its purity. In this lab, you are to carry out three recrystallizations and a series of melting point and mixed melting point determinations. For the latter part, you will work in groups of two." It then divides the lab activity into melting points, recrystallization, and procedure contents. The lab not only provides written directions but also includes pictorial diagrams and pictures of laboratory equipment. The laboratory directions are very well-written and the pictures truly aid the researcher in checking that the equipment has been safely set up.

**Oxidation**

*Title:* Oxidation
*URL:* http://www.topscience.org/oxidation.htm
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* oxidation reduction/experiments
*Review: TOPScience*, is an online science magazine and catalog. TOPScience Learning Systems, and has been setting the standard for hands-on science and math for 25 years. It is a nonprofit educational publisher dedicated to making inexpensive, creative, hands-on lessons available to everyone. TOPScience Learning Systems sells very inexpensive curriculum activities (task card series) by grade level per topic.

*Title:* Mr. Green's Home Page
*URL:* http://www.tvgreen.com/
*Grade Level:* High school

*Search Engine:* http://www.metacrawler.com
*Key Search Words:* oxidation reduction/experiments
*Review:* Mr. Green is a science teacher at Alta Loma High School in Rancho Cucamonga, California. At the home page click on "AP Chemistry" at the top right of the page. Now scroll down and click on the table of contents on the AP Chemistry page. Finally, scroll to Chapter 4 and click on it, and then choose your redox topic from the following links on the left: Oxidation States, Oxidation-Reduction, Redox Reactions, Agents, Identify the Half-Reactions, and Balancing Redox. If you go back to the AP Chemistry page, you can also click on either "AP homework," "calendar," or "notes." The homework icon leads you to a list of activity links on the left of the page. Scroll to the redox titration lab and click on it. You will now have the laboratory activity for a redox titration lab, including the chemistry content, the materials that you need to organize, and the procedure. The notes icon is a shortcut to the specific chapter notes. You can also reach these through the table of contents.

### Periodic Table

*Title:* WebElements Periodic Table of the Elements
*URL:* http://www.shef.ac.uk/~chem/Web-elements/
*Grade Level:* Any grade level
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table tutorials
*Review:* This Web site was developed by Mark Winter (University of Sheffield, England), Royal Society of Chemistry 1998 HE Teaching Award winner. WebElements aims to be a high-quality source of information on the WWW relating to the periodic table. Professional scientists and students will all find something useful. It was designed for students at universities and schools and contains thousands of graphics illustrating the elements' structures and properties. Elements 113, 115, and 117 are not known but are included in the table to show their expected positions, and elements 114, 116, and 118 have only been reported recently. WebElements is rated as one of the MARS Best of Free Reference Web Sites of 2001. MARS is the Machine-Assisted Reference Section of the Reference and User Services Association of the American Library Association. Clicking on any of the elements in the periodic table leads you to the essential information, an audio clip (you need Real Player) for a brief description of the element, and a picture of the element. For example, if you click on "Al" you get the following:

Name: aluminum; Symbol: Al; Atomic number: 13; Atomic weight: 26.981538, (2); CAS Registry ID: 7429–90–5; Group number: 13; Group name: Period number: 3, and Block: p-block. Clicking on any of the boldface words provides you with more information. Scroll down the left side of the page and find links such as Index for aluminum, Key data, History, Uses, Geology, Biology, Reactions of aluminum, Compounds, Bond enthalpies, Radii in compounds, Lattice energies, Reduction potentials, Electronic configuration, Ionization energies, Electron affinities, Electro negativities, Effective nuclear charges, Electron binding energies, Atom radii, Valence shell radii, Bulk properties, Thermal properties, Thermodynamic properties, Crystal structure, NMR, Naturally occurring isotopes, Radioisotopes, and a "search" window. A quick review of this Web site will show you that it is indeed worthy of all of its awards and distinctions.

*Title:* The Comic Book Periodic Table of the Elements
*URL:* http://www.uky.edu/projects/chemcomics/
*Grade Level:* Any grade level
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table tutorials
*Review:* At the home page you will find the following: "Welcome to the Periodic Table of Comic Books. Click on an element to see a list of comic book pages involving that element. Click on a thumbnail on the list to see a full comic book page. For technical information about an element, follow the link to Mark Winter's WebElements. We recommend that you start with oxygen to see some of our best stuff. There's something for everyone here!" The introduction truly explains this Web site. It really is a great resource for students who are seeking a light and fun look at the periodic table of elements.

*Title:* David D. Hsu Chemicool Periodic Table
*URL:* http://www.chemicool.com/
*Grade Level:* Any grade level
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table tutorials
*Review:* This Web site states, "Most of the information for this web page was taken from the from Cabrol, D.; Moore, J. W.; Rittenhouse, R.C. J. Chem. Educ.: Software, Special Issue 2, 1992 (KC? Discoverer) and Schatz, P. F.; Moore, J. W.; Holmes, J. L.; Kotz, J. C. J. Chem. Educ.: Software Vol. 2D, No. 2, 1994 (Illustrated Periodic Table). Additionally, the Perkin-Elmer Periodic Table v2.02g was

used for Atomic mass, density, volume, group, heat of fusion, heat of vaporization, specific heat, and shells." At the home page either click on an element found on the periodic table or type in an element name or symbol in the search window. For example, I typed in the word "boron" in the search window. This led me to general information, states, energies, oxidation and electrons, appearance and characteristics, reactions, other forms, radius, conductivity, and abundance tables concerned with Boron. In addition, at the top of the page there are links to take you quickly to those tables and there is a direct link to the *Encyclopedia Britannica* for you to use in your research.

*Title:* Modeling the Periodic Table: An Interactive Simulation
*URL:* http://www.genesismission.org/educate/scimodule/cosmic/ptable.html
*Grade Level:* Grades 5 to 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table materials
*Review:* This Web site contains an educational activity designed by scientists at the JPL labs in connection with the Genesis space program. "The stand-alone activity 'Modeling the Periodic Table: An Interactive Simulation' is accompanied by a Teacher's Guide (pdf) with background, lesson procedures, and links to other materials needed for planned instruction." With modification, it is appropriate for grades 5 to 12. It also makes a great reference handout for students. NOTE: To run the Simulation, your system will need a Power Mac or Windows 95/98. Teachers seeking a full module that incorporates the simulation should use Cosmic Chemistry: Understanding Elements (recommended for grades 5 to 9) or Cosmic Chemistry: An Elemental Question (recommended for grades 8 to 12). At the Web home page click on the periodic table found on the right of the page. The table will then be enlarged and will be interactive. You can click on any of the elements found at the top of the empty table and drag the element to its position on the chart. Clicking on the Analyze button on the bottom of the chart leads you to more information about each element. Also there is an information box on the bottom right that gives you the full name, atomic weight, symbol and whether it is a liquid, solid, or a gas. The purpose of the activity is to design your own model of the elements. This is an interesting activity and is fun to do.

*Title:* Science Mall–USA
*URL:* http://www.jensansci.com/
*Grade Level:* Middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table materials
*Review:* The new site for Jensan Scientifics Space science, Earth science, and science gifts. This Web site claims to be the "source for the finest Earth and Space Science gifts and study sets, created for teachers, students, & enthusiasts of any age! Jensan Scientifics provides materials designed just for you." On the left side of the home page scroll down to "chemistry and the periodic table" link and click on it. You will then observe that there are five products for sale concerning the periodic table. Prices range from $12.95 for a Star Dust: Elements of the Universe study set to $635 for a Grand Tour of the Periodic Table museum-grade study set. There is a minimum cost of $15 for an order.

*Title:* A Periodic Table of the Elements Meet and Learn Website: For Science
*URL:* http://periodictable.com/
*Grade Level:* Any grade level
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* periodic table experiments
*Review:* The home page allows you to search as a student, teacher, or chemist Biologist, or you can search under "seeking products." "Clicking on the Student link leads you to the periodic table, a series of pages following today's periodic table to its logical conclusion—3D; AAE in the Spotlight; the Alexander Arrangement has been making the news—especially with Glenn Seaborg; comical elements: Riddles and other learning fun aspects of elements and the periodic table; study links: Reviewed links to other places on the Internet with element and chart information, and history of the periodic table: A brief look at the thinking, personalities, and development of the periodic chart over time." This is a great resource for all age levels.

### Proteins

*Title:* Mathematical Modeling in Pharmaceutical Development
*URL:* http://mitacs-gw.phys.ualberta.ca/mmpd/

*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* proteins tutorials
*Review:* The site has a lot of material about proteins, mainly motor proteins. There are a lot of URLs about different things related to proteins, including pictures, movies, literature, references for books, and such. When you go to the home page, scroll to the middle of the page and click on "mini-tutorials on-line." It will take you to the mini-tutorials page, where tutorials are offered on Cell Biophysics, Human Physiology, and Pharmacokinetics. Under the heading Cell Biophysics, there is a list of major headings of tutorials. By clicking the topic of your interest, for example, "motor proteins," you would again see a page containing the list of headings of different topics offered. Click on one, for example, "Roles and Functions of Motor Proteins," and it will give you the sublist of topics along with their URLs—in this case: Role of motor proteins in cell division; Role of motor proteins in cell motility; and the Role of motor proteins in cell motility-assays involving motor proteins and their functions.

*Title:* Phytochemistry Tutorials
*URL:* http://www.friedli.com/index.html?
*Grade Level:* College
*Search Engine:* http://www.dogpile.com
*Key Search Words:* protein tutorials
*Review:* The site has tutorials about proteins, mainly related to plant/phytochemistry. To go to protein tutorials, click the "health" icon on the home page. On the left-hand side of the page, click the "tutorials" icon. The page will display a list of phytochemistry tutorials. Click on "proteins," and it will take you to yet another list of protein topics. Click the topic of your interest.

*Title:* Biochemistry in 3D—Lehninger Principles of Biochemistry
*URL:* http://www.worthpublishers.com/lehninger3d/index.html
*Grade Level:* College
*Search Engine:* http://www.dogpile.com
*Key Search Words:* proteins tutorials
*Review:* A very good site for 3-D pictures with brief descriptions. By clicking the URL, you would reach the home page of "Biochemistry in 3D—Lehninger Principles of Biochemistry." Tutorials are listed on the

home page; you just have to click on them. The tutorials give a brief description and very interactive, three-dimensional pictures. It is a very easy site to work on, but you need Netscape Communicator to run the tutorials.

*Title:* Massey University
*URL:* http://www.massey.ac.nz
*Grade Level:* High school and college
*Search Engine:* http://www.dogpile.com
*Key Search Words:* proteins tutorials
*Review:* An interactive site with tutorials, which allows the user some control over what is displayed and permits experimentation and self-learning by clicking on buttons and by manipulating image information. To look for protein tutorials, select "departments" from the home page. This takes you to the list of departments like College of Education or College of Business. Under the heading College of Sciences, click Molecular Biosciences. It would lead you to the main page of the Institute of Molecular Biosciences. Click "teaching," and click "tutorials" on the next page. If you scroll down a little bit, you will see a list of tutorials. Click one according to your interest, for example: 122.231 Tutorial: DNA Structure. Scroll down on the introduction page and click one of the choices, for example: DNA-Protein Interactions.

*Title:* University of Cambridge Department of Biochemistry.
*URL:* http://www-cryst.bioc.cam.ac.uk/
*Grade Level:* Postgraduate and scientific research
*Search Engine:* http://www.dogpile.com
*Key Search Words:* proteins tutorials
*Review:* The site provides a collection of structure-based alignments of homologous protein sequences. The database is compiled from structures present in the PDB (Protein Data Bank) and these have been grouped into just over 800 multimember families at present. This type of information is useful in two main areas:

- Comparative modeling—predicting a protein's structure by comparing it with sequence homologs of known structure
- Detecting distantly related proteins by using structural as well as sequence comparison—the hypothesis being that structure is more strictly conserved than sequence

*Title:* Accelrys
*URL:* http://www.accelrys.com/
*Grade Level:* College
*Search Engine:* http://www.dogpile.com
*Key Search Words:* proteins tutorials
*Review:* A company site, which offers a variety of simulation software for life sciences.

*Title:* EDVOTEK, The Biotechnological Education Company
*URL:* http://www.edvotek.com/
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* proteins experiments
*Review:* EDVOTEK is a molecular biology and biotechnology education site. The site claims that from the simplest molecular biology techniques to the most complex, it has a teacher-tested alternative for the lab. To search for protein experiments, go to the home page. On the left side of it, click on Experiments. From the list of experiments, choose the one of your interest. For example, I chose Experimenting with Proteins and Enzymes. This again would give you a list of different experiments. Click on the one you like, for example: Molecular Weight Determination of Proteins.

*Title:* Biochemistry
*URL:* http://biochemlinks.com/bclinks/biochem.cfm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* protein experiments
*Review:* The Web site is maintained by Dyann K. Schmidel, PhD, and contains plenty of stuff on biochemistry. To go for protein experiments, scroll down, and under the heading Biochemistry Lab Experiments, you will see the subheading Biochemistry Lab Exercises by B. Ganong. Click on it and the next page will show you the introduction. Scroll down a little bit to see a list of experiments. Click on one, for example, Acid Base Behavior of Amino Acids. The site also provides links for other disciplines of science like general biology, general chemistry, and so on.

*Title:* Lab on Web
*URL:* http://www.labonweb.com/
*Grade Level:* Master's, PhD, research, professional

*Search Engine:* http://www.dogpile.com/
*Key Search Words:* lab experiments + proteins
*Review:* This Web site has various tools and software to help mainly in gene discovery lab experiments. They claim that their tools improve the quality and accuracy of experiments, simplify the delivery of information, and help researchers make more informed decisions throughout the discovery process. On the center of the home page, you will see a list of tools and products offered by them, but to utilize their resources you need to have a password. On the left hand side, the home page contains some demos of their products. By clicking on one of them, you can get an idea of what they are offering. For example, click on IRACE, and the next page would show you the demo. The demo is not interactive, but by clicking the any of the icons on top of the page, you could a little more about it.

*Title:* Microbial Pathogenesis Lab Home Page
*URL:* http://www.nwfsc.noaa.gov/home-page.html
*Grade Level:* College, master's, research, and professional
*Search Engine:* http://www.dogpile.com
*Key Search Words:* proteins experiments
*Review:* This is a U.S. Department of Commerce Web site. It has a research project concerned with the virulence factors of pathogenic bacteria found in fishery-related products that are a threat to human health or to fish. To look for protein-related experiments, click "protocols" on the left side of the home page. On the next page would be the title Molecular Biology Protocols. Scroll down a little bit and click on one of experiment/procedures that are of interest to you. Let us choose "DNA purification, plasmid mini-preps, diatomaceous earth, . . . " Click on it. The next page will give you information all about the experiment and its procedure, with an introduction in the beginning and observations and hints for troubleshooting at the end.

### Reaction Rates

*Title:* Introduction to Chemistry: Observation and Description
*URL:* http://dl.clackamas.cc.or.us/ch104–01/
*Grade Level:* High school and college
*Search Engine:* http://www.dogpile.com
*Key Search Words:* reactions materials
*Review:* As the title suggests, the site is related to chemistry. To look for reactions, or reactions of materials, on the left side of the home page,

click on Table of Contents. The next page would give you the full contents of the course. Scroll down and click on Chemical Reaction. From the list of topics choose one of your interest. Let's say you chose "chemical reactions creating materials with new colors." It would take you to the next page giving some examples of how materials change colors when they react with each other.

*Title:* Chemical Reaction Rates
*URL:* http://pc65.frontier.osrhe.edu/hs/science/crate.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemical reaction rates
*Review:* This Web page is a part of a "Chemistry Class Internet Science Room" developed by Frontier High School in Red Rock, Oklahoma. The Web site outlines a two-day lesson plan, with a lab, for instruction about chemical reaction rates. The site outlines the relevant information for each day's lesson, including definition of terms, a discussion of factors influencing reaction rates, an explanation of how single and multistep reactions occur, and an introduction to the chemical rate equation. There are several practice questions included within the lessons, with answers and explanations provided. There are several icons present throughout the lessons, which provide links to items such as laboratory worksheets, expanded definition of terms, self-tests, grading criteria, and external Web sites pertaining to topics in chemistry and careers in chemical fields. This Web site, while not very flashy, is full of readily available pertinent information. The self-tests and explanations of answers to problems make this a good Web site for students who may not have fully understood all that was presented to them in class.

*Title:* Rates of Reaction
*URL:* http://www.newi.ac.uk/buckleyc/react.htm
*Grade Level:* Grades 11 and 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry reaction rates
*Review:* This Web site is designed to give an introduction to the topic of reaction rates. It s a site that is directly formulated for students on an eleventh- or twelfth-grade level studying chemistry. It is also evident that this site was designed for a specific course because some of the text refers to previous class discussions. If one is not familiar with rates of reaction, one may have difficulty understanding the subject

matter accessed in this Web site. I do not think this would be a good resource to go to for basic information about reaction rates. I would not recommend this site.

*Title:* Chem4kids.com:Reactions:Rates
*URL:* http://www.chem4kids.com/files/react_rates.html
*Grade Level:* All grade levels
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry reaction rates
*Review:* This Web site is an excellent source for beginning chemistry students or for older students who need additional help understanding chemistry concepts. It is written in a straightforward, clear manner that even the youngest student can understand. The site contains five broad chemistry topics, including matter, atoms, elements, reactions, and biochemistry. The presentation of each broad topic begins with a thorough, yet simple, explanation of the concept. The topic is then divided into more detailed subtopics and includes activities, examples and quizzes to supplement the information. The reaction topic includes subtopics of acids and bases, thermodynamics, equilibrium, reaction rates, and catalyst-inhibitor. The reaction rate section begins with a definition of a reaction and key points that are associated with every reaction. Next, reaction rate is defined and a simple explanation of collision theory is given. The author then provides information on forces that change the speed of reactions and how to measure rates. In summary, this Web site is well-designed and very well-organized. It is most suitable as an introduction to chemistry concepts or as supporting information to that provided in school. Any student who is struggling to understand chemistry concepts would find this Web site very useful and easy to understand.

*Title:* Chem4kids
*URL:* www.chem4kids.com
*Grade Level:* Elementary grades
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemistry reactions K–8
*Review:* The Chem4kids Web site is designed for the beginning chemistry student. It provides links to sites with basic information on such topics as matter, atoms, elements, reactions, and biochemistry, and there is even a link called Et Cetera that touches on a number of miscellaneous subjects in chemistry. When you click on Reactions, a general, easy-to-understand explanation and a list of key points are provided.

For more specific, detailed information, there are links on Acids and Bases, Thermodynamics, Reaction Rates, Catalyst Inhibitors, and Equilibrium. The Equilibrium link, for example, offers a clear, simple definition of equilibrium and describes the concept of "spontaneous processes." It uses attractive graphics to demonstrate examples and even provides a short article about the Frenchman who discovered the principle of equilibrium, Henri Le Chatelier. Another link, Matter, also gives basic information and links to specifics on Copper, Graphite, Helium, Iron, Neon, Sulfur, and other elements. When you click on Helium, you get a simple and concise description with pictures of a helium tank and balloons, which young kids can relate to and understand. The other links mentioned above are equally well-constructed and easy to follow. This is a wonderful site for teachers of students who are beginning to explore the fundamentals of chemistry and for students themselves to refer to for simple information and fun learning activities.

*Title:* Links to Chemistry Experiments, Demonstrations
*URL:* http://www.chemistrycoach.com/Links%20to%20chemistry_experiments.htm
*Grade Level:* All grade levels
*Search Engine:* http://www.aol.com
*Key Search Words:* chemistry reaction experiments
*Review:* Chemistry Coach is a free Web site produced by Wilton High School, Wilton, Connecticut. This Web page offers you are variety of information about chemistry dealing with experiments, lessons, methods, facts, and much more. At the top of the Web page you can click on the topics Demonstration and Experiments. By clicking on one of these topics you will see a list of links about each topic. Clicking on Experiments brings you to links that have entirely new Web pages to offer you information on chemistry and individual experiments. The Individual Experiments links have subtopics in all areas of chemistry (e.g., food chemistry, density, property matter, soaps, etc.). In this area you can click on "reactions." Reactions that are available are as follows: Observing Reactions, Doing Chemistry, Rust, Hyper Chemistry, Metal Reactivity's Lab, Types of Reactions Lab, A Silver/Copper Replacement Reaction, Doing Chemistry Put a Shine on It, and Professor Shakhashiri Volcano Bizarre Stuff. These sites give you an overview of the lessons and provide detailed methods of how to engage in the experiments. This is a great way to be hands-on

with chemistry reactions in your classroom. At the bottom of this Web site you can return to the Wilton High School Chemistry home page which provides you with links to this Web site organization, tutorials, pedagogy, links, eccentric assignments, current course activities, local study skills pages, Web reviews quotations, and other stuff. You can also click on the Index for this Web site and links for chemistry teachers, which provide you with lesson plans, sites, and articles. This is a fabulous way to have fun learning in chemistry class.

*Title:* Homework Study Tips: Chemistry
*URL:* http://homeworktips.about.com/cs/chemistry/
*Grade Level:* Grades 5 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry reaction rates for kids
*Review:* This Web site is provided by About.com Teens and the Princeton Review and is useful for all grades beginning with grade 5. It is written in plain English and is easy to read and understand. This site provides a few different tables of elements, a page all about acids and bases, a chemical reaction page, quizzes on all its topics, and a reaction rates page. This site also gives you study tips on all chemistry topics and is easy for anyone grades 5 and up to use. The table of elements gives you all the vital information on all the elements. Other pages will give you elements reaction rates and other vital information. This site is a very good one and is recommended for anyone that needs tips on chemistry.

*Title:* Utah State Office of Education/Utah State Science
*URL:* http://www.usoe.k12.ut.us/curr/science/core/lesnplndir. html
*Grade Level:* K to 8, also for teachers (K to 8)
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemistry reaction rates experiments
*Review:* The Utah State Science State Office of Education Web site is a free site developed by Utah State educators to provide instructional activities and information that aligns with the science core curriculum guidelines for the state of Utah. The left side of the site lists grade levels and general science categories: Biological Science, Chemistry, Earth Science, and Physics. The right side of the site offers links for teachers, students, and parents. Upon selecting a category or grade level, the user will proceed to other parts of the Web site. In this instance chemistry was selected, and the user was able to

choose from different chemistry experiments or topics. The teacher portion of the Web site leads the teacher to experiments with lesson plans. The lesson plans include objective, materials, procedures, and suggestions to be used during instruction. There were several experiments for chemistry reaction rates. The lesson plans do not list the intended grade level, and for the chemistry reaction rates experiments, the students need to have some science background. The lesson plans provide clear directions for completing the activities. This site provides links for other science-related sites. It also allows educators who are using the experiments to complete evaluations. This site does not offer a search category, which would have made it easier to navigate and to find specific topics. Overall, this site can be a great resource for teachers interested in conducting experiments in the classroom; however, students may require assistance in order to benefit from using this site. Also, the parent resources are very limited.

*Title:* Reaction Rates: Frequently Asked Questions
*URL:* http//antoine.fsu.umd.edu/chem./senese/101/kinetics/faq.shtml
*Grade Level:* High school
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemistry reaction rates
*Review:* This Web site was created by Fred Sense from the Department of Chemistry at Frostburg State University. On his Web site Fred created a list of frequently asked questions about chemistry reaction rates. He categorized the questions into topics that chemistry reaction rates fall into, such as rate laws, reaction mechanisms, reactions in aqueous solution, stepwise reactions, and temperature and reaction rates. Each topic has frequently asked questions listed below them. All one has to do is click on one of the questions that they are interested in learning about. Once you have clicked on the question, a very detailed answer comes up and explains everything you could ever think about on that particular topic. In addition to the frequently asked questions about chemistry reaction rates, Fred has frequently asked questions about twenty-five other chemistry topics, such as chemical bonding, the periodic table, acids and bases, molecules and compounds, and so on. As well as the frequently asked questions, Fred has a location on his Web site that allows one to ask him any question that they would like answered. All one has to do is e-mail him the question and he will try to answer the question to the best of his ability. When you e-mail him your question, he will send the answer to your e-mail address. Fred Sense's Web site does not just answer frequently asked questions about chemistry topics.

On the left side of his Web site, he has many options one can click on to learn more about chemistry. An exam guide, glossary, and information about common compounds are just some of the options on the left side of the Web site. The exam guide provides ten different ways to help pass one's next exam on most chemistry topics, such as matter, atoms and ions, chemical changes, and so on. The glossary allows one to browse by topic or simply to type in the word one needs to know about. Once the search is complete, a very detailed definition comes up for the word searched. The "common compounds" link allows one to enter the formula or name of a substance one needs to know about. This link provides everything one needs to know about the formula or substance one is interested in, such as its molecular weight, uses, incompatibilities, and so forth. All in all, Fred's Web site is an attractive, colorful Web site that has very helpful information about general chemistry topics such as chemistry reaction rates. It is an effective tool that provides one with any type information one is looking for when it comes to chemistry. This is an excellent resource.

*Title:* Rates of Chemical Reactions
*URL:* http://pc65.frontier.osrhe.edu/hs/science/prate.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry reaction rates
*Review:* This Web site is very well-designed. There are many different colors throughout the Web site to get the readers' attention. There are also highlighted areas that got my attention. At the top of the page there is a section that says "week 15." Underneath that section there is an area you can click on to change the day of the week that you are looking at and there is also a lab section and a vocabulary section. The next section is the key terms for the week. Some of the words include endothermic, exothermic, and collision theory. The next section shows the question of the day. On this particular day the question was "What is activation energy?" Following this question are the types of reactions based on energy. In this section we also have a "lab key," where you learn a fact about reaction rates. The third section is an explanation of what causes reaction rates to change. The samples in this section are concentration, surface area, temperature, and catalysts. The fourth section is an in-class activity for the students to do. The activity is to find an exothermic reaction that you can produce in class. Then there are instructions on how to do the activity. The last section is another question of the day that deals

with the first question asked. In this section there is also an in-class assignment.

*Title:* Physical Science Class
*URL:* http://pc65.frontier.osrhe.edu/science.hps.2.htm
*Grade Level:* High school
*Search Engine:* http:///www.metacrawler.com
*Key Search Words:* chemistry reaction rates
*Review:* Physical Science Class is a Web site for students of Frontier High School in Oklahoma. The Physical Science Web page offers many definitions of scientific concepts. Some of these concepts include chemical bonding, equations, chemical reaction rates, and much more. Clicking on Reaction Rates leads you to key terms and definitions for different types of reactions and how reactions are affected. Looking at the top of the page, you will see a link to the vocabulary test. This would be an excellent practice test for those students interested in reaction rates. If you scroll down to the "lab key" and click on it, you will find a lab report that gives the directions for two different types of reactions. On the left-hand side you would record your observations. This is a great Web site for chemistry students. The easy-to-read (and understand) definitions are also a plus.

*Title:* Rates of Chemical Reactions
*URL:* http://pc65.frontier.osrhe.edu/hs/science/prate.htm# one
*Grade Level:* High school; upper middle school, with modifications
*Search Engine:* www.altavista.com
*Key Search Words:* chemistry reaction rates
*Review:* As I browsed this Web site, I found exactly what I was looking for—chemistry. What I didn't expect to find was that the Web site is actually daily lessons from a physical science class working on chemical reactions, complete with lab and vocabulary tests. Upon entering the Web site one comes upon key terms for the week, obviously to be used in the vocabulary test later on. Your next stop further on down the page (it is not a very complicated Web site), is the question of the day. Day 1's question is, "What is activation energy?" This would be like the anticipatory set. After the question come class notes on the two types of reactions based on energy and on activation energy. Then come the notes on reaction rates. After reviewing the notes, the next step along the page is "Do Now." You are given questions that can be completed through the information given to you in the daily notes and by clicking on a little, colorful diamond that brings

you to a chemical compound table. After completing the questions, you can scroll down to the bottom of the screen and find the answer to the question of the day, which was, "Activation energy is the energy needed to start a chemical reaction. All chemical reactions require energy to begin. Enough energy is available from the environment to start some reactions. For others, additional energy must be added before the reacting will begin." Then on to Day 2, and the next question of the day. This part of the page is very much the same as the beginning but with different information (obviously). But this area has a little icon that says Science Career: Biochemist. By clicking on this icon, you can go to a Web page and learn all about a career in biochemistry. Each week a new career is highlighted. To get to the lab assignment you can click on Lab at the top of the first page, or you can click on an the Lab Key icon on the second page. This will bring you to an entire lab report setup. Finally, you can click on Vocabulary Test at the top of the first page, and there you are ready to take the test.

### Reactions

*Title:* Lee's Chemistry Page
*URL:* http://ocean.otr.usm.edu/~leleuter/chem.html
*Grade Level:* Grades 11 and 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry reactions
*Review:* Lee's Chemistry Page is a Web site where one can choose from a list of chemistry topics such as biochemistry, organic lab, constants/unit conversions, and organic chemistry reactions. When you choose "organic chemistry reactions," a long list appears of many different chemicals and their reactions in alphabetical order. I clicked on "the alkene reaction," and an outline containing all of the information one would need about this topic appeared, along with helpful diagrams illustrating the reactions they will have. Another great aspect of this Web site can be found on the home page. A list of other useful Web sites related to chemistry is provided. All in all, I found this to be a useful Web site that I would recommend to others in search of this type of information.

*Title:* Organic Reaction Quizzes and Summaries
*URL:* http://www.towson.edu/~sweeting/orgxs/reactsum.htm
*Grade Level:* High school or college

*Search Engine:* http://www.google.com
*Key Search Words:* chemistry reactions
*Review:* Organic reaction quizzes and summaries is a tutorial for organic chemistry students. If you scroll down to the middle of the page, you will see a list of organic functional groups with summaries to the reaction and syntheses for each group. After you read these summaries you can click on the organic or inorganic quiz to test your knowledge. Once you reach the quiz site you can solve the formula. Once you have attempted to solve the formula, you can click on the answer button to see if your answer was correct. This is an excellent site for those who need practice, and great review for those who need a brush-up.

*Title:* Chemistry Tutor: Chemical Reactions
*URL:* http://library.thinkquest.org/2923/react2.html
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry reactions + high school
*Review:* The Chemistry Tutor Web site is designed to help high-school students with their chemistry homework. It includes broad categories, such as introduction to chemistry, equations, lab safety, types of chemical reactions, chemistry calculations, and a list of science/chemistry links for students and teachers. The chemical reactions section consists of a basic definition and example of the following types of reactions: combustion, synthesis, decomposition, dissociation, single replacement, and double replacement. The definitions of each type of reaction are concise and straightforward. There is not much detail provided on this Web site. Due to this lack of detail and lack of original presentation of the material, it does not appear that this site would be much help to chemistry students. The actual information provided is written in the same manner as a high-school chemistry textbook.

*Title:* Vis-Ed
*URL:* http://www.vis-ed.com/017–2.html
*Grade Level:* Middle school and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry reactions
*Review:* This Web site that I chose isn't your normal informational Web site. This Web site is a Web site where you are allowed to order dif-

ferent chemistry reaction cards to find out about chemistry reactions. On the top of the Web site is its title, Vis-Ed. Underneath that is your selection area where you can either login, go to the home page, contact the company, view what you have bought, or check out. On the side of the Web site is an area where you can search different information for the Web site. Also on the left are different subjects that you can get information on to assist you in your studies as well as your knowledge of a subject. In the middle of the page is a card that shows different reactions that you would receive if you ordered the cards. One of the cards shows propylene and the other isopropyl chloride. At the bottom of the page is the price of the cards and an option for the quantity that you want to buy. This site would be beneficial for anyone who is having problems in a particular subject.

*Title:* Chemical Reactions: Prediction of Products
*URL:* http://eppe.tripod.com/reaction.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical reactions
*Review:* This Web site was created by Erik Epp. On his Web site Erik gathers together a collection of Chemistry, AP Chemistry, and Organic Chemistry course notes. These notes are available for people to read through, review, and learn. Within these notes is a section on chemical reactions. Erik lists multiple chemical reactions, such as a synthesis reaction, a single displacement reaction, a double displacement reaction, and a decomposition reaction. With all of these reactions, Erik gives a very detailed description of the reaction, its equation, and its image. If one clicks on one of the images, the image has the capability to be enlarged so one can get a closer look at the reaction. The images are color-coded by atoms and very easy to follow. Between the description, equation, and image, this Web site is a very helpful and suitable resource for students to use when learning about chemical reactions. In addition to chemical reactions, Erik talks about additional chemistry topics and supplies the Web site with notes on these topics as well. Such topics include metric prefixes, stoichiometry, gas laws, the periodic table, chemical bonding, nomenclature, properties of organic compounds, and so forth. At the top of Erik's home page, he includes links that students can click on that will supply them with additional chemistry links, chemistry images, chemistry animation, and chemistry humor on any of the chemistry

topics. All in all, Erik's Web site is very helpful for students to use to gather information about chemistry topics such as chemistry reactions. The Web site has many different and creative ways of gathering information on any topic dealing with chemistry, especially chemistry reactions.

*Title:* ChemViz
*URL:* http://ChemViz.ncsa.uiuc.edu
*Grade Level:* Grades 7 to 12
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemistry reactions
*Review:* ChemViz is a Web site funded by the National Science Foundation and is geared toward instructing the user on how to successfully use two major features: Waltz, which helps the student calculate orbitals or electrons densities within a box, and Cambridge Structural Database (CSD), which is on-line and helps the user look up coordinates and see models of molecules. This Web site is free and can be easily obtained after completing a request a ChemViz account page. The left side of the Web page offers links such as Getting to Know ChemViz, Getting an Account, Logging On, Single Images, Animations, Using the CSD, ChemViz Curriculum, ChemViz Resources, and Nanocad. Clicking on Nanocad provides the student with the luxury of drawing molecules on screen, putting bonds between atoms, erasing bonds, and minimizing energy to create a better molecule. This Web site is a standard resource for science, physics, and chemistry students and is an excellent substitute for conducting laboratory experiments. However, students should be encouraged to utilize other Web sites to get a variety of information on chemical reactions.

*Title:* Chemistry Tutor
*URL:* http://library.thinkquest.org/2923/
*Grade Level:* High school
*Search Engine:* http://www.msn.com
*Key Search Words:* chemistry reactions, chemistry tutor
*Review:* Chemistry Tutor is a Web site that defines different chemistry terms. It uses simple language and is easy to navigate. The chemical terms are listed by category. Some of the categories are Laws and Reactions, Intro to Chemistry, and Elements. Under each category are two to three more terms. The users click on the desired term. Each category is listed in its own box. Each term is defined, and in the case

of reactions a formula is provided to illustrate the various chemical reactions. Additional links to other chemistry Web sites are also provided. Chemistry Tutor is part of the Think Quest Web site. Think Quest provides Web sites for many different categories besides science. It was easier to find the Chemistry Tutor by using the msn.com search engine than by searching from the main page of the Think Quest Web site. The Chemistry Tutor Web site would be a useful tool to use as a test review or for a basic introduction to chemistry terms. Due to its simplistic nature, this site makes a good supplement to classroom texts, but it may not be beneficial if used without additional resources.

*Title:* Relevant (High School) Chemistry Resources on the Web
*URL:* http://www.chemistrycoach.com/high.htm
*Grades:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry reactions in schools for kids
*Review:* This Web site is relevant for kids grades 9 through 12 only. It consists of all main topics that deal with chemistry, including periodic tables, terms and definitions, publications, discoveries and inventions, and chemistry projects one can do. This site is easy to navigate through. Under each main topic there are several sub topics that you can search through. This site also lets you go right to where you want to go without unneeded effort.

*Title:* Types of Chemical Reactions
*URL:* http:/www.usoe.k12.ut.us/curr/science/core/8thgrd/integrated/chemphys/chemtype.htm
*Grade Level:* Grade 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical reactions
*Review:* This Web site is a part of the Utah State Science Education Web site. This address will bring you directly to discussion on chemical reactions. From this site, you can link to a number of experiments, such as "endothermic reaction activity" and "exothermic reaction activity." At the bottom of the page, there are also links to go to other activities, all related to chemical reactions. Among these links are Micromixture Separation Activity, Phase Change Ice Cream Activity, Physical and Chemical Changes, Physical and Chemical Properties, Reactant and Products, Root Beer Phase Change Activity, Types of Matter, Variables, and the Water Lab. It is easy to use.

### Redox Reaction

*Title:* KIWI Web Chemistry & New Zealand
*URL:* http://www.chemistry.co.nz/chem.htm
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* redox reaction
*Review:* This site not only has a lot of information about redox reaction but also links to a list of related subtopics. If you click on Redox Reactions, you will get a definition of redox reactions, examples of equations, and so on. The following is a list of subcategories that this Web site links; each of these topics has subcategories as well with more links. Chemistry Defined links to Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, Physical Chemistry, Stoichiometry, Nuclear Chemistry, Alchemy, Biochemistry, and Time Capsule list a chronology of notable achievements. Famous Scientists—web list of famous scientists; Acids and Bases—lists of subcategories with sites of information on acids and bases, quizzes, etc; Redox Reactions links to Redox Reactions and Equations; Oxidation Number Assignments; Oxidation—Reduction Test Sheet; Test Answers Equations; chemical equations, oxidation states, and balancing of equations; What is a Mole?—definition of mole; Cooking at Altitude—frequently asked questions Periodic Tables; Mendeleev's Periodic Table; Element Tables; Chemicol Periodic Table; Comic Book Periodic Table; and some other tables. Crystals—Crystal Types; Shapes and Sizes; Color and Light Crystal Forming Crystal Gardens; Crystal Recipes; String Crystals; Crystal Books; Detergents—links to Water Surfactants History Synthetics Soil ID.

*Title:* Oxidation—Reduction—"REDOX" Reactions
*URL:* http://pc65.frontier.osrhe.edu/hs/science/credox.htm
*Grade Level:* High school
*Search Engine:* http://www.askjeeves.com
*Key Search Words:* what is chemistry redox reaction
*Review:* Oxidation—Reduction—"REDOX" Reactions is a free Web site produced by Frontier High School, Red Rock, Oklahoma. This Web page offers you are a four-day lesson plan with objectives, important colorful definitions, tips, rules, examples, scoring criteria, portfolio assignments, chemical formulas, and research links. This site is has an eye-catching way of cueing you into important information such as key terms, helpful tips, and rules. Day 1 you learn how to differentiate

a redox equation from others. On Day 2 you learn how to balance a redox equation. Days 3 and 4 you are able to experiment and get hands-on experience with redox reactions. On the right side of the screen an interactive science graphic brings you into another link to explore chemistry. Further down the page you are able to link onto another interactive site that provides you with the lab key to answers with illustrations to guide the explanations of the solutions. After each lesson plan you are able to click on a check mark to review the correct answers and see the balanced equations and half-reaction solutions. All lessons have a portfolio assign-ment and you can link into what and how the assignment will be assessed. At the bottom of the Web page you are able to research other links. The links are as follows: Oxidation Numbers and Redox Reactions—Roanoke Valley Governor's School; Oxidation/Reduction—University of Hawaii; Chemical Reactions—Virtual Chem Class; "Simple" Redox Experiments—Institute for Materials Research; Redox Centers in Cells—University of Illinois in Urbana–Champaign. This site also provides you with a reproducible test by clicking on Skills Test. This is a great resource for teachers and for students as well. This site really keys you into the facts by its colorful components, use of graphics, and illustrations.

*Title:* Teachers First Resource
*URL:* http://biochemlinks.com
*Grade Level:* All grade levels
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry redox reactions in classroom
*Review:* This science Web site offers seven main topics to click on: General Biology, General Chemistry, Organic Chemistry, Biochemistry, Biotechnology, and Teaching Science. I clicked on to General Chemistry, and under the heading Introduction to Chemistry, there were thirteen links to choose from. I clicked on General Chemistry by J. Hardy, which had an extensive list of Web pages, some of which were titled Atomic Structure, Reactions in Solutions, Chemical Bonds, Redox Reactions, and there were many more specific chemistry topics. I clicked on Redox Reactions, and a list of topics within this specific subject was provided. Each of these takes you to a very brief definition of the term; for example, Oxidation by Oxygen explains that oxygen is about 19 percent of the atmosphere. It lists the three elements that it cannot react with and describes the common reaction for oxygen: combustion. This Web site also has links to

Learning Activities on topics like Common Chemicals, Enthalpy, Periodic and Soluble Puzzles, and a periodic table quiz. The Teaching Science link has a long list of topics for teachers to click on. Some interesting ones were the ACS Chemistry Center: Educational Resources; Bad Chemistry: Mistaught Concepts; and Project Primary: Activities for K–3 Teachers, Teaching Tools, and Teacher Discussion Groups. This Web site offers loads of links to information for students and teachers, ranging from general information for beginning chemistry students to more specific topics with more explanations for high-school and college students.

*Title:* Redox Reactions and Equations
*URL:* http://www.chemistry.co.nz/redox_new.htm
*Grade Level:* Grades 11 and 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry redox reactions
*Review:* This Web site is a very thorough explanation of redox reaction rates. One thing that I really like about this Web site is the author's understanding that he is dealing with difficult subject matter and he tries to break the information down to an understandable level. In addition, he defines the different terms in the text so as not to confuse the readers. The author also supplies example problems, which help the students gain a better understanding of what they are doing. If I were a teacher I would definitely suggest my students should look up this Web site to get helpful and understandable information about chemistry redox reactions.

*Title:* Redox Chemistry
*URL:* www.chem.csustan.edu/chem3070/3070m08.htm
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry redox reactions
*Review:* This Web site is very beneficial to students who need assistance on chemistry redox reactions. At the top of the page it explains when oxidation occurs. It also explains what reduction is. The Web site then goes on to explain that every redox reaction must have both an oxidant and a reductant. It also explains that there has to be oxidation to have reduction. Following this part of the Web site are eighteen sample questions that you are allowed to click on to show your best answer. The Web site then informs you of the correct answer. One of the sample questions is, "The corrosion of metals, such

as the rusting of iron, is an example of A. reduction, B. oxidation, C. proton transfer, D. transmutation."

*Title:* Oxidation and Reduction
*URL:* http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch9/redoxframe.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry redox reactions
*Review:* This Web site provides students with general chemistry help on all types of topics, including redox reactions. The help provided to students on redox reactions covers topics such as oxidation-reduction reactions, the role of oxidation numbers in oxidation-reduction reactions, oxidizing agents and reducing agents, reducing agent pairs, and the relative strengths of metals as reducing agents. With each of these specific topics, the Web site gives a detailed description of the topic using words and equations. The equations are color-coded and written step-by-step. They are very easy to follow and coincide effectively with the written description. Once you have read the information, the Web site provides a practice problem on each individual topic. After you have completed the problem, the answer to the problem is available below the practice problem. All you have to do is click on "answer," and the answer is available to you. In addition to this helpful information, the Web site's home page supplies the students with many more opportunities to gather further information on chemistry. The Web site has a glossary that allows students to look up any chemistry terms they are unfamiliar with. Students can brush up on over thirty general chemistry topics. Resources, problem solving, laboratory information, and old general chemistry tests are some of the additional options on the home page of this Web site. All in all, this Web site is an excellent source of helpful information on general chemistry, including redox reactions.

*Title:* UNC–Chapel Hill Chemistry Fundamentals
*URL:* http://www.shodor.org/UNChem/index.html
*Grade Level:* High school and college
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry redox reactions
*Review:* This is an excellent site for those students who want an introduction to chemistry or those who need to brush up on their chemistry skills. On the left-hand side of the page are a list of links that will lead

you to almost every aspect of chemistry. The first link, WebElements, leads you to a periodic table, which a chemistry student should always have on hand. If you scroll down a little ways, you will see Advanced Concepts. If you click on that it will lead you to a list of more advanced topics, one being redox chemistry. If you click on redox reactions it will give you the definition, overview, steps to follow to balance a redox equation, different formulas, and much more. If you go back to the home page and scroll down to section tests you will notice that there is a pre- and posttest available to take on your own. If you click on one of those tests you will find several different test topics, one being redox. Back at the home page, you can scroll all the way down to calculators. If you click on Redox, it will lead you to a redox reactions calculator. Here, you can plug in input values and get results. This site would benefit anyone involved in chemistry, due to the interactive exercises.

*Title:* Caveman to Chemist Projects: Redox Reactions
*URL:* http://cator.hsc.edu/~kmd/caveman/projects/rxn.2/
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* redox reactions
*Review:* This Web site was created at Hampden-Sydney College, which despite its exotic-sounding name is located just outside of Richmond, Virginia. The Caveman to Chemist Web site is part of a freshman-level chemistry course. As described by the Web site: "this website is a course in exploring landmark technologies on the road to a modern industrial civilization." The project on redox reactions is a foundation for understanding the development of explosives. The shortcoming of this page is that it contains a too-brief explanation of what a redox reaction is and omits any discussion of oxidation numbers. However, there is a very detailed explanation of how to balance a redox reaction that makes this site very useful. There are also several challenging sample problems with a link to their solutions, and a self-correcting sample quiz. I thought the overall concept of teaching chemistry in a broader context was really cool. Much better than the dry lectures you normally get in a general chemistry class. The main page is worth a visit.

*Title:* Paul's Chemistry Lab
*URL:* http://www.geocities.com/CapeCanaveral/lab/5875/
*Grade Level:* Grade school through graduate school

*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry redox
*Review:* Paul's Chemistry Lab is a Web site that provides users with different links to other Web sites. The areas included are chemistry, biology, and astronomy. Upon clicking the "chemistry" link, the user is shown many different chemistry topics and can choose one. The Web site is colorful and easy to navigate. After choosing the topic redox, the user was directed to an Internet chemistry site, which is maintained by colleges and universities from the state of Hawaii. This site is very informative; it is designed to provide students with the basic knowledge needed to understand the Chemistry Redox topic. As the students progress through the subtopics, the details become more comprehensive. The concepts are extended, and students can test themselves with examples and easily check the answers. The site uses visual depictions for explanations and formulas. The site discusses various types of redox reactions, such as combination, decomposition, and displacement. The last section of the site supplies everyday examples of redox reactions. Two of these examples are bleach and batteries. This section may serve better as an introduction to the site rather than at the conclusion of the site. Overall, this is a very comprehensive chemistry redox site that can be used to enhance high-school to college-level chemistry knowledge.

*Title:* Chemtutor
*URL:* www.chemtutor.com
*Grade Level:* High school or college
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemistry redox reactions
*Review:* The Chemtutor Web site is designed to provide basic chemistry help for high-school and college students. The designers of this Web site state, "Pretty is not our aim, but there is a lot of good information here," which is an accurate description of the site. There is nothing glitzy or colorful about the way the material is presented, but it is thorough and well-written. The site contains information on many chemistry topics, including the math you need for chemistry, atomic structure, elements, states of matter, reactions, compounds, acids and bases, and oxidation and reduction reactions. The topics of kinetics and thermochemistry are currently being developed. The section on redox reactions is quite detailed and easy to understand. The subtopics include How are redox reactions different?; Oxidation states; Is it a redox reaction?; Half reactions; Reduction or oxidation?;

Practice with assigning oxidation states; and Balancing redox reactions. Each of these subtopics is thoroughly explained. Due to the detail provided and ease of use, this Web site would be very useful to high-school and college students who need additional help with the chemistry courses.

*Title:* What Is Chemistry
*URL:* www.tld.jcu.edu.au/course/CAUTscience/
*Grade Level:* Elementary and high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry reaction rates
*Review:* This Web site's home page offers a list of general topics in chemistry, one of which is Reaction Rates. When you click on to this, you get a brief introduction consisting of a short explanation and key questions to think about such as: Why do we need a match to start a fire? and What does a catalyst do? As you go on to the next page, the main menu appears at the top with specific sites to go to for simple and complex information on Reaction Mechanisms, Rate Determining Step, Collision Theory, and Factors Affecting Reaction Rates. Each of these links offers a number of pages about the specific subject, beginning with simple explanations and graphics to more detailed, complicated ones. For example, the topic Reaction Mechanisms has five pages of information, which begins with a definition and a PowerPoint graphic of the process of sugar cubes being stirred in a cup of hot liquid. The next page displays an equation with graphics and a brief explanation. The remaining pages progress to more complex information and graphics. The other subjects on the menu each have several pages with eye-catching graphics and easy-to-understand explanations. There is also a WebBoard students can click on if they want to ask questions or discuss material with fellow students. This Web site is constructed in such a way that young or beginning chemistry students can learn through a step-by-step process, which is neither overwhelming nor wordy. In addition, it offers teachers ways to present material clearly and simply.

*Title:* Kiwi Web Chemistry & New Zealand
*URL:* http://www.chemistry.co.nz/redox_test.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry + redox + reactions
*Review:* When I entered this Web site I had no idea what to expect. I knew nothing about redox reactions and little more about chemistry. When

the site opens you are introduced to a chemistry home page that offers every different type of chemistry you could ask for. It took me a minute to find the words Redox Reactions in the middle of the paragraph explaining the site, though they were highlighted in a different color from the rest of the text. But after a few moments I found them and clicked on the term. This brings you to a page that offers the definition of redox reactions. After reading the definition, you need to click on Redox Reactions and Equations. This click brings you to a page that breaks down each type of equation and thoroughly explains it. Even I began to understand the process after reading most of the information. It is simplified as much as possible. After learning about redox reactions, your next click is to Oxidation Number Assignment. Here you find questions to test the knowledge you have gained. After each question you can check your answer against theirs. Then you can click on Oxidation-Reduction Test Sheet. There you find two questions you need to answer. Again when you are done with the question you can check your answer against their answer. After going through this part of the Web site, I decided to continue browsing. I found that not only can you find out information on any type of chemistry you would want, but they give you in-depth information on New Zealand and on other topics, like stain removal. There is a bookstore and other areas I have yet to explore.

*Title:* Chemistry Vocabulary
*URL:* http://misterguch.brinster.net/vocabulary.html
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry redox reactions for kids
*Review:* This site gives a list of common chemistry terms and laws and their definitions It is easy to navigate, and the definitions are in plain chemistry language. It is very helpful for high-school chemistry students.

*Title:* NDRL Radiation Chemistry Center
*URL:* http://allen.rad.nd.edu/
*Grade Level:* Graduate school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical redox
*Review:* The Notre Dame Radiation Laboratory (NDRL) was first established in 1964 by Professor Milton Burton with support from the U.S. Atomic Energy Commission; its purpose was to conduct research on radiation chemistry and closely allied fields. The NDRL is the leading laboratory in the United States for radiation chemistry, and the study

of chemical reactions induced by ionizing. Research is guided by the general needs and interest of the U.S. Department of Energy and its office of basic energy sciences. Programs offered by NDRL include radical reaction, mechanisms, radical structure and properties, heavy ion radiolysis, track structure, redox processes in coordination compounds, and radiation chemistry. Clicking "redox processes in coordination compounds" gives the student an overview of the applications of electronic and molecular structure of metal complexes to the rates of redox reaction and gives the accomplishment of the Zeeman mechanisms. This Web site is geared toward graduate students whose interest lie in chemistry, biochemistry, physics, civil engineering, and other interdisciplinary topics. This Web site is a quality resource, one all chemistry and physics students should take advantage of.

### Safety

*Title:* Dr Cal's Guide to Good Laboratory Practices
*URL:* http://search.metacrawler.com/crawler?general = %2Bchemistry+2Bsafety+cat = opendir
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* safety in chemistry labs
*Review:* Dr. Cal's Guide to Good Laboratory Practices is a free Web site designed and maintained by Dr. Cal Chany. This Web page offers a variety of chemistry resources ranging from Webivore (an award winning Internet research tool) to Bio Med Net (a gateway to thousands of evaluated biomedical Web sites). The left side of the Web page offers the student links to Lab Safety, Preparing for the Lab, Report Writing, Organic Lab Tips, Chemistry Resources, Study Help, and Good Practices for Industry. Clicking on Study Help gives the chemistry student access to study skills, note taking, listening, test preparation, taking and writing tests, objective tests, and multiple-choice tests. This Web site is an excellent resource for all students in the field of science, physics, and chemistry. However, due to the exceptional quality of this Web site, all students should be encouraged to take advantage of this site and make an effort to use some of the study ideas wherever applicable.

*Title:* Lab Safety
*URL:* http://tigger.uic.edu/~magyar/Lab_Help/Lab_Safety/lab_safety.html

*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry safety
*Review:* This Web site was produced by Dr. Cal Chany from the University of Illinois of Chicago. On his Web site, Dr. Cal created a list of basic safety laboratory procedures that should be followed and are expected of all students in the laboratory. Some of his rules discuss eye protection; required clothing; the handling of flammable solvents; knowing the location of the nearest fire extinguisher, exit, telephone, eye wash station, and so forth; and what to do in the case of an emergency. In addition to laboratory safety, the left side of Dr. Cal's Web site acts a guide to good laboratory practices and has helpful chemistry information that can be useful in the laboratory. Dr. Cal provides information on how to prepare the laboratory and write a good laboratory report. He also gives helpful organic lab tips, study help, and chemistry resources. This Web site is an excellent resource for chemistry safety and the fundamentals of chemistry laboratory safety.

*Title:* Science Lab Safety Rules: Frontier High School Science Lab
*URL:* http://pc65.frontier.osrhe.edu/hs/science/clab.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry safety/chemistry laboratory safety
*Review:* This Web site has been created by Frontier High School in California and includes safety rules for the chemistry laboratory. The rules are well-written and thorough. Some areas covered are lab responsibility, safety glasses, protective clothing, contact lenses, long hair, and jewelry. The site also includes information on different accidents that may occur in a science lab and how to treat and react to the accident. Some of these described are broken glass, chemical spills, fire, and cuts and scrapes. Finally, the site discusses lab safety equipment such as an eye wash station, safety shower, fire safety blanket, and fire extinguisher. The site also includes research links on chemistry safety if additional information is needed. The site is clear, easy to understand, and appropriate for high-school students.

*Title:* Chemistry Demonstrations and Animation
*URL:* http://www.sde.state.id.us/bots/itv/guide/science/chemistry.htm
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry reactions

*Review:* ITV is a free Web site produced by the Idaho Department of Education. The Chemistry Demonstration and Animation Web page offers a selection of demonstrations, experiments, and animated segments. Chemical concepts that may be complicated and hazardous to illustrate in the classroom are presented on a tape. Some of the experiments are Mercury Determination Using a Spectrophotometer—Accuracy and Precision, An Exothermic Reaction, Energy State and Chlorophyll, and Effects of Temperature and Pressure. This is an excellent source for chemistry students who are interested in learning more about chemical reactions.

*Title:* CHEMistry for Life
*URL:* http://www.chemistryforlife.net/
*Grade Level:* K to 2
*Search Engine:* http://metacrawler.com
*Key Search Words:* chemistry in the classroom
*Review:* CHEMistry for Life is a Web site developed by sixteen European science centers and museums under the title CISU: Chemical Industry Association for Scientific Understanding. Its goal is to present scientific principles and information clearly and accessibly in order to lessen the anxiety people feel about chemistry. The Web page features a Virtual Gallery link where you can click through different corridors for interactive exhibits on topics like ultraviolet rays and sunscreen preparation, acid testing and the use of the pH meter, the distillation process, earthquakes, and more. You can also link on various icons that take you to detailed descriptions on how to conduct experiments on topics such as corrosion, growing crystals, chemistry in an aquarium, and building a battery. There is a fun link called The Crime Lab, which is an interactive workshop dealing with a realistic hit-and-run case in a forensic lab and offers activities at various workstations to investigate the many areas of the crime. Another link called Global Themes provides articles and short films on eight important areas of chemistry, and there is a Teachers Link with more in-depth information on all of this. This site is informative, easy to understand, and fun.

*Title:* Flinn Scientific, Inc.—Flinn Scientific Student Safety Contract
*URL:* http://www.flinnsci.com/home page/safe/contract.html
*Grade Level:* All grade levels
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry safety in schools

*Review:* This Web page gives an excellent sample of chemistry safety guidelines as well as a contract for students to sign and keep on hand so they can refer back to the safety rules at all times. This page also includes a contract for parents to sign before a student is allowed to participate in any laboratory experiment. This is an excellent source for teachers to examine so that they can create their own safety guidelines as well as student contracts. The only downfall with this site is that you have to be a "Flinn Scientific customer" to reproduce this exact contract.

*Title:* Chem Lab Safety
*URL:* http://wwitch.unl.edu/safety/
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chem lab safety
*Review:* The Chem Lab Safety Web site is presented by the Department of Chemistry at the University of Nebraska. It is designed to provide high-school students with the basic guidelines and components of lab safety practices. The site discusses the correct handling of equipment, proper attire in the lab, and how to handle various chemicals. This site is easy to navigate and utilizes an easy-to-follow table of contents. This site also describes how to respond to problems in the lab, such as how to properly dispose of broken glass. A key element that makes this site worthwhile is the use of photographs depicting students using the equipment either correctly or incorrectly. These visual reminders serve to demonstrate the importance of lab safety. This site could serve as a terrific introduction to chemistry safety at the start of the semester. It is a valuable resource that should be an important element of every chemistry classroom.

*Title:* Safety in the Chemistry Laboratory
*URL:* http://chemlabs.uoregon.edu/Safety/GeneralInstructions.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry safety
*Review:* This Web site is designed to inform the public of the different safety features for a chemistry lab. The Web site explains that a laboratory is a place of learning and discovery, but it can also be a place of danger. To mitigate the danger the Web site lists different rules that should be learned. The first set of rules deals with the attire in the laboratory. Some of the rules in this section are wearing safety goggles

at all times, no contact lenses even when wearing goggles, long hair must be tied back, and long pants must be worn. The second section includes the conduct of the students. Some of the rules in this section include no eating, drinking, or smoking in the laboratory and never taste anything. The third and final section explains the proper handling of chemicals and equipment. In this section they inform the reader that all chemicals are hazardous, and you are to always know what chemicals you are using. This is a very beneficial Web site for all people who are going to enter a laboratory. I would suggest that all students working in a school laboratory should read these guidelines prior to entering a laboratory.

*Title:* Safety and Laboratory Rules for Organic Chemistry Laboratories
*URL:* http://www.towson.edu/~sweeting/safeorg.htm#goggles
*Grade Level:* AP high school and college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry safety
*Review:* This on-line service was drafted by L. M. Sweeting and adopted by the Organic Group provided through Towson University. The Safety and Laboratory Rules for Organic Chemistry Laboratories provides fourteen rules. Clicking on key words of the rules listed brings you into specific subcategories of operating procedures, attitudes and preparation, your working environment, glassware, safety equipment, toxic hazards, heat hazards, is there a fire, laboratory electrical equipment, pressure hazards, and waste disposals. This site provides you with direct points of safety in the organic chemistry laboratories. This is a great resource if you are looking for the basic guidelines for safety tips and rules.

*Title:* Flinn Scientific, Inc.
*URL:* www.flinnsci.com
*Grade Level:* All grade levels
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry safety
*Review:* This Web site gives many excellent reminders for safety. This topic of safety is broken into many subtopics, such as laboratory chemical safety, eye and eyewear safety, general laboratory safety, and frequently asked safety questions, and it also highlights safety products available that really work. Each subtopic is broken down even smaller to include various topics such as hazardous chemical storage, preventing chemical spills, and goggle safety. As far as safety goes,

this Web site is a great place to refer to with any chemistry safety questions.

*Title:* Lab and Safety
*URL:* http://www.dist214.k12.il.us/users/asanders/lab.html
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical safety
*Review:* This Web page contains links that will bring you to lab manuals, chemical safety fact sheets, and so on. There is also a link to a database containing over 130 hazardous chemicals that can be searched by names, formulas, and registry numbers. The Web page lists titles of the different sections with hyperlinks. It is very well-organized and easy to use.

*Title:* Table of Contents for the High School Safety WebPages
*URL:* http://wwitch.unl.edu/safety/hslabcon.html
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* high hchool chemistry lab safety
*Review:* This is a Web site created by students at the University of Nebraska at Lincoln that is directed at high-school chemistry students. The main page is a table of contents that contains links to a number of pages of content in a variety of lab safety topics. The pages can be accessed randomly from the table of contents or sequentially through the use of "next page" links at the bottom of each page. Each page contains a concise overview of a topic, including dos and don'ts as well as some humorous photos demonstrating each. It would take a student about a half an hour to review the entire site. Because it does not attempt to present too much information at once, this Web site is a good introduction to laboratory safety that should be appealing to high-school students. However, while the list of topics covered is comprehensive, the depth of coverage is not. Many of the topics would need to be covered in greater detail as the particular hazard was encountered during the year.

### Solids/Tutorials

*Title:* Solids
*URL:* http://pc65.frontier.oshre.edu/hs/science/csolid.htm
*Grade Level:* Grades 9 to 12

*Search Engine:* http://www.google.com
*Key Word Search:* chemistry solids
*Review:* This Web site is part of the Frontier High School Internet Science Room, which features an entire year's worth of general chemistry curriculum available on-line. This Web page starts off with an outline of objectives, followed by a three-lesson tutorial about various crystalline structures and the types of defects commonly found in crystals. Each lesson contains either an in-class group assignment or a homework assignment. At the bottom of the page there is a list of links to be used to assist in completing class and homework assignments. This Web site presents the topic of solids as crystalline structures in a clear and uncluttered way. It is a good introduction to the topic and most likely comprehensive enough to teach a high-school class on the nature of solids.

*Title:* Smile Program Chemistry Index
*URL:* http://www.iit.edu/~smilecheminde.html
*Grade Level:* Elementary through high school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry solids
*Review:* The Smile Program Chemistry Index is designed for elementary to high-school teachers. It is an index of various lesson plans and science experiments which teachers can use in their science classes. The topics are divided into the following categories: Basic Tools, Atomic Structures, States of Matter, Chemical Reactions, and Elements and Compounds. Each lesson plan lists the objective, materials, strategies, and assessment process to be utilized during the lesson. The following experiments were listed in the States of Matter section: Solids, Liquid, or Gas, in which the students had to correctly identify the substance; Introduction to Gas, in which the students were introduced to different definitions; and Frozen Solids, in which the students experimented with solids. Each of these experiments appeared easy to accomplish with a minimum amount of setup time. There were many other lesson plans and experiments listed. Due to the vast number of lessons listed, it may take some time for a teacher to navigate through the site in order to find appropriate material, as there doesn't seem to be a keyword feature included in this site. Overall, though, this site seems to be a very good resource for teachers seeking chemistry lesson plans and experiments, and since the objectives are listed for each lesson, the teacher can quickly determine if the lesson will meet his or her needs.

*Title:* Chem4kids
*URL:* http://www.chem4kids.com/
*Grade Level:* Intermediate to high school
*Search Engine:* www.altavista.com
*Key Search Words:* chemistry for kids + solids
*Review:* This is the best Web site that I have yet come across. It is extremely simple to navigate and packed with loads of pertinent information. All you have to do is find the area of chemistry you are studying and click the "name" icon. This takes you to the topic and offers a range of material on it. If you are unsure what you should choose, you can go to the site map, which gives you an overview of the site, and get specific ideas. If you are just browsing there is a search function on most of the pages. They have over fifty photo-enhanced examples of chemicals and compounds, and quizzes and cool activities. If you are still totally unsure, you just click on the Site Tour icon and every click takes you step-by-step through the site until you find what you are looking for. Chem4kids was started in 1997, and two years later Kapili.com was born. In September of 2001 they launched GEOGRAPHY4KIDS. You can reach these new sites from the Chem4kids site. They even have cool desktop wallpaper that you can download for your computer! This site is great in a classroom or for use at home with homework or projects.

*Title:* Solids, Liquids, and Gases
*URL:* http://www.galaxy.net/~k12/phases/
*Grade Level:* K to 8
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry solids
*Review:* This Web site is designed by the Hands-On Technology Program. On this Web site both students and teachers can utilize the information provided. Both students and teachers will find science experiments and other hands-on activities that will help students become excited about learning science topics such as solids, liquids and gases. All of the experiments are designed so that the children can do them using everyday, inexpensive materials. Some of the experiments include making molecules, moving molecules, the power of ice, a chemical curiosity, and air atoms. Each experiment supplies the student with the required materials and directions needed to complete the experiment. Along with the materials and directions, a worksheet is provided for the students to complete as they work through the experiment. The worksheet is set up in a laboratory report format so

that the students can get an idea of what completing a real laboratory report is like. Once the students have successfully completed the worksheet, a correct and thorough example of the worksheet is available for the students to look at and compare their worksheet to. In addition to these experiments, this Web site provides notes to the teachers and additional references. The teachers' notes provides information on each experiment in case teachers decide to use one of these experiments in their classroom. The references are Web sites that teachers can use to gather information and additional activities for their classroom. Further experiments on the weather, dinosaurs, plants, geometry, and the human body are also available to teachers and students on the home page of this Web site. All in all, this Web site is a great resource for both teachers and students to use. It incorporates fun ways children can learn about a topic in school. Teachers can also get new ideas to use in their classrooms.

*Title:* Net Equation: Your Online Source for Chemistry Equations
*URL:* http://library.thinkquest.org/c004970/main.htm
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry solids
*Review:* Net Equation is an excellent source for many different topics related to chemistry. On the left-hand side of this page is a list of links that lead you to the topics of matter, acid/base reactions, nuclear chemistry, and so forth. Clicking on States of Matter will lead you to a chapter on the four main phases of matter, solids being one of them. If you scroll down you will see a link to Types of Solids. Here, you will read about the five categories of solids. On this page you can also click on the animation to see how a shock to a crystal can offset an arrangement. On the left-hand side of this page, you will see the section navigator. Scrolling down will lead you to Solubilities of Solids. If you click here, you will see a list of compounds (solids), whether they are negative or positive, and whether they are soluble. This is an excellent site for chemistry students needing extra help. This site can also be used as a study guide. One last thing I should note is that this site has a message board that students can use to raise questions and receive answers.

*Title:* Wondernet—Your Science Place in Cyberspace
*URL:* www.acs.org/wondernet
*Grade Level:* Elementary school

*Search Engine:* http://www.google.com
*Key Search Words:* chemistry solids
*Review:* Wondernet is a colorful, kid-friendly, science Web site for elementary-school students. As you enter the Web site, you are greeted by dinosaur cartoon characters. After choosing "activities" you are shown a list of chemistry topics, including chemistry and art, volcanoes, food science, soil, gases, states of matter, and wonders of water. The "states of matter" section includes an elementary-level definition of matter and some information on how matter can change from one state to another. You are then asked to choose a hands-on activity or experiment that further explains the concept. The activity that is related to chemistry solids involves shaving cream and determining if it has the characteristics of a solid, liquid, or gas. There are experiments for many chemistry topics, and they all seem to be easy to perform, safe, appropriate for young students, and include detailed instructions. This is a great Web site for elementary science teachers or parents that want to try some easy experiments at home. The site is very easy to navigate, and due to the colorful cartoon characters and simple language, it would seem to be very appealing to children.

*Title:* ScienceNet—How Do the Particles of Solids, Liquids, and Gases Behave Differently?
*URL:* http://www.sciencenet.org.uk/database/chemistry/structBond/c002205.html
*Grade Level:* Grade 11
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry solids
*Review:* This Web site is helpful if you are looking for a basic description on the structure and bonding of chemistry solids. It seems to be a part of a series of questions and answers. However, only two sections discuss solids, section 3.3 and 3.4, and only briefly do they mention anything about solids. The main gist of the answer is explaining that particles in a solid cannot move freely and that the particles inside the solid vibrate faster the higher it is heated. The other answer focuses on if solids sink or float and a discussion about density follows. If you are looking for a thorough explanation of chemis-try solids this is not the Web site for you. I would not recommend this site.

*Title:* Chemistry Tutor
*URL:* http://library.thinkquest.org/2923/
*Grade Level:* Grades 11 and 12

*Search Engine:* http://www.google.com
*Key Search Words:* chemistry solids
*Review:* This site is best for eleventh and twelfth grade students, and it helps with chemistry homework. It provides topics in chemistry including equations, lab safety, laws, reactions, and an introduction to chemistry. Under each topic there are subtopics. This Web site is very easy to navigate through and is written in easy-to-understand language. There are also pictures and examples you can follow.

*Title:* States of Matter: Solids Liquids, and Gases
*URL:* http://www.itt.edu/~smile/ch9611.html
*Grade Level:* K to 3
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry solids
*Review:* This Web site in beneficial for teachers of grades K to 3. The main topics of the Web site are Objectives, Materials Needed, Strategies, Assessment, Conclusion, and Definitions. The majority of this Web site shows different experiments for different groups of children. In the "strategy" section, an experiment is given and then directly under it are the results that should appear from doing the experiment. The first experiment deals with filling a jar with carbonated soda and adding salt. The results say bubbles should form in the liquid, and then it explains why. The reasoning behind this experiment was that each bubble seen in the soda was a collection of carbon dioxide gas. For the conclusion they discuss matter and the forms of matter, one being solids. This section is followed up by the definition of solids, which according to this Web site is any material or substance that is not a liquid or gas. A solid has a definite shape and volume. This Web site would be suitable for young children because the activities are fun.

*Title:* General Chemistry Topic Review
*URL:* http://chemed.cm.purdue.edu
*Grade Level:* Elementary and high school
*Search Engine:* http:/www.google.com
*Key Search Words:* general chemistry: chemistry solids
*Review:* This Web site comes under the heading General Chemistry Topic Review. Listed on it are about thirty specific chemistry topics, one of which is The Structure of Solids. When you click on this, it takes you to a site titled Categories of Solids Based on the Solid Pack, and three types of solids are discussed: Chrystalline Solids, Amorphous Solids, and Polycrystalline Solids. It goes on to explain that the extent of

how crystalline a solid is has an effect on the physical properties of the solid, and a few examples are described. The second main link takes you to Categories of Solids Based on Bonds that Hold the Solids Together, and solids are classified as either molecular, covelant, ionic, or metallic. These categories are defined simply and clearly with examples, equations, and graphics. On the left side of the Web page is a list of links to click on to for more specific information. They include The Structure of Metals, which has information on nine subjects, such as the Structure of Metals and Other Monatomic Solids and Closest-Packed Structures. There are also links for Unit Cells, a periodic table, and a glossary of chemistry terms. Finally, a link called Cool Applets offers very useful, "cool" applets, with topics such as a Balancing Equations Tutorial, originating from Wake Forest University; Limiting Reagents, from Carnegie Mellon; and VSEPR Theory, from Purdue University. This Web site tackles complex topics in a clear and organized way, and students approaching them for the first time will find this site informative, helpful, and not too intimidating.

*Title:* Smile
*URL:* http://www.iit.edu/~smile/omdex.html
*Grade Level:* K to 12
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemistry solids
*Review:* The Smile Web site is an attractive and colorful Web site, designed to enhance the learning of math and science in elementary and high-school students; through the use of the phemenological approach. This Web site offers over 800 lesson plans available in biology, chemistry, math, and physics. The Web site also gives the user access to six awards and reviews links. These include Education Planet, School International, NSTA Scilinks, Study Web, Big Chalk, and Schoolsnet. Clicking on School International offers the user 38,000 free educational resources reviewed by teachers in the UK. It also offers curriculum guides, free registration, a newsletter, mail zone, search guides, advance search guides, homework helpers, games, and so on. This is Web site is an exceptional resource for students and teachers alike, one that is highly recommended.

**Solubility/Tutorials**

*Topic:* Solubility
*URL:* www.chem4kids.com

*Grade Level:* Grades 5 to 9
*Search Engine:* http://www.msn.com
*Review:* Chem4kids is really the only site I found that breaks solubility down for children so that they can easily understand. The examples given are experiments they can do at home to further understand. We find "solubility" under the heading of Matter. We are first introduced to solutions. This gets kids to visualize a glass of water and then to imagine that we add sugar to that glass of water and stir, and it dissolves. What happens when the sugar dissolves into the water? Now imagine another glass of water, and this time we stir sand into it. The sand just sinks to the bottom and sits there. The sugar-water combo is a solution; the sand-water combo is a mixture. The site then explains what can be in a solution and about solutes, solvents, and concentration. In a step-by-step process we learn exactly how the breakdown works when we are making a solution. Just what happens in that glass of sugar water? We learn the solvent makes room for the solute molecules and how the solute and the solvent interact with each other until the concentration of the two substances is equal throughout the system or glass. Can anything change a solution? Yes, the site tells us scientists use the word "solubility" to describe what this means: the ability of the solvent to dissolve into the solute. Temperature, pressure, and structure are discussed as some of the things that change a solution and affect solubility. We can compare oil and water and our sugar water example, which is an easy enough demonstration to do in class when discussing solubility.

*Title:* Solutions and Solubility
*URL:* http://www.dist214.k12.il.us/users/asanders/sol.html
*Grade Level:* All grade levels
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what is solubility
*Review:* This Web site is a great resource for teachers of all grades that are learning about solubility and solutions. The site begins by having a page with different hyperlinks related to the topic (solubility rules, properties of solutions, solubility and temperature, solubility calculations, and teacher explanations, examples, and exercises). By clicking on any of those hyperlinks you are immediately taken to another Web page with detailed information on the link you have clicked on. What I found to be a great hyperlink to use is the link for teacher explanations, examples, and exercises. This link takes you to a page where you can click on a number of new links to find worksheets and

other information that would be great handouts in your classroom. Another helpful thing about this Web site is that while reading the information on the Web page, if you do not know what a particular science word means, you just have to click on that word and it brings you to a new page with an explanation of what that word is! I think that this is a great Web site to use because not only does it give explanations and questions while on the Web, but it gives you a number of worksheets that you can use in the classroom to help reinforce what you and the Web site have taught!

*Title:* Solubility
*URL:* http://library.thinkquest.org/2690/exper/exp17.htm
*Grade Level:* Grades 4 to 6
*Search Engine:* http://www.google.com
*Key Search Word:* solubility
*Review:* The site describes an experiment you can do at home on solubility. It lists materials, procedures, what to observe, discussion, and advanced discussion. The experiment is simple, pouring salt and water together and flour and water together and observing what happens. The discussion section points out that not everything dissolves in water. The advanced discussion section details polar and nonpolar molecules. This is a good Web site because it is simple. The discussion section explains solubility in terms most children can understand easily.

*Title:* Solubility
*URL:* www.chem.uncc.edu/faculty/murphy/1252/chapter17B
*Grade Level:* Junior high and above
*Search Engine:* http://www.google.com
*Key Search Word:* solubility
*Review:* This is a very simple site. There are no bright colors or interesting graphics. The good part about this site is that the students have choices as to how to view the information. They can either click on the link they need from the table of contents, or they can click on the "start" link and then keep clicking "next" to view everything. The information is not just presented in text. There are diagrams of the soluble materials in the solvents. The choice of searching helps both students who knows exactly what information they need as well as students who are unsure or need everything. Some of the links are Solubility Equilibrium, Solubility Problem, Ion Effect, pH, Precipitation, Separation of Ions.

*Title:* about.com
*URL:* http://chemistry.about.com/c/ht/01/06/How_Bubble_Solution0993665859.htm?iam = dpile&terms = solutions+in+chemistry
*Grade Level:* Elementary school
*Search Engine:* http://www.metacrawler.com
This Web resource is from About.Homework Help: Chemistry. This site is designed for the elementary student and features a recipe: How to Make a Bubble Solution. This would be an excellent resource for an elementary student to create his or her own safe solution. Of greater interest is the vast number of links on this page to other scientific resources. There is a box of links with the title Essentials, which links to items such as the Periodic Table of the Elements, Chemistry How-To Guide, and Chemistry News, as well as many other resources. There is also a long list of links related to chemistry down the side of the page, with other links to Clip Art, Databases, Homework Help, Weird Science, and many more. There are also links to related sites about biology and mathematics. This would be an excellent site for a teacher to bookmark on a classroom computer.

*Title:* Solubility
*URL:* http://chem4kids.com/files/matter_solution.html
*Grade Level:* All grades
*Search Engine:* http://www.aol.com
*Key Search Words:* children, science, solubility
*Review:* This Web site is very informative. It offers a colorful layout and tons of information covering a broad range of science related topics. There is a section on solutions that explains in great detail things such as mixtures, solubility, solvents, and concentration. The language is fairly simple and could be understood by children even in the lower grades. The site is easy to navigate and offers a search box that you can use to look up specific topics or terminology. This site would be beneficial to students studying solutions and would provide them with definitions and explanations of items in this area of science.

*Title:* Hyper-Chemistry on the Web
*URL:* http://library.thinkquest.org/2690/exper/epx17.htm
*Grade Level:* Grades 3 and 4
*Search Engine:* http://www.google.com
*Key Search Word:* solubility

*Review:* This site is one of over 4,000 sites created for the Think Quest Library. While the subject of solubility was what I was particularly looking for on this site, there were several other links to scientific sites created by students. These sites may come in handy in the future. Each have unique features such as interactive periodic tables, experiments, and chemistry links. Once you click on the solubility site, there is a question that asks, "Can all substances dissolve in water?" The two substances used in this experiment were salt and flour. Students are asked to observe what happens when each are separately placed into water. At the end, the site discusses why the salt dissolves and the flour does not. This is an extremely simple experiment, but it can be broadened by trying other objects and substances. It is a clean and easy experiment to do with minimal cost. An advance discussion of polar and nonpolar molecules is offered at the end, with links. Definitely a good site for young chemists!

*Title:* Solubility
*URL:* www.sciencebyjones.com
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* teaching solubility
*Review:* I have used this Web site before for other searches. The site was created by a high-school teacher who has notes on the Web for students and others. When arriving on the site, it gives you many options for topics. Clicking on "solubility," you get the definition of the word, along with other words and definitions associated with solubility. At the end of the page there is an option to click on solubility rules. When entering this section, there are the five rules of solubility followed by a table of solubility test for over 100 ionic compounds. Overall I think that this Web site provides a lot of valuable information for high-school students, maybe even junior high-school students. The information that is present is well stated and easy to follow.

*Title:* Links to Chemistry Experiments, Demonstrations
*URL:* http://www.chemistrycoach.com/Links%20to%20chemistry_experiments.htm#Solutions, Solubility
*Grade Level:* K to 8
*Search Engine:* http://www.yahoo.com
*Key Search Words:* solubility and links

*Review:* This is a site dedicated, like the title says, to chemistry experiments and demonstrations. This is a great source for teachers rather than a student source. The site has a number of links that provide the teacher with a wealth of information on various chem–related topics. The site also contain a section titled Individual Experiments. It is there where you will find a list of twenty or so solutions and solubility experiments that can be performed at home or in the classroom.

*Title:* Solubility
*URL:* http://library.thinkquest.org/2690/exper/exp17.htm
*Grade Level:* Grade 6 and above
*Search Engine:* http://www.google.com
*Key Search Word:* solubility
*Review:* This is an experiment. Can all substances dissolve in water? This Web site gives you the materials needed and the procedure to complete this experiment. You are to put flour and water in one cup and salt and water in another. This experiment demonstrates how the salt dissolves and the flour does not. It then talks about polar molecules and nonpolar molecules. There is an advanced discussion link also. I like this Web site. There are also other links to other experiments. The experiment is broken down so it is easily understandable.

*Title:* Solubility
*URL:* http://www.twinkiesproject.com/solubility.html
*Grade Level:* Grades 10 to 12 and college
*Search Engine:* http://www.google.com
*Key Search Word:* solubility
*Review:* This site cleverly, and quite amusingly, uses a Twinkie to explain the procedure for completing a solubility test. The two pages of information contained here follow the standard scientific format for conducting such a test. Each aspect of the test procedure is described, and color photographs are included for the viewer to see the results. The test information is clearly and concisely identified. The observations are broken down into Before Test, Immediate Results, and Long Term Results. The texture, color, and size of the test samples are explained in each area of observation. Photographs show the actual comparison between the control and the experimental Twinkies. Conclusions are given, as well as possible applications for further use. At the end of the discussion, the authors encourage the viewer to complete his own Twinkie solubility test and share the results with them. Additional

links are provided to view other aspects of the T.W.I.N.K.I.E.S. Project. You really must see this site! It's a uniquely clever approach for conducting a solubility test.

*Title:* Matter, Energy, Machines, Some things dissolve in others and some do not
*URL:* http://www.expage.com/minnesotared
*Grade Level:* Middle school
*Search Engine:* http://www.google.com
*Key Search Word:* solubility
*Review:* I really liked this site, which is very easy to understand. It gives three different experiments to do. One is creating a psychedelic lava lamp, another is a silly soup experiment, and the last is a liquid sandwich. All three use materials that can be found around the house and are very easy to do. What I liked about this site is that after each experiment, it explained what was going on and why things did not dissolve. For example, in the lava lamp, the reason was that oil floats on the water because it is less dense and therefore won't dissolve. It explains concepts in terms that most people will understand. This site also gives links to seventeen other sites. These include lesson plans on solubility and discuss other materials that will or will not dissolve in certain materials, so if you need more information, just click on one of the other sites to find it.

*Title:* Twinkies Project—Solubility Test
*URL:* http://www.twinkiesproject.com/solubility.html
*Grade Level:* Any grade level
*Search Engine:* http://www.askjeeves.com
*Key Search Words:* what is solubility
*Review:* I have searched on a weekly basis for sites that can be utilized by students in elementary school. Every week I come across extensive, sometimes rather boring tutorials on the science topic of the week, which are always informative but definitely over the heads of younger students. Maybe I'm just trying to justify referring any of my classmates to a site called The Twinkies Project. After I discovered this site I wondered who was paying the tuition for these college students. I also thought that some people have too much free time on their hands. I then started to think that if you tried this experiment with a first grader, for the rest of their natural life they would be able to explain what solubility means. For that reason alone I highly recommend this site to anyone.

*Title:* Solubility
*URL:* http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch18/soluble.html
*Grade Level:* Grade 10 through college
*Search Engine:* http://www.google.com
*Key Search Word:* solubility
*Review:* This is a Web site for Purdue University general chemistry. Therefore, I think a sophomore in high school could benefit from this site as well as a university student because it is a wonderful Web site. This is a great site that really breaks down the definition of solubility; for instance, it provides the example of sugar dissolving in a cup of coffee. There are vivid examples breaking down the chemical makeup of bonds and ionic solids. These formulas are shown in an illustration of a beaker. Wonderful examples are given to illustrate and help the student comprehend the breakdown of solids and solubility equilibrium. In addition, there is a section that displays the solubility rules, which is very important if a student needs to conduct experiments or prepare for an exam. Included on this Web site are definitions associated with solubility. On the last page of the Web site there is a chart of soluble salts with the formula breakdowns. In conclusion, this Web site offers a variety of help to a student in high school or a college student. I learned from this site just reviewing it!

*Title:* Solubility
*URL:* http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch18/soluble.html
*Grade Level:* College
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* solubility
*Review:* This Web site is very technical and, at the same time, quite simple. The Solubility Web site covers three areas of solubility: "Why do some solids dissolve in water?" "Solid Equilibrium," and "Solubility Rules." To answer the question of why some solids dissolve in water, this portion begins with the example of sugar in coffee. The example is further broken down into sugar in water and the energy needed to break the molecular bonds. A diagram and the molecular construction, $C_{12}H_{22}O_{11}$, accompany this example. This is about as far as I was able to follow the Web site without having to reread. However, a college student studying solubility would probably have no difficulty reading this site and translating it into useful information. This portion also introduces ionic solids, which are salts. The

site focuses on salts for the remainder of the three topics. A diagram accompanies this discussion of ions and polar solvent molecules. From what I understand, it is a wonderful diagram and explanation, but I think I may have skipped Intro to Solubility and gone straight to AP Solubility. The next section discusses Solid Equilibrium. The section is based on the following: "When solids dissolve in water, they dissociate to give the elementary particles from which they are formed." The terms "saturated solubility" and "solubility" are examined. There are formulas and diagrams, which would definitely be sufficient for a struggling college student. The final section discusses solubility even further, examining patterns found when experimenting with different solubilities. These three aspects are examined: A salt is soluble if it dissolves in water to give a solution with a concentration of at least 0.1 moles per liter at room temperature. A salt is insoluble if the concentration of an aqueous solution is less than 0.001 M at room temperature. Slightly soluble salts give solutions that fall between these extremes. Finally, there is a table including solubility rules for compounds in water. This portion gives a list of soluble salts and one of insoluble salts. It is in the form of a chart, with many chemical formulas listed. Again, this would be helpful for the solubility savvy, but not so much for me. The only problem I had with the Web site was the amount of technical vocabulary. I'm also a big fan of links to other helpful sights, which this Web site did not have. However, diagrams and explanations were as simple and useful as possible.

**Solutions/Tutorials**

*Title:* Solutions Math and Science Tutoring: Framingham, Ashland, Hopkinton, Mass.
*URL:* http://ppscott.tripod.com
*Grade Level:* High school and college undergraduate level
*Search Engine:* http://www.google.com
*Key Search Words:* biology solutions
*Review:* This Web site takes an in-depth look at scientific concepts and methods in the field of biology and life science. The home page is titled "Solutions Tutoring." Under the title, the categories are as follows: Home Biology/Life Science, Chemistry/Earth Science/Physical Science, Math/Algebra, Physics, and Links. Below that is an introduction to and photo of the designer of this site, Peter Scott, who offers his services as a private tutor to students wanting to improve their

math and science skills. I clicked on the category Biology/Life Science, which took me to a page titled "Biology Solutions." The top left-hand column listed a repeat of the categories displayed under the title on the home page. Below that, also in the left-hand column, I found a list of biology links. I clicked on the On-Line Biology Book and was hooked! The table of contents was fantastic—there were sixty terrific chapters! The subjects ranged from atoms to biospheres and mass extinctions. I decided to start at the beginning and clicked on the Introduction, which was revised June 21, 2001. This introductory chapter began with the definition of biology, "the study of life," and went on to demystifying the subject of biology. The author tapped into familiar subject areas like the deciphering of DNA and its relationship to headline-grabbing issues like the O. J. Simpson trial and President Clinton's impeachment trial, noting "The stain does not lie!"—instantly putting even the most intimidated visitor at ease. The definitions and explanations are all easy to follow and help the novice understand even the most difficult concepts. In addition, the introductory chapter was filled with many colorful photos, scales, and even a simple phylogenetic representation of the three domains of life. I especially liked the section that explained the characteristics of living things. M. J. Farabee of the Estrella Mountain Community College hosts the On-Line Biology Book. I'll definitely go back and explore this site! The On-Line Bio Book can be reached directly at http://gened.emc.maricopa.edu and is well worth a visit!

*Title:* MSc in Designing Chemical Solutions (2001–2)
*URL:* http://www.ncl.ac.uk/chemistry/postgrad/msc/msc1.htm
*Grade Level:* Undergraduate and graduate
*Search Engine:* http://www.google.com
*Key Search Words:* chemical solutions in teaching
*Review:* This site "describes how innovation in chemistry can be applied to current everyday issues such as pollution control, in-situ imaging, clean energy conversion, etc., through exploitation of recent advances in synthesis, dynamics, electron transfer, and catalysis. In addition it teaches the basic principles by which modern physical chemistry can be applied to problems of immediate industrial concern, highlights common themes such as electron transfer and photoactivation which are prevalent in many emerging chemical technologies and to expose the underlying principles leading to successful technologies." This Web site will provide a student with a beginning and an understanding of what needs to be taken in order to obtain a degree in chemistry.

*Title:* Creative Chemistry
*URL:* http://www.creative-chemistry.org.uk/funstuff/jigsaw/solutions.htm
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* chemical solutions
*Review:* What a treasure trove of innovative, intriguing, interesting, and inspiring ways to provide "solutions" to difficulties with selected chemistry topic areas . . . or just to have some fun! The Web site opens to a jigsaw puzzle picture of chemical flasks and beakers, in "broken up" format along the side. The object is to assemble the pieces to match the sample photo. Two reassuring aspects to this introductory section, as well as to the entire Web site, are the ever-present option to restart the selected option and the ever-present option to "cheat" (although you will not get the "Congratulations" message at the end, if you choose this option). The first sidebar to be investigated was Fun Stuff Index. From here, the author invited browsers to "Get down (and across) with my interactive Crossword Puzzles." Once selected, the browser could choose to explore interactive crossword puzzles, to solve on-line or to download for later enjoyment. Some of the crossword puzzles were shaped to fit their subjects (e.g., the Chemical Apparatus puzzle was flask-shaped). As each clue was highlighted, the browser could type in the correct response. Other titles of puzzles included in this sections were Hard Rocks, Fossil Fuels, Round Table, Haber Process, Rates of Reaction, Chemical Families, Acids, Alkalis and Salts, and Metals and Ores. Although the "cheat" option was present, most students who had completed study on a topic probably would not need to access the feature. In the next option, the author challenged visitors to "test your nerves against the clock in the Impossible Mission Quizzes (there are three difficulty levels and a choice of Missions)." The levels of difficulty were described as "tame," "normal," and "hideous nightmare," the distinguishing feature being the time allotted to register responses to the five questions posed. The "missions," or subject areas covered, were Acid/Alkali, Metals and Reactivity, and Oil/Air. A scoring feature recorded the number and percentage of correct answers. Under the Activities sidebar was an index of multiple chemical activities. Each activity provided a brief synopsis, optional slide shows/movies, student notes and teacher notes, and a detailed laboratory protocol to follow. (Note: Adobe Acrobat Reader program is necessary to access some of these options and may be downloaded, if necessary.) The pro-

tocols have been safety reviewed, and caution is appropriately suggested where necessary. The following choices are offered: Alien Masks, Anodizing Aluminum (coloring aluminum can segments), Blueprinting (making sun-sensitive paper), Dyeing (using natural sources of pigmentation), Egg Rockets (comparing inflated balloon releases for distances, not speed, traveled), Fingerprinting, Flame Tests, Paints, Urine Analysis (using prepared samples, not donations), and the soon-to-be-released Hideous Slime. Moving on to the GCSE section provided an overview of the Harrogate High School course of study for the AQA Double or Single Award Module Science program. A chart was provided to link an AQA Module number to the Title/Topic, Worksheet, Revision Drill, and Impossible Missions options. (Note: For some of these options, the browser must be Adobe Acrobat and/or Java enabled.) This section was very instructive, while maintaining a "playful" format. The ScI Tune Up Garage option cleverly compared conducting and writing a laboratory protocol with tuning up a car, incorporating planning, obtaining and analyzing phases, as well as an apparatus quiz section, advice sheets and a training exercise. The Periodic Trends section highlighted group and family periodicity. The rest of the options in this section focused on reviewing chemical concepts, using interactive FUN and either a time, or limited number of tries challenge, as central components of their design. Molecular Warehouse enabled browsers to resize, rotate and flip views between wire frame and space-filling motifs of, alkanes, carbon allotropes, trigonal bypyramidal molecules, and isomeric options. The Chemical Breakout Game format was reminiscent of the Pong game set up, with each successful rebound uncovering more and more of the (hidden) periodic table. Just-for-Fun Tetris was just that and could be set at either of two levels: Hi IQ or Normal. The Word Search, Concentration Game, Chemical Hangman, Jigsaw Review, and Slide Puzzle games all sounded reasonably manageable but became intensely competitive when played against time or against fictitious opponents. The last option in this section was entitled Chemical Calculator. Here, the fully functional faceplate of a scientific calculator allowed students to access common chemical constants, calculate root values, ln and logarithmic values, and exponents, to perform complex mathematical operations. In summary, this Web site was a joyful discovery and a lighthearted look at the often intimidating world of chemistry. The variety of modes of presentation, the interactive features, the frequent requests for feedback to the author sprinkled throughout the selections, and the high-

lighting of new and updated portions, kept this well-maintained site as interesting as it was informative.

*Title:* Expert Laboratory Solutions
*URL:* http://www.chemsw.com/13050.htm
*Grade Level:* High school and above
*Search Engine:* http://www.google.com
*Key Search Words:* chemical solutions
*Review:* Expert Laboratory Solutions is a Web site designed by ChemSW (Chemistry Software for Windows). The Web site presents software to provide quick and easy access to over 3,000 standard methods for preparing chemical solutions. In other words, the programs provide tools to calculate or confirm the standard methods for preparing a laboratory solution. On the top of the page, you can click on the "Home" button to get to "products news," and "site directory." If you click on the "about as" button, also located at the top of the page, you get a description of ChemSW as a leading provider of chemistry and laboratory software and related services. Also at the top of the page, you can click on the "products" button, which takes you to a page that offers different software categories: chemical inventory, chromatography, material science, quality control, and so on. Clicking on the "new" button will take you to a list of new software the company has to offer. You also can click on the "contact" button to obtain a form to make comments and to type your information so the company can contact you. The last button is the "search" button, which gives you the opportunity to search the site. If you scroll down to the bottom of the page, you will see a sample of software and you can also download a demo. Right below that, you can see the pricing list and the "add to shopping cart" buttons.

*Title:* CHEMTUTOR
*URL:* http://www.chemtutor.com/solutions.htm
*Grade Level:* High school and above
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* solutions in chemistry
*Review:* This site offers no fanfare, music, or cute little extras. It is straightforward information about selected chemistry topics. What is most beneficial is that it is a quick reference for students having difficulty or needing to understand something basic in an area of chemistry, and it provides easy experiments using typical house items such as eggs, syrup, and milk to demonstrate the concept being reinforced.

The opening page lists the topics and links on the left side, or they can each be accessed simply by continuing to scroll down after reading about a topic. Topics in order are Properties of Solutions, Other Types of Mixtures, Concentration, Dissolving Solids into Liquids, Dissolving Gases into Liquids, Dissolving Liquids into Liquids, Solubility, Colligative Properties, Concentration Math in Stoichiometry, and Math Problems in Concentrations and Solutions. The latter two links were the only links that had their own set of additional links for more information, formulas, or actual problems to work out. This is beneficial to the user because the user is provided with not only the formulas and explanations but also quick quizzes to practice applications. Answer sheets with explanations are also included in these sections. The last link stated provides sublinks to all basic chemistry topics, such as the periodic table, acids/bases, matter, reactions, atom structure, and compounds. The first eight links were easy-to-understand explanations of the topic along with hands-on experiments, rules to follow, safety tips, properties, formulas, and definitions (all terminology/vocabulary is italicized to alert the user to importance). Once the vocabulary was introduced, it was used in later links in context, so if the user jumps ahead to topics, he or she may need to scroll backward to obtain a definition if needed. The bottom of each page of individual topics has a link to return to the home page. The site is user-friendly and easy to navigate through. The information is compact; however, the examples and experiments suggested provide for easy understanding of the concepts.

*Title:* Solutions
*URL:* http://pc65.frontier.osrhe.edu/hs/science/psolut.htm
*Grade Level:* High school and middle school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* solutions, chemistry
*Review:* This time I found a site that is set up for a five-day, course work project. Actually, as I learned later, it is part of a larger site. Right at the top there are links to Day 1, Day 2, Day 3, a lab, a vocabulary test, and a Chemical Reactions WebQuiz, There is also a large vocabulary list of key terms for the week, including simple words such as solution, solvent, solute, concentrated, dilute, saturated, and unsaturated. Scrolling down, one will find a question of the day, definitions and diagrams, tips, a to-do list, and a homework assignment. It is a rather clever setup, and most of the information needed to proceed with the day's lesson is provided. The page continues on like this as the user

scrolls downward to day 2 and day 3. There is one research link to Purdue University, which leads to a review of general chemistry topics. I found that this page was set up for a high school–level physical science class at Frontier High School in Red Rock, Oklahoma. However, middle school physical science teachers might find this an interesting resource. If I were still in a science classroom, I would definitely use it.

*Title:* Solutions—Bubbles
*URL:* http://www.bubbles.com
*Grade Level:* Grade 6
*Search Engine:* http://www.lycos.com
*Review:* This Web site is designed for small children, although I never met an adult that didn't like bubbles, and therefore anyone may enjoy this site. It is geared to teach young children how to make a bubble solution as a science experiment. It gives precise directions, even including the best bubble makers, which are Dawn and Joy dish washing soaps. Professor Bubbles gives three different recipes to try. Professor Bubbles designed this Web site, and in 1992 he won the Stella del Circo/City of Verona Award for creative excellence. He was even on the David Letterman show. This Web site includes everything you always wanted to know about bubbles and more than you need to know. He even includes a list of songs about bubbles. When you click on the song the music plays. The first song is that old favorite by Don Ho, "Tiny Bubbles." Bubbles, bubbles, and more bubbles, this Web site is an excellent experiment for very young children and on a nice, sunny day can be a lot of fun for everyone. So go make bubble solutions with Professor Bubbles.

*Title:* Solution Chemistry
*URL:* http://pc65.frontier.osrhe.edu/hs/science/psolut.htm
*Grade Level:* High school
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* what are chemistry solutions
*Review:* This Web site offers a three-day and one-day lab lesson on chemical solutions. The Web site states the new words the student will learn about. Then it states a goal or question of the day. In addition the Web creator uses pictures to illustrate the process of solutions. Finally the creator gives ideas for homework to give students so the learning does not stop at school, but continues on at home. I would recommend this page for any high school teacher who is going to teach about solutions.

*Title:* ChemFinder.com
*URL:* http//ChemFinder.cambridgesoft.com
*Grade Level:* High school, undergraduate, and graduate
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* chemical solutions
*Review:* ChemFinder.com is a database and Internet-searching Web site. The site offers multiple Web sites where you can find specific databases, purchase software, and other related information. The site has a search area where you can input a chemical name, CAS#, or molecular formula. On the left side of the home page are helpful sections. One section gives instructions on the Web site, a glossary, feedback, a Typos Quiz, and indexed sites. Another section gives you a list of Web sites to join, purchase products, or use databases. This Web site would be useful to a high-school student doing research, a chemistry teacher looking to buy software, or a professional looking for work-related literature. The site is easy to navigate and user-friendly.

*Title:* Science and Mathematics
*URL:* http://geocities.com/thesciencefiles/sciencepg.html
*Grade Level:* Elementary through high school
*Search Engine:* http://www.yahoo.com
*Key Search Words:* science, mixtures and solutions
*Review:* This site is part of the Worsley School Website. The Science and Mathematics portion of this site offers many categories to choose from, including Mathematics, Physics, Space and Astronomy, Biology, Chemistry, Computers, General Interest, Elementary Math and Science, and Science Links. While at this site you can find out definitions and examples of many scientific words, such as solutions; however, this is just the tip of the iceberg. There are some terrific facts, experiments, and other fun stuff to explore, like possible uses for robotic cockroaches. The site has over 2,000 pages of resources, free files, interactive lessons helpful hints and fun activities. This Web site is highly recommended for students, parents, and teachers.

*Title:* Solutions
*URL:* http://www.nhptv.org/kn/vs/scilab7b.htm
*Grade Level:* Middle school and high school
*Search Engine:* http://www.dogpile.com
*Key Search Words:* chemical solutions K–12
*Review:* This site is provided by New Hampshire Public Television. It not only provides an extensive overview of chemical solutions but also

covers the whole subject of chemistry. The site provides areas for teachers and students, including lesson plans. There are thirty thorough sites within this site. These sites range from Chem4kids to an interactive periodic table. This is a valuable resource to teachers and students in the subject of chemistry.

### Stoichiometry/Tutorials

*Title:* Stoichiometry
*URL:* http://www.chemical-stoichiometry.net/tutorial.htm
*Grade Level:* Undergraduate and graduate
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* stoichiometry
*Review:* Upon entering "Chemical Reaction Stoichiometry (CRS) Tutorial, Java Applet, and Resources," the user will see that it is set up in frames. That is, all of the user's choices are located on the left side of the screen. When a choice is made, a new screen will appear to the right, while the left side of the page remains. The first choice on the left is "Introduction—What Is CRS?" This section is the meat of the page and includes a basic definition, an explanation of why it's important, some examples, and a historical background. The rest of the links are "Atom-balance to chemical equations," "A Universal Method (MRM)," "Java Applet JSTOICH," "Outline of CRS applications," "Exercises in CRS," and "Additional Material." This part includes nomenclature, literature cited, and acknowledgments. Please note that Adobe Acrobat Reader must be installed to view these links correctly. Finally, the last section is entitled "CRS Resources," which includes a bibliography and computer software.

*Title:* Stoichiometry
*URL:* http://www.gsu.edu/~mstjrh/stoichiometry.htlm
*Grade Level:* High school
*Search Engine:* http://www.google.com
*Key Search Words:* stoichiometry Web sites
*Review:* This Web site is an Internet based lesson plan for high school chemistry students. The goal of this lesson plan is to teach what stoichiometry is. Calculations, applications, and Internet computer skills will be developed. Students will need calculators to complete the assignments. This lesson is designed for the students to work in teams. There are four Web sites for the students to explore. Upon exploration the student teams are to complete worksheets. An answer key

is provided for the teams to check their work. The Web site begins with the definition of stoichiometry, which is a derivative of two Greek words, *stanchion* (meaning "element") and *metron* (meaning "measure"). It is a chemical reaction and the mathematical part of chemistry. Jeremias Benjaim Richter (1762–1807) wrote the first principles of stoichiometry. This Web site can be a valuable lesson plan for high school chemistry students.

*Title:* From Caveman to Chemist—Stoichiometry
*URL:* http://cator.hsc.edu/~kmd/caveman/projects/stoich/index.html
*Grade Level:* Undergraduate and high school
*Search Engine:* http://www.dogpile.com
*Key Search Word:* stoichiometry
*Review:* The first page of this site is titled, "Would you be interested in a book on caveman chemistry?" and is followed by the word "Stoichiometry," which is located in the center of the page just under the title. To the left, just below "Stoichiometry," you see the subtitle, "The New Hotdogs," and I instantly wondered what this had to do with stoichiometry. Reading further, I discovered that stoichiometry is a long word that "denotes the general process of figuring out how much stuff you need to make something." In the case stated as an example, a nonchemical stoichiometry might be something like this: How many wheels would be needed when building 100 cars? 4 wheels × 100 cars = 400. Simple, right? Well, the designer of this site, Kevin M. Dunn, a professor at Hampden-Sydney College in Virginia goes into great detail to try to simplify the process of stiochiometry. He points out that chemical stiochiometry problems are no more complicated than figuring out that one needs to multiply 4 wheels by 100 cars to get 400 wheels. The difference when figuring chemical stiochiometry problems is to use unit factor analysis and to become familiar with the "Three New Hotdogs." This revelation finally brings me back to an explanation of the subtitle: "Hotdog number one," Mole Ratio (X moles A / Y moles B), "Hotdog number two," Formula Weight (Z grams A / Mole A), and "Hotdog number three," Normal Gas Volume, (24.4 L gas / mole gas). Naturally this made a lot of sense, and not being scientifically minded, I appreciated the effort Professor Dunn had put into simplifying the process. I discovered that the reason a chemist must be aware of stoichiometry is that he must be sure to mix reactants in the proper amounts—especially when dealing with gunpowder or acids! Professor Dunn is also an author and is in the process of writ-

ing two textbooks; both can be accessed on-line, *From Caveman to Chemist* and *Soap, String, Sulfur and Spirits*. First, I checked out the prologue and found quotes from Shakespeare's *A Midsummer Night's Dream* that referenced the need for prologues. After reading the excerpts I clicked on "NEXT>>>" and discovered that Professor Dunn had decided to write this book in the hopes of both motivating and stimulating his students' curiosity about stiochiometry. I found this site to be informative and great for an individual wanting to develop a better understanding of chemical stoichiometry problem solving.

*Title:* "The IrYdium Project" at Carnegie Mellon University, Funded by the National Science Foundation
*URL:* http//ir.chemistry.cmu.edu/irproject/applets.stoich
*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Word:* stoichiometry
*Review:* This is a Web site for college professors teaching chemistry courses. I didn't understand much of what was on it but was attracted to it because my daughter graduated from CMU as a math major! The home page describes the IrYdium Project. It "develops software that can be integrated flexibly into introductory chemistry courses." The home page has links to 1) "Applets" which are defined as a supplements to calculations (for solving a problem) "providing imagery that helps students see beyond a route mathematical procedure." There are nine different applets, one of which is "stoichiometry." Also on the home page are links to: 2) Curriculum, which has virtual lab activities and a description of the educational philosophy of the program, 3) Links—such as curriculum initiatives, organizations and conferences, resources, Educational resources, and for high school teachers, 4) Just for fun—leads to some weird pages such as "Bad Chemistry" and "Bad Rain," 5) Feedback—a place for you to give your name and e-mail address and feedback on any of the applets you used, 6) Sponsors—a list of current and past sponsors, 7) About—names of project leaders, some historical information and a list of papers, articles, and related events. This site can be useful to college professors teaching chemistry and related courses. It appears to be pretty technical.

*Title:* From Caveman to Chemist
*URL:* www.cator.hsc.edu
*Grade Level:* Advanced high school and undergraduate

*Search Engine:* http://www.askjeeves.com
*Key Search Words:* what is stoichiometry
*Review:* This site was developed in 2000 for a Chemistry 104 course at Hampden-Sydney University in Virginia. The page it opens to explains how stoichiometry relates to "Three New Hotdogs"—evidently the next step in solving chemical equations. The site explains stoichiometry in basic, fun terms, so the "caveman" can understand. The three hotdogs refer to the mole ratio, formula weight, and natural gas volume. Each hotdog has an explanation, equations, and good examples for the lost soul or one who is being introduced to the concept. Scrolling down, the next heading is What Is this Good For? which explains why chemists need to know how much "stuff" to use for a particular purpose. Scrollong down more brings you to the heading Yes, but What Is this Mole Thing?, which gives a refresher on mole ratios and a link to the Caveman to Chemist home page, which is an introduction to the course with links to historical landmarks! Going back and scrolling down more is the heading Criteria for Success, which has a link to Unit Factor Analysis (UFA) that has breakdowns of common unit conversions for all new potential chemists (cavemen). This area explains in basic terms and detail the steps for UFA with good examples and exact explanations to solve these kinds of equations. There is a heading on this page, Extending Menu, with an example of What Is the Weight Percentage of Carbon in Glucose? Again, it shows exactly, step-by-step, how to solve this problem. The bottom of the page has a link for a practice quiz for the user to see how he or she is doing, and the "return" link at the bottom of each page brings you back to the site's home page. Easy to navigate through, this site gives excellent basic examples and uses simple and fun terminology to guide the user through the basics of stoichiometry.

*Title:* General Chem Tutorials
*URL:* http//gaia.fc.peachnet.edu/tutor/index3.htm
*Grade Level:* high school/undergraduate/graduate/business
*Search Engine:* http://www.metacrawler.com
*Key Search Word:* stoichiometry
*Review:* The Web site General Chem Tutorials is a resource site where you can choose from multiple of topics, such as rxn stoichiometry, nomenclature, and structure of atoms. After choosing a topic it brings you to another page where again there are multiple of topics to choose from (empirical formulas, the mole and mole mass, and Avogadro's formula). This particular Web site seems to be the most de-

tailed site I have visited to date. Once you are in a specific topic it gives you an array of choices and information, which really can be helpful to the science person. I would definitely recommend and use this site as a resource in chemistry.

*Title:* Stoichiometry
*URL:* http://www.shodor.org/UNChem/basic/stoic/
*Grade Level:* High School and undergraduate college for review
*Search Engine:* http://www.google.com
*Key Search Word:* stoichiometry
*Review:* The topic of stoichiometry can be confusing to the uninitiated student, but this Web site offers a systematic approach to defining and solving its mysteries. The opening page begins by defining stoichiometry as the "accounting method behind chemistry," in order to calculate and solve for mass, mole, or percent composition information from chemical equations. The first main category listed, What Is a Chemical Equation, describes the basic techniques of formula writing. Relevant terms are highlighted and explained in text format and then shown in graphic form. The graphic shows a sample equation that has been labeled with the terms subscript, coefficient, reaction direction, product, and reactant, where appropriate. The second main category, The Mole, defines the term and explains its relationship to coefficients in an equation and gram molecular weights. Next, under the heading of Balancing Chemical Equations, the Law of Conservation of Mass is cited as the underlying basis for balancing equations. A suggested model for balancing equations is presented as an alternative to the hit-or-miss method. The next three main categories, Limiting Reagents, Percent Composition, and Empirical and Molecular Formulas, all utilize the problem-solving approach. Each section begins with a definition of what information is known and then explains, in stepwise fashion, how the desired information can be determined. Sample problems are worked through so that students can observe and monitor the logical thought progression patterns in these calculations. The Density section was very brief, simply stating the formula and definition. The last main category, Concentrations of Solutions, presents definitions of, and differentiations between, molarity and molality, as well as how to convert from one to the other. Colligative properties are introduced and their relationship to solution concentration explained. Practice problems to covert molal solutions to molar (and vice versa), and solve for grams, moles, and/or number of atoms are provided, with answers only a click away. As a sidebar to this site, a

Course Chapter compilation is listed. The choices here include Calculator Fundamentals, Math Review, Basic Concepts, Advanced Concepts, Section Tests (Pretests and Posttests), Useful Materials, and Online Calculators. All are helpful, but this last option was, by far, the most interesting. Available are separate calculators specifically designed to assist with: Redox Reactions, Kinetics, Thermodynamics, Nuclear Decay, Linear Leas Squares, Newton's Method Equation Solvers, Compressability, Units Conversion and Nomenclature! This Web site presented its factual information in clear, systematic format, with concise definitions, a review of the most common stoichiometric relationships and sample problems to solve. Its user-friendly and organized approach should enable most students to finish their computations successfully, in the time it takes to spell s-t-o-i-c-h-i-o-m-e-t-r-y!

**Thermodynamics/Tutorials**

*Title:* Basic Cycles and Components—Thermodynamics
*URL:* filebox.vt.edu/eng/mech/scott
*Grade Level:* High school through college
*Search Engine:* about.com
*Key Search Words:* thermodynamics, cycles and components
*Review:* The Basic Cycles and Components Web site is maintained by Virginia Tech. It offers introductory descriptions and definitions of key terms in chemistry thermodynamics. It is designed primarily for new chemistry students. The site is easy to navigate. The various terms are easily defined in clear and understandable language. Formulas and flowcharts are also used to illustrate the basic concepts. Some of the cycles explored in this Web site were the steam cycle and the refrigeration cycle. Through the use of the flowcharts and formulas it was easy to compare and contrast the elements that create each cycle. This site also provides a guest book for viewers to comment about their experience using the Web site. Initially it took some searching to actually find the link for this site, but it was well worth the effort. This site is basic enough that it can be utilized in the high school classroom.

*Title:* Energy Is Conserved: The First Law of Thermodynamics
*URL:* http://www.cchem.berkeley.edu/~chem130a/sauer/outline/firstlaw.html
*Grade Level:* High school through college
*Search Engine:* http://www.metacrawler.com

*Key Search Words:* chemistry thermodynamics and units
*Review:* This Web site was created by Charles J. Russell and is a part of the Biophysical Chemistry Virtual Classroom at Berkeley College. Russell believes that imagining thermodynamics as a game is the most pleasant way to learn about thermodynamics. Therefore, he set this Web site up as if thermodynamics were a game. The concept behind the game to be played is understanding the patterns of energy change and how these changes relate to the states of matter. Once Russell explains what the game of thermodynamics is all about, he discusses what the first rule, otherwise known as the first law, of thermodynamics is. He discusses the breakdown of energy into various forms such as work and heat and talks about the equations and changes in the states of matter. Russell is very descriptive with his information and provides a lot of definitions to words related to thermodynamics. This Web site is a very helpful resource to students and provides a lot of help information to a very complicated subject, thermodynamics.

*Title:* Thermodynamics
*URL:* www.factmonster.com/ce6/sci/A0848442.html
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* thermodynamics and units
*Review:* The main Web page contains a brief definition of thermodynamics. Also included is a list of links to pages containing an introduction to thermodynamics, and information on each of the three laws (there is no coverage of the zeroeth law). Each linked page has an explanation of a thermodynamic law as well as links to other fact monster pages concerned with supporting topics, many of which contain an explanation of the units involved. For example, the Web page explaining the first law contains links to kinetic gas theory, temperature, heat capacity, and the laws of conservation of energy. Both the temperature and heat capacity pages contain discussion on the units of these properties. In turn, each supporting page contains links to other pages containing information supporting their main topic. This page is part of a true "web" of information. Although this site is comprehensive in the information it presents, it has little of an interactive nature, making it a good reference source but probably not a great instructional tool.

*Title:* Applied Thermodynamics
*URL:* http://taftan.com/thermodynamics/

*Grade Level:* Grade 12
*Search Engine:* http://www.google.com
*Key Search Words:* thermodynamics and units in education
*Review:* This site gives definitions of different terms, laws, and units. This site is not that easy to read, but students can get through it if they take the time.

*Title:* Biological Energy Conversion, Review of Elementary Thermodynamics
*URL:* http://www.life.uiuc.edu/crofts/bioph354/lect3.html
*Grade Level:* College
*Search Engine:* http://www.google.com
*Key Search Words:* thermodynamics and units
*Review:* This site is in lecture format, discussing thermodynamics and the concepts that apply to biochemical systems. If you scroll down a little ways, you will see a link called "Lessons from classical thermodynamics." If you click here, you will learn about the changes in state and reversible process, and be sure to note the formulas. If you click back to the main page, you will see a link to "units and dimensions used in bioenergetics." This link covers energy, substance, electrical charge, gas content, redox span, and light. The main page also brings you to other links related to thermodynamics. If you scroll halfway down the page you will see links to some the famous thermodynamicists, such as Sadi Cornot, Joule, Clausius, and Maxwell. I would not recommend this site to everyone, only those who have a good, solid background in chemistry.

*Title:* Laws of Thermodynamics
*URL:* http://gened.maricopa.edu/bio/bio181/BIOBK/BioBookEner1.html
*Grade Level:* College
*Search Engine:* http://www.yahoo.com
*Key Search Words:* chemistry thermodynamics
*Review:* In this Web site readers learn what different forms of energy exist as. At the top of the page you are able to choose any of the following: Laws of Thermodynamics, Potential vs. Kinetic Energy, Learning Objectives, and Links. In the section, First Law of Thermodynamics, you have the option of clicking on another page, developed by Dr. John Pratte of Clayton State University. This link will bring you to more information covering thermodynamics. In the second section there is information on the second law of thermodynamics. The next section discusses potential and kinetic energy, and this is followed by the learn-

ing objectives. The learning objectives are taken from a biology class. The objective on thermodynamics is "Define Energy; be able to state the first and second laws of thermodynamics."

*Title:* Frank Potter's Science Gems: Physical Science I
*URL:* http://www.sciencegems.com/physical.html#9
*Grade Level:* All grade levels
*Search Engine:* http://www.ixquick.com
*Key Search Words:* thermodynamics and units
*Review:* Frank Potter's Science Gems is a free Web site produced by Frank Potter. This Web page informs you of weekly updated new resources. Currently there are over 12,000 WWW resources provided. This Web page offers you subcategories, including Temperature and Thermal Expansion, Ideal Gases, Heat and the First Law of Thermodynamics, Kinetic Theory of Gases, Heat Engines, Entropy, and the Second Law of Thermodynamics. Clicking on "thermodynamics" provides you links to explore under specific minimum grade levels of K, 3, 6, 9, University, and Graduate. These links provide you with lessons, resources, activities, experiments, software, and virtual labs. Some of these links may provide the connection with Java/Java Applet. Creations, suggestions, and strategies come from a variety of universities all over the United States and Italy. This is a great Web site to plunge into information for different grade levels on how to teach the basic to the most complex ideas about thermodynamics.

*Title:* Thermodynamics
*URL:* www.factmonster.com/ce6/sci/a0848442.html
*Grade Level:* Grades 9 to 12
*Search Engine:* http://www.google.com
*Key Search Words:* thermodynamics and units
*Review:* This Web site is excellent and very thorough. The first thing that pops up on the screen is a definition of thermodynamics. Following this is a list of the different sections on this site: an introduction; the thermodynamic system and its environment; the first, second, and third laws of thermodynamics; and a bibliography. Inside each section, the topic is explored in an easily comprehensible fashion, completely nonthreatening to a student doing research. Yet while the information provided is easily comprehensible, it is also very thorough. I would definitely recommend this site to a high-school student researching thermodynamics.

*Title:* Botany Online: Physical Chemistry—Thermodynamics
*URL:* http://www.biologie.uni-hamburg.de/b-online/e18/18a.htm
*Grade Level:* High school or college
*Search Engine:* http://www.google.com
*Key Search Words:* chemistry thermodynamics
*Review:* This Web site includes basic terms associated with thermodynamics. Some of the terms that are explained are "open and closed system," "surroundings," "exothermic," "endothermic," "entropy," and "free energy." The first and second laws of thermodynamics are thoroughly explained and expressed mathematically. The author relates the second law of thermodynamics to "the phenomenon life with all its aspects like growth, reproduction and evolution." The detailed explanation makes the law easier to understand and more meaningful. The Web site is very clear and well-written and would be a good resource for high-school or college chemistry students.

*Title:* Thermodynamics and Thermal Physics
*URL:* http://www.cchem.berkeley.edu/
*Grade Level:* High school (higher grades) and college
*Search Engine:* http://www.metacrawler.com
*Key Search Words:* thermodynamics in chemistry
*Review:* On the first page of this Web site are eight topics on thermodynamics to click on: 1st Law, 2nd Law, 3rd Law, Chemical Equilibrium, Physical Equilibrium, Diffusion and Sedimentation, Basic Kinetics, and Enzyme Kinetics. When I clicked on 1st Law, The Rationale of the Thermodynamics Game asks two questions: What is this game of Thermodynamics all about? and What is the playing field like? I clicked on the first question and learned that this is the study of the patterns of energy change, specifically energy conversion and the stability of molecules and direction of change. We are given two simple examples of this, one being the different kinds of energies that happen when a brick is knocked off a ledge and hits the ground, such as kinetic, light, sound, and chemical. It goes on to explain that the "playing field" is defined by its system and surroundings, and a simple example of the system that exists when heating a pot of water on the stove is described. The two types of exchanges that occur between the system and surroundings is discussed and, based on this, three kinds of systems—isolated, closed, and open—are described. Different forms of energy, thermodynamic processes, and how energy is broken down are explained and shown through basic equations, such as work = external force $\times$ distance. When I clicked on the 2nd Law,

which is concerned with entropy, it is defined as "a measure of disorder and the belief that the entropy of the universe increases because the energy and volume of a system are constant and every change adds to entropy." Though this seems simple enough, many more detailed definitions and equations on topics such as the carnot heat cycle are provided as this page continues. Unfortunately, when I clicked on the other original six topics included in the heading, the Web pages were not available at that time. However, the sites on the first and second laws of thermodynamics in chemistry were explained as simply and clearly as possible for such a complex and extensive subject. This site would be helpful primarily for college students and possibly advanced high-school students.

# 3
# Supplies

Whether you are looking for a microscope to use in your research or a specific slide necessary for you to help your child do a science activity at home, chemistry supplies and information on the best places to order supplies is a must. This section will focus on chemistry supplies.

*Title:* Carolina Biological
*URL:* http://www.carolina.com/
*Grade Level:* All grade levels
*Review:* Carolina Biological has an on-line catalog that allows you to browse at your leisure. Scroll down the left menu to "chemistry" and click on the link, which will take you to the chemistry section of the catalog. The menu also has supplies for the K–6 science teacher and the middle school or junior high school science teacher. Each item is accompanied by a picture, and a click on the item provides you more information about the item, including the cost and a link to order. This is a very user-friendly way to order supplies from a reputable business.

*Title:* Science Stuff
*URL:* http://www.sciencestuff.com
*Grade Level:* Grade school and middle school
*Review:* At the home page, you will find four links on the left of the page these links are "chemistry," "toys," "environment," and "laboratory." When you click on each link, new subtitles appear. For instance, clicking on "chemistry" provides access to "models and charts."

There also is a sale link on the left of the home page highlighting the items that are reduced in price. This supply house is very limited but worth a look at the sales link.

*Title:* Fisher Science Education
*URL:* http://www.fisheredu.com
*Grade Level:* All grade levels
*Review:* Fisher Science Education is more than a supply catalog. At the home page, the site highlights science news from several the worldwide news sources, including CNN, the *New York Times*, and so forth, and also contains "science fact of the day" and "from my classroom to yours." In addition there are products on sale and products' announced highlights. At the top of the home page are links called "catalog," "teacher resources," and "fisher worldwide," to name three of the many links. When you place your mouse arrow on each of the links, a new sublist appears. Teacher resources have teacher tips, science calendar, science-ed directory, and FAQs. The on-line catalog is extremely easy to use. There are a "browse" button and a "search" window, in which you can type your needs either specifically or generally. For instance, if you type the word "chemistry," you will be provided with a long list of items that are chemistry related. The same shorter list will appear if you type the more specific term "thermometer." Clicking on one of the items in the list brings you to the specific page of the item with a picture and other information. You can order by clicking on the "add to my cart" button. The "science calendar" link is worth a look. It is organized by month and gives you science information on either science inventions or scientists' birth dates per day per month. Clicking on "teacher tips" leads you to a menu listed by discipline (e.g., biology, chemistry). The tips contain demonstration and laboratory activities. The science-ed directory provides you the address and phone numbers of science-related programs, museums, and agencies, listed by state. This Web site is extremely well maintained and will provide you more than supply information.

*Title:* Chemical Online
*URL:* http://www.chemicalonline.com/
*Grade Level:* College
*Review:* This is a Web site that provides good reviews of the chemistry books they sell. Clicking on Buy on Line leads you to a number of dif-

ferent links. The most interesting is the link to LabEx.com, which sells used laboratory equipment. Back at the home page, clicking on the "news and community" link leads you to free software to download, discussion forums, and events calendar. Even though this Web site focuses on industrial chemistry, the books, and news and community are worth a look.

*Title:* Sargentwelch.com
*URL:* http://www.sargentwelch.com/
*Grade Level:* High school and above
*Review:* Sargent Welch and VWR can be found on this Web site. This is the site to use to obtain MSDS (Material Safety Data Sheet) information concerning specific chemicals, which is required by OSHA (Occupational Safety and Hazard Administration). The home page provides links to their complete catalog, safety, grants, correlations, grants, Web partners, MSDS, and sci references. The correlations link provides lists of supplies needed for various curriculum. For instance, there is a "high school" planning list containing the name of the material, the catalog number, and price per unit. This spreadsheet list would come in handy when ordering year to year. There are correlations for high school, middle school, AP biology, ChemCOm, AP environmental listing, Biology: A community Context Materials List, EZ Prep, Science Fair, and Harcourt Brace elementary science books grades 1–5. "Sci references" is a great resource, linking you to general resources, resources by discipline and subject, program and organizational resources, general science educational resources, and newsgroups related to science education. "Web partners" leads you directly to partners in various specific areas, such as Science Links and Ohaus microscopes.

*Title:* Science Kit and Boreal Labs
*URL:* http://www.sciencekit.com
*Grade Level:* Middle school through high school
*Review:* This company claims to be "the leading supplier of science materials and equipment to science teachers throughout the United States." At the home page find links to classroom activities provided in all disciplines, a recommended materials list link that allows you to type in the title of textbook that you are using in order to receive a list of materials that are recommended for use in the activities, and a markbook download containing seating plans and other organiza-

tional tools. You can order a catalog and place an order through their order assistant; however, there is not a catalog available on-line, which is a definite disadvantage of this Web site.

*Title:* Ward's Natural Science Establishment
*URL:* http://www.wardsci.com
*Grade Level:* Middle school, high school
*Review:* Ward specializes in biology, geology, and life/environmental Earth/physics subjects. Ward's catalog is not on-line, but a complete list of subtopics is available by clicking on the subjects at the home page. You can, however, view their new products on the Web by clicking on the "new product" link and clicking on the specific product.

*Title:* Daigger Laboratory Equipment and Supplies
*URL:* http://www.daigger.com
*Grade Level:* High school through college and above
*Review:* Daigger's catalog has to be the easiest and most user-friendly supply-house catalog. You can search the catalog by clicking on the alphabetical keys, or by typing in the name or catalog number in a search window, or by browsing the catalog virtually. They have over 75,000 products in their easy-to-use catalog. If you click on "c" for chemicals, you will be led to a list of science materials all beginning with the letter "c," starting with calculators and ending with chemicals (after cylinders). If you know the name of the chemical that you are searching for, you can click on the first letter of the chemical name or scroll down an alphabetical list of chemicals until you reach your product. Clicking on the product provides you information and ordering prices as well as MSDS sheets.

*Title:* Edmund Scientific Company
*URL:* http://www.scientificsonline.com
*Grade Level:* All grade levels
*Review:* Edmund's Scientific to a scientist is like a candy store to a candy lover. There is the usual catalog by topic link list on the left of the home page. Unique to this site is the Gift Search link, which allows you to search for a science gift by topic or by price. Great idea! At "ten dollars or less" you can buy a drinking bird for only $7.95. For those of you looking for good deals, there is a clearance link. The "tech tips" link is invaluable for hints on using technology equip-

ment. Topics like "how to read a binoculars power" provides the novice with expert advise and information.

*Title:* Educational Innovations, Inc.
*URL:* http://www.teachersource.com/
*Grade Level:* All grade levels
*Review:* "The Master Teacher Source for Science Workshop Supplies" is the goal of Educational Innovations, Inc. The company was started to provide science workshop professionals with one-source shopping for their science supplies. At the home page find links to their extensive catalog as well as a timetable listing of upcoming science shows and conferences at which they will be holding workshops. Their catalog is divided into subjects and topics. A click on the "physical science/chemistry" link leads you to a more specific subtopic index. Because this site was designed for people who do workshops, the prices for the items decrease with the increase of quantity. Usually you order in 1–10, 11–29, and over-30 quantities.

*Title:* Flinn Scientific
*URL:* http://www.flinnsci.com/
*Grade Level:* High School only
*Review:* A great resource site includes links to chemistry, biology, and safety with proven solutions to problems, Flinn freebies, and laboratory design for designing a current laboratory, computer interface technology, and Flinn scientific order maker. I did not find their catalog on-line. I think that you have to download it after clicking on the "order maker" link. This is a definite problem with this site. However, all the other links provide you wonderful resources to use. The "safety" link even has an e-mail conference for use with your science department at departmental meetings. The information provided with the laboratory design link is wonderful and could be useful in order to upgrade a laboratory. Flinn freebies look to be wonderful resources but are only for certified, high school science teachers.

*Title:* Pasco Scientific
*URL:* http://www.pasco.com/
*Grade Level:* Middle school to high school
*Review:* Pasco Scientific have the goal to design, manufacture, and service the highest-quality products for science teachers worldwide. Clicking on "products" leads you to access their catalog on-line. The

catalog is indexed according to subject and topic. You can browse the complete index or type in a topic at the search window. Unique to Pasco is the "experiment central" link. By clicking on either the Data Studio Library or the Science Workshop Library, you can download over 400 experiments total. A click on Chemistry Experiments Grades 9–12 will allow you to download thirty-three chemistry experiments. In order to do so you will need a zip utility drive.

# 4
# Museums, Science Centers, and Summer Programs

Science can be found in general museums and science centers or in specific organizations like nature centers and parks, zoos and aquariums, and planetariums and observatories. This chapter will provide you with links to Web sites that provide directories of these resources with direct links to the site. In addition, the best sites will be reviewed. Science summer programs are usually either locally or nationally supported. Science museums and centers no longer are drab storage areas of objects with signs saying "do not touch" on the objects. Currently they are fun resources for informal learning. They are places to touch, discover, and explore. There are more than 400 science centers and museums around the world. These can be found at the Association of Science and Technology Centers Web site at http://www.astc.org; a review of this site is provided in this chapter. In addition a directory of all-formal science museums/centers, nature centers/parks, zoos/aquariums/aviaries, and planetariums/observatories can be found at the Science Adventures Web site at http://www.scienceadventures.org.

*Title:* Association of Science and Technology Centers
*URL:* http://www.astc.org
*Grade Level:* All grade levels
*Review:* This is a Web site for science museum professionals. It provides you information about the ASTC and also resources for developing exhibits and resource materials for the science museum worker. Even though this part of the Web site is focused on the museum professional, there also is a link to "find a science center," which provides you with a search page where you can search for a science center first

by country then by state. The link will then give you another direct link to the science center plus its address and phone and fax numbers. If you don't want to find a science center but wish to explore, you click on the "click here to explore" link, click on "try science," "parent," "site map" links, or type in a subject in the search window. The "try science" link leads you to live interactive sites that allow you to explore specific topics live. For instance, you can watch the penguins at Montreal Biodome or observe the panoramic view from Mt. Washington. Very cool!

*Title:* Earthcam
*URL:* http://www.earthcam.com/
*Grade Level:* All grade levels
*Review:* This is the reference to use to search for live, real-time science and exploration. The main menu gives you a number of choices for science, including Education Cams, Weather Cams, Space Cams, and Science Cams. When you click on Weather Cam, you are able to access 797 real-time cam sites. You can narrow that number at the search window by typing in your interest or topic or by clicking on one of the ten subject links, including "forecast," "outdoor," "ski and surf reports," "kids," "streaming," "weather," "indoor," "remote control," "news," and "seismograph." The 797 referenced Web sites contain a linking URL and a description of the site. For example, the 150-foot solar tower cam gives you a view from Mt. Wilson, California, high atop the tower. The image is captured every four minutes from the Mount Wilson Observatory. It is a spectacular view! The link provides accurate weather conditions; for instance, the weather today is recorded as clear, calm, and 78° F. The live Web cam has links for you to learn more about research done through the observatory home page at the UCLA Department of Astronomy.

*Title:* Science Adventures
*URL:* http://www.scienceadventures.org
*Grade Level:* All grade levels
*Review:* This site has a vast reference base for over 1,798 links to "museums/science centers," "nature centers/parks and gardens," "zoos, aquariums and aviaries," and "planetariums and observatories." It was developed by the Eisenhower Regional Consortia for Mathematics and Science Education. Clicking on any of these four topics or typing in your own topic at the search window leads you to a list of Web sites alphabetized by state. Clicking on the title of the organization (e.g., California

Science Center) provides you with additional information, including a direct link to the center's Web page, description of the center, contact information including phone number, and other information, including reservation availability and procedures.

*Title:* Exploratorium
*URL:* http://www.exploratorium.edu
*Grade Level:* All grade levels
*Review:* This museum was founded in 1969 by noted physicist and educator Dr. Frank Oppenheimer. The mission of the museum is to "create a culture of learning through innovative environments, programs, and tools that help people to nurture their curiosity about the world around them." It is housed within the walls of San Francisco's Palace of Fine Arts in California. The home page of the Exploratorium offers a myriad of live Web cams, including one that displays a total solar eclipse from Zambia! You can even visit their movable live roof cam or exhibit cam. The Exploratorium is an interesting site to visit to view and understand the latest innovative technology. Its extensive exploration into live Web cams makes this museum unique and worthy of visiting on-line or in person.

*Title:* Educational Outreach at JPL
*URL:* http://eis.jpl.nasa.gov/eao/students.html
*Grade Level:* Middle level through high school
*Review:* This program site of NASA at the Jet Propulsion Laboratories in California provides a list of programs for kids mostly provided via the Internet. Cassini's Kids' Corner is written by kids for kids. Information about the Cassini spacecraft and Saturn is provided, including both easy and advanced model plans of the spacecraft for you to build. Other links include KidSat, the Space Place, and TOPEX/Poseidon Educational Outreach.

*Title:* Wonderama "Explorations in Science Education"
*URL:* http://www.wonderama.org/
*Grade Level:* Ages 5 to 14
*Review:* Wonderama is an East Lansing, Michigan, corporation that provides hands-on summer science programs at low cost to local Community Education Centers. Even though the programs are limited to the Michigan area, you can use their Web site, which provides hands-on experiments, gidgets and gadgets (cheap materials), and links to Student Works.

*Title:* SHARP: Summer High School Apprenticeship Research Program
*URL:* http://mtsibase.com/sharp/
*Grade Level:* High school (at least 16 years old)
*Review:* Every year NASA operates an eight-week summer program for high school students at their Field Installations. Students are selected for their aptitude and interest in science and engineering careers. Eligibility in SHARP includes being at least sixteen years old by the start of the program in June, being a U.S. citizen, completion of two college preparatory mathematics and science courses, strong aptitude and interest in a career in science, engineering, or technology, permanent resident of the state of the Field Installation, willingness to participate in a formal interview, and availability full-time Monday through Friday, forty hours weekly, throughout the entire eight weeks. Field Installations are in California, Texas, Alabama, Ohio, West Virginia, Florida, Maryland, and Virginia. NASA also has a program called SHARP Plus Quality Education for Minorities (QEM) Network, which is highlighted at http://qemnetwork.qem.org/sharpplus.html. This program's goal is to increase the success and participation of minorities in science and is held on participating college campuses; eligibility is based on aptitude and interest in a career in science.

*Title:* Project Seed
*URL:* http://208.209.231.10:8080/portal/Chemistry?PID = acsdisplay.html&DOC = education%5Cstudent%5Cprojectseed.html
*Grade Level:* High school
*Review:* This project, supported by the American Chemical Society, is designed to encourage economically disadvantaged high school students to pursue careers in chemistry. Students apply, and those who are chosen work in research at a participating college. Application form and specifics about eligibility are available at this URL. This Web page can also be reached by accessing the American Chemical Society's home page at http://www.acs.org, and then type in Project Seed in the search window. This will lead you to the Project Seed link that you will click on. This path seemed easier than typing in the long URL for Project Seed.

*Title:* Boston Museum of Science
*URL:* http://www.mos.org/
*Grade Level:* All grade levels

*Review:* This museum has the typical "what's happening," "general information," "store," and "support the museum" links. However, it also has an on-line virtual exhibit link that is worth visiting. Currently the exhibits are the Virtual Fish-Tank, Secrets of Aging, Secrets of the Ice, Messages, Everest, Leonardo, Oceans Alive, Scanning Electron Microscope, Theatre of Electricity, WeatherNet, Dance of Chance, Science Learning Network, and Big Dig Archeology. Most of these are noninteractive but provide great resources on specific topics. Some are local. The WeatherNet link provides current local weather information, including an interactive map.

*Title:* Science Learning Network
*URL:* http://www.sln.org/
*Grade Level:* All grade levels
*Review:* This is an on-line network of people interested in demonstrating a new model of inquiry education. It was founded by the Exploratorium, Boston Museum of Science, the Franklin Institute of Philadelphia, Miami Museum of Science, Science Museum of Minnesota, Oregon Museum of Science and Industry, and each museum's supporting school, and is funded by the National Science Foundation (NSF) and Unisys Corporation. The group expanded to include international museums, including Heureka, the Finnish Science Center, Science Museum of London, New Metropolis Science and Technology Center Netherlands, Science Museum, Japan Science Foundation, Singapore Science Center, and Exploradome in France. You can directly link to the museums. Each museum has developed resources that are shared on-line. To access these, click on the "explore our resources" link. Many of these resources are available in different languages, although the Exploradome in France seems to be only in French.

*Title:* Franklin Institute Science Museum
*URL:* http://sln.fi.edu/tfi/
*Grade Level:* Middle school
*Review:* The Franklin Institute's mission is to promote the public understanding of science. It opened its doors to the public in 1934. It includes the Fels Planetarium, the Mandell Center, the Tuttlemann IMAX Theatre, and the Musser Theatre. In addition to the usual links to the programs, store, and resources, the Franklin Institute has a link called Welcome to my World! Careers in Science and Tech-

nology. Accessing this link brings you to a menu of career choices, including science teacher, geologist, meteorologist, chemist, and computer administrator, for you to explore. For example, you can click on the "chemist" link and spend a day with a chemist. This is a nice career exhibit for younger middle-school students. It also includes links to further explorations in the field of chemistry.

*Title:* The Field Museum in Chicago
*URL:* http://www.fieldmuseum.org/
*Grade Level:* All grade levels
*Review:* The Field Museum's strength is in its research and collections. Objects in Anthropology, Botany, Environmental and Conservation, Geology, and Zoology are only a few of the major links that you can open. When you access any one of these links you are provided with the major research that is currently being done and a brief yet informative description of the research. Usually there is another link for more information. At the home page, you can access some wonderful resources through the education link. Currently programs on environmental rescue and a virtual underwater expedition are being highlighted.

*Title:* Smithsonian Museum of Natural History
*URL:* http://www.mnh.si.edu/
*Grade Level:* All grade levels
*Review:* The strength of this museum, like the Field Museum in Chicago, lies in its research and collections division. There are over 124 million objects and specimens held at the National Museum. In order to search for an object, click on the Research & Collections link at the home page. That leads you to a menu on the left; click on site map. You can then click on the "databases" link, which brings you to Informatics, Collections Databases, Reference Databases, and Bibliographies. The Collections Databases narrows your search to an easier searchable list. If you were interested in fish, you might click on Fish Collection—Online Images. Clicking on an individual fish image leads you to a classification and identification key for that particular fish. For Instance, USNM 00336651 is Genus—Pervagor, Species—Melanocephalus found in the Pacific Ocean off the Island of Tonga in a 1993 expedition. It has the date collected, by whom, on which vessel, and any ecological information. The research and collection component of the National Museum is invaluable for the researcher. They also offer a number of educational programs, some of

which are free. Expedition to the Galapagos is a free program that is connected to the IMAX film *On the Galapagos*. It includes photo journals, video footage, and field notes.

*Title:* National Geographic
*URL:* http://www.nationalgeographic.com
*Grade Level:* All grade levels
*Review:* The National Geographic Web site offers the same quality material that they do in their magazine. There are "map," "kids," "education," "forum," and "live events" links on the home page. Clicking on the "education" link brings you to a list of resources for teachers. The Online Adventures link leads you to searchable windows, in which you type in subject area, type of resource, and grade level. This research tool will help you in finding information, videos, and live programs.

# 5
# Careers

This section concerns careers in science, and lifelong learning and professional organizations are great resources for you to begin your research. Depending upon your age, educational background, and career interest, you will have a vast number of Web sites to chose from. Included in this chapter are the best resources for both upper-level high-school students and college students. These Web sites not only focus on professional organizations but also include societies, federal and state agencies, private companies, and nonprofit groups.

*Title:* Science, Math, and Engineering Career Resources
*URL:* http://www.phds.org
*Grade Level:* Advanced college degrees
*Review:* Sounds like this site is only for people with their doctorate degrees, but that is not the case. In fact, the site contains information for would-be scientists from students in high school to people with advanced degrees. It ranks graduate schools, posts jobs, and allows you to upload your résumé. It also has links to finding employment, graduate school, and career information. The recommended links were impressive sites that were designed by professionals in the field of science, most of whom work at professional organizations such as AAAS, NAS, and so forth. This is a new Web site and worth a look.

*Title:* American Association for the Advancement of Science
*URL:* http://www.aaas.org
*Grade Level:* College and above

*Review:* At the main menu, choose "science careers" at the search window. This takes you to the main career Web site, where you can job search, post your résumé, join a job-alert e-mail group, find out about career fairs, peruse employer profiles and employer links, and obtain advice and perspectives. If you click on to the "advice and perspectives" link, you can obtain help with your résumé and cover letter or you can access past articles on science career advice.

*Title:* American Society of Limnology and Oceanography
*URL:* http://aslo.org/
*Grade Level:* High school and above
*Review:* On the left side of the Web site, scroll down to the Student Information link and click on it. This will provide you with career information including advice on presentations, advice on aquatic science careers, and a career links program. If you go down to the Educational Resources link and click on it, you will then be given a list of resources. Some are at the college level; however, there are a few at the high school level, such as the Strategies for Pursuing a Career in Marine Mammal Science link.

*Title:* Science Career Information for College and High School Students
*URL:* http://www.geocities.com/capecanaveral/hangar/4707/hs-career.html
*Grade Level:* High school and college level
*Review:* At the main menu are general topics in biology, biotechnology, genetics, health, physiology, and virology. Also included in the main menu are topics in undergraduate teaching, technology transfer, science writing, law, bioinformatics, public policy, and science education, and a scientist's guide to traditional and alternative careers. There is a wealth of information for the serious person who is looking for a career move in science or for the high school student to find financial resources and career information on science-related careers.

*Title:* Careers in Science and Engineering
*URL:* http://www.nap.edu/readingroom/books/careers/
*Grade Level:* Focuses on college level but also can be used by high-school students
*Review:* This Web site is produced by the National Academy of Sciences. The main menu gives you links to notices, staff and guidance groups, acknowledgments, notes on how to use the guide, request for comments, and contents. Clicking on "contents" shifts you to a career

guidance index, including "what are your career goals," "how can you meet your career goals," "what survival skills and personal attributes do you need to succeed," "what education do you need to reach your career goals," "how do you get the job that is right for you," and "action points," a bibliography, and a discussion of scenarios. This Web site at first glance seems to be an excellent career development site for the advanced student. However, at the end of the contents list is a list of profiles that would be of benefit to the novice high school student. Profiles include "How does a Geneticist/Molecular Biologist get to be a Patent Lawyer?" and "How does a Research Biologist get to be a high school teacher?" These are personal stories that will appeal to all students of science. This site is personal, interesting, and informative and very well-written. A must for anyone interested in careers in science.

*Title:* Chemsoc.org
*URL:* http://www.chemsoc.org
*Grade Level:* College and above
*Review:* This Web site provides a database of career development training opportunities in chemistry, and links to and reviews of other Web sites regarding chemistry careers. It provides information from England, the United States, and Canada. The home page is rather confusing, but click on either "careers and job center," "weblinks," or "learning resources." At the "learning resources" link, click directly on specific careers. You then can choose from an A to Z career resource list, which includes items such as "brilliant careers" and "choosing a chemistry degree." At the home page again click on "careers and job center" to obtain the latest list of jobs, help with a résumé or application letter, interview techniques, or other opportunities. The "weblinks" link leads you to over 3,000 tried, tested, and reviewed Web sites. This is an excellent resource for the college student and beyond.

*Title:* American Chemical Society
*URL:* http://www.acs.org
*Grade Level:* High school and above
*Review:* Type in the word "careers" at the opening search window. This leads you to another list; click on "careers and jobs." You now either click on JobSpectrum.org or C & EN Classifieds. JobSpectrum.org is the chemistry careers connection and provides the service of posting your résumé for a fee. It also has free information about careers in

chemistry and information on salaries. A click on the C & EN Classifieds provides you access to the Newsmagazine of the chemical world on-line. Scroll to the "career and employment" link on the left of the page and you will have access to the latest articles on careers in chemistry. Very informative and current. Great resource!

*Title:* College and Career Preparation tips for NYC High School Students
*URL:* http://www.fordham.edu/step/dugan/timeline.htm
*Grade Level:* Grades 9 to 12
*Review:* Even though this is specifically for New York City High School students and written by a Fordham career counselor, it is applicable to all high school students. It is general and not focused on science; however, it includes all the necessary materials any student needs for career development. It includes advice for grades 9 and 10, summer between grades 10 and 11, grade 11, summer between grades 11 and 12, fall of grade 12, and spring of grade 12. It is comprehensive, including suggestions for standardized test taking, financial aid and scholarship advice, and links. I praise this site highly and recommend it to any high school student in need of career advice.

*Title:* Usnews.com: Education
*URL:* http://www.usnews.com/usnews/edu/home.htm
*Grade Level:* High school
*Review:* A searchable database reviewing over 1,400 colleges. Includes reports on campuses, financial aid guides, and scholarship information.

*Title:* College Recruiter.com
*URL:* http://www.adguide.com/highschool/
*Grade Level:* High school
*Review:* You can search for a job by choosing a category, location, job level, and type of job. You can post your résumé or go to the career center and ask a question from the experts for free.

*Title:* O*net On line
*URL:* http://online.onetcenter.org/
*Grade Level:* All grade levels
*Review:* O*net on line includes a database for the public in order to find information on skills, abilities, knowledges, work activities, and interests connected to careers and jobs. It is available for over 950 occupations according to the Standard Occupational Classification

system. This Web site helps job seekers find which jobs fit their skills, knowledge, and interests; explore different careers; research the steps necessary to secure their dream job; maximize their earning potential; and, finally, know what it takes to be successful in their chosen field. The site has a low-vision version and a text-only version. The home page allows you to explore "find occupations," "skills search," "related occupations," "snapshot," "details," and "crosswalk." "Find occupations," "related occupations," and "skills search" link you to occupations and related occupations that you identify. "Snapshot" helps you explore a specific occupation through a worker. "Details" and "crosswalk" link you to more information on careers. If you click on "find occupations," you will be led to a search window, where you type in the title of the job. For instance, type in the word "chemist" and click on the "life, physical science, and social science" link, and four job titles appear for you to explore. If you clicked on the "chemists" link, you could either find similar job titles or explore the job in-depth, including skills needed, education needed, and so on. This is an invaluable Web site for any student exploring careers.

# Glossary

**Bookmark**
A Web browser tool used to store URL addresses for the user.

**Boolean Search Strategies (AND, NOT, OR)**
Used to define a search.

**Browser Software**
An aid for using the Internet. Most common are Netscape Navigator (Communicator), and Microsoft Internet Explorer (Explorer).

**Domain or DNS (Domain Name System)**
The last part of the URL, which provides the type of organization and the name of the organization. For example, in the URL http://www.cs.csubak.edu, *cs.csubak.edu* is the DNS; *cs.csubak* indicates the name of the organization, and *edu* indicates the type (educational) of organization.

**Finger**
An Internet tool used to access names of people on other Internet sites.

**FTP (File Transfer Protocol)**
A common method used to move files between Internet sites.

**Gopher**
A program developed in 1991 that became second to the World Wide Web.

**Home Page**
Indicates the main Web page for a business, organization, person, and so on.

**HTML (Hypertext Markup Language)**
Language used to create hypertext documents, which are used on the WWW.

**HTTP (Hypertext Transfer Protocol)**
A protocol used on the WWW.

**Internet**
The worldwide-linked computer network system.

**Keyword**
The word used in a search.

**Link**
An association between two Web sites. Usually the information of one site is "linked" to the information of the other.

**Metasearch Engine (or Multiengine Search)**
A search tool that utilizes multiple search engines.

**Mosaic**
A web browser. Precursor to Netscape Navigator.

**Netscape Navigator**
A web browser. The main author is Mark Andreessen. He and Jim Clark founded Mosaic Communications, which became Netscape Communications Corporation.

**Newsgroup**
A name for discussion groups on Usenet.

**Search Engine**
A tool that allows you to search the WWW.

**Server**
Can refer to a searching program or to the machine it is operating on.

**URL (Uniform Resource Locator)**
An address of a Web site.

**Usenet**
A worldwide system used for discussion.

**Web Site**
The name of the site of a specific URL.

**WWW (World Wide Web)**
A worldwide computer information system of the Internet.

# Index

**About the Author**

JUDITH A. BAZLER is Associate Professor of Science Education in the Department of Curriculum and Instruction at Monmouth University.