

## Appendix A

# Scientific Units: The Metric System

.....

**M**uch of the work chemists do involves measuring — things like the mass, volume, or length of a substance.

Because chemists must be able to communicate their measurements to other chemists all over the world, they need to speak the same measurement language. This language is the SI system of measurement (from the French *Système International*), commonly referred to as the *metric system*. There are actually minor differences between the SI and metric systems, but for the most part, they're interchangeable.

The SI system is a decimal system. There are base units for mass, length, volume, and so on, and there are prefixes that modify the base units. For example, *kilo-* means 1,000; a kilogram is 1,000 grams, and a kilometer is 1,000 meters.

This appendix lists the SI prefixes, base units for physical quantities in the SI system, and some useful SI-English conversions.

## *SI Prefixes*

Use Table A-1 as a handy reference for the abbreviations and meanings of various SI prefixes.

<b>Table A-1</b>		
<b>SI (Metric) Prefixes</b>		
<b>Prefix</b>	<b>Abbreviation</b>	<b>Meaning</b>
Tera-	T	1,000,000,000,000 or $10^{12}$
Giga-	G	1,000,000,000 or $10^9$
Mega-	M	1,000,000 or $10^6$

(continued)

**Table A-1 (continued)**

<b>Prefix</b>	<b>Abbreviation</b>	<b>Meaning</b>
Kilo-	K	1,000 or $10^3$
Hecto-	H	100 or $10^2$
Deka-	Da	10 or $10^1$
Deci-	D	0.1 or $10^{-1}$
Centi-	C	0.01 or $10^{-2}$
Milli-	M	0.001 or $10^{-3}$
Micro-	$\mu$	0.000001 or $10^{-6}$
Nano-	N	0.000000001 or $10^{-9}$
Pico-	P	0.000000000001 or $10^{-12}$

## Length

The base unit for length in the SI system is the *meter*. The exact definition of meter has changed over the years, but it's now defined as the distance that light travels in a vacuum in  $\frac{1}{299,792,458}$  of a second. Here are some SI units of length:

1 millimeter (mm) = 1,000 micrometers ( $\mu\text{m}$ )

1 centimeter (cm) = 10 millimeters (mm)

1 meter (m) = 100 centimeters (cm)

1 kilometer (km) = 1,000 meters (m)

Some common English to SI system length conversions are

1 mile (mi) = 1.61 kilometers (km)

1 yard (yd) = 0.914 meters (m)

1 inch (in) = 2.54 centimeters (cm)

## Mass

The base unit for mass in the SI system is the *kilogram*. It's the weight of the standard platinum-iridium bar found at the International Bureau of Weights and Measures. Here are some SI units of mass:

1 milligram (mg) = 1,000 micrograms ( $\mu\text{g}$ )

1 gram (g) = 1,000 milligrams (mg)

1 kilogram (kg) = 1,000 grams (g)

Some common English to SI system mass conversions are

1 pound (lb) = 454 grams (g)

1 ounce (oz) = 28.4 grams (g)

1 pound (lb) = 0.454 kilograms (kg)

1 grain (gr) = 0.0648 grams (g)

1 carat (car) = 200 milligrams (mg)

## Volume

The base unit for volume in the SI system is the *cubic meter*. But chemists normally use the *liter*. A liter is  $0.001 \text{ m}^3$ . Here are some SI units of volume:

1 milliliter (mL) = 1 cubic centimeter ( $\text{cm}^3$ )

1 milliliter (mL) = 1,000 microliters ( $\mu\text{L}$ )

1 liter (L) = 1,000 milliliters (mL)

Some common English to SI system volume conversions are

1 quart (qt) = 0.946 liters (L)

1 pint (pt) = 0.473 liter (L)

1 fluid ounce (fl oz) = 29.6 milliliters (mL)

1 gallon (gal) = 3.78 liters (L)

## Temperature

The base unit for temperature in the SI system is *Kelvin*. Here are the three major temperature conversion formulas:

Celsius to Fahrenheit:  $^{\circ}\text{F} = (9/5)^{\circ}\text{C} + 32$

Fahrenheit to Celsius:  $^{\circ}\text{C} = (5/9)(^{\circ}\text{F} - 32)$

Celsius to Kelvin:  $^{\circ}\text{K} = ^{\circ}\text{C} + 273$

## Pressure

The SI unit for pressure is the *pascal*, where 1 pascal equals 1 newton per square meter. But pressure can also be expressed in a number of different ways, so here are some common pressure conversions:

1 millimeter of mercury (mm Hg) = 1 torr

1 atmosphere (atm) = 760 millimeters of mercury (mm Hg) = 760 torr

1 atmosphere (atm) = 29.9 inches of mercury (in Hg)

1 atmosphere (atm) = 14.7 pounds per square inch (psi)

1 atmosphere (atm) = 101 kilopascals (kPa)

## Energy

The SI unit for energy (heat being one form) is the *joule*, but most folks still use the metric unit of heat, the *calorie*. Here are some common energy conversions:

1 calorie (cal) = 4.184 joules (J)

1 food Calorie (Cal) = 1 kilocalorie (kcal) = 4,184 joules (J)

1 British thermal unit (BTU) = 252 calories (cal) = 1,053 joules (J)

## Appendix B

# How to Handle Really Big or Really Small Numbers



**T**hose who work in chemistry become quite comfortable working with very large and very small numbers. For example, when chemists talk about the number of sucrose molecules in a gram of table sugar, they're talking about a very large number. But when they talk about how much a single sucrose molecule weighs in grams, they're talking about a very small number. Chemists can use regular longhand expressions, but they become very bulky. It's far easier and quicker to use exponential or scientific notation.

## *Exponential Notation*

In *exponential notation*, a number is represented as a value raised to a power of ten. The decimal point can be located anywhere within the number as long as the power of ten is correct. In *scientific notation*, the decimal point is always located between the first and second digit — and the first digit must be a number other than zero.

Suppose, for example, that you have an object that's 0.00125 meters in length. You can express that number in a variety of exponential forms:

$0.00125 \text{ m} = 0.0125 \times 10^{-1} \text{ m}$ , or  $0.125 \times 10^{-2} \text{ m}$ , or  $1.25 \times 10^{-3} \text{ m}$ , or  $12.5 \times 10^{-4} \text{ m}$ , and so on.

All these forms are mathematically correct as numbers expressed in exponential notation. In scientific notation, the decimal point is placed so that there's one digit other than zero to the left of the decimal point. In the preceding example, the number expressed in scientific notation is  $1.25 \times 10^{-3} \text{ m}$ . Most scientists automatically express numbers in scientific notation.

Here are some positive and negative powers of ten and the numbers they represent:

$$1 \times 10^0 = 1$$

$$1 \times 10^1 = 10$$

$$1 \times 10^2 = 1 \times 10 \times 10 = 100$$

$$1 \times 10^3 = 1 \times 10 \times 10 \times 10 = 1,000$$

$$1 \times 10^4 = 1 \times 10 \times 10 \times 10 \times 10 = 10,000$$

$$1 \times 10^5 = 1 \times 10 \times 10 \times 10 \times 10 \times 10 = 100,000$$

$$1 \times 10^{10} = 1 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10,000,000,000$$

$$1 \times 10^{-1} = \frac{1}{10} = 0.1$$

$$1 \times 10^{-2} = \frac{1}{100} = 0.01$$

$$1 \times 10^{-3} = \frac{1}{1000} = 0.001$$

$$1 \times 10^{-10} = \frac{1}{10,000,000,000} = 0.0000000001$$

## *Addition and Subtraction*

To add or subtract numbers in exponential or scientific notation, both numbers must have the same power of ten. If they don't, you must convert them to the same power. Here's an addition example:

$$(1.5 \times 10^3 \text{ g}) + (2.3 \times 10^2 \text{ g}) = (15 \times 10^2 \text{ g}) + (2.3 \times 10^2 \text{ g}) = 17.3 \times 10^2 \text{ g (exponential notation)} = 1.73 \times 10^3 \text{ g (scientific notation)}$$

Subtraction is done exactly the same way.

## *Multiplication and Division*

To multiply numbers expressed in exponential notation, multiply the coefficients (the numbers) and add the exponents (powers of ten):

$$(9.25 \times 10^{-2} \text{ m}) \times (1.37 \times 10^{-5} \text{ m}) = (9.25 \times 1.37) \times 10^{(-2 + -5)} = 12.7 \times 10^{-7} = 1.27 \times 10^{-6}$$

To divide numbers expressed in exponential notation, divide the coefficients and subtract the exponent of the denominator from the exponent of the numerator:

$$(8.27 \times 10^5 \text{ g}) \div (3.25 \times 10^3 \text{ mL}) = (8.27 \div 3.25) \times 10^{5-3} \text{ g/mL} = 2.54 \times 10^2 \text{ g/mL}$$

## Raising a Number to a Power

To raise a number in exponential notation to a certain power, raise the coefficient to the power and then multiply the exponent by the power:

$$(4.33 \times 10^5 \text{ cm})^3 = (4.33)^3 \times 10^{5 \times 3} \text{ cm}^3 = 81.2 \times 10^{15} \text{ cm}^3 = 8.12 \times 10^{14} \text{ cm}^3$$

## Using a Calculator

Scientific calculators take a lot of drudgery out of doing calculations. They enable you to spend more time thinking about the problem itself.

You can use a calculator to add and subtract numbers in exponential notation without first converting them to the same power of ten. The only thing you need to be careful about is entering the exponential number correctly. I'm going to show you how to do that right now:

I assume that your calculator has a key labeled *EXP*. The *EXP* stands for  $\times 10$ . After you press the *EXP* key, you enter the power. For example, to enter the number  $6.25 \times 10^3$ , you type 6.25, press the *EXP* key, and then type 3.

What about a negative exponent? If you want to enter the number  $6.05 \times 10^{-12}$ , you type 6.05, press the *EXP* key, type 12, and then press the  $\div$  key.

When using a scientific calculator, *don't* enter the  $\times 10$  part of your exponential number. Press the *EXP* key to enter this part of the number.







## Appendix C

# Unit Conversion Method

You'll find that it's often unclear how to actually set up chemistry problems to solve them. A scientific calculator will handle the math, but it won't tell you what you need to multiply or what you need to divide.

That's why you need to know about the *unit conversion method*, which is sometimes called the *factor label method*. It will help you set up chemistry problems and calculate them correctly. Two basic rules are associated with the unit conversion method:

- ✔ **Rule 1:** Always write the unit and the number associated with the unit. Rarely in chemistry will you have a number without a unit. Pi is the major exception that comes to mind.
- ✔ **Rule 2:** Carry out mathematical operations *with* the units, canceling them until you end up with the unit you want in the final answer. In every step, you must have a correct mathematical statement.

How about an example so you can see those rules in action? Suppose that you have an object traveling at 75 miles per hour, and you want to calculate its speed in kilometers per second. The first thing you do is write down what you start with:

$$\frac{75 \text{ mi}}{1 \text{ hr}}$$

Note that per Rule #1, the equation shows the unit and the number associated with it.

Now convert miles to feet, canceling the unit of miles per Rule #2:

$$\frac{75 \text{ mi}}{1 \text{ hr}} \times \frac{5,280 \text{ ft}}{1 \text{ mi}}$$

Next, convert feet to inches:

$$\frac{75 \text{ mi}}{1 \text{ hr}} \times \frac{5,280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in}}{1 \text{ ft}}$$

Convert inches to centimeters:

$$\frac{75 \cancel{\text{mi}}}{1 \text{ hr}} \times \frac{5,280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \times \frac{2.54 \text{ cm}}{1 \cancel{\text{in}}}$$

Convert centimeters to meters:

$$\frac{75 \cancel{\text{mi}}}{1 \text{ hr}} \times \frac{5,280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \times \frac{2.54 \cancel{\text{cm}}}{1 \cancel{\text{in}}} \times \frac{1 \text{ m}}{100 \cancel{\text{cm}}}$$

And convert meters to kilometers:

$$\frac{75 \cancel{\text{mi}}}{1 \text{ hr}} \times \frac{5,280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \times \frac{2.54 \cancel{\text{cm}}}{1 \cancel{\text{in}}} \times \frac{1 \cancel{\text{m}}}{100 \cancel{\text{cm}}} \times \frac{1 \text{ km}}{1000 \cancel{\text{m}}}$$

Stop and stretch. Now you can start working on the denominator of the original fraction by converting hours to minutes:

$$\frac{75 \cancel{\text{mi}}}{1 \cancel{\text{hr}}} \times \frac{5,280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \times \frac{2.54 \cancel{\text{cm}}}{1 \cancel{\text{in}}} \times \frac{1 \cancel{\text{hr}}}{100 \cancel{\text{cm}}} \times \frac{1 \text{ km}}{1000 \cancel{\text{m}}} \times \frac{1 \text{ hr}}{60 \text{ min}}$$

Next, convert minutes to seconds:

$$\frac{75 \cancel{\text{mi}}}{1 \cancel{\text{hr}}} \times \frac{5,280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \times \frac{2.54 \cancel{\text{cm}}}{1 \cancel{\text{in}}} \times \frac{1 \cancel{\text{hr}}}{100 \cancel{\text{cm}}} \times \frac{1 \text{ km}}{1000 \cancel{\text{m}}} \times \frac{1 \cancel{\text{hr}}}{60 \cancel{\text{min}}} \times \frac{1 \cancel{\text{min}}}{60 \text{ s}}$$

Now that you have the units of kilometers per second (km/s), you can do the math to get the answer:

$$0.033528 \text{ km/s}$$

Note that you can round off your answer to the correct number of significant figures. Appendix D gives you details on how to do so, if you're interested. The rounded-off answer to this problem is

$$0.034 \text{ km/s or } 3.4 \times 10^{-2} \text{ km/s}$$

Note that although the setup of the preceding example is correct, it's certainly not the only correct setup. Depending on what conversion factors you know and use, there may be many correct ways to set up a problem and get the correct answer.

Now I want to show you one more example to illustrate an additional point. Suppose that you have an object with an area of 35 inches squared, and you want to figure out the area in meters squared. Again, the first step is to write down what you start with:

$$\frac{35.0 \text{ in}^2}{1}$$

Now convert from inches to centimeters, but remember that you have to cancel inches *squared*. You must square the inches in the new fraction, and if you square the unit, you have to square the number also. And if you square the denominator, you have to square the numerator, too:

$$\frac{35.0 \cancel{\text{in}}^2 (2.54 \text{ cm})^2}{1 (1 \cancel{\text{in}})^2}$$

Now convert from centimeters squared to meters squared in the same way:

$$\frac{35.0 \cancel{\text{in}}^2 (2.54 \cancel{\text{cm}})^2}{1 (1 \cancel{\text{in}})^2} \times \frac{(1 \text{ m})^2}{(100 \cancel{\text{cm}})^2}$$

Now that you have the units of meters squared ( $\text{m}^2$ ), you can do the math to get your answer:

$$0.0225806 \text{ m}^2$$

And if you want to round off your answer to the correct number of significant figures (see Appendix D for details), you get

$$0.023 \text{ m}^2 \text{ or } 2.3 \times 10^{-2} \text{ m}^2$$

With a little practice, you'll really like and appreciate the unit conversion method. It got me through my introductory physics course!



## Appendix D

# Significant Figures and Rounding Off

.....

**S**ignificant figures (no, I'm not talking about some supermodel) are the number of digits that you report in the final answer of the mathematical problem you are calculating. If I told you that one student determined the density of an object to be 2.3 g/mL and another student figured the density of the same object to be 2.272589 g/mL, I bet that you would naturally believe that the second figure was the result of a more accurate experiment. You might be right, but then again, you might be wrong. You have no way of knowing whether the second student's experiment was more accurate unless both students obeyed the significant figure convention. The number of digits that a person reports in his or her final answer is going to give a reader some information about how accurately the measurements were made. The number of the significant figures is limited by the accuracy of the measurement. This appendix shows you how to determine the number of significant figures in a number, how to determine how many significant figures you need to report in your final answer, and how to round your answer off to the correct number of significant figures.

## *Numbers: Exact and Counted Versus Measured*

If I ask you to count the number of automobiles that you and your family own, you can do it without any guesswork involved. Your answer might be 0, 1, 2, or 10, but you would know exactly how many autos you have. Those are what are called *counted numbers*. If I ask you how many inches there are in a foot, your answer will be 12. That is an *exact number*. Another exact number is the number of centimeters per inch — 2.54. This number is exact by definition. In both exact and counted numbers, there is no doubt what the answer is. When you work with these types of numbers, you don't have to worry about significant figures.

Now suppose that I ask you and four friends to individually measure the length of an object as accurately as you possibly can with a meter stick. You then report the results of your measurements: 2.67 meters, 2.65 meters, 2.68 meters, 2.61 meters, and 2.63 meters. Which of you is right? You are all within experimental error. These measurements are measured numbers, and measured values always have some error associated with them. You determine the number of significant figures in your answer by your least reliable *measured* number.

## Determining the Number of Significant Figures in a Measured Number

Here are the rules you need to determine the number of significant figures, or *sig. figs.*, in a measured number.

- ✓ **Rule 1:** All nonzero digits are significant. All numbers, one through nine, are significant, so 676 contains three sig. figs.,  $5.3 \times 10^5$  contains two, and 0.2456 contains four. The zeroes are the only numbers that you have to worry about.
- ✓ **Rule 2:** All of the zeroes between nonzero digits are significant. For example, 303 contains 3 sig. figs., 425003704 contains nine, and  $2.037 \times 10^6$  contains four.
- ✓ **Rule 3:** All zeros to the left of the first nonzero digit are *not* significant. For example, 0.0023 contains two sig. figs. and 0.0000050023 contains five (expressed in scientific notation it would be  $5.0023 \times 10^6$ ).
- ✓ **Rule 4:** Zeroes to the right of the last nonzero digit are significant if there is a decimal point present. For example, 3030.0 contains five sig. figs., 0.000230340 contains six, and  $6.30300 \times 10^7$  also contains six sig. figs.
- ✓ **Rule 5:** Zeroes to the right of the last nonzero digit are *not* significant if there is not a decimal point present. (Actually, a more correct statement is that I really don't know about those zeroes if there is not a decimal point. I would have to know something about how the value was measured. But most scientists use the convention that if there is no decimal point present, the zeroes to the right of the last nonzero digit are not significant.) For example, 72000 would contain two sig. figs and 50500 would contain three.

## Reporting the Correct Number of Significant Figures

In general, the number of significant figures that you will report in your calculation will be determined by the *least* precise measured value. What values qualify as the least precise measurement will vary depending on the mathematical operations involved.

### Addition and subtraction

In addition and subtraction, your answer should be reported to the number of decimal places used in the number that has the fewest decimal places. For example, suppose you're adding the following amounts:

$$2.675 \text{ g} + 3.25 \text{ g} + 8.872 \text{ g} + 4.5675 \text{ g}$$

Your calculator will show 19.3645, but you are going to round off to the hundredths place based on the 3.25, because it has the fewest number of decimal places. You then round the figure off to 19.36.

### Multiplication and division

In multiplication and division, you can report the answer to the same number of significant figures as the number that has the *least* significant figures. Remember that counted and exact numbers don't count in the consideration of significant numbers. For example, suppose that you are calculating the density in grams per liter of an object that weighs 25.3573 (6 sig. figs.) grams and has a volume of 10.50 milliliters (4 sig. figs.). The setup looks like this:

$$(25.3573 \text{ grams}/10.50 \text{ mL}) \times 1000 \text{ mL/L}$$

Your calculator will read 2414.981000. You have six significant figures in the first number and four in the second number (the 1000 mL/L does not count because it is a exact conversion). You should have four significant figures in your final answer, so round the answer off to 2415 g/L. Only round off your final answer. Do not round off any intermediate values.

## Rounding Off Numbers

When rounding off numbers, use the following rules:

- ✓ **Rule 1:** Look at the first number to be dropped; if it is 5 or greater, drop it and all the numbers that follow it, and increase the last retained number by 1. For example, suppose that you want to round off 237.768 to four significant figures. You drop the 6 and the 8. The 6, the first dropped number, is greater than 5, so you increase the retained 7 to 8. Your final answer is 237.8.
- ✓ **Rule 2:** If the first number to be dropped is less than 5, drop it and all the numbers that follow it, and leave the last retained number unchanged. If you're rounding 2.35427 to three significant figures, you drop the 4, the 2, and the 7. The first number to be dropped is 4, which is less than 5. The 5, the last retained number, stays the same. So you report your answer as 2.35.



# Index

## • A •

- accidents, nuclear power plants, 78
- acetone, 245
- acetylene (ethyne), alkyne
  - hydrocarbon, 240
- acid deposition, 290
- acid ionization constant, 199
- acid rain, 209, 290, 297–300, 307–308
- acid-base reactions, 201
- acidosis, 208
- acids
  - amphoteric, 201–202
  - antacids, 209–210
  - Arrhenius theory, 195–196
  - blue litmus testing, 203
  - Bronsted-Lowery theory, 196–197
  - carboxylic, 243–244
  - concentration, 197
  - diprotic, 198
  - ethanoic, 243
  - formic, 243
  - household sources, 194
  - indicators, 202–203
  - macroscopic view, 193–194
  - methanoic, 243
  - microscopic view, 195–197
  - monoprotic, 198
  - neutral litmus testing, 203
  - neutralization reaction, 195
  - pH scale, 205–209
  - strength, 197
  - strong varieties, 197–198
  - titration procedure, 203–204
  - weak varieties, 199–200
- activation energy, 80, 123
- activity series, common metals, 128
- actual yield, 173
- addition, 334, 343
- addition polymers, 261–265
- additives, gasoline, 254–255
- aerobic bacteria, water pollution, 310
- aftershaves, consumer chemistry, 281–282
- agents, 150–151
- agriculture, 309–310
- air conditioners, 292–293
- air pollution, 289–300
- airplane glue, methyl ethyl ketone, 245
- alcohols, 242–243
- aldehydes, 244–245
- alkali metals, 60, 62–63, 86
- alkaline earth metals, 60, 62–63
- alkaloids, naturally occurring amines, 246
- alkalosis, 208
- alkanes, 232–238, 249
- alkenes, 239–240, 249
- alkynes, 240
- alloys, 102
- alpha emission, 69
- alpha particle, 69
- aluminum cans, electrochemistry use, 147
- aluminum chlorohydrate, 279
- amberggris, perfume ingredient, 282
- amides, 246
- amines, 246
- ammonia, 113–114, 277
- amphetamines, amines use, 246
- amphoteric, 201–202
- amphoteric surfactant, 272
- anaerobic bacteria, water pollution, 311
- analytical chemistry, 10
- analyzation, chemist activity, 13
- angular momentum quantum number,
  - 40, 41–43
- anionic surfactant, 272
- anions, 51, 90–91, 128
- anode, 157
- antacids, 209–210

- antilog relationship, 207
  - antimatter, 71
  - antiperspirants, 278–279
  - ants, formic acid source, 243
  - applied chemistry, 12
  - aqueous solution, 127
  - aquifer zone, water recycling, 303
  - Archimedes Principle, volume
    - measurement, 25, 317
  - aromatic compounds, 319
  - aromatic hydrocarbons, 241
  - Arrhenius theory, 195–196
  - art preservationist, chemistry field, 14
  - aspartame, 320
  - asphalt, petroleum refining process, 249
  - aspirin, development history, 287–288
  - astringent, 279
  - atmosphere, air pollution, 289–290
  - atmospheric pressure, 214–216
  - atomic bombs, nuclear fission use, 76
  - atomic mass, 56
  - atomic mass units (amu), 32, 166
  - atomic number, 34, 53, 66
  - atomic structures
    - atomic number, 34
    - Bohr model, 38–40
    - Carbon 12 scale, 32
    - electrons, 32–33, 38–48
    - ions, 33, 50–51
    - isotopes, 49–50
    - mass number, 34
    - neutrons, 32–33
    - nucleus, 33–38
    - positive versus negative charge, 33
    - protons, 32–33
    - quantum mechanical model, 40–44
    - subatomic particles, 31–33
    - valence electrons, 48, 63
  - atomic weight, 34, 56
  - atoms
    - atomic number, 34
    - Carbon 12 scale, 32
    - central, 106
    - counting by weighing, 165–166
    - defined, 20, 31–32
    - electrons, 38–48
    - ions, 33, 50–51
    - isotopes, 49–50
    - mass number, 34
    - normally neutral charge, 33
    - nuclear chemistry component, 66
    - nucleus, 33–38
    - oxidation state, 91–92
    - subatomic particles, 31–32
  - Aufbau Principle, 45–46
  - automobile air conditioners, 292–293
  - automobile batteries, 158–159
  - automobiles, pollution, 307
  - automotive trim, polypropylene, 263
  - Avogadro, Amedeo (Avogadro's Law/number), 167, 222–224, 321
- B •**
- bacterial growth, biochemical reaction, 142
  - Bakelite, formaldehyde use, 245
  - baking soda, formic acid neutralizer, 243–244
  - balancing, 131–134, 152–155
  - barometers, 214–215
  - bases
    - amphoteric, 201–202
    - Arrhenius theory, 195–196
    - baking soda, 243–244
    - Bronsted-Lowery theory, 196–197
    - concentration, 197
    - household sources, 194
    - indicators, 202–203
    - macroscopic view, 193–194
    - microscopic view, 195–197
    - neutral litmus testing, 203
    - neutralization reaction, 195
    - red litmus testing, 203
    - strength, 197
    - strong varieties, 198
    - weak varieties, 201

basic research, 12  
bathrooms, chemicals, 278–286  
batteries, electrochemistry use, 147  
battery cases, polypropylene, 263  
bearings, polytetrafluoroethylene, 265  
benzophenone, sunscreen ingredient, 283  
benzene, 241, 253, 319  
Bequeral, Henri (radioactivity), 319  
beta emission, 69–70  
beta particle, 69  
bicarbonates, antacid, 209  
binary compounds, 103–104  
binary metal hydride, 151  
biochemical reaction, 142  
biochemistry, 10  
biodegradable, 275  
biological oxygen demand (BOD), 310–311  
biotechnology, 10  
bleach, laundry room uses, 276  
blends, gasoline, 252  
blue litmus paper, acid testing, 203  
body powders, consumer chemistry, 280  
Bohr, Niels (Bohr model), 38–40, 321  
boiling point (bp), 18, 186  
boiling point elevation, 186–187  
bomb calorimeter, 161  
bonding  
  coordinate-covalent bond, 196  
  covalent, 89, 99–120  
  electrons, 108  
  hydrogen, 115  
  ionic, 85–87  
  metallic, 102  
  nonpolar covalent, 111  
  polar covalent, 111, 113–114  
bottle caps, 262  
bottles, 263, 266  
Boyle, Robert (Boyle's Law), 217–218  
branched hydrocarbons, 234–235  
branched polymers, 259  
break-even point, nuclear fusion, 81–82  
breeder reactors, nuclear fission use,  
  79–80  
bromine, magnesium, 94–95

Bronsted-Lowery theory, 196–197, 201  
buffers, controlling pH, 208–209  
builders, detergent compound, 274  
buret, 204  
burning, 130  
butane, 133–134, 234, 248–249

## • C •

calcium hydrogen phosphate, 278  
calcium sulfide, depilatory ingredient, 286  
calcium thioglycolate, depilatory, 286  
calculators, using, 335  
calorie (cal), 29–30, 161, 332  
Carbon 12 scale, atomic mass units, 32  
Carbon 14, radioactive dating uses, 74  
carbon tetrachloride, 238  
carbonates, antacid, 209  
carboxylic acids, 243–244  
carpeting, polypropylene, 263  
catalysts, 143–145  
catalytic converters, 255  
catalytic cracking, petroleum, 249–251  
catalytic reforming, refining process, 251  
cationic surfactant, 272  
cations, 50, 69, 88–92  
cellulose (wood), 258–259  
Celsius (C) scale, temperature, 28–29  
centi (c), SI system, 22  
central atom, 106  
chain reactions, nuclear fission, 75–76  
chalk, toothpaste ingredient, 278  
Charles, Jacques (Charles's Law), 219–220  
chemical bond, 27, 89  
chemical change, 9  
chemical equations, 122  
chemical properties, 23  
chemical reactions  
  activation energy, 123  
  balancing, 131–134  
  balancing by inspection, 132  
  burning butane, 133–134  
  catalysts, 143–145  
  chemical equations, 122

- chemical reactions (*continued*)
  - chemical equilibrium, 134–136
  - chemical kinetics, 140–145
  - coefficients, 122
  - collision theory, 123–126
  - combination, 126–127
  - combustion, 130
  - concentration of the reactants, 141
  - decomposition, 127
  - defined, 9
  - double displacement, 129–130
  - dynamic chemical equilibrium, 135
  - endothermic, 123, 125–126
  - equilibrium constant, 135–136
  - exothermic, 123–125
  - Haber process, 131–136
  - heterogeneous catalysis, 143–144
  - homogeneous catalysis, 144–145
  - intermediate compounds, 124
  - limiting reactants, 174–175
  - mechanism, 124
  - metathesis, 129–130
  - mole concepts, 169–175
  - nature of the reactants, 140–141
  - neutralization, 130
  - particle size of the reactants, 141
  - percent yield, 173–174
  - precipitation, 129
  - pressure of gaseous reactants, 141
  - products, 122–123
  - reactants, 122–123
  - reactive site, 124
  - redox, 131
  - reduction-oxidation, 131
  - single displacement, 127–128
  - stoichiometry, 171–173
  - synthesis, 121
  - temperature influence, 142–143
  - transition state, 124–125
- Chemical Rubber Company (CRC) Handbook*, 226
- chemistry nerds, 321–324
- chemists, 12–14
- chlorine, 45, 85–87
- chlorofluorocarbons, ozone, 292–293
- chloroform, halogenated hydrocarbon, 238
- chrome bumpers, electrochemistry use, 147
- chrome plating, water pollution, 307
- chromium compounds, water pollution, 307
- cinnamates, sunscreen ingredient, 283
- civetone, perfume ingredient, 282
- classification, 53
- Clean Air Act of 1970, 254–255, 297
- Clean Water Action Plan of 1998, 306
- cleaners, kitchen chemistry, 277
- Cobalt-60, gamma radiation emitter, 70
- coco butter, skin softener, 279
- codes, plastic recycling, 269
- coefficients, 122, 132, 134
- cold cream formulation, 279
- colligative properties, 186–190
- collision postulate, 213
- collision theory, 123–126
- colloids, 191
- colognes, consumer chemistry, 281–282
- colors, 24, 39
- combination reactions, 126–127
- combined gas law, 221–222
- combustion reactions, 130, 161–162
- combustion, redox reaction, 147
- components, book sections, 3–5
- composition postulate, 212
- compounds
  - binary covalent, 103–104
  - counting by weighing, 165–166
  - cycloalkanes, 238
  - defined, 20–21
  - detergents, 274
  - empirical formula, 168–169
  - fixatives, 281–282
  - formula weights, 166
  - intermediate, 124
  - ionic, 94–97
  - isomers, 106, 234
  - macromolecules, 257

molecular weight, 166  
 percentage composition data, 168  
 concentrated, 179  
 concentration, 197  
 concentration units, 179–185  
 condensation, 18, 19  
 condensation polymerization, 266–268  
 condensation polymers, 266–268  
 condensed structural formulas, 110  
 condenses, 302  
 conductivity tester, 97–98  
 consumer chemistry, 271–286  
 containment, nuclear fusion control, 81  
 conversions  
   calorie (cal)/joule (J), 30  
   Fahrenheit/Celsius scales, 29  
   SI system to English, 22–23, 330  
 coordinate-covalent bond, 196  
 corrosion inhibitors, 274  
 counted numbers, 341  
 counting, by weighing, 165–166  
 covalent bonding, 89  
 covalent bonds, 99–116  
 covalent compounds, 166  
 covalently bonded, 51  
 creams, consumer chemistry, 279  
 crenation, 190  
 crisscross rule, ionic compounds, 95–96  
 critical mass, nuclear fission, 75–76  
 Crosslinked polyethylene (CLPE), 261–262  
 crosslinked polymers, 259  
 crystal lattice, 16  
 cubic meter, measurement unit, 331  
 Curie, Marie (radioactivity), 322  
 cycloalkanes, 238

## • D •

Dalton, John (atomic theory), 322  
 Dalton's Law, 225–226  
 Daniell, John Frederic (Daniell cells),  
   156–157  
 decomposition reactions, 127

dehydration reaction, 245  
 delocalized, 241  
 denaturing, 242  
 density, 25–26  
 deodorants, consumer chemistry, 278–279  
 depilatories, consumer chemistry, 286  
 deposition, 19  
 detergents, 274–275, 277, 284  
 deuterium, 49, 80  
 diatomic, 100, 151  
 diatomic molecule, 100  
 diesel fuel, petroleum refining process, 249  
 diethyl ether, 245  
 dilute, 179  
 dipole-dipole interaction, 115  
 diprotic acids, 198  
 direct electron transfer, 155  
 direct relationship, 219  
 dishwashing detergents, kitchen, 277  
 disinfectants, amines use, 246  
 dispersion force, intermolecular force, 115  
 dissociates, 198  
 distillation, 248  
 disulfide bonds, 283, 286  
 division, 334–335, 343  
 double displacement reactions, 129–130  
 drink glasses, polystyrene, 264  
 drinking water, treatment methods, 314  
 dry ice, sublimation process, 19  
 ductile, 57  
 dyes, 246, 285  
 dynamic chemical equilibrium, 135

## • E •

educators, chemistry field, 14  
 egg cartons, polystyrene, 264  
 elastomers, polymer classification, 260  
 electricity  
   conductivity tester, 97–98  
   electrochemistry use, 147  
   nuclear power plants, 77–79  
   positive versus negative charge, 33

- electrochemical cells, 155–159
- electrochemistry
  - combustion reactions, 161–162
  - electrochemical cells, 155–159
  - electroplating, 159–160
  - LEO goes GER phrase, 150
  - oxidation rules, 151–152
  - redox reactions, 148–155
- electrodes, 156
- electrolytes, 51, 97–98, 160
- electrolytic cells, 159–160
- electromagnetic spectrum, 39
- electron capture, 71
- electron clouds, 40
- electron configurations
  - alkali metals, 62–63
  - alkaline earth metals, 62–63
  - bromide anion, 94–95
  - bromine, 94
  - chlorine, 48, 86
  - halogens, 62–63
  - magnesium, 94
  - magnesium cation, 94
  - noble gases, 62–63
  - oxygen, 46
  - sodium, 86
- electron-dot formulas, 101, 106–108, 110
- electronegativity, 111
- electron-pair geometry, 117
- electrons, 32–33, 38–48, 63, 66, 87, 108
- electroplating, 159–160
- electrostatic attraction, 89
- electrostatic precipitators, 299
- elements
  - atomic number, 34
  - defined, 20
  - electronegativities, 111–113
  - isotope representation, 66
  - mass number, 34
  - periodic table (illustrated), 54–55
  - periodic table arrangements, 56–64
  - table of, 35–37
- emollients, skin softeners, 279
- empirical formula, 105, 168
- emulsion, 279
- end note, perfume mixtures, 282
- endothermic, 123, 125–126
- energy
  - activation, 123
  - conversions, 332
  - defined, 26
  - electromagnetic spectrum, 39
  - heat versus temperature, 29–30
  - kinetic, 26–27, 82, 123
  - Law of Conservation of Energy, The, 27
  - measurement methods, 27–30
  - potential, 27
- energy level diagram, electrons, 45–47
- energy levels, 39, 43–44
- environmental chemist, 14
- Environmental Protection Agency (EPA), 306
- enzymes, detergent compound, 274
- equations
  - balancing the nuclear reaction, 67
  - burning butane, 133–134
  - chemical, 122
  - combination reactions, 126–127
  - combustion reactions, 130
  - decomposition reactions, 127
  - density of a substance, 24
  - double displacement reactions, 129
- electron capture, 71
- Fahrenheit/Celsius conversions, 29
- Haber process, 131–136
- ideal gas, 224–225
- ionic, 128
- net-ionic, 150–151
- neutralization reactions, 130
- positron emission, 70
- precipitation reactions, 129
- radioactive half-life, 73
- Radon-222 (Rn-222), 69
- redox reactions, 131
- single displacement reactions, 127–128
- sublimation, 19

water from gas to solid, 18  
 water from solid to liquid, 18  
 equilibrium constant, 135–136  
 equilibrium system, 136–140  
 esters, 244  
 ethanoic acid, 243  
 ethanol, 243  
 ethers, 245–246  
 ethyl alcohol, 242  
 ethyne (acetylene), 240  
 eutrophication, 309  
 evaporates, 302  
 exact numbers, 341  
 excite state, 39  
 exothermic, 123, 124–125  
 expanded structural formula, 233–234  
 experiment, 11  
 exponential notation, 333–334  
 extensive properties, 24  
 eye shadow, consumer chemistry, 280–281

## • F •

face powders, consumer chemistry, 280  
 factor label method, 337–339  
 Fahlberg (saccharin), 320  
 Fahrenheit (F) scale, temperature, 28–29  
 families. *See* groups  
 Faraday, Michael (electrochemistry), 322  
 ferric ion, 97  
 fibers, polymer classification, 260  
 Fiedler-Weiss, Dr. Virginia (Minoxidil), 320  
 fillers, detergent compound, 274  
 filtering, drinking water treatment, 314  
 fission, 75  
 fissionable, 75  
 fixatives, perfume compounds, 281–282  
 flashlight cells, 157–158  
 food wraps, 261  
 force postulate, 213  
 forces, 115  
 forensic chemist, 14  
 formaldehyde, 242, 245

formic acid, 243  
 formula weights, 166  
 formulas  
   condensed structural, 110  
   covalent bonds, 104–110  
   defined, 94  
   electron-dot, 101, 106–108  
   empirical, 105, 168–169  
   expanded structural, 233–234  
   KISS principle, 106  
   Lewis, 101, 108–110  
   molecular (true), 105–106, 233–234  
   structural, 106–110, 233–234  
   temperature conversions, 331  
   toothpaste, 278  
   true (molecular), 105–106  
 fossil fuels, 289  
 fractional distillation, petroleum, 248–249  
 fragment, 82  
 freezing, 18, 19  
 freezing point (fp), 19, 187  
 freezing point depression, 187–188  
 Freon-12, chlorofluorocarbons, 292–293  
 freons, halogenated hydrocarbon, 238  
 Frey, Art (sticky notes), 320  
 functional groups, 242–246  
 fusion, 80  
 fusion torch, 82

## • G •

gain of electrons, 149  
 gain of hydrogen, 150  
 gain of oxygen, oxidation component, 149  
 galvanic cells, 155–156  
 gamma emission, 70  
 gas, water physical state, 114  
 gaseous diffusion, 226–227  
 gaseous pressure, reactants, 141  
 gases  
   atmospheric pressure, 214–216  
   Avogadro's Law, 222–224  
   Boyle's Law, 217–218

gases (*continued*)

Charles's Law, 219–220  
 combined gas law, 221–222  
 Dalton's Law, 225–226  
 gaseous diffusion, 226–227  
 Gay-Lussac's Law, 220–221  
 Graham's Law, 226–227  
 greenhouse, 293–295  
 ideal, 214  
 ideal gas equation, 224–225  
 Kinetic Molecular theory of Gases, 211–214  
 laws, 216–227  
 microscopic view, 211–214  
 noble, 61  
 state of matter, 17  
 stoichiometry, 225  
 gaskets, silicones, 268  
 gasohol, 243  
 gasoline, 249, 252–255  
 Gay-Lussac, Joseph-Louis (Gay-Lussac's Law), 220–221  
 geometry, molecular, 117  
 global warming, 294–295  
 gold, pure substance, 20  
 Goodyear, Charles (rubber vulcanization), 318  
 Graham, Thomas (Graham's Law), 226–227  
 gram (g), SI system, 22  
 greases, petroleum refining process, 249  
 greenhouse effect, air pollution, 293–295  
 grocery bags, 261  
 ground state, 39  
 groundwater, water recycling, 303  
 groups (families), 60–63

## • H •

Haber process, 131–136  
 hair care, consumer chemistry, 283–386  
 hair spray, ozone depletion, 291–293  
 half-life, 71–74  
 half-reactions, 148  
 halogenated hydrocarbons, 238  
 halogens, 60, 62–63

heat capacity, water, 304  
 heat of vaporization, water property, 305  
 heat versus temperature, 29–30  
 heating oil, petroleum, 249  
 heavy metals, water pollution, 306–307  
 helium, isoelectronic with hydrogen, 100  
 hemolysis, 190  
 heterogeneous catalysis, 143–144  
 heterogeneous mixtures, 21  
 high-density polyethylene (HDPE), 261–262  
 historical work preservationist, 14  
 homogeneous catalysis, 144–145  
 homogeneous mixtures, 21  
 Hula-Hoop, high density polyethylene, 262  
 Hund's Rule, 46  
 hydrated aluminum chloride, 279  
 hydration, 240  
 hydrocarbons, 232–241  
 hydrogen, 20–21, 49–50, 100–101  
 hydrogen bomb, nuclear fusion use, 80  
 hydrogen bonding, 115–116  
 hydrogen bonds, water properties, 303–305  
 hydrogen fluoride, 113–114  
 hydrogen peroxide, hair bleach use, 285  
 hydrogenation, 240  
 hydrologic cycle (water cycle), 302–303  
 hydrophilic, 272  
 hydrophobic, 272  
 hydroxides, antacid, 209  
 hypertonic, 190  
 hypothesis, 11  
 hypotonic, 190

## • I •

ice, 16, 17, 304  
 ideal gas, 214  
 ideal gas equation, 224–225  
 inch, English system, 23  
 indicators, 202–205  
 indirect electron transfer, 156  
 indole, perfume ingredient, 282  
 indoor-outdoor carpeting, 263  
 industrial research chemist, 14  
 Industrial Revolution, 289–290



industry, 306, 307, 310  
 infectious agents, water pollution, 308  
 ingredient, 21  
 inner transition metals, 64  
 inorganic chemistry, 10–11  
 inorganic compounds, naming, 96  
 insulation, polystyrene, 264  
 intensive properties, 24  
 intermediate compounds, 124  
 intermolecular force, 115  
 International Union of Pure and Applied  
   Chemistry (IUPAC) rules, 235–236  
 Iodine-131, beta particle emitter, 69–70  
 ion-electron method, 152–155  
 ion-exchange resin, water softeners, 275  
 ionic bonds, 85–87, 101–102  
 ionic compounds, 94–97, 129, 166  
 ionic equations, 128  
 ionic salts, 51  
 ionically bonded, 51  
 ionize, 82, 195  
 ions  
   anions, 51, 89–91  
   cations, 50, 69, 88–90  
   conductivity tester, 97–98  
   defined, 33, 50, 87–88, 128  
   electron configurations, 51  
   ferric, 97  
   ionic bonds, 85–89  
   ionic compounds, 94–97  
   isoelectronic, 51  
   monoatomic, 51  
   naming conventions, 92  
   oxidation state, 91–92  
   polyatomic, 51, 92–93  
 Iron, electron configuration, 48  
 irregular solids, measuring volume, 317  
 isobutane, branched hydrocarbon, 234–235  
 isoelectronic, 51, 63, 88  
 isomers, 106, 234–235  
 isooctane, octane rating scale, 252–253  
 isopropyl alcohol, 242  
 isotonic, 190  
 isotopes, 49–50, 66–75

## • J •

jet fuel, petroleum refining process, 249  
 joule (J), SI system, 30, 332

## • K •

Kekule, Fredrich (benzene structure), 319  
 Kelvin (K) scale, temperature, 28–29, 331  
 kerosene, petroleum refining process, 249  
 ketones, 244–245  
 kilo (k), SI system, 22  
 kilocalorie (kcal), 29, 30  
 kilogram (kg), SI system, 22, 330  
 kilometer (km), SI system, 22  
 kinetic energy  
   catalysts, 143–145  
   collision theory component, 123  
   defined, 26–27  
   heat versus temperature, 29–30  
   measurement methods, 28–29  
   radioactive particles, 82  
   temperature effects, 142–143  
 Kinetic Molecular Theory of Gases, 211–214  
 kinetics, 140  
 KISS principle (Keep It Simple, Silly), 106  
 kitchen, consumer chemistry, 277

## • L •

lake, 281  
 landfills, heavy metal contamination  
   source, 306, 308–309  
 lanolin, skin softener, 279  
 laundry room  
   bleach, 276  
   detergents, 274–275  
   soaps, 273  
   surfactants, 272  
   water softeners, 275–276  
 Lavoisier, Antoine (father of chemistry), 322  
 Law of Conservation of Energy, The, 27  
 Law of Conservation of Mass, 131

## laws

- Avogadro's Law, 222–224
- Boyle's Law, 217–218
- Charles's Law, 219–220
- combined gas, 221–222
- Dalton's Law, 225–226
- gases, 216–227
- Gay-Lussac's Law, 220–221
- Graham's Law, 226–227
- Le Chatelier, Henri, (Le Chatelier's Principle), 136–140
- lead acetate, hair coloring, 285
- lead, water pollution, 306–307
- leisure suits, polyester, 266
- length, SI/English conversion, 22, 330
- LEO goes GER (Lose Electrons Oxidation: Gain Electrons Reduction), 150
- Lewis formula, 101, 108–110
- lids, crosslinked polyethylene (CLPE), 262
- like-dissolves-like, rule of solubility, 177
- limiting ingredient, 174
- line spectrum, 39
- linear polymers, 259
- lipstick, consumer chemistry, 281
- liquids
  - boiling point, 186
  - freezing point, 187
  - state of matter, 16–17
  - vapor pressure, 186
  - water physical state, 114
- liter (L), SI system, 23
- litmus paper, acid-base testing, 203
- London force, intermolecular force type, 115
- London smog, 295
- Los Angeles smog, 295
- loss of electrons, oxidation component, 148–149
- loss of hydrogen, oxidation component, 149
- loss of oxygen, reduction component, 150
- lotions, consumer chemistry, 279
- low-density polyethylene (LDPE), addition polymerization, 261
- l-pentene, octane rating scale, 253

lubricating oils, petroleum refining process, 249

LUST (leaking underground storage tanks), water pollution, 309

## • M •

- macromolecules, 257
- macroscopic level, solids, 16
- macroscopic view, 12, 193–194
- magnesium, combining with bromine, 94–95
- magnetic quantum number, 43
- malleable, 57
- man-made decay, radioactivity, 66–68
- man-made isotopes, 67–68
- manometers, atmospheric pressure measurement method, 216
- marsh gas, petroleum refining process, 248–249
- mascara, consumer chemistry, 280–281
- mass
  - atomic mass units (amu), 32
  - English conversions, 331
  - extensive property, 24
  - measuring, 330–331
  - SI/English conversion, 22
  - subatomic particles, 32
- mass defect, 75
- mass number, 34, 66
- matter
  - change of state, 17–19
  - defined, 9
  - measurement methods, 22–23
  - mixtures, 21
  - positive versus negative charge, 33
  - pure substances, 20–21
  - states of, 16–17
- mauve dye, 318
- measured numbers, significant numbers, 342
- measurements
  - atmospheric pressure, 214–216
  - atomic mass units (amu), 32
  - bomb calorimeter, 161

- chemist activity, 13
- energy, 27–30
- SI (Système International) system, 22–23
- SI/English conversions, 22–23
- specific gravity (sg), 24
- medical tracers, 74
- medicine cabinet, consumer chemistry, 287
- melanin, 283
- Melmac, formaldehyde use, 245
- melting, 17
- melting point (mp), 17
- Mendeleev, Dmitri (periodic table), 53, 323
- mercaptan, natural gas additive, 238
- mercury, water pollution, 307
- mesosphere, 291
- metal ions, lipstick ingredient, 281
- metallic bonding, 102
- metalloids, 57–59
- metals
  - activity series, 128
  - alkali, 60
  - alkaline earth, 60
  - ductile property, 57
  - inner transition, 64
  - malleable property, 57
  - periodic table classification, 57–59
  - transition, 64
  - water pollution 306–307
- metathesis reactions, 129–130
- meter (m), SI system, 22, 330
- methanoic acid, 243
- methanol, 242
- methyl alcohol, 242
- methyl ethyl ketone, 245
- methyl tert-butyl ether (MTBE), octane booster, 255
- metric system
  - energy measurement, 332
  - length, 330
  - mass, 330–331
  - pressure measurement, 332
  - SI prefixes, 329–330
  - temperature conversion formulas, 331
- micelles, 272
- microscopic level, solids, 16
- microscopic view, 12, 195–197, 211–214
- middle note, perfume mixtures, 282
- milk jugs, 261–262
- milli (m), SI system, 22
- milligram (mg), SI system, 22
- mining, heavy metal contamination source, 306, 307
- Minoxidil
  - hair growth, 320
  - male pattern baldness treatment, 287
- mixtures, 21
- model proving, chemist activity, 13
- models
  - Bohr, 38–40
  - defined, 11
  - quantum mechanical, 40–44
- modified equilibrium constants, 202
- molality (m), 184
- molarity (M), 182–184
- mole, 167
- mole concept
  - Avogadro's number, 167
  - chemical reactions, 169–175
  - empirical formula, 168–169
  - limiting reactants, 174–175
  - molality (m), 184
  - molarity (M), 182–184
  - percent yield, 173–174
  - percentage composition, 168
  - reaction stoichiometry, 171–173
  - real world uses, 167–169
- molecular (true) formula, covalent bonds, 105–106
- molecular formulas, alkanes, 233–234
- molecular geometry, 117
- molecular level, 10
- molecular weights, 166
- molecules
  - defined, 100, 103
  - electron-pair geometry, 117
  - intermolecular force, 115
  - molecular geometry, 117
  - right/left handed, 318

- momentum, 40
  - monatomic, 51, 151
  - monoatomic anions, 90–91
  - monoatomic cations, 89–90
  - monoprotic acids, 198
  - mothballs (naphthalene), 19, 241
  - motion postulate, Kinetic Molecular Theory of Gases, 212–213
  - Motoring octane value, gasoline, 254
  - multiplication, 334, 343
  - multipurpose cleaners, kitchen chemistry, 277
  - muratic acid, cautions/concerns, 277
- **N** ●
- nail polish, consumer chemistry, 281
  - naphthalene (mothballs), aromatic compound, 241
  - natural decay, radioactivity, 68–71
  - natural gas, petroleum refining process, 248–249
  - natural gasoline, petroleum refining process, 249
  - natural logarithm, 73
  - natural monomers, 258–259
  - Nature of the Chemical Bond, The* (Linus Pauling), 323
  - negative charge, subatomic particles, 33
  - negligible concept, quantities, 212
  - net-ionic equations, 150
  - neutral litmus paper, acid-base testing, 203
  - neutralization reaction, 130, 195
  - neutron rich, 68
  - neutrons
    - mass number, 34
    - neutral charge, 33
    - nuclear chemistry component, 66
    - subatomic particle, 32–33
  - n-heptane, octane rating scale, 252–253
  - nitrocellulose, nail polish ingredient, 281
  - noble gases
    - electron configurations, 62–63
    - properties, 61
    - Radon-222, 82
  - nonbonding electrons, 108
  - nonelectrolytes
    - covalently bonded, 51
    - described, 51, 97–98
  - nonionic surfactant, 272
  - nonmetals
    - covalent bonds, 101–102
    - periodic table classification, 57–59
    - properties, 57
  - non-point sources, water pollution, 305
  - nonpolar covalent bonds, 111
  - nonrenewable resources, petroleum, 247
  - nonstick coatings, polytetrafluoroethylene, 265
  - normal (straight-chained) alkanes, 232–233
  - notes, perfume mixtures, 282
  - n-pentene, octane rating scale, 253
  - nuclear chemistry
    - alpha emission, 69
    - alpha particle, 69
    - antimatter, 71
    - atoms, 66
    - balancing the nuclear reaction, 67
    - beta emission, 69–70
    - beta particle, 69–70
    - electron capture, 71
    - electrons, 66
    - fission, 74–80
    - gamma emission, 70
    - isotopes, 66
    - medical tracers, 74
    - natural radioactive decay, 68–71
    - neutron rich isotopes, 68
    - neutrons, 66
    - nuclear fusion, 80–82
    - nucleus, 66
    - positron emission, 70–71
    - protons, 66

radiation effects, 82  
 radioactive dating, 74  
 radioactive half-lives, 71–74  
 radioactivity, 66–74  
 radon, 82  
 reaction arrow, 67  
 safe handling, 73–74  
 transmutation, 67  
 nuclear fission, 76–80  
 nuclear fusion, 80–82  
 nuclear glue, 33  
 nuclear reaction, 67  
 nucleus, 33–34, 38, 66  
 numbers, 333–344  
 nylon stockings, polyamides, 266–267

• 0 •

octane rating scale, gasoline, 252–254  
 octet rule, 63, 87  
 oil of wintergreen, 244  
 optical brighteners, detergent, 274  
 optically active molecules, 318  
 orbitals, 40  
 organic chemistry, 11, 231–246  
 osmosis, 189  
 osmotic pressure, 188–190  
 osteoporosis, 210  
 oxidation, 148–149, 151–152  
 oxidation number method, 152  
 oxidation state, atoms, 91–92  
 oxidizing agent, 150  
 oxygen, 21, 46  
 oxygenate, 255  
 ozone layer, air pollution effects, 291

• p •

packing material, polystyrene, 264  
 para-aminobenzoic acid (PABA), 283  
 parachutes, polyamides, 267  
 paraffin-based waxes, petroleum, 249  
 particle size, reactants, 141

particulates, 289–290  
 parts per million (ppm), 184–185  
 pascal, measurement unit, 332  
 Pasteur, Louis (optically active molecules), 318  
 Pauling, Linus (*The Nature of the Chemical Bond*), 323  
 percent composition, 179–182  
 percent yield, mole concept, 173–174  
 percentage composition, 168  
 percentages, 179–182  
 perfumes, consumer chemistry, 281–282  
 periodic table, 54–64  
 periodicity, 53  
 periods, periodic table component, 56  
 Perkin, William (mauve dye), 318  
 permanents, consumer chemistry, 286  
 peroxides, 151, 245  
 petroleum, 247–251  
 petroleum jelly, skin softener, 279  
 pH scale, 206–209  
 phase changes, 17–18  
 phenol, aromatic compound, 241  
 phenolphthalein, 203–205  
 photochemical smog, 290, 295–297  
 photosynthesis, 147, 289  
 physical chemistry, 11  
 physical properties, 23  
 physical states, water, 114  
 pine oil, kitchen chemistry, 277  
 pipes, polyvinyl chloride, 264  
 plastic rope, polypropylene, 263  
 plastics, 260, 268–269  
 Plunkett, Roy (Teflon), 319  
 plutonium-239, fissionable isotope, 75  
 point sources, water pollution, 305  
 polar covalent bonding, 113–115  
 polar covalent bonds, 111  
 polishes, silicones, 268  
 Polonium-204, electron capture, 71  
 Polonium-218, radon health issues, 82  
 polyamides, 266–267  
 polyatomic, 51, 151

- polyatomic ions, 92–93
  - polyester, condensation polymer, 266
  - polyethylene, 261–262
  - polymerization, 240
  - polymers, 257–268
  - polypropylene, 263
  - polystyrene, 263–264
  - polytetrafluoroethylene, 264–265
  - polyvinyl chloride, 264
  - positive charge, subatomic particles, 33
  - positron emission, 70–71
  - postulates, 212–214
  - potable water, 301
  - Potassium-40, positron emission, 70
  - potential energy, 27
  - pounds (lbs), English system, 23
  - power plants, 77–79
  - precipitation reactions, 129–130
  - preignition, gasoline, 252
  - pressure, 213–216
  - primary sewage treatment, 311–312
  - principal quantum number, 41
  - products, 122, 124–130, 135–136
  - professions, chemistry fields, 13–14
  - proof, 181
  - propane, petroleum, 248–249
  - properties
    - alkali metals, 60
    - alkaline earth metals, 60
    - boiling point elevation, 186–187
    - chemical, 23
    - colligative, 185–190
    - extensive, 24
    - families (groups), 60
    - freezing point depression, 187–188
    - halogens, 60
    - intensive, 24
    - metalloids, 57
    - metals, 57
    - noble gases, 61
    - nonmetals, 57
    - osmotic pressure, 188–190
    - physical, 23
    - semimetals, 57
    - vapor pressure lowering, 186
    - water, 114, 303–305
  - protons, 32–34, 66
  - pure chemistry, 12
  - pure substances, 20
- Q •**
- qualitative analysis, 10, 85
  - quality control chemist, 13
  - quantitative analysis, 10
  - quantities, negligible concept, 212
  - quantized, 39
  - quantum mechanical model, 40–44
  - quantum numbers, 40–44
  - quantum theory, 40
- R •**
- racemic acid, 318
  - radiation, 82
  - radiation burn, 82
  - radical reactive site, polymers, 261
  - radioactive dating, 74
  - radioactivity, 33, 66–74, 82, 319
  - radon, health issues, 82
  - Radon-222, 60, 82
  - reactants, 122–131, 135–136, 140–141
  - reaction arrow, 67
  - reaction mechanism, 124
  - reactions, 239–240, 245
  - reactive site, 124
  - readers, author's assumptions, 2–3
  - recycling, plastics, 268–269
  - red litmus paper, base testing, 203
  - redox (reduction-oxidation) reactions
    - balancing equations, 152–155
    - bleaches, 276
    - combustion, 161–162
    - defined, 131, 148
    - Leo goes GER phrase, 150
    - net-ionic equations, 150–151

oxidation, 148–149  
oxidation rules, 151–152  
reduction, 149–150  
reducing agent, 151  
refined, 248  
refinery, 248  
refrigerants, chlorofluorocarbons, 292–293  
Research octane rating, gasoline, 254  
respiration, redox reaction, 147  
reverse osmosis, 189  
ring systems, alkanes, 238  
Roman numerals, valence electrons, 63–64  
ropes, polypropylene, 263  
rounding off numbers, 344  
rubber vulcanization, 318  
rules  
  IUPAC, 235–236  
  oxidation numbers, 151–152  
  solubility, 177  
runoff, water recycling, 303  
Rutherford, Ernest (atom nucleus), 33, 323

## • S •

S-35, man-made isotope, 67  
saccharin, 320  
sales representative, chemistry field, 14  
salt bridge, 156  
salts, 51, 89  
sandwich bags, 261  
sandwich wrap, polyethylene, 261–262  
saponification, 273  
saturated solutions, 178–179  
scales, temperature, 28–29  
Schlatter, James (aspartame), 320  
science, 10, 12  
scientific method, 11  
scientific notation, 333  
scientific units, 329–332  
scrubbers, 300  
sea of electrons, 102  
Seaborg, Glenn (transuranium), 324  
seals, silicones, 268  
secondary sewage treatment, 311  
semimetals, properties, 57  
semipermeable membrane, 188  
serendipity, 287  
sewage treatment, 311–314  
shampoos, consumer chemistry, 284  
shapes, VESPR theory, 117–120  
shells, Bohr model, 39  
Shroud of Turin, Carbon 14 dating, 74  
SI prefixes, 329–330  
SI system of measurement, 329–332  
significant figures, 341–343  
silicon valley, 57  
silicones, condensation polymer, 267–268  
simulated leather, polyvinyl chloride, 264  
single displacement reactions, 127–128  
skin care, consumer chemistry, 279–283  
smog, air pollution, 295–297  
soaps, laundry room uses, 273  
sodium, combining with chlorine, 85–87  
sodium fluoride, toothpaste ingredient, 278  
sodium perborate, detergent, 274  
sodium sulfide, depilatory ingredient, 286  
soft drink bottles, polyester, 266  
solid air fresheners, 19  
solids, 16, 25–26, 114  
solubility, 177  
solutes, 177  
solutions  
  buffers, 208–209  
  colligative properties, 185–190  
  colloids, 191  
  concentrated, 179  
  concentration units, 179–185  
  crenation, 190  
  defined, 21, 177  
  dilute, 179  
  hemolysis, 190  
  hypertonic, 190  
  hypotonic, 190  
  isotonic, 190  
  like-dissolves-like rule, 177  
  molality, 184

- solutions (*continued*)
- molarity, 182–184
  - parts per million (ppm), 184–185
  - percent composition, 179–182
  - pH scale, 205–209
  - proof, 181
  - saturated, 178–179
  - solutes, 177
  - solvents, 177
  - supersaturated, 178–179
  - versus suspension, 191
  - unsaturated, 178–179
  - volume/volume percentage, 181–182
  - weight/volume percentage, 180–181
  - weight/weight percentage, 180
- solvent, 177, 305
- specific gravity (sg), 24
- spectroscope, 39
- spin pairing, electrons, 46
- spin quantum number, 43
- spotty ignition, gasoline, 252
- stannous, toothpaste ingredient, 278
- starch, natural monomer, 258–259
- states of matter, 16–17
- steam, 17
- sticky notes, 320
- stoichiometric ratio, 172
- stoichiometry, 171, 225
- storm surges, global warming effect, 294
- straight-chained alkanes, 232–233
- straight-chained heptane, 252–253
- straight-run gasoline, petroleum, 249
- stratosphere, air pollution effects, 291
- strength, 197
- stress, 136
- strong acids, 197–198
- strong bases, 198
- structural formulas, 106–110, 233–234
- Styrofoam cups, polystyrene, 263–264
- subatomic particle, 31–34, 38–44, 48–51, 63
- subcritical, 75
- sublimation, 19
- subshells, quantum mechanical model, 41
- substances, density equation, 24
- substituent groups, 235
- subtraction, 334, 343
- Sun Protection Factor (SPF) rating, 283
- sunscreen, consumer chemistry, 283
- suntan lotion, consumer chemistry, 283
- supersaturated solutions, 178–179
- surface tension, water property, 303
- surfactants, laundry room uses, 272
- surgical implants, silicones, 268
- suspension, 191
- suspension agents, detergent, 274
- synthesis, 1, 121, 165
- synthesization, chemist activity, 13
- synthesize, 13
- Système International (SI) system, 22–23, 329–332

## • T •

- Table of Elements, 35–37
- table salt, ionic bonds, 85–87
- talc, body/face powder ingredient, 280
- tar, petroleum refining process, 249
- technology, 12
- Teflon, 319
- temperatures
- boiling point of water (at sea level), 18
  - Celsius scale, 28–29
  - chemical kinetics, 142–143
  - conversion formulas, 331
  - Fahrenheit scale, 28–29
  - global warming, 294–295
  - versus heat, 29–30
  - Kelvin scale, 28–29
  - melting point of ice, 17
  - nuclear fusion control issue, 81
  - specific gravity component, 24
- terpenes, kitchen chemistry, 277
- tertiary sewage treatment, 313–314
- tetraethyl lead, gasoline additive, 254
- tetraethyl lead, water pollution, 307
- theoretical chemistry, 13



theoretical yield, 173  
 theory, 11  
 theory proving, chemist activity, 13  
 thermal inversion, 295–296  
 thermal pollution, 178, 310  
 thermoplastic polymers, 259–260  
 thermosetting polymers, 260  
 thermosphere, 291  
 time, nuclear fusion control issue, 81  
 titanium dioxide, 278, 283  
 titration procedure, 203–204  
 toothpaste, consumer chemistry, 278  
 top note, perfume mixtures, 282  
 toys, 262  
 transition metals, 64  
 transition state, collision theory, 124–125  
 transmutation, 67  
 transuranium elements, 324  
 trash bags, 261  
 triple bond, 102  
 tritium, nuclear fusion, 80  
 troposphere, air pollution effects, 290–291  
 true (molecular) formula, 105–106  
 TV cabinets, 262  
 Tyndall effect, 191

## • U •

Uncertainty Principle, 40  
 unionized, 199  
 unit conversion method, 337–339  
 unsaturated hydrocarbons, 239–240  
 unsaturated solutions, 178–179  
 uranium-235, fissionable isotope, 75  
 urea, organic synthesis development, 231  
 UV rays, 283, 291

## • V •

valence electrons, 48, 63–64  
 Valence Shell Electron-Pair Repulsion  
 (VESPR), 117–120  
 valve seats, polytetrafluoroethylene, 265

vanishing cream formulation, 279  
 vapor pressure, 186  
 vapor pressure lowering, 186  
 Viagra, development history, 287  
 volatility, 252  
 voltaic cells, 155–156  
 volume, 23–25, 317, 331  
 volume postulate, 212  
 volume/volume percentage, 181–182  
 vulcanization, rubber, 318

## • W •

wastes, nuclear fission problem, 78–79  
 wastewater, treatment methods, 311–314  
 water  
   amphoteric, 201–202  
   aquifer, 303  
   Archimedes Principle, 25  
   boiling point temperature, 18  
   compounds, 20–21  
   condensation, 302  
   covalent bonds, 114–116  
   dipole-dipole interaction, 115  
   electron-dot formula, 106–108  
   evaporation, 302  
   gas to solid phase change, 18  
   groundwater, 303  
   heat of vaporization, 305  
   high heat capacity, 304  
   hydrogen bonding, 115–116  
   hydrogen bonds, 303–305  
   hydrologic cycle, 302–303  
   ice state, 304  
   intermolecular forces, 115  
   Lewis formula, 108  
   physical states, 114  
   polar covalent bonding, 114–115  
   properties, 114, 303–305  
   runoff, 303  
   solid to liquid phase change, 18  
   solvent uses, 305

water (*continued*)

specific gravity component, 24

surface tension property, 303

surfactants, 272–275

VSEPR theory, 117–120

water cycle (hydrologic cycle), 302–303

water dissociation constant, 202

water molecules, 16

water pollution, 306–314

water softeners, laundry room, 275–276

waxes, silicones, 268

weak acids, 199–200

weak bases, 201

Web sites

American Chemical Society, 325

chemistry.About.Com, 326

ChermClub.com, 328

Exploratorium, The, 328

Institute of Chemical Education, 328

Material Safety Data Sheets (MSDS), 326

Plastics.com, 327

U.S. Environmental Protection  
Agency, 326

Webbook, 327

Webelements.com, 327

weight, counting objects by, 165–166

weight/volume percentage, 180–181

weight/weight percentage, 180

weighted average, 50, 56

Wohler, Friedrich (urea compound), 231

wood (methyl) alcohol, 242

• **Y** •

yields, actual versus theoretical, 173–174

• **Z** •

zinc oxide, sunscreen ingredient, 283

zinc peroxide, deodorant ingredient, 279



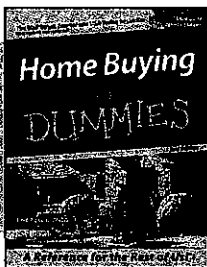
# FOR DUMMIES®

The easy way to get more done and have more fun

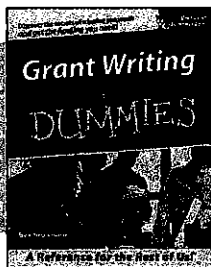
## PERSONAL FINANCE & BUSINESS



0-7645-2431-3



0-7645-5331-3



0-7645-5307-0

### Also available:

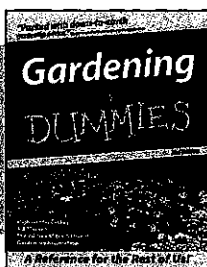
Accounting For Dummies  
(0-7645-5314-3)  
Business Plans Kit For Dummies  
(0-7645-5365-8)  
Managing For Dummies  
(1-5688-4858-7)  
Mutual Funds For Dummies  
(0-7645-5329-1)  
QuickBooks All-in-One Desk Reference For Dummies  
(0-7645-1963-8)

Resumes For Dummies  
(0-7645-5471-9)  
Small Business Kit For Dummies  
(0-7645-5093-4)  
Starting an eBay Business For Dummies  
(0-7645-1547-0)  
Taxes For Dummies 2003  
(0-7645-5475-1)

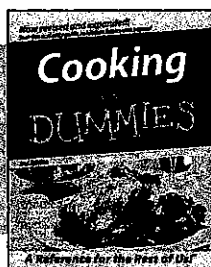
## GARDEN, FOOD & WINE



0-7645-5295-3



0-7645-5130-2



0-7645-5250-3

### Also available:

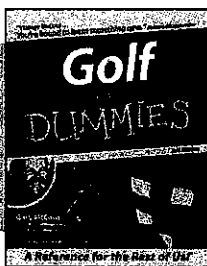
Bartending For Dummies  
(0-7645-5051-9)  
Christmas Cooking For Dummies  
(0-7645-5407-7)  
Cookies For Dummies  
(0-7645-5390-9)  
Diabetes Cookbook For Dummies  
(0-7645-5230-9)

Grilling For Dummies  
(0-7645-5076-4)  
Home Maintenance For Dummies  
(0-7645-5215-5)  
Slow Cookers For Dummies  
(0-7645-5240-6)  
Wine For Dummies  
(0-7645-5114-0)

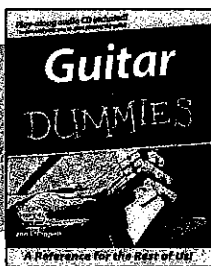
## ARTS, SPORTS, HOBBIES & PETS



0-7645-5167-1



0-7645-5146-9



0-7645-5106-X

### Also available:

Cats For Dummies  
(0-7645-5275-9)  
Chess For Dummies  
(0-7645-5003-9)  
Dog Training For Dummies  
(0-7645-5286-4)  
Labrador Retrievers For Dummies  
(0-7645-5281-3)  
Martial Arts For Dummies  
(0-7645-5358-5)  
Piano For Dummies  
(0-7645-5105-1)

Pilates For Dummies  
(0-7645-5397-6)  
Power Yoga For Dummies  
(0-7645-5342-9)  
Puppies For Dummies  
(0-7645-5255-4)  
Quilting For Dummies  
(0-7645-5118-3)  
Rock Guitar For Dummies  
(0-7645-5356-9)  
Weight Training For Dummies  
(0-7645-5168-X)

Available wherever books are sold.  
www.dummies.com or call 1-877-762-2974 to order direct





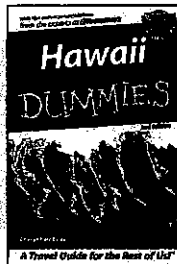
# FOR DUMMIES<sup>®</sup>

A world of resources to help you grow

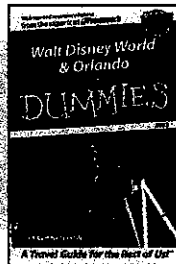
## TRAVEL



0-7645-5453-0



0-7645-5438-7



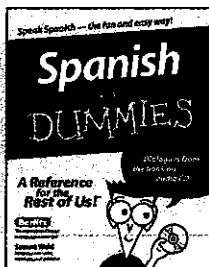
0-7645-5444-1

### Also available:

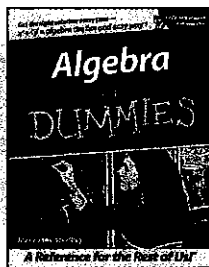
America's National Parks For Dummies (0-7645-6204-5)  
 Caribbean For Dummies (0-7645-5445-X)  
 Cruise Vacations For Dummies 2003 (0-7645-5459-X)  
 Europe For Dummies (0-7645-5456-5)  
 Ireland For Dummies (0-7645-6199-5)

France For Dummies (0-7645-6292-4)  
 Las Vegas For Dummies (0-7645-5448-4)  
 London For Dummies (0-7645-5416-6)  
 Mexico's Beach Resorts For Dummies (0-7645-6262-2)  
 Paris For Dummies (0-7645-5494-8)  
 RV Vacations For Dummies (0-7645-5443-3)

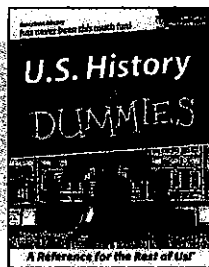
## EDUCATION & TEST PREPARATION



0-7645-5194-9



0-7645-5325-9



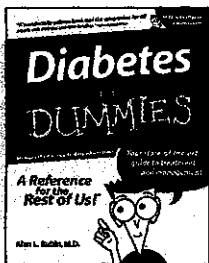
0-7645-5249-X

### Also available:

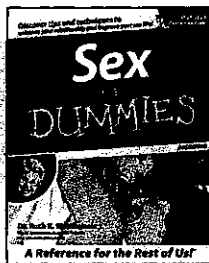
The ACT For Dummies (0-7645-5210-4)  
 Chemistry For Dummies (0-7645-5430-1)  
 English Grammar For Dummies (0-7645-5322-4)  
 French For Dummies (0-7645-5193-0)  
 GMAT For Dummies (0-7645-5251-1)  
 Inglés Para Dummies (0-7645-5427-1)

Italian For Dummies (0-7645-5196-5)  
 Research Papers For Dummies (0-7645-5426-3)  
 SAT I For Dummies (0-7645-5472-7)  
 U.S. History For Dummies (0-7645-5249-X)  
 World History For Dummies (0-7645-5242-2)

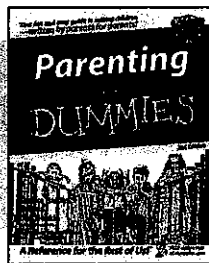
## HEALTH, SELF-HELP & SPIRITUALITY



0-7645-5154-X



0-7645-5302-X



0-7645-5418-2

### Also available:

The Bible For Dummies (0-7645-5296-1)  
 Controlling Cholesterol For Dummies (0-7645-5440-9)  
 Dating For Dummies (0-7645-5072-1)  
 Dieting For Dummies (0-7645-5126-4)  
 High Blood Pressure For Dummies (0-7645-5424-7)  
 Judaism For Dummies (0-7645-5299-6)

Menopause For Dummies (0-7645-5458-1)  
 Nutrition For Dummies (0-7645-5180-9)  
 Potty Training For Dummies (0-7645-5417-4)  
 Pregnancy For Dummies (0-7645-5074-8)  
 Rekindling Romance For Dummies (0-7645-5303-8)  
 Religion For Dummies (0-7645-5264-3)

Available wherever books are sold. Go to [www.dummies.com](http://www.dummies.com) or call 1-877-762-2974 to order direct

# FOR DUMMIES<sup>®</sup>

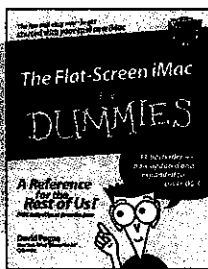


Plain-English solutions for everyday challenges

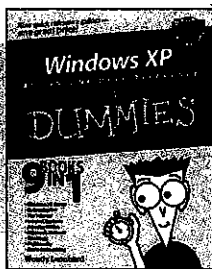
## & BUSINESS COMPUTER BASICS



0-645-0838-5



0-7645-1663-9



0-7645-1548-9

### Also available:

Excel 2002 All-in-One Desk Reference For Dummies (0-7645-1794-5)

Office XP 9-in-1 Desk Reference For Dummies (0-7645-0819-9)

PCs All-in-One Desk Reference For Dummies (0-7645-0791-5)

Troubleshooting Your PC For Dummies (0-7645-1669-8)

Upgrading & Fixing PCs For Dummies (0-7645-1665-5)

Windows XP For Dummies (0-7645-0893-8)

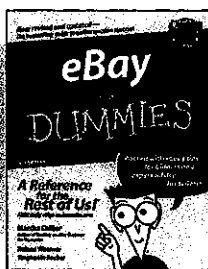
Windows XP For Dummies Quick Reference (0-7645-0897-0)

Word 2002 For Dummies (0-7645-0839-3)

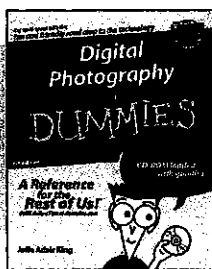
## NET & DIGITAL MEDIA



0-7645-0894-6



0-7645-1642-6



0-7645-1664-7

### Also available:

CD and DVD Recording For Dummies (0-7645-1627-2)

Digital Photography All-in-One Desk Reference For Dummies (0-7645-1800-3)

eBay For Dummies (0-7645-1642-6)

Genealogy Online For Dummies (0-7645-0807-5)

Internet All-in-One Desk Reference For Dummies (0-7645-1659-0)

Internet For Dummies Quick Reference (0-7645-1645-0)

Internet Privacy For Dummies (0-7645-0846-6)

Paint Shop Pro For Dummies (0-7645-2440-2)

Photo Retouching & Restoration For Dummies (0-7645-1662-0)

Photoshop Elements For Dummies (0-7645-1675-2)

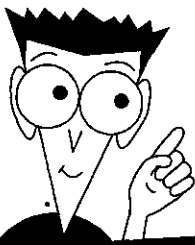
Scanners For Dummies (0-7645-0783-4)



Get smart! Visit [www.dummies.com](http://www.dummies.com)

- Find listings of even more Dummies titles
- Browse online articles, excerpts, and how-to's
- Sign up for daily or weekly e-mail tips
- Check out Dummies fitness videos and other products
- Order from our online bookstore

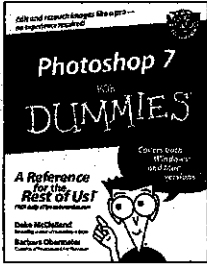
Available wherever books are sold. Go to [www.dummies.com](http://www.dummies.com) or call 1-877-762-2974 to order direct



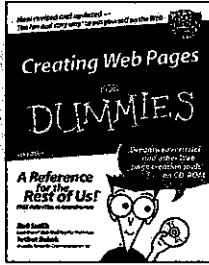
# FOR DUMMIES<sup>®</sup>

Helping you expand your horizons and realize your potential

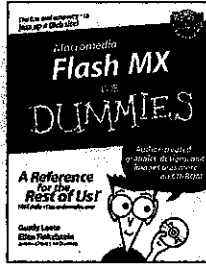
## GRAPHICS & WEB SITE DEVELOPMENT



0-7645-1651-5



0-7645-1643-4



0-7645-0895-4

### Also available:

Adobe Acrobat 5 PDF For Dummies (0-7645-1652-3)

ASP.NET For Dummies (0-7645-0866-0)

ColdFusion MX for Dummies (0-7645-1672-8)

Dreamweaver MX For Dummies (0-7645-1630-2)

FrontPage 2002 For Dummies (0-7645-0821-0)

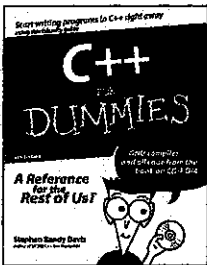
HTML 4 For Dummies (0-7645-0723-0)

Illustrator 10 For Dummies (0-7645-3636-2)

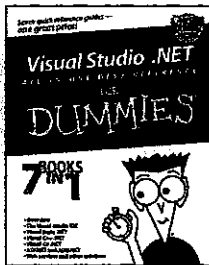
PowerPoint 2002 For Dummies (0-7645-0817-2)

Web Design For Dummies (0-7645-0823-7)

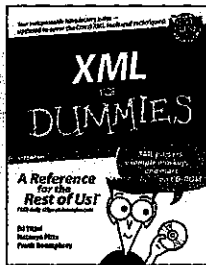
## PROGRAMMING & DATABASES



0-7645-0746-X



0-7645-1626-4



0-7645-1657-4

### Also available:

Access 2002 For Dummies (0-7645-0818-0)

Beginning Programming For Dummies (0-7645-0835-0)

Crystal Reports 9 For Dummies (0-7645-1641-8)

Java & XML For Dummies (0-7645-1658-2)

Java 2 For Dummies (0-7645-0765-6)

JavaScript For Dummies (0-7645-0633-1)

Oracle9i For Dummies (0-7645-0880-6)

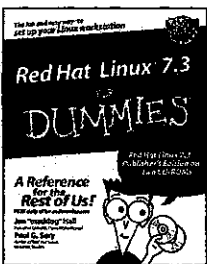
Perl For Dummies (0-7645-0776-1)

PHP and MySQL For Dummies (0-7645-1650-7)

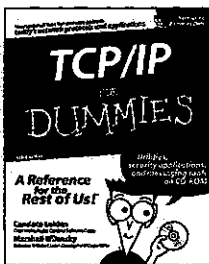
SQL For Dummies (0-7645-0737-0)

Visual Basic .NET For Dummies (0-7645-0867-9)

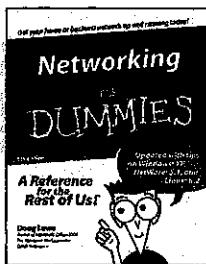
## LINUX, NETWORKING & CERTIFICATION



0-7645-1545-4



0-7645-1760-0



0-7645-0772-9

### Also available:

A+ Certification For Dummies (0-7645-0812-1)

CCNP All-in-One Certification For Dummies (0-7645-1648-5)

Cisco Networking For Dummies (0-7645-1668-X)

CISSP For Dummies (0-7645-1670-1)

CIW Foundations For Dummies (0-7645-1635-3)

Firewalls For Dummies (0-7645-0884-9)

Home Networking For Dummies (0-7645-0857-1)

Red Hat Linux All-in-One Desk Reference For Dummies (0-7645-2442-9)

UNIX For Dummies (0-7645-0419-3)

Available wherever books are sold.

Go to [www.dummies.com](http://www.dummies.com) or call 1-877-762-2974 to order direct



Includes examples of  
**chemistry in action**  
in everyday life



## See how chemistry works in everything from soaps to medicines to petroleum

Whether you're taking a chemistry course or you're curious about what chemists do, this fun and easy guide will get you up to speed in matter and energy, elements and atoms, acids and gases, and much more. You'll understand the basic concepts and discover how chemistry affects our day-to-day lives — from the home to the environment.

**John T. Moore Ed.D.** has been a teacher for more than thirty years. Numerous grants have permitted him to focus on the professional development of elementary and middle school teachers in science.

**THE  
DUMMIES  
WAY**

*Explanations in plain English*  
*"Get in, get out" information*  
*Icons and other navigational aids*  
*Tear-out cheat sheet*  
*Top ten lists*  
*A dash of humor and fun*

\$19.99 US  
\$29.99 CN  
£13.95 UK

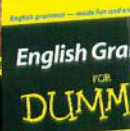
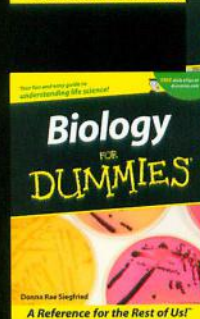
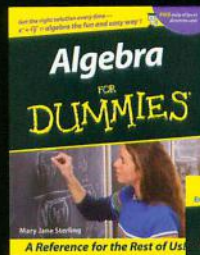
ISBN 978-0-7645-5430-8



Science


9 780764 554308

For more  
**plain-Engl**  
advice, see:



**Get smart**  
@ [www.dummies.com](http://www.dummies.com)

- ✓ Find listings of all our books
- ✓ Choose from many different subject categories
- ✓ Sign up for eTips at [etips.dummies.com](http://etips.dummies.com)

For Dummies®  
A Branded Imprint of  
 **WILEY**