Succeeding in Science

The following suggestions are meant to help you:

- -Learn more
- -Get better scores on tests and quizzes
- -Improve your problem solving and critical thinking skills
- -Do better on labs
- -Decrease your anxiety level

Since there is no single method of study that works for everyone, you should adapt these suggestions to fit your needs. However, based on many years of teaching science and several years as a student before that, we have observed that successful students make use of most, if not all of these methods.

1. Discipline yourself to read the chapter before you hear the lecture in class. Having a foundation of understanding will help you immensely for when you hear the material from your instructor.

2. Don't try to read the whole chapter in one sitting. If you have time, you may want to skim the chapter to see where you are heading, but in general learn the chapter a section at a time so you don't get overwhelmed by the information. You may even want to keep notebook paper handy to jot down notes or questions you have for your teacher. Also, don't highlight the whole book.

3. Take good notes in class. You may think you can remember the material over a period of time, but you will probably have lapses in memory when it comes to quiz or test time. Also, remember that the instructor is going to emphasize the material that he or she thinks is important. This is the information you will want to remember. Notes are also a good summary so you don't have to continue to re-read the chapter in detail.

4. It is crucial that you try the problems that are given by the instructor and those that are in the book. Science is not a spectator sport. You will never get proficient at problem solving if you don't practice, and that doesn't mean watching someone else do it.

5. Learn the method of solution in solving problems associated with a particular concept, don't just try to memorize particular problems. You may memorize 100 problems and the 101st might be different. If you know the method you can figure out how to solve the problem. This will help you avoid having to accuse your instructor of giving you "trick" questions.

6. Find a quiet place to work away from distractions such as the television. It is generally difficult to absorb information when your attention is divided.

7. Do the problems for a section while the material is still fresh in your mind. This will help enforce your understanding and bring out any questions or difficulties you have before you move on to new material.

8. Don't be afraid to ask questions during class and take advantage of help sessions that are provided. Don't let your misunderstanding snowball. Take care of small problems before they lead to bigger problems that are more difficult to overcome. Above all, keep up with the material.

9. Use lab activities as an opportunity to help enforce your knowledge of the chapter. Unfortunately, many students view labs as "playtime" and they not only miss out on points by doing a haphazard job on the procedure, they miss out on an excellent hands-on way of learning the material. In the worst-case scenario a student misbehaving in the lab may receive a zero for the lab and be restricted from further activities.

10. When you are problem solving, think about what you are doing and try to visualize the problem in your head. Don't just blindly start plugging numbers in. Often times it helps students to take inventory on the problem. Associate values with variables, then it is usually easier to figure out what you are being asked to solve.

11. Pay attention to significant digits and dimensional analysis. Remember not every trailing decimal digit that your calculator gives you is necessarily applicable to the result. Real life calculations are limited by the precision of the measuring devices. There are rules for determining significant digits in mathematics, but your best rule is common sense. Dimensional analysis is an excellent way to check your work. After you have done all of the calculations, is the unit(s) that you are left with the one(s) you were seeking? If not, there is obviously a problem with your calculation.

12. Become familiar with the functions on your calculator and learn to use them correctly. Incorrect usage can cause problems with the order of operations and several other things. Students have an especially difficult time entering numbers in scientific notation. Depending on the problem, sometimes they get lucky and get the right answer. More often than not they get the wrong answer and do more work in the process. Bring your calculator along with your other materials to class everyday.

13. Continue to work on your algebra skills, especially graphing, solving for variables and the quadratic equation.

14. Last but not least, keep a positive attitude about the class. Whether you are interested in science or not, you are there to learn so you might as well make the most of the opportunity. Science will affect you in many ways throughout your life. At the very least, having a basic understanding of the concepts of science will help you make intelligent, well-informed decisions as a voting member of society and with respect to the choices you make about yourself personally.

Safety in the Laboratory

Working in the laboratory is an interesting and rewarding experience. During your labs, you will be actively involved from beginning to end - from setting some change in motion to drawing some conclusion. In the laboratory, you will be working with equipment and materials that can cause injury if they are not handled properly. However, the laboratory is a safe place to work if you are careful. Accidents do not just happen. They are caused-by carelessness, haste, and disregard of safety rules and practices. Safety rules to be followed in the laboratory are listed below. Before beginning any lab work, read these rules, learn them, and follow them carefully.

General

1. Be prepared to work when you arrive at the laboratory. Familiarize yourself with the lab procedures before beginning the lab.
2. Perform only those lab activities assigned by your teacher. Never do anything in the laboratory that is not called for in the laboratory procedure or by your teacher. Never work alone in the lab. Do not engage in any horseplay.
3. Work areas should be kept clean and tidy at all times. Only lab manuals and notebooks should be brought to the work area. Other books, purses, brief cases, etc. should be left at your desk or placed in a designated storage area
4. Clothing should be appropriate for working in the lab. Jackets, ties, and other loose garments should be removed. Open shoes should not be worn.
5. Long hair should be tied back or covered, especially in the vicinity of open flame.
6. Jewelry that might present a safety hazard, such as dangling necklaces, chains or bracelets should not be worn in the lab.
7. Follow all instructions, both written and oral, carefully.
8. Safety goggles and lab aprons should be worn.
9. Set up apparatus as described manual or by your teacher. Never use a makeshift setup.
10. Always use the prescribed instrument (tongs, test tube holder, forceps, etc.) for handling apparatus or equipment
11. Keep all combustible materials away from open flames.
12. Never touch any substance in the lab unless specifically instructed to do so.
13. Never put your face near the mouth of a container that is holding chemicals
14. Never smell any chemicals unless instructed to do so by your teacher. When testing for odors, use a wafting motion to direct the odors to your nose.
15. Any activity involving poisonous vapors should be conducted in the fume hood
16. Dispose of waste materials as instructed by your teacher.
17. Clean up all spills immediately.
18. Clean and wipe dry all work surfaces at the end of class. Wash your hands thoroughly.
19. Know the location of emergency equipment (First aid kit, fire extinguisher, fire shower, fire blanket, etc.) and how to use them.
20. Report all accidents to the teacher immediately.
21. Read and double check labels on reagent bottles before removing any reagent. Take only as much reagent as you need.
22. Do not return unused reagent to stock bottles.
23. When transferring chemical reagents from one container to another, hold the containers out away from your body.
24. When mixing an acid and water, always add the acid to the water.
25. Avoid touching chemicals with your hands. If chemicals do come in contact with your hands, wash them immediately.
26. Notify your teacher if you have any medical problems that might relate to lab work, such as allergies or asthma
27. If you will be working with chemicals in the lab, avoid wearing contact lenses. Change to glasses, if possible, or notify the teacher.

Handling Glassware

28. Glass tubing, especially long pieces, should be carried in a vertical position to minimize the likelihood of breakage and to avoid stabbing anyone
29. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass. Dispose of the glass as directed by your teacher.
30. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) with water or glycerin before attempting to insert it into a rubber stopper.
31. Never apply force when inserting or re-moving glassware from a stopper. Use a twisting motion. If a piece of glassware becomes "frozen" in a stopper, take it to your teacher.
32. Do not place hot glassware directly on the lab table. Always use an insulating pad of some sort.
33. Allow plenty of time for hot glass to cool before touching it. Hot glass can cause painful burns. (Remember: Hot glass looks cool.)

Heating Substances

34. Exercise extreme caution- when using a gas burner. Keep your head and clothing away from the flame.
35. Always turn the burner off when it is not in use.
36. Do not bring any substance into contact with a flame unless instructed to do so.
37. Never heat anything without being instructed to do so.
38. Never look into a container that is being heated.
39. When heating a substance in a test tube, make sure that the mouth of the tube is not pointed at yourself or anyone else.
40. Never leave unattended anything that is being heated or is visibly reacting.

First Aid in the Laboratory Classroom

Accidents do not often happen in well-equipped chemistry laboratories if students understand safe laboratory procedures and are careful in following them. When an occasional accident does occur, it is likely to be a minor one. The school nurse is responsible for treating injuries. However, for some types of injuries, you must take action immediately, before the nurse takes over. The following Information will be helpful to you if an accident occurs.

1. **Shock.** People who are suffering from any severe injury (for example, a bad burn or major loss of blood) may be in a state of shock. A person in shock is usually pale and faint. The per-son may be sweating, with cold, moist skin and a weak, rapid pulse.

Shock is a serious medical condition. Do not allow a person in shock to walk anywhere--even to the nurse's office. While emergency help is being summoned, place the victim face up in a horizontal position, with the feet raised about 30 centimeters. Loosen any tightly fitting clothing and keep him or her warm.

2. **Chemicals in the Eyes.** Getting any kind of a chemical into the eyes is undesirable, but certain chemicals are especially harmful. They can destroy eyesight in a matter of seconds. Be cause you will be wearing safety goggles at all times in the lab, the likelihood of this kind of accident is remote. However, if it does happen, flush your eyes with water immediately. Do Not attempt to go to the office before flushing your eyes. It is important that flushing with water be continued for a prolonged time--about 15 minutes. While flushing is continuing, the school office should be informed.

3. **Clothing or Hair on Fire**. A person whose clothing or hair catches on fire will often run around hysterically in an unsuccessful effort to get away from the fire. This only provides the fire with more oxygen and makes it burn faster. For clothing fires, throw yourself to the ground and roll around to extinguish the flames. For hair fires, use a fire blanket to smother the flames Notify the instructor immediately.

4. **Bleeding from a Cut.** Most cuts that occur in the chemistry laboratory are minor. For minor cuts, apply pressure to the wound with sterile gauze, and take the victim to the school nurse. If the victim is bleeding badly, raise the bleeding part, if possible, and apply pressure to the wound with a piece of sterile gauze. While first aid is being given, someone else should notify the school office.

5. **Chemicals in the Mouth.** Many chemicals are poisonous to varying degrees. Any chemical taken into the mouth should be spat out and the mouth rinsed thoroughly with water. Note the name of the chemical and notify the nurse immediately. If the victim swallows a chemical, note the name of the chemical and notify the nurse immediately. If necessary, the office will contact the Poison Control Center, a hospital emergency room, or a physician for instructions.

6. **Acid or Base Spilled on the Skin.** Flush the skin with water for about 16 minutes. Take the victim to the school front office.

7. **Breathing Smoke or Chemical Fumes.** All experiments that give off smoke or noxious gases should be conducted in a well-ventilated fume hood. This will make an accident of this kind unlikely. If smoke or chemical fumes are present in the laboratory, all persons--even those who do not feel ill--should leave the laboratory immediately. Make certain that all doors to the laboratory are closed after the last person has left. Since smoke rises, stay low while evacuating a smoke-filled room. Notify the nurse immediately. Thoroughly ventilate the room before going back to work.

Laboratory Safety Agreement

I have read and understood the attached document on safety and first aid in the laboratory.______________
(Date)

The front office of the school is located:

____
(State location)

The nearest fire alarm to the chemistry laboratory is located:

____
(State location)

The laboratory's fire blanket is located:

____
(State location)

The nearest telephone to the chemistry laboratory is located

____
(State location)

I have read and understood the attached document on safety and first aid in the laboratory and agree to abide by the rules and procedures described in within. I will also abide by any other rules and regulations provided by my chemistry teacher.

____ ______________________
(Name - Please print clearly) (Date)

____
(Signature)

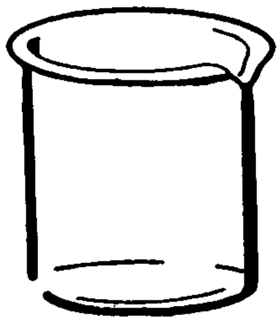
I have read and understand the attached rules and procedure and pledge my support in encouraging my son/daughter to follow them.

____ ______________________
(Parent/Guardian name - Please print clearly) (Date)

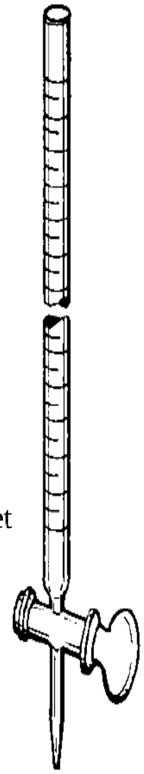
____
(Signature)

Note: Read to the bottom of the *meniscus* on graduated glassware.

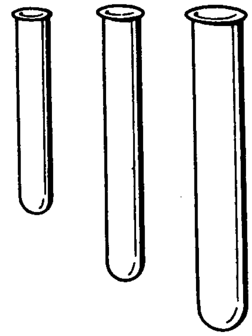
Common Labware



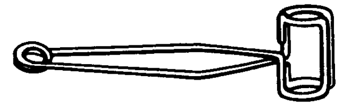
Beaker



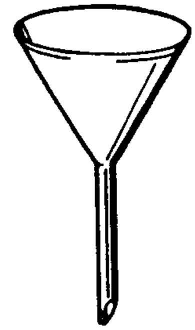
Buret



Test Tubes



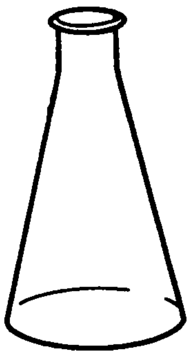
Test Tube Holder



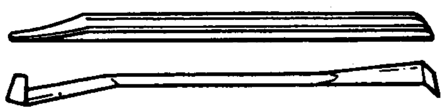
Funnel

Evaporating Dish

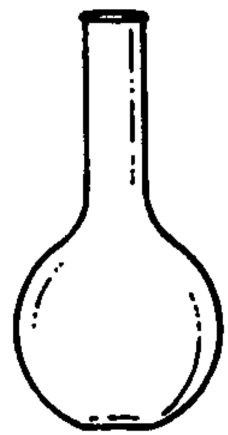
Watch Glass



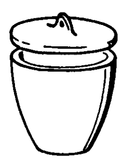
Erlenmeyer Flask



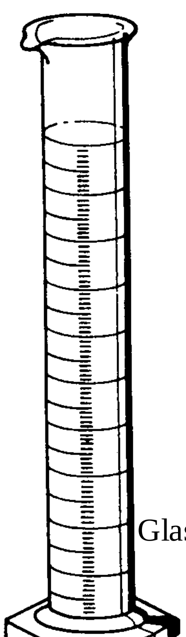
Scoop **or** Spatula



Volumetric Flask

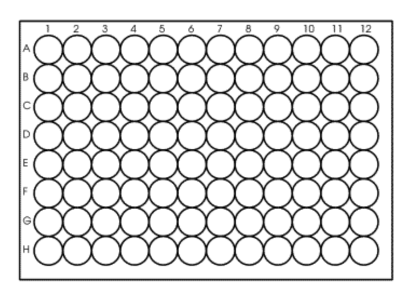


Crucible with Lid



Graduated Cylinder

Glass Stirring Rod



Well Plate

Forceps (Tweezers)

Dropper Pipet

Precise Measuring Devices
- -Graduated cylinder
- -Buret
- -Volumetric flask (good for one volume)

Approximate Measuring Devices
- -Erlenmeyer Flask
- -Beaker

Rules for Counting Significant Figures

1. Nonzero integers. Nonzero integers always count as significant figures. For example, the number 1457 has four nonzero integers, all of which count as significant figures.

2. Zeros. There are three classes of zeros:

Leading zeros are zeros that precede all of the nonzero digits. They never count as significant figures. For example, in the number 0.0025, the three zeros simple indicate the position of the decimal point. The number has only two significant figures, the 2 and the 5.

Captive zeros are zeros that fall between nonzero digits. They always count as significant figures. For example, the number 1.008 has four significant figures.

Trailing zeros are zeros at the right end of the number. They are significant only if the number contains a decimal point. The number one hundred written as 100 has only one significant figure, but written as 100., it has three significant figures.

3. Exact numbers. Often calculations involve numbers that were not obtained using measured devices but were determined by counting: 10 experiments, 3 apples, 8 molecules. Such numbers are called exact numbers. They can be assumed to have an unlimited number of significant figures. Exact numbers can also arise from definitions. For example, 1 inch is defined as exactly 2.54 centimeters. Thus in the statement 1 in. = 2.54 cm, neither 2.54 nor 1 limits the number of significant figures when it is used in a calculation.

Addition/Subtraction:

The result of an addition and/or subtraction may contain only as many decimal digits as the number with the fewest decimal digits in the computation.

Multiplication/Division:

The result of a multiplication and/or division may contain only as many significant digits and the number with the fewest total significant digits in the computation.

Rounding:

Look at the number to the right of the last digit you will be reporting; if the number is 5 or greater, round your last digit up. If the number is 4 or less, leave the last digit as is.

When performing multiple computations, try to avoid intermediate rounding as this tends to compound the errors in your result.

Writing a Formal Lab Report

Adapted from: www.chemistrycoach.com

Use the following design when writing formal lab reports. Although many lab reports will not be formal ones, you are expected to know the details of this design and to understand the logical sequence of ideas within it.

Title: A concise statement of the problem

Introduction: A statement of objectives or a hypothesis may be necessary if the TITLE does not fully describe the problem being studied. The hypothesis is what you think will happen during the investigation. It differs from a guess in that it is based upon prior knowledge or evidence. It should be supported by previously developed evidence and/or concepts.

Materials: Complete lists of materials used are required in our biology experiments.

Procedure: Write a procedure only if you have actively taken part in the process of designing the experiment, otherwise state the source of the procedure. Explain, with diagrams, what you did in order to collect the DATA. You should understand and be able to apply the principles involved in running a controlled experiment. You are encouraged to identify the assumptions upon which the experiment is based.

Quantitative Data: Evidence collected during the experiment; numbers read directly from laboratory instruments (clocks, rulers, balances, etc., but not calculators). Data should be well organized and tabulated when possible. Use care in scale reading and use significant figures when taking measurements. Develop a sense of how much data is desirable. Understand the need for carrying out multiple experiments and strive to get reproducible data when practical. Do not hide or eliminate suspected faulty data but present it. Later, in your CONCLUSIONS, you may explain why you have decided not to use suspected errors in your analysis.

Qualitative Data: Other forms of evidence, qualitative in nature that may be useful in the interpretation of QUANTITATIVE DATA; for example, something unexpected that happened during the carrying out of the PROCEDURE that may affect your CONCLUSIONS. In qualitative experiments which are frequently carried out in biology, these observations may be the only form of evidence collected. Then a RESULTS section may be unnecessary, and CONCLUSIONS will be based upon the QUALITATIVE DATA.

Calculations: Use illustrations (sample problems) to show how you converted DATA into RESULTS. You are encouraged to use calculators and computers. Computer programs or spreadsheets used in the analysis should appear in this section. Use significant figures in calculations involving measurements. Use units as well as numbers in all calculations. Use dimensional analysis to accomplish this. Write equations of any straight lines from graphs of experimental DATA or RESULTS.

Results: The final form in which the evidence is prepared. You perform CALCULATIONS on the DATA in order to develop RESULTS. Your CONCLUSIONS should be understandable by looking at your RESULTS. Tabulate results of primary variables in a meaningful order. Graph variables to detect general trends. When possible (if $y=mx+b$), supply equations of these graphs. Understand the gain in information and usefulness when results are converted into systematic tables, graphs, and finally equations.

Conclusions: Contain the answers to the problem stated in the TITLE and INTRODUCTION. Base your conclusions on your RESULTS, not despite them. Look for more than one conclusion to the problem, with suggestions for further work in order to differentiate these at a later date. It is not necessary to do the further work. Understand that conclusions from one experiment usually form the hypotheses to new experiments. Explain experimental errors that appear in the results. Show an awareness of the limitations of the results when making generalizations. In more complicated problems, or when results are ambiguous, provide a discussion section to explain the rationale behind the conclusions.

Producing an XY Scatter Graph with Linear Regression Analysis in Microsoft Excel

Place your X axis data (abscissa) beginning in cell A1 and continuing vertically downward. Do the same with your Y axis data (ordinate) beginning in cell B1 on downward. You should now have two columns of data on your worksheet. Beginning at cell A1, click and hold the left mouse button while you drag the mouse diagonally until you have highlighted the complete block of data cells. Now select the chart wizard icon from the toolbar at the top of the worksheet (it has a little picture of a chart on it). Begin by choosing XY (scatter) as your type of graph. Select the chart sub-type that is described as "Scatter. Compares pairs of values". Click the button that says *Next*. Click the *Series* tab and highlight *Series1* from the series window. Click in the *Name* window and type a good description of your data. Click the *Next* button again. On the *Titles* tab, enter a descriptive title for your chart. (Note that the title will default to the Series1 name that you typed in. You may leave it at that if that's what you want). For *Value (X) axis*, type in a description of your independent variable (A column data). For *Value (Y) axis*, type in a description of your dependent variable (B column data). Click the *Gridlines* tab and select only the minor gridlines for x and only the major gridlines for y. (This setting for gridlines is only a guided suggestion. You may have to adjust this setting according to your needs).

(**Optional:** In the Data Labels tab you may want to check *Label Contains X Value* and *Label Contains Y Value* if you would like to have your ordered pairs listed next to the data points on your graph.)

Now click on the *Finish* button. Your graph should now be visible within your worksheet.

Linear Regression Analysis:

With the graph still selected in your spreadsheet, choose *Chart* from the Excel menu then click on *Add Trendline…* from the submenu.
On the *Type* tab select *Trend/Regression Type* as *Linear*.
On the *Options* tab, select *Display Equation on Chart*.
Finally, click OK in the lower right hand corner of the window.

You may have to click and drag your linear regression equation to another area of the chart if it is in the way of your data plots, but otherwise your graph should be done.

Importing into Microsoft Word: Open a new Microsoft Word document and type a heading for your report. Be sure to include your name(s). Go back to Excel and highlight the data cells from your spreadsheet then copy and paste them into your Word document. Do the same thing for your chart by clicking on the graph to select it and then using the copy/paste function.

If you have any questions, be sure to ask your instructor before you turn the assignment in.

Metric Conversion Table

English to Metric	Metric to English
LINEAR	
inch (in.) = 25.4millimeters (mm)	millimeter (mm) = 0.3937 inches (in.)
foot (ft.) = 0.3048meters (m)	meter (m) = 3.281 feet (ft.)
mile (mi.) = 1.6093 kilometers (km)	kilometer (km) = 0.6214 miles (mi.)
AREA	
inch^2 (sq.in.) = 645.15 millimeters^2 (mm^2)	millimeter^2 (mm^2) = 0.000155 inches^2 (sq.in.)
foot^2 (sq.ft.) = 0.0929 meters^2 (m^2)	meter^2 (m^2) = 10.764 feet^2 (sq.ft.)
VOLUME	
inch^3 (cu.in.) = 0.01639 liters (l)	liter (l) = 61.024 inches^3 (cu.in.)
quart (qts.) = 0.94635liters (l)	liter (l) = 1.0567 quarts (qts.)
gallon (gal.) = 3.7854 liters (l)	liter (l) = 0.2642 gallon (gal.)
inch^3 (cu.in.) = 16.39 centimeters^3 (cc)	centimeter^3 (cc) = 0.06102 inches^3 (cu.in.)
foot^3 (cu.ft.) = 28.317 liters (l)	liter (l) = 0.03531 feet^3 (cu.ft.)
foot^3 (cu.ft.) = 0.02832 meters^3 (m^3)	meter^3 (m^3) = 35.315 feet^3 (cu.ft.)
fluid ounce (fl.oz.) = 29.57 millileters (ml)	milliliter (ml=) 0.03381 fluid ounce (fl.oz.)
MASS	
ounce (oz.) = 28.35 grams (g)	gram (g) = 0.03527 ounces (oz.)
pound (lbs.) = 0.4536 kilograms (kg)	kilogram (kg) = 2.2046 pounds (lbs.)
ton (2000 lbs.) = 907.18 kilograms (kg)	kilogram (kg) = 0.001102 tons (2000 lbs.)
ton (2000 lbs.) = 0.90718 metric tons (t)	metric ton (t) = 1.1023 tons (2000 lbs.)
ton (long) (2240 lbs.) = 1013.05 kilograms (kg)	kilogram (kg) = 0.000984 tons (long) (2240 lbs.)
PRESSURE	
inches Hg (60^{o}F) = 3600 kilopascals (kPa)	kilopascal (kPa) = 0.2961 inches Hg (60^{o}F)
pound/sq.in. (PSI) = 6.895 kilopascals (kPa)	kilopascal (kPa) = 0.145 pounds/sq.in. (PSI)
pound/sq.in. (PSI) = 0.0703 kilograms/sq.cm. (kg/cm^2)	kilogram/sq.cm. (kg/cm^2) = 14.22 pounds/sq.in. (PSI)
pound/sq.in. (PSI) = 0.069 bars	bar = 14.5 pounds/sq.in. (PSI)
inches H_2O (60^{o}F) = 0.2488 kilopascals (kPa)	kilopascal (kPa) = 4.0193 inches H_2O (60^{o}F)
bar = 100 kilopascals (kPa)	kilopascal (kPa) = 0.01 bars
POWER	
horsepower (hp) = 0.746 kilowatts (kW)	kilowatts (kW) = 1.34 horsepower (hp)
ft.-lbs./min. = 0.0226 watts (W)	watts (W) = 44.25 ft.-lbs./min.
TORQUE	
pound-inches (in.-lbs.) = 0.11298 newton-meters (N-m)	newton-meters (N-m) = 8.851 pound-inches (in-lbs)
pound-feet (ft.-lbs.) = 1.3558 newton-meters (N-m)	newton-meters (N-m) = 0.7376 pound-feet (ft.-lbs)
pound-feet (ft.-lbs.) = .1383 kilograms-meter (kg-m)	kilogram-meter (kg-m) = 7.233 pound-feet (ft.-lbs)
VELOCITY	
mile/hour (m/h) = 0.11298 kilometers/hour (km/hr)	kilometer/hour (km/hr) = 0.6214 miles/hour (m/h)
foot/second (ft./sec.) = 0.3048 meters/second (m/s)	meter/second (m/s) = 3.281 feet/second (ft/s)
foot/minute (ft./min.) = 0.3048 meters/minute (m/min)	meter/minute (m/min) = 3.281 feet/minute (ft/min)
TEMPERATURE	
^{o}Celsius = 5/9 (^{o}F - 32)	^{o}Fahrenheit = 9/5 ^{o}C + 32

COMMON METRIC PREFIXES

mega (M) = 1,000,000 or 10^6	deci (d) = 0.1 or 10^{-1}
kilo (k) = 1,000 or 10^3	centi (c) = 0.01 or 10^{-2}
hecto (h) = 100 or 10^2	milli (m) = 0.001 or 10^{-3}
deka (da) = 10 or 10^1	micro (m) = 0.000001 or 10^{-6}

Commonly Used Formulas and Values

General:
$c = 3.0x10^8$ m/s
% Yield = (actual/theoretical) * 100
Density (d) = mass/Volume
1μ (micro) $=10^{-6}$
1n (nano) = 10^{-9}
Relative Error = (|Actual - Measured| / Actual) * 100
Absolute Error = (Measured / Actual) * 100

Stoichiometry:
n (moles) =mass/molar mass
$N_A = 6.022x10^{23}$ (Avogadro's number)

Solutions:
M = mol/L
$M_1V_1 = M_2V_2$

Thermochemistry:
$K = {}^oC + 273.15$
1 joule (J) = 4.184calories (cal)
1,000cal = 1kilocalorie (kcal or Cal)
$q = mc\Delta T$

Gases:
PV = nRT
R = .0821Latm/molK
1atm = 760mmHg = 101.3kPa = 101,300Pa
d = MP/RT
M = mRT/PV

Acid/Base:
$pH = pK_a + \log([\text{conj. base}]/[\text{acid}])$
$[H_3O^+] = 10^{-pH}$
$[OH^-] = 10^{-pOH}$
pH + pOH = 14
$K_w = 1.0x10^{-14}$
$[H_3O^+][OH^-] = 1.0x10^{-14}$
$K_aK_b = K_w$
$pH = -\log[H_3O^+]$
$pOH = -\log[OH^-]$

Electrochemistry:
$E^o_{cell} = E^o_{red} + E^o_{ox}$
$E^o_{cell} = E^o_{cathode} - E^o_{anode}$
F = 96,480C/mol e^-

Atomic Chemistry:
$\lambda = h/(mv)$
$h = 6.626x10^{-34}$Js
$E = h\nu = hc/\lambda$
$\Delta E = -R_H\ (1/n_{hi}^2 – 1/n_{lo}^2)$
$R_H = 2.18x10^{-18}$J
$c = \lambda\nu$

Ion List

The following ions and their charges should be committed to memory:

I. You should be able to determine main group element charges from their position on the periodic table.

II. Transition Element Charges:

Ag	Silver	1+			
Zn	Zinc	2+			
Cu	Copper	1+	Copper(I)	Cuprous	
		2+	Copper(II)	Cupric	
Hg	Mercury	1+	Mercury(I)	Mercurous	Exists as Hg_2^{2+}
		2+	Mercury(II)	Mercuric	
Fe	Iron	2+	Iron(II)	Ferrous	
		3+	Iron(III)	Ferric	
Mn	Manganese	2+	Manganese(II)	Manganous	
		3+	Manganese(III)	Manganic	
Co	Cobalt	2+	Cobalt(II)	Cobaltous	
		3+	Cobalt(III)	Cobaltic	
Au	Gold	3+			
Ni	Nickel	2+			
Cr	Chromium	2+	Chromium(II)	Chromous	
		3+	Chromium(III)	Chromic	

For an element with two possible charges, the higher charge ends in –ic and the lower in -ous

III. Polyatomic Ions:

NH_4^+	Ammonium	**HCO_3^-**	Bicarbonate (Hydrogen carbonate)
SO_4^{2-}	Sulfate	MnO_4^-	Permanganate
SO_3^{2-}	Sulfite	ClO^-	Hypochlorite
NO_3^-	Nitrate	ClO_2^-	Chlorite
NO_2^-	Nitrite	ClO_3^-	Chlorate
PO_4^{3-}	Phosphate	ClO_4^-	Perchlorate
OH^-	Hydroxide	$C_2O_4^{2-}$	Oxalate
CN^-	Cyanide	CrO_4^{2-}	Chromate
$C_2H_3O_2^-$	Acetate	$Cr_2O_7^{2-}$	Dichromate
CO_3^{2-}	Carbonate		

For elements that have more than one possible combination with oxygen, the higher number of oxygens ends in –ate and the lower in -ite

IV. **Miscellaneous(Post Transition Elements):**

			Standardized (IUPAC)	**Trivial**
Sn	Tin	2+	Tin(II)	Stannous
		4+	Tin(IV)	Stannic
Pb	Lead	2+	Lead(II)	Plumbous
		4+	Lead(IV)	Plumbic
Bi	Bismuth	3+		

Solubility Characteristics of Ionic Compounds:

Soluble Compounds	Exceptions
Almost all salts of Na^+, K^+, NH_4^+ Salts of: Nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Compounds containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

Insoluble Compounds	Exceptions
Most salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-}	Salts of NH_4^+ and the alkali metal cations $Ba(OH)_2$ is soluble
Most metal sulfides, S^{2-}	
Most metal hydroxides and oxides	

Assigning Oxidation Numbers:

1. In free elements (that is, in the uncombined state), each atom has an oxidation number of zero. Thus each atom in H_2, Br_2, Na, Be, K, O_2, and P_4 has the same oxidation number: zero.
2. For ions composed of only one atom, the oxidation number is equal to the charge on the ion. Thus Li^+ has an oxidation number of +1; Ba^{2+} ion, +2; Fe^{3+}, +3; I^- ion, -1; O^{2-} ion, -2; and so on. All alkali metals have an oxidation number of +1, and all alkaline earth metals have an oxidation number of +2 in their compounds. Aluminum has an oxidation number of +3 in all its compounds.
3. The oxidation number of oxygen in most compounds (for example, MgO and H_2O) is -2, but in hydrogen peroxide (H_2O_2) and peroxide ion (O_2^{2-}), its oxidation number is -1.
4. The oxidation number of hydrogen is +1, except when it is bonded to metals in binary compounds. In these cases (for example, LiH, NaH, and CaH_2), its oxidation number is -1.
5. Fluorine has an oxidation number of -1 in all its compounds. Other halogens (Cl, Br, and I) have negative oxidation numbers when they occur as halide ions in their compounds. When combined with oxygen-for example in oxoacids and oxoanions, they have positive oxidation numbers.
6. In a neutral molecule, the sum of the oxidation numbers of all the atoms must be zero. In a polyatomic ion, the sum of oxidation numbers of all the elements in the ion must be equal to the net charge of the ion. For example, in the ammonium ion, NH_4^+, the oxidation number of N is 3- and that of H is +1. Thus the sum of the oxidation numbers is -3 + 4(+1) = +1, which is equal to the net charge of the ion.

Activity Series of Select Elements:

(Least Active) Au, Hg, Ag, Cu, H_2, Pb, Sn, Ni, Cd, Fe, Zn, Cr, Al, Mg, Na, Ca, K **(Most Active)**

Diatomic Elements:

H_2, N_2, F_2, O_2, I_2, Cl_2, Br_2 (Pneumonic for memorization: **H**ave **N**o **F**ear **O**f **I**ce **C**o**l**d **B**eve**r**ages)

Redox Equation Balancing
Ion-Electron Method

In acid solution:

1. Write two half-reactions, one representing the oxidation, and the other the reduction, that occur in the reaction. It is not necessary to know which is which at this point.

2. In each half-reaction, balance all atoms except hydrogen and oxygen.

3. Balance oxygen atoms in each half-reaction by adding one H_2O molecule for each oxygen atom needed. Never use O_2, OH^-, or any other form of oxygen.

4. Balance the hydrogen atoms by adding hydrogen ions, H^+. Never use H_2, OH^-, or any other form of hydrogen.

5. Balance the charges by adding the proper number of electrons (e^-). If steps 1-4 have been done properly, electrons will be added to the left side of one half-reaction and to the right side of the other.

6. Multiply each half-reaction by the appropriate number so that the two half-reactions have the same number of electrons. Add the half-reactions, and cancel the electrons **(they must cancel)**. Also cancel all common ions and molecules. Simplify the coefficients of the equation if possible.

If reaction takes place in basic solution:

7. In addition to steps 1-6, add one OH^- ion for each H^+ ion to both sides of the equation in step 6. Combine the H^+ and the OH^- ions on one side of the reaction into H_2O molecules. Cancel H_2O molecules that appear on both sides of the equation, and simplify if possible.

If the redox reaction does not take place in acidic or basic solution, then you can usually solve the problem by inspection. Just make sure that both atoms and charges are balanced.

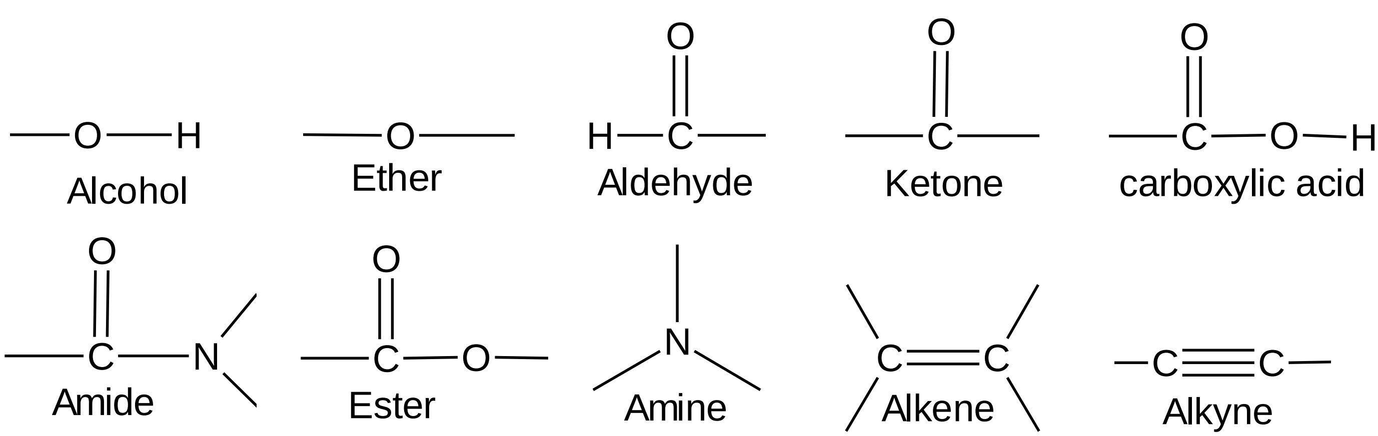
Common Strong Acids and Bases			
Acid	**Name of Acid**	**Base**	**Name of Base**
HCl	Hydrochloric acid	LiOH	Lithium hydroxide
HBr	Hydrobromic acid	NaOH	Sodium hydroxide
HI	Hydroiodic acid	KOH	Potassium hydroxide
HNO_3	Nitric acid	$Ca(OH)_2$	Calcium hydroxide
$HClO_4$	Perchloric acid	$Sr(OH)_2$	Strontium hydroxide
H_2SO_4	Sulfuric acid	$Ba(OH)_2$	Barium hydroxide

Base Triplets and Associated Amino Acids

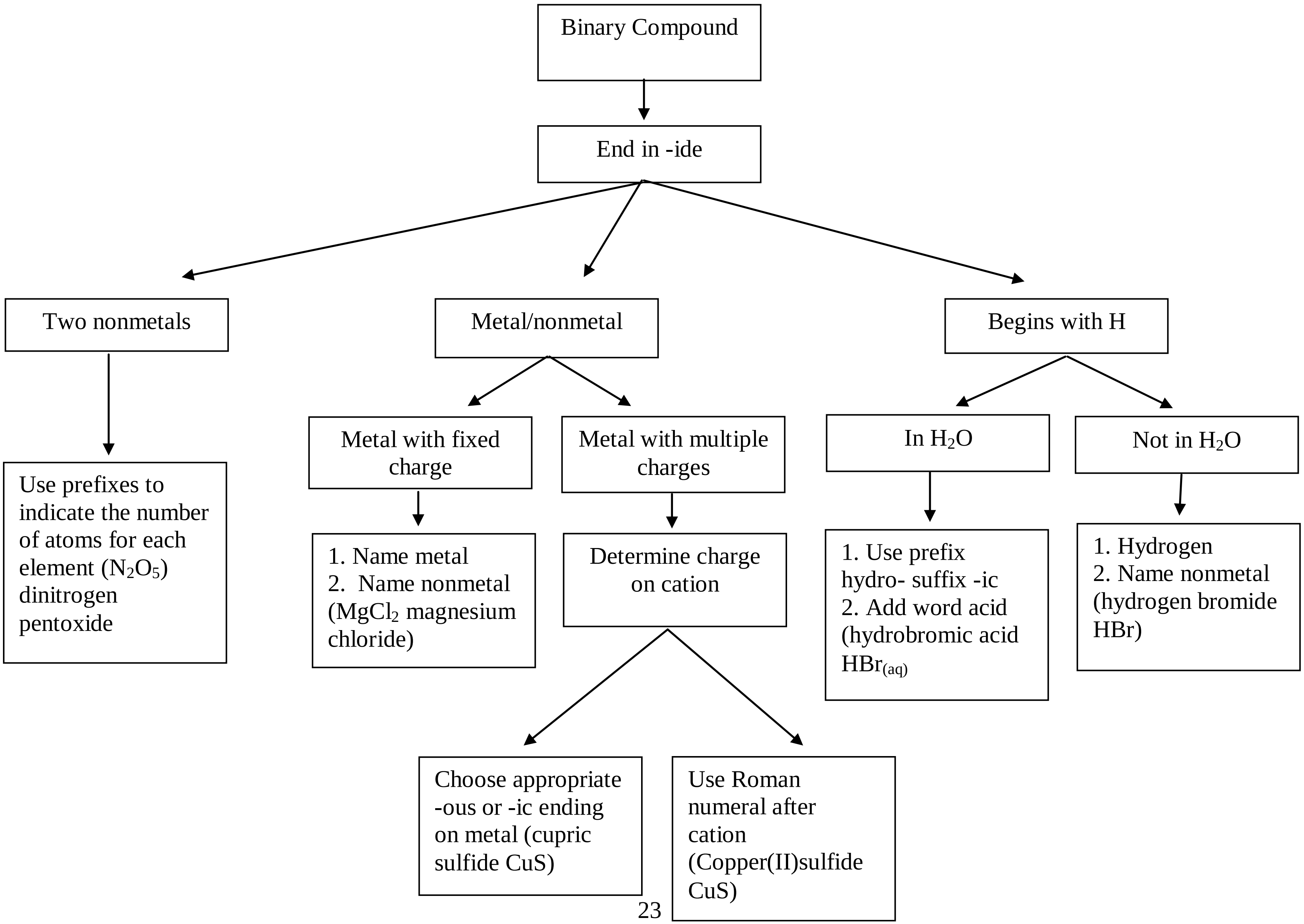
First Base	Second Base: U		C		A		G		Third Base
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	**U**
	UUC		UCC		UAC		UGC		**C**
	UUA	Leu	UCA		UAA	Termination	UGA	Termination	**A**
	UUG		UCG		UAG	Termination	UGG	Trp	**G**
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	**U**
	CUC		CCC		CAC		CGC		**C**
	CUA		CCA		CAA	Gln	CGA		**A**
	CUG		CCG		CAG		CGG		**G**
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	**U**
	AUC		ACC		AAC		AGC		**C**
	AUA		ACA		AAA	Lys	AGA	Arg	**A**
	AUG	Met	ACG		AAG		AGG		**G**
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	**U**
	GUC		GCC		GAC		GGC		**C**
	GUA		GCA		GAA	Glu	GGA		**A**
	GUG		GCG		GAG		GGG		**G**

Gly - Glycine	Ala - Alanine	Phe - Phenylalanine	Val - Valine
Leu - Leucine	Ile - Isoleucine	Pro - Proline	Met - Methionine
Ser - Serine	Thr - Threonine	Asn - Asparagine	Gln - Glutamine
Cys - Cysteine	Tyr - Tyrosine	Trp - Tryptophan	Lys - Lysine
Arg - Arginine	His - Histidine	Asp - Aspartic acid	Glu - Glutamic acid

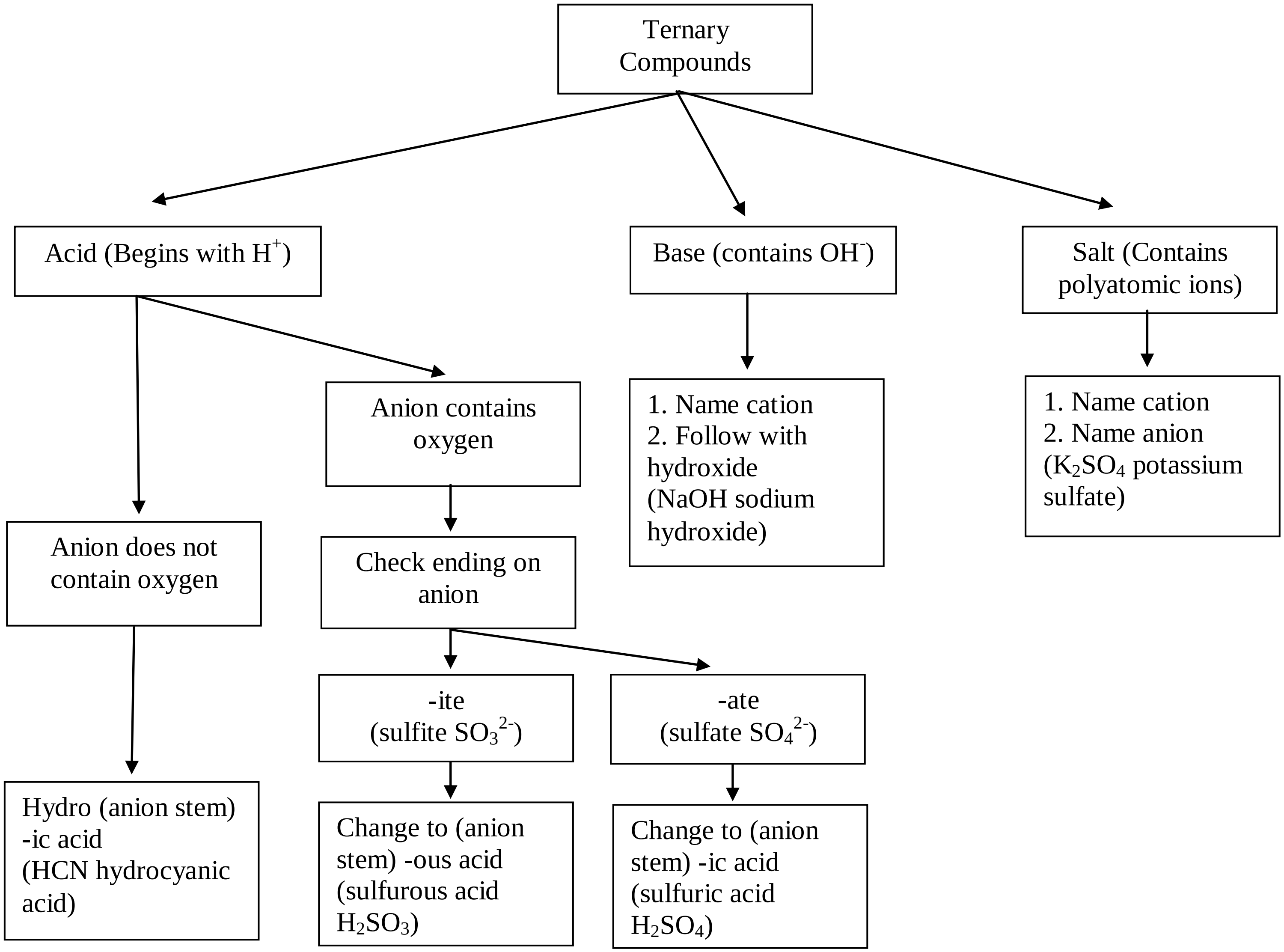
Common Organic Functional Groups



Nomenclature Flowchart - Binary Compounds



Nomenclature Flowchart - Ternary Compounds



Nomenclature Rules

Acids		
Notes: 1. Have leading hydrogen(s) in the compound formula (usually). 2. Dissociate in solution to produce H^+ ions. 3. When writing the formula, include one hydrogen for each negative charge on the "anion". (Note: Technically acids are not ionic compounds but this serves as a useful rule for writing the correct formula.)		
Combinations you will encounter:	**Rules:**	**Examples:**
Those containing oxygen (oxoacids)	1. Identify the polyatomic ion. 2.Change -ate endings to -ic Change -ite endings to -ous 3. Write the name of the polyatomic ion with the change in the ending. 4. Write the word acid.	HNO_3 nitric acid (from nitrate) H_3PO_4 phosphoric acid (from phosphate) H_2SO_4 sulfuric acid (from sulfate)
Those not containing oxygen	1. Write the word hydro 2. Write the name of the "anion" with its ending changed to -ic 3. Write the word acid.	Examples: HCl hydrochloric acid HCN hydrocyanic acid HBr hydrobromic acid

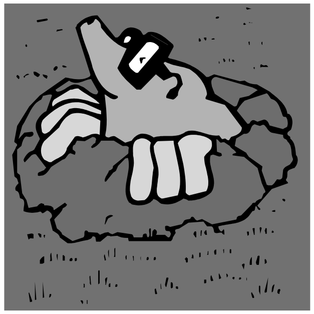
Naming Ionic Compounds		
Notes: 1. Compounds where electrons are transferred between elements (usually between metals and nonmetals) 2. When writing formulas for these compounds the charges between the cation and anion must be balanced to that the overall compound is *neutral*.		
Combinations you will encounter:	**Rules:**	**Example:**
Metal with a fixed charge paired with a nonmetal	1. Name the metal 2. Name the nonmetal with the ending changed to -ide	NaCl Sodium chloride
Metal with a fixed charge paired with a polyatomic anion	1. Name the metal 2. Name the polyatomic anion	$Mg(NO_3)_2$ Magnesium nitrate
Metal with a variable charge paired with a nonmetal	1. Name the metal using: Roman numeral for charge or Latin derivative (if available) with -ic or -ous ending 2. Name the nonmetal with the ending changed to -ide	$FeCl_3$ Iron(III)chloride Ferric chloride
Metal with a variable charge paired with a polyatomic anion	1. Name the metal using: Roman numeral for charge or Latin derivative (if available) with -ic or -ous ending 2. Name the polyatomic anion	$Sn(NO_3)_4$ Tin(IV)nitrate Stannic nitrate
Polyatomic cation paired with a polyatomic anion	1. Name the polyatomic cation 2. Name the polyatomic anion	NH_4NO_3 Ammonium nitrate

Naming Covalent Compounds (Molecules)		
Notes: 1. Compounds where electrons are shared and **no** ions form (usually between nonmetals and nonmetals) 2. These compounds are the ONLY ones that use prefixes (mono, di, tri, etc.)		
Combinations you will encounter:	**Rules:**	**Example:**
Nonmetal element paired with a nonmetal element	1. Name the first occurring element using the prefix corresponding to the subscript (except mono-) 2. Name the second occurring element using the prefix corresponding to the subscript and changing the ending to -ide	Cl_2O_7 Dichlorine heptoxide

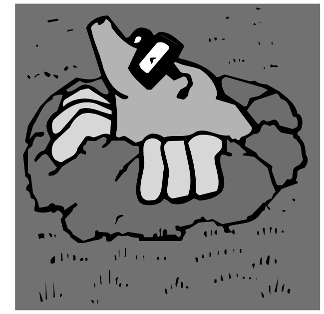
Electronegativities

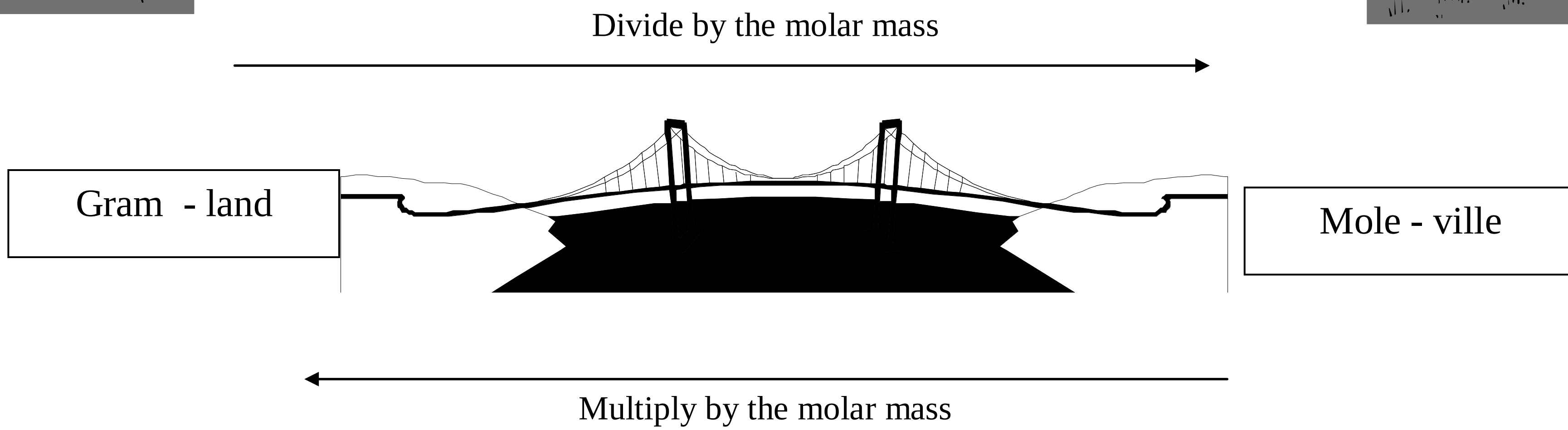
1 1A																	18 8A
1 (2.1) H Hydrogen 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He Helium 4.003
3 (1.0) Li Lithium 6.941	4 (1.5) Be Beryllium 9.012											5 (2.0) B Boron 10.81	6 (2.5) C Carbon 12.01	7 (3.0) N Nitrogen 14.01	8 (3.5) O Oxygen 16.00	9 (4.0) F Fluorine 19.00	10 Ne Neon 20.18
11 (1.0) Na Sodium 22.99	12 (1.2) Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 (1.5) Al Aluminum 26.98	14 (1.8) Si Silicon 28.09	15 (2.1) P Phosphorus 30.97	16 (2.5) S Sulfur 32.07	17 (3.0) Cl Chlorine 35.45	18 Ar Argon 39.95
19 (0.9) K Potassium 39.10	20 (1.0) Ca Calcium 40.08	21 (1.3) Sc Scandium 44.96	22 (1.4) Ti Titanium 47.88	23 (1.5) V Vanadium 50.94	24 (1.6) Cr Chromium 52.00	25 (1.6) Mn Manganese 54.94	26 (1.7) Fe Iron 55.85	27 (1.7) Co Cobalt 58.93	28 (1.8) Ni Nickel 58.69	29 (1.8) Cu Copper 63.55	30 (1.6) Zn Zinc 65.39	31 (1.7) Ga Gallium 69.72	32 (1.9) Ge Germanium 72.59	33 (2.1) As Arsenic 74.92	34 (2.4) Se Selenium 78.96	35 (2.8) Br Bromine 79.90	36 Kr Krypton 83.80
37 (0.9) Rb Rubidium 85.47	38 (1.0) Sr Strontium 87.62	39 (1.2) Y Yttrium 88.91	40 (1.3) Zr Zirconium 91.22	41 (1.5) Nb Niobium 92.91	42 (1.6) Mo Molybdenum 95.94	43 (1.7) Tc Technetium (98)	44 (1.8) Ru Ruthenium 101.1	45 (1.8) Rh Rhodium 102.9	46 (1.8) Pd Palladium 106.4	47 (1.6) Ag Silver 107.9	48 (1.6) Cd Cadmium 112.4	49 (1.6) In Indium 114.8	50 (1.8) Sn Tin 118.7	51 (1.9) Sb Antimony 121.8	52 (2.1) Te Tellurium 127.6	53 (2.5) I Iodine 126.9	54 Xe Xenon 131.3
55 (0.8) Cs Cesium 132.9	56 (1.0) Ba Barium 137.3	57 (1.1) La Lanthanum 138.9	72 (1.3) Hf Hafnium 178.5	73 (1.4) Ta Tantalum 180.9	74 (1.5) W Tungsten 183.9	75 (1.7) Re Rhenium 186.2	76 (1.9) Os Osmium 190.2	77 (1.9) Ir Iridium 192.2	78 (1.8) Pt Platinum 195.1	79 (1.9) Au Gold 197.0	80 (1.7) Hg Mercury 200.6	81 (1.6) Tl Thallium 204.4	82 (1.7) Pb Lead 207.2	83 (1.8) Bi Bismuth 209.0	84 (1.9) Po Polonium (210)	85 (2.1) At Astatine (210)	86 Rn Radon (222)
87 (0.8) Fr Francium (223)	88 (1.0) Ra Radium 226.03	89 (1.1) Ac Actinium 227.03	104 Rf *Rutherfordium* (261)	105 Db *Dubnium* (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ** (269)	111 ** (272)	112 ** (277)	Unknown	114 **	Unknown	116 (Suspect)	Unknown	118 (Retracted)

58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (147)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
90 Th Thorium 232.0	91 Pa Protactinium (231)	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (242)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (249)	99 Es Einsteinium (254)	100 Fm Fermium (253)	101 Md Mendelevium (256)	102 No Nobelium (254)	103 Lr Lawrencium (257)

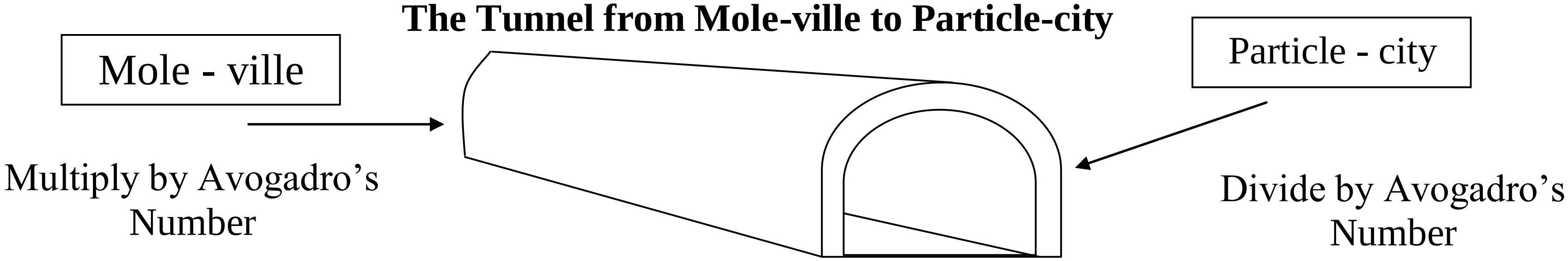


Directions from Gram-land to Mole-ville via the Mole Bridge

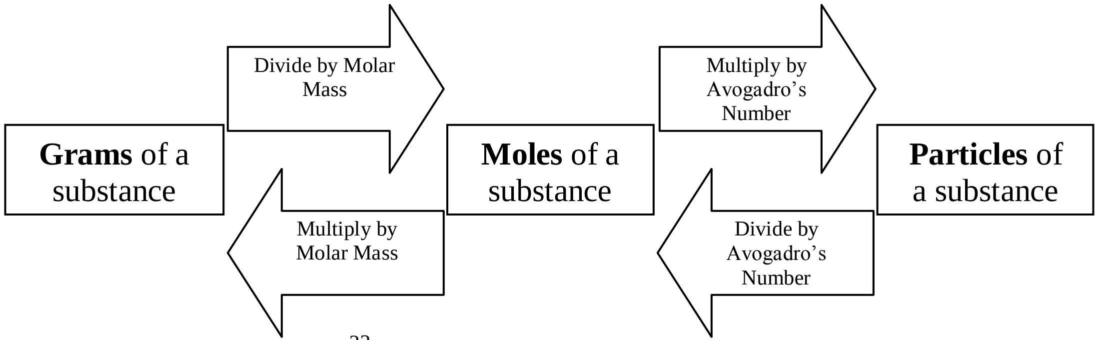




The Tunnel from Mole-ville to Particle-city



Helpful Stoichiometric Relationships



Avogadro's Number = $6.022x10^{23}$

Avogadro's number represents the number of carbon atoms in exactly 12.0g of the Carbon-12 isotope.

If the "particle" listed in the above table is a compound, to find the number of atoms of a particular element you must multiply the subscript of that element by the total number of particles.

A "**mole**" of something is $6.022x10^{23}$ units of that something (atoms, molecules, baseballs, etc.)

The **atomic mass** of an atom is the mass of the atom expressed in amu's (atomic mass units) where 1 amu is about the mass of a proton or neutron (specifically 1.660538×10^{-24} grams).

The **molar mass** of a substance is the mass (usually expressed in grams) required to obtain $6.022x10^{23}$ (Avogadro's number) units of that substance.

The atomic mass and molar mass are numerically the same; however the units are *very different*.

Never use coefficients of a balanced equation to determine the molar mass of a substance. **Only** use coefficients to compare mole ratios or reactants and products.

When **balancing equations**, **never** change the subscripts of a compound and never place coefficients in the middle of a compound. **Only** use coefficients placed in front of the entire compound.

A **limiting reagent** is the substance that you run out of first in a reaction. It should always be used to calculate the amount of product produced since it will determine the extent of the reaction (i.e. the other reactant(s) will have some leftovers).

Percent composition = (mass represented by a particular element)/(mass of the whole compound)

Percent yield = (actual grams of product formed)/(theoretical grams of product that could be formed)

Molecules refer to covalently bonded compounds only.

Standard Reduction Potentials (Volts), 25°C

Reaction	E^o
$F_2 + 2e^- \rightarrow 2F^-$	+2.87
$Co^{3+} + e^- \rightarrow Co^{2+}$	+1.80
$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_{4(s)} + 2H_2O$	+1.69
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.49
$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$	+1.46
$Cl_2 + 2e^- \rightarrow 2Cl^-$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.33
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	+1.23
$Br_2 + 2e^- \rightarrow 2Br^-$	+1.07
$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$	+0.96
$Hg^{2+} + 2e^- \rightarrow Hg$	+0.85
$Ag^+ + e^- \rightarrow Ag$	+0.80
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77
$I_2 + 2e^- \rightarrow 2I^-$	+0.54
$Cu^+ + e^- \rightarrow Cu$	+0.52
$Fe(CN)_6^{3-} + e^- \rightarrow Fe(CN)_6^{4-}$	+0.36
$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34
$Cu^{2+} + e^- \rightarrow Cu^+$	+0.15
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	+0.15
$2H^+ + 2e^- \rightarrow H_2$	0.00
$Fe^{3+} + 3e^- \rightarrow Fe$	-0.04
$Pb^{2+} + 2e^- \rightarrow Pb$	-0.13
$Sn^{2+} + 2e^- \rightarrow Sn$	-0.14
$Ni^{2+} + 2e^- \rightarrow Ni$	-0.25
$Co^{2+} + 2e^- \rightarrow Co$	-0.29
$PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$	-0.359
$PbI_2 + 2e^- \rightarrow Pb + 2I^-$	-0.365
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	-0.40
$Cd^{2+} + 2e^- \rightarrow Cd$	-0.40
$Fe^{2+} + 2e^- \rightarrow Fe$	-0.41
$Cr^{3+} + 3e^- \rightarrow Cr$	-0.74
$Zn^{2+} + 2e^- \rightarrow Zn$	-0.76
$2H_2O + 2e^- \rightarrow H_{2(g)} + 2OH^-$	-0.83
$V^{2+} + 2e^- \rightarrow V$	-1.18
$Mn^{2+} + 2e^- \rightarrow Mn$	-1.18
$Al^{3+} + 3e^- \rightarrow Al$	-1.66
$Mg^{2+} + 2e^- \rightarrow Mg$	-2.37
$Na^+ + e^- \rightarrow Na$	-2.71
$Li^+ + e^- \rightarrow Li$	-3.04

Top to bottom on chart = Increasing strength as reducing agent
Bottom to top on chart = Increasing strength as oxidizing agent