Periodic Table of the Elements

1 H 1.00794																1 H 1.00794	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (289) (287)		116 (289)		118 (293)

58 Ce 140.116	59 Pr 140.90765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04	71 Lu 174.967
90 Th 232.0381	91 Pa 231.03588	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

S.E. Van Bramer, 7/22/99

1995 IUPAC masses and Approved Names from http://www.chem.qmw.ac.uk/iupac/AtWt/
masses for 107-111 from C&EN, March 13, 1995, P 35
112 from http://www.gsi.de/z112e.html
114 from C&EN July 19, 1999
116 and 118 from http://www.lbl.gov/Science-Articles/Archive/elements-116-118.html

SIGNIFICANT FIGURES AND CALCULATIONS

All measurements involve uncertainty. Since it is very important that the uncertainty in the final result is known, rules have been developed for counting the significant figures in each number and determining the correct number of significant figures in the final result of calculations.

SIGNIFICANT FIGURES IN ANY MEASURMENT INCLUDE:

1. All the digits known in the measurement with certainty.
2. Plus one digit that is estimated (uncertain)

RULES FOR COUNTING SIGNIFICANT FIGURES IN MEASURMENT GIVEN:

1. Nonzero integers ALWAYS count as significant figures.
2. Zeros. There are three classes of zeros.
   a. Leading zeros are zeros that come before all the nonzero digits. These are NOT significant figures. Examples:

   b. Captive zeros are zeros between nonzero digits. These ARE significant figures. Examples:

   c. Trailing zeros are zeros to the right of the nonzero digits. They are significant ONLY if the number contains a decimal point. Examples:

3. Exact numbers comes in two classes, too.
   a. Numbers determined by counting are exact. (Assume infinite sig fig) Examples:

   b. Numbers arising from definitions (i.e. conversion factors) are exact. Examples:

We *Love* SCIENTIFIC NOTATION because

1. The number of significant figures is easily notated
2. Fewer zeros must be written for very large and very small numbers

RULES FOR SIGNIFICANT FIGURES IN MATHMATICAL OPERATIONS

1. Multiplication/Division
   The number of significant figures in the result(product) is the same as the nember of digits in the factor with the least number of digits (least precise).
   Examples:

2. Addition/Subtraction
   The number of significant figures in the result is the same number of decimal places as the least precise measurement used in the calculation.
   Example:

RULES FOR ROUNDING

1. In the actual calculation, carry the extra digits throughout the final result, THEN ROUND!!!

2. If the digit to be removed
   a. Is less than 5, the preceding digit stays the same.
      Examples:

   b. Is equal to or greater than 5, the preceding digit is increased by 1.
      Examples:

SIGNIFICANT FIGURES
or
SIGNIFICANT DIGITS

Does the measurement have a decimal?

NO	YES
1. Find the first non-zero.	1. Find the first non-zero.
2. Find the last non-zero.	2. Count **THAT NUMBER** and all others **AFTER IT**.
3.Count the **FIRST** and **LAST** number and all others **BETWEEN**	

Calculations

MULTIPLICATION/DIVISION	ADDITION/SUBTRACTION
1. Identify the number of **SIGNIFICANT FIGURES.**	1. Identify the **LEAST PRECISE MEASUREMENT**.
2. Calculate	2. Calculate
3. **ROUND** the answer using **SIGNIFICANT FIGURES.**	3. **ROUND** the answer to match the **LEAST PRECISE MEASUREMENT.**

Why The Rule for Significant Digits Gives the Correct Answer

Take a look at the calculation of the density of a liquid, and use the example to see why this rule about significant digits exists. In this example, we're showing the actual ±uncertainty we can expect. This uncertainty tells us how large, or how small our actual measured data might be. Here's the data:

	Measured Result	**Could be as high as**	**Could be as low as**
Mass of liquid	68.24 ±0.01 g	68.25 g	68.23 g
Volume of liquid	90.2 ±0.2 mL	90.4 mL	90.0 mL

Since density = mass/volume, we can use this data to calculate the biggest (divide the largest possible mass by the smallest possible volume) and smallest (divide the smallest possible mass by the largest possible volume) densities we could have.

	Mass (g)	**Volume (mL)**	**Density (g/mL)**
Largest density	68.25	90.0	0.7583333333333
Smallest density	68.23	90.4	0.7547566371681

We've highlighted in red the digit at which the two answers are different. Notice that it is at the third significant digit. If the numbers are different at the third significant digit, then obviously all the other answers to right of them are totally meaningless. The rule we have works: **always round off the answer to the shortest number of significant digits** – in this case the three digits in the volume. So you should calculate the density measured here as (68.24 g)/(90.2 mL) = 0.7565410199557 and then report it rounded off to 0.757 g/mL at the third significant digit.

HOW TO NAME AN IONIC COMPOUND

1. Identify the cation and anion using Tables 4.1, 4.2, and 4.4.

2. If the cation is a metal that can have more than one charge, then determine the cation charge in this formula.

   Write the cation name first, using Roman numerals for the charge, and then write the anion name last.

3. If the cation is either a polyatomic ion or a metal that can have only one charge, then write the cation name first followed by the anion name.

HOW TO WRITE A FORMULA FOR AN IONIC COMPOUND

1. Identify the cation and anion names in the compound name.

2. Write the symbols for the cation and anion side by side.

3. If the cation name is followed by Roman numerals, then assign that amount of charge to the cation, and determine the anion charge, based on Tables 4.1, 4.2, and 4.4.

4. If the cation is not followed by Roman numerals, then determine the ions charge, based on Tables 4.1, 4.2, and 4.4.

5. Find the least common multiple of the ions' charges.

6. If polyatomic ions are not present, use subscripts to indicate how many of each ion would be necessary to have the amount of charge designated by the least common multiple.

7. If polyatomic ions are present, use subscripts and parentheses to indicate how many of each ion would be necessary to have the amount of charge designated by the least common multiple.

HOW TO WRITE A FORMULA FOR A MOLECULAR (Covalent) COMPOUND

1. The less-electronegative element is given first. It is given a prefix only if it contributes more than one atom to a molecule of the compound. Generally order goes: C, P, N, H, S, I, Br, Cl, O, F.

2. The second element is named by combining a prefix indicating the number of atoms contributed by the element, the root of the name of the second element and the ending –ide.

3. The o or a at the end of a prefix is usually dropped when the word following the prefix begins with another vowel, e.g. monoxide or pentoxide.

Polyatomic Ions

-ate and -ite

→If they end with -ate

Inside the 4-shape…4 oxygens

PO_4^{3-} SO_4^{2-} AsO_4^{3-}

SeO_4^{2-} TeO_4^{2-}

Outside the 4-shape…3 oxygens

NO_3^- CO_3^{2-} ClO_3^-

BrO_3^- FO_3^-

→If they end with -ite

Subtract one oxygen from those ending in -ate.

CHARGES STAY THE SAME!!!

PO_4^{3-} becomes PO_3^{3-} phosphate becomes phosphite

SO_4^{2-} becomes SO_3^{2-} sulfate becomes sulfite

NO_3^- becomes NO_2^- nitrate becomes nitrite

CO_3^{2-} becomes CO_2^{2-} carbonate becomes carbonite

ClO_3^- becomes ClO_2^- chlorate becomes chlorite

What are the charges?

→Follow the pattern.

C	N		
	P	S	Cl

2-	1-		
	3-	2-	1-

CO_3^{2-}	NO_3^-		
	PO_4^{3-}	SO_4^{2-}	ClO_3^-

Weird Polyatomics		
1+	1-	2-
ammonium	acetate	peroxide
	cyanide	
	hydroxide	

How Many Oxygens in the Oxyanion?				
Inside or Outside 4-Shape	per-_____-ate per- = one more	-ate	-ite	hypo-_____-ite hypo- = one less
Inside	5	4	3	2
Outside	4	3	2	1
	(become -ic acids)		(become -ous acids)	

What Do I Do With Extra Hydrogen Atoms On The Polyatomic Ion?				
How Many Extra Hydrogen Atoms?	Prefix At The Front	Change the Charge	Formula	Example Name
0	(none needed)	don't	PO_4^{3-}	phosphate
1	(none needed)	Add 1+	HPO_4^{2-}	hydrogen phosphate
2	di	Add 2+	$H_2PO_4^{-}$	dihydrogen phosphate

A Bite of Pus: I Ate it and got Sick		
Acids must have hydrogen	-ate changes to -ic acid	-ite changes to -ous acid

Binary Acids (without oxygen)	Oxyacids (with oxygen)	
	Original Anion	Name
	ends in -ate	_____-ic acid
hydro-_____-ic acids	ends in -ite	_____-ous acid

Given: g A — Unknown: mol A

1 STEP

$$\text{g A} \times \frac{\text{1 mol A}}{\text{g A}} = \quad \text{mol A}$$

(Periodic Table Mass)

Example: Convert 2.5 g of carbon to moles.

Given: mol A — Unknown: atoms A

1 STEP

$$\text{mol A} \times \frac{6.022 \times 10^{23}\ \text{atoms A}}{\text{1 mol A}} = \quad \text{atoms A}$$

Example: Convert 2.5 moles of carbon to atoms.

Given: g A — Unknown: atoms A

2 STEPS

$$\text{g A} \times \frac{\text{1 mol A}}{\text{g A}} \times \frac{6.022 \times 10^{23}\ \text{atoms A}}{\text{1 mol A}} = \quad \text{atoms A}$$

(Periodic Table Mass)

Example: Convert 2.5 g of carbon to atoms.

Given: atoms A — Unknown: mol A

1 STEP

$$\text{atoms A} \times \frac{\text{1 mol A}}{6.022 \times 10^{23}\ \text{atoms A}} = \quad \text{mol A}$$

Example: Convert 2.5 atoms of carbon to moles.

Given: mol A — Unknown: g A

1 STEP

$$\text{mol A} \times \frac{\text{g A}}{\text{1 mol A}} = \quad \text{g A}$$

(Periodic Table Mass)

Example: Convert 2.5 moles of carbon to g.

Given: atoms A — Unknown: g A

2 STEPS

$$\text{atoms A} \times \frac{\text{1 mol A}}{6.022 \times 10^{23}\ \text{atoms A}} \times \frac{\text{g A}}{\text{1 mol A}} = \quad \text{g A}$$

(Periodic Table Mass)

Example: Convert 2.5 atoms of carbon to g.

Types of Reactions

Reactants $\longrightarrow$ Products

NOTES

Honors Chemistry

Chapters 6 & 7

TYPE 1

SYNTHESIS
2 → 1

Element + Element → Compound

TYPE 2

DECOMPOSITION
1 → 2

a) binary compound → element + element
b) metal hydroxide → metal oxide + H_2O
c) metal chlorate → metal chloride + O_2
d) metal carbonate → metal oxide + CO_2

TYPE 3

COMBUSTION
Hydrocarbon + O_2

a) complete combustion → CO_2 + H_2O
b) incomplete combustion → CO + H_2O

TYPE 4

SINGLE REPLACEMENT
Element + Compound

a) metal + XZ → metal Z + X
b) halogen + XZ → X halogen + Z

TYPE 5

DOUBLE REPLACEMENT
Compound + Compound

AB + CD → AD + CB

Diatomic Molecules

H_2
O_2
N_2
F_2
Cl_2
Br_2
I_2

s = solid
l = liquid
g = gas
aq = aqueous (water solution)

Type of Reaction	Reactant Characteristic(s)	Product Characteristic(s)	Other Possible Types
Synthesis/Composition	2 or more	only 1	redox, combustion
Decomposition	only 1	2 or more	redox
Single Replacement/Displacement	1 element + 1 compound	new element + new compound	redox
Double Replacement/Displacement	2 compounds	switch, 2 new compounds	precipitation, acid-base
Combustion	fuel + O_2	$CO_2 + H_2O$	redox, synthesis
Redox/Oxidation-Reduction	O_2 possible, metal loses electrons, nonmetal gains electrons	O_2 possible, metal loses electons, nonmetal gains electrons	synthesis, combustion, single replacement
Precipitation	2 aqueous compounds	1 solid and 1 aqueous compound	acid-base, double replacement
Acid-Base	H = acid, OH = base	salt + water	double replacement, precipiation

Type of Reaction	General Equation	Helpful Hints
Synthesis/Composition	$A + X \rightarrow AX$	check charges of ions
Decomposition	$AX \rightarrow A + X$	gas usually produced
Single Replacement/Displacement	$A + BX \rightarrow AX + B$	use the activity series
Double Replacement/Displacement	$AX + BY \rightarrow BX + AY$	positives bond with negatives
Combustion	Hydrocarbon + $O_2 \rightarrow CO_2 + H_2O$	no CO_2 for flamable gases or metals
Redox/Oxidation-Reduction	metal - e- $\rightarrow$ metal$^{+\text{ charge}}$ metal$^{+\text{ charge}}$ - e- $\rightarrow$ metal$^{\text{more + charge}}$ nonmetal + e- $\rightarrow$ nonmetal$^{-\text{ charge}}$ nonmetal$^{-\text{ charge}}$ + e- $\rightarrow$ nonmetal$^{\text{more - charge}}$	OIL RIG: oxidation is the loss of electrons, reduction is the gain of electrons
Precipitation	2 aqueous compounds $\rightarrow$ solid compound + aqueous compound	use the solubility chart
Acid-Base	$HX + AOH \rightarrow AX + H_2O$	look for H and OH as reactants

Table 8.1

General Rules for Solubility of Ionic Compounds (Salts) in Water at 25 °C

1. Most nitrate (NO_3^-) salts are soluble.
2. Most salts of Na^+, K^+, and NH_4^+ are soluble.
3. Most chloride salts are soluble. Notable exceptions are AgCl, $PbCl_2$, and Hg_2Cl_2.
4. Most sulfate salts are soluble. Notable exceptions are $BaSO_4$, $PbSO_4$, and $CaSO_4$.
5. Most hydroxide compounds are only slightly soluble.* The important exceptions are NaOH and KOH. $Ba(OH)_2$ and $Ca(OH)_2$ are moderately soluble.
6. Most sulfide (S^{2-}), carbonate (CO_3^{2-}), and phosphate (PO_4^{3-}) salts are only slightly soluble.*

*The terms *insoluble* and *slightly soluble* really mean the same thing: such a tiny amount dissolves that it is not possible to detect it with the naked eye.

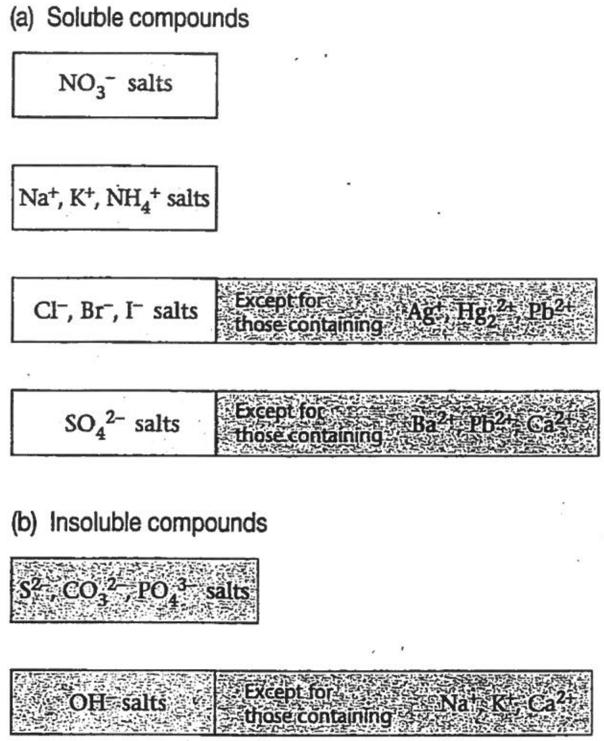

Figure 8.3
Solubilities of common compounds

TABLE 8-3 *Activity Series of the Elements*

Activity of metals		Activity of halogen nonmetals
Li Rb K Ba Sr Ca Na	React with cold H_2O and acids, replacing hydrogen. React with oxygen, forming oxides.	F_2 Cl_2 Br_2 I_2
Mg Al Mn Zn Cr Fe Cd	React with steam (but not cold water) and acids, replacing hydrogen. React with oxygen, forming oxides.	
Co Ni Sn Pb	Do not react with water. React with acids, replacing hydrogen. React with oxygen, forming oxides.	
H_2 Sb Bi Cu Hg	React with oxygen, forming oxides.	
Ag Pt Au	Fairly unreactive, forming oxides only indirectly.	