

## Measurement and Communication:

1. Complete the following table of prefixes.

Factor	Prefix	Abbreviation
$10^6$	mega	M
$10^3$	kilo	k
$10^2$	hecto	h
$10^1$	deka	da
$10^{-1}$	deci	d
$10^{-2}$	centi	c
$10^{-3}$	milli	m
$10^{-6}$	micro	$\mu$
$10^{-9}$	nano	n
$10^{-12}$	pico	p

2. A student weighed a mass 4 times and obtained the following masses:

25.5g, 29.6g, 23.6g, 27.3g

The actual value is known to be 10.20045g

What can be said about the accuracy and precision of the measurements?

- not accurate (correct) or precise (reproducible)

3. Write the following numbers in scientific notation with the same number of significant digits.

- a) 0.000005187  $\underline{5.187 \times 10^{-6}}$   
 b) 7,247  $\underline{7.247 \times 10^3}$   
 c) 16,140  $\underline{1.614 \times 10^4}$   
 d) 0.0921  $\underline{9.21 \times 10^{-2}}$

4. Convert the following numbers from scientific notation into decimal form.

- a)  $4.562 \times 10^6$   $\underline{4,562,000}$   
 b)  $8.276 \times 10^{-8}$   $\underline{0.00000008276}$

5. Complete the following calculations. Include all units and don't forget about sig figs.

a)  $1.0068\text{g} + 2.15\text{g} + 8.3\text{g} = 11.5\text{g}$

b)  $21.05\text{cm} - 12.1\text{cm} = 9.0\text{cm}$

c)  $\frac{1.50 \times 10^{-2} \text{ mol}}{40.0\text{mL}} = 3.75 \times 10^{-4} \text{ mol/mL}$

d)  $\frac{432.8\text{g}}{21.8\text{cm} \times (7.645\text{cm} - 3.58\text{cm})} = \frac{432.8\text{g}}{21.8\text{cm} \times 4.065} = 4.88\text{g/cm}^2$

6. Convert 12 milliamperes into megaamperes.

$$12 \text{ mA} \times \frac{1 \text{ A}}{10^3 \text{ mA}} \times \frac{1 \text{ MA}}{10^6 \text{ A}} = 1.2 \times 10^{-8} \text{ MA}$$

7. Convert 42.6 μmol/mL into mol/L.

$$\frac{42.6 \mu\text{mol}}{\text{mL}} \times \frac{10^3 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ mol}}{10^6 \mu\text{mol}} = 0.0426 \text{ mol/L}$$

8. Determine how many significant figures are in each of the following numbers:

- |            |   |              |   |
|------------|---|--------------|---|
| a) 1.00300 | 6 | e) 0.003050  | 4 |
| b) 780.00  | 5 | f) 7,000,800 | 5 |
| c) 0.1110  | 4 | g) 0.00567   | 3 |
| d) 3000    | 1 | h) 3.000     | 4 |

### Mole Conversions:

1. Calculate the MOLAR MASS of the following substances.

a) CuSO <sub>4</sub>	Cu: 1 × 63.5 = 63.5	b) Ca(MnO <sub>4</sub> ) <sub>2</sub>	Ca: 1 × 40.1 = 40.1
	S: 1 × 32.1 = 32.1		Mn: 2 × 54.9 = 109.8
	O: 4 × 16.0 = 64.0		O: 8 × 16.0 = 128.0
	<hr/>		<hr/>
	159.6 g/mol		277.9 g/mol

2. Calculate the number of moles of CO<sub>2</sub> that would be present in 8.7 × 10<sup>18</sup> molecules of CO<sub>2</sub>.

$$8.7 \times 10^{18} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} = 1.4 \times 10^{-5} \text{ mol CO}_2$$

3. How many grams of Copper would be present in 4.5 × 10<sup>-3</sup> moles of Copper?

$$4.5 \times 10^{-3} \text{ mol} \times \frac{63.5 \text{ g}}{1 \text{ mol}} = 0.29 \text{ g}$$

4. Calculate the mass (in g) of 2.7 × 10<sup>21</sup> molecules of ammonia (NH<sub>3</sub>): → 14.0 + 3.0 = 17.0 g/mol

$$2.7 \times 10^{21} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{17.0 \text{ g}}{1 \text{ mol}} = 0.076 \text{ g NH}_3$$

5. Determine the mass (in grams) of one atom of Silver.

$$1 \text{ atom} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{107.9 \text{ g}}{1 \text{ mol}} = 1.792 \times 10^{-22} \text{ g Ag}$$

6. How many molecules are in 75.6 g of CH<sub>3</sub>C(OH)<sub>2</sub>CH<sub>3</sub>? → (12.0 × 3) + (16.0 × 2) + (1.0 × 8)

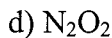
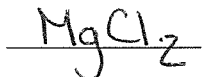
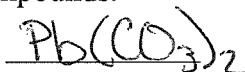
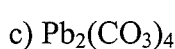
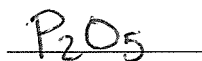
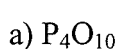
$$75.6 \text{ g} \times \frac{1 \text{ mol}}{76.0 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 5.99 \times 10^{23} \text{ molecules} = 76.0 \text{ g}$$

7. What is the volume occupied by 15 mg of SbH<sub>3(g)</sub> at STP?

$$15 \text{ mg} \times \frac{1 \text{ g}}{10^3 \text{ mg}} \times \frac{1 \text{ mol}}{124.8 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.0027 \text{ L SbH}_3$$

## Percentage Composition, Empirical and Molecular Formulae:

1. Write the empirical formula for each of the following compounds.



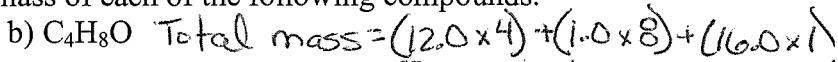
2. Calculate the percentage composition by mass of each of the following compounds.



$$\text{Total mass} = (12.0 \times 1) + (16.0 \times 2) = 44.0 \text{ g/mol}$$

$$\%C = \frac{12.0 \text{ g}}{44.0 \text{ g}} \times 100\% = 27.3\% C$$

$$\%O = \frac{32.0 \text{ g}}{44.0 \text{ g}} \times 100\% = 72.7\% O$$

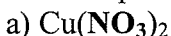


$$\%C = \frac{48.0 \text{ g}}{72.0 \text{ g}} \times 100\% = 66.7\% C$$

$$\%H = \frac{8.0 \text{ g}}{72.0 \text{ g}} \times 100\% = 11\% H$$

$$\%O = \frac{16.0 \text{ g}}{72.0 \text{ g}} \times 100\% = 22.2\% O$$

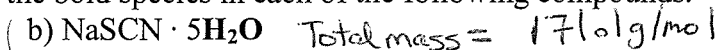
3. Calculate the percentage composition of the bold species in each of the following compounds.



$$\text{Total mass} = 187.5 \text{ g/mol}$$

$$NO_3 \text{ mass} = 2(14 + (3 \times 16.0)) = 124.0 \text{ g/mol}$$

$$\frac{124.0 \text{ g/mol}}{187.5 \text{ g/mol}} \times 100\% = 66.1\% NO_3$$

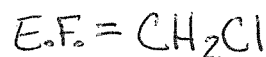


$$H_2O \text{ mass} = 90.0 \text{ g/mol}$$

$$\%H_2O = \frac{90.0 \text{ g/mol}}{171.0 \text{ g/mol}} \times 100\% = 52.6\% H_2O$$

4. a) A compound has the following composition: 24.24% C, 4.04% H and 71.72% Cl. What is the empirical formula of the compound?

$$\text{mol C} = 24.24 \text{ g} \times \frac{1 \text{ mol}}{12.0 \text{ g}} = 2.02 \text{ mol} / 2.02 = 1$$



$$\text{mol H} = 4.04 \text{ g} \times \frac{1 \text{ mol}}{1.0 \text{ g}} = 4.04 \text{ mol} / 2.02 = 2$$

$$\text{mol Cl} = 71.72 \text{ g} \times \frac{1 \text{ mol}}{35.5 \text{ g}} = 2.02 \text{ mol} / 2.02 = 1$$

b) If the molecular mass of this compound is 99.5 g/mol, what is the molecular formula?

$$n = \frac{\text{molecular mass}}{\text{empirical mass}} = \frac{99.5 \text{ g/mol}}{49.5 \text{ g/mol}} = 2 \quad \text{Molecular formula} = C_2H_4Cl_2$$

$$E.F. = (1 \times 12.0) + (2 \times 1.0) + (1 \times 35.5) = 49.5 \text{ g/mol}$$

5. The molar mass of a compound is 58 g/mol. What is the molecular formula of the compound if the empirical formula is  $C_2H_5$ ?

$$n = \frac{\text{molecular mass}}{\text{empirical mass}} = \frac{58 \text{ g/mol}}{29.0 \text{ g/mol}} = 2 \quad \text{Molecular formula} = C_4H_{10}$$

$$E.F. = (2 \times 12.0) + (5 \times 1.0) = 29.0 \text{ g/mol}$$

## Molarity Calculations:

1. If a 4.50g sample of solid NaOH is dissolved to make 0.500L of solution, what is the molarity of the solution?  $\rightarrow 40.0\text{g/mol}$

$$\frac{4.50\text{g}}{0.500\text{L}} \times \frac{1\text{mol}}{40.0\text{g}} = 0.225\text{M}$$

2. How many grams of  $\text{Na}_2\text{CO}_3$  would be required to produce 400.0mL of 0.600M  $\text{Na}_2\text{CO}_3$ ?  $\rightarrow 106.0\text{g}$

$$400.0\text{mL} \times \frac{1\text{L}}{10^3\text{mL}} \times \frac{0.600\text{mol}}{1\text{L}} \times \frac{106.0\text{g}}{1\text{mol}} = 25.4\text{g Na}_2\text{CO}_3$$

3. If 75.7g of Magnesium chloride are mixed with sufficient water to make a 0.885M solution, what is the volume of the solution?  $\text{MgCl}_2 = 95.3\text{g/mol}$

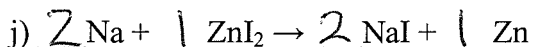
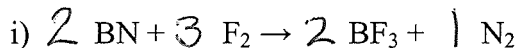
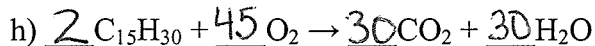
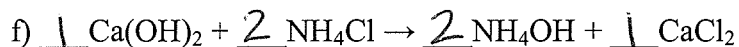
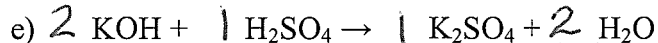
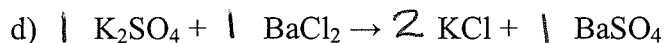
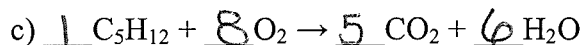
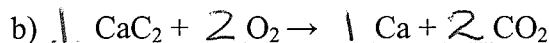
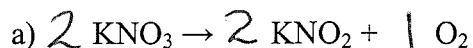
$$75.7\text{g} \times \frac{1\text{mol}}{95.3\text{g}} \times \frac{1\text{L}}{0.885\text{mol}} = 0.898\text{L}$$

4. How many mL of 16.4 M  $\text{H}_2\text{SO}_4$  are needed to prepare 755mL of 0.25M  $\text{H}_2\text{SO}_4$ ?

$$\begin{aligned} m_1 &= 16.4\text{M} & m_1 v_1 &= m_2 v_2 & v_1 &= \frac{0.25\text{M} \times 755\text{mL}}{16.4\text{M}} \\ v_1 &= ? & v_1 &= \frac{m_2 v_2}{m_1} & v_1 &= 12\text{mL} \\ m_2 &= 0.25\text{M} \\ v_2 &= 755\text{mL} \end{aligned}$$

## Chemical Reactions and Equations:

1. Balance and classify the following chemical reactions.



Type of Reaction

Decomposition

Single Replacement

Combustion

Double Replacement

Neutralization

Double Replacement

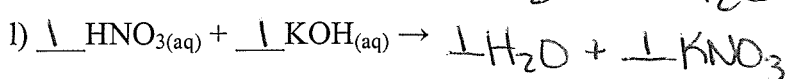
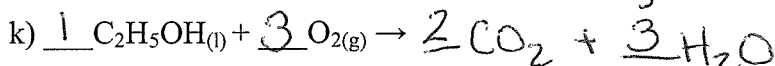
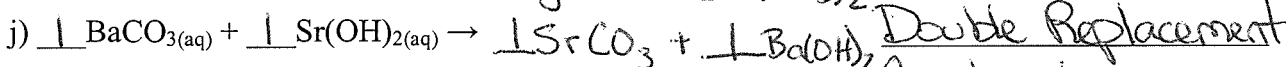
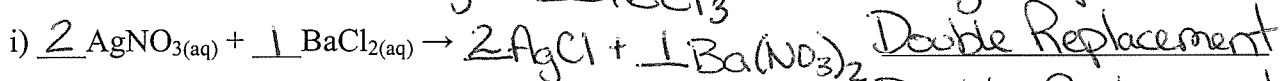
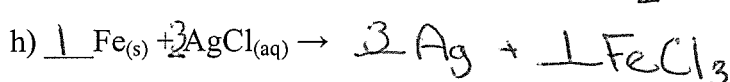
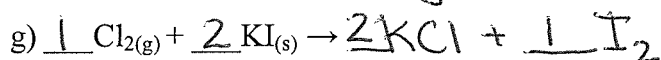
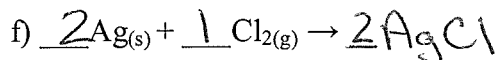
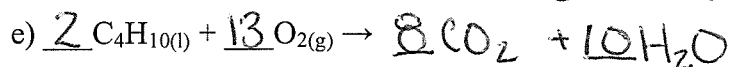
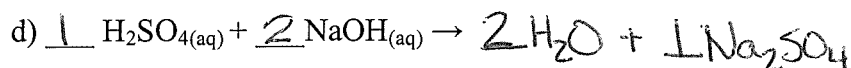
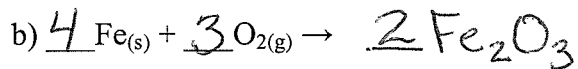
Combustion

Combustion

Single Replacement

Single Replacement

2. Classify, complete AND balance the following chemical equations. Type of Reaction



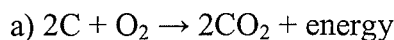
### Energy of Reactions:

1. Define ENDOTHERMIC and EXOTHERMIC reactions.

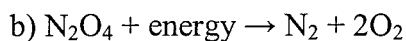
Endothermic: heat is absorbed from the surroundings during the reaction

Exothermic: heat is released by the reaction into the surroundings

2. Classify the following reactions as either endothermic or exothermic.



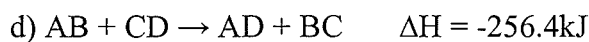
exothermic



endothermic



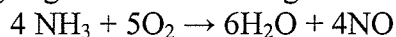
exothermic



exothermic

## Stoichiometry:

1. Ammonia combines with oxygen gas in the following reaction:



a) How many moles of  $\text{NH}_3$  are needed to combine with 3.57 moles of  $\text{O}_2$  gas?

$$3.57 \text{ mol O}_2 \times \frac{4 \text{ mol NH}_3}{5 \text{ mol O}_2} = 2.86 \text{ mol NH}_3$$

b) If 1.5 grams of  $\text{NO}$  is produced in the above reaction, how many grams of  $\text{NH}_3$  were reacted?

$$1.5 \text{ g NO} \times \frac{1 \text{ mol NO}}{30.0 \text{ g NO}} \times \frac{4 \text{ mol NH}_3}{4 \text{ mol NO}} \times \frac{17.0 \text{ g NH}_3}{1 \text{ mol NH}_3} = 0.85 \text{ g NH}_3$$

2.  $3\text{Na}_2\text{CO}_3 + 2\text{FeCl}_3 \rightarrow 6\text{NaCl} + \text{Fe}_2(\text{CO}_3)_3$

a) How many grams of  $\text{NaCl}$  will be produced from the reaction of 0.080 moles of  $\text{Na}_2\text{CO}_3$  with excess  $\text{FeCl}_3$ ?   
  $\hookrightarrow 58.5 \text{ g/mol}$

$$0.080 \text{ mol Na}_2\text{CO}_3 \times \frac{6 \text{ mol NaCl}}{3 \text{ mol Na}_2\text{CO}_3} \times \frac{58.5 \text{ g NaCl}}{1 \text{ mol NaCl}} = 9.4 \text{ g NaCl}$$

b) How many grams of  $\text{FeCl}_3$  would be needed to react with 4.2g of  $\text{Na}_2\text{CO}_3$ ?   
  $\hookrightarrow 162.3 \text{ g/mol}$   $\hookrightarrow 106.0 \text{ g/mol}$

$$4.2 \text{ g Na}_2\text{CO}_3 \times \frac{1 \text{ mol Na}_2\text{CO}_3}{106.0 \text{ g Na}_2\text{CO}_3} \times \frac{2 \text{ mol FeCl}_3}{3 \text{ mol Na}_2\text{CO}_3} \times \frac{162.3 \text{ g FeCl}_3}{1 \text{ mol FeCl}_3} = 4.3 \text{ g FeCl}_3$$

3.  $3\text{Mg} + 2\text{AlCl}_3 \rightarrow 3\text{MgCl}_2 + 2\text{Al}$

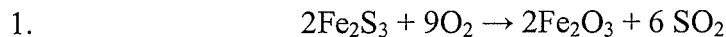
a) How many grams of  $\text{MgCl}_2$  would be formed if 50.0 mL of 0.200 M  $\text{AlCl}_3$  is reacted with excess  $\text{Mg}$ ?   
  $\hookrightarrow 95.3 \text{ g/mol}$

$$50.0 \text{ mL} \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{0.200 \text{ mol AlCl}_3}{1 \text{ L}} \times \frac{3 \text{ mol MgCl}_2}{2 \text{ mol AlCl}_3} \times \frac{95.3 \text{ g MgCl}_2}{1 \text{ mol MgCl}_2} = 1.43 \text{ g MgCl}_2$$

b) How many mL of 0.150 M  $\text{AlCl}_3$  would be needed to react completely with 2.00g of  $\text{Mg}$ ?

$$2.00 \text{ g Mg} \times \frac{1 \text{ mol Mg}}{24.3 \text{ g Mg}} \times \frac{2 \text{ mol AlCl}_3}{3 \text{ mol Mg}} \times \frac{1 \text{ L AlCl}_3}{0.150 \text{ mol AlCl}_3} \times \frac{10^3 \text{ mL AlCl}_3}{1 \text{ L AlCl}_3} = 366 \text{ mL AlCl}_3$$

## Excess and Limiting Reagents/Percent Yield:



In a chemical reaction 6.92g of  $\text{Fe}_2\text{S}_3$  is combined with 4.54g of oxygen gas.

a) Which reactant is the **LIMITING** reagent?

$$6.92\text{g Fe}_2\text{S}_3 \times \frac{1\text{mol Fe}_2\text{S}_3}{207.9\text{g}} \times \frac{2\text{mol Fe}_2\text{O}_3}{2\text{mol Fe}_2\text{S}_3} = 0.0333\text{mol Fe}_2\text{O}_3$$

$$4.54\text{g O}_2 \times \frac{1\text{mol O}_2}{32.0\text{g O}_2} \times \frac{2\text{mol Fe}_2\text{O}_3}{9\text{mol O}_2} = 0.0315\text{mol Fe}_2\text{O}_3$$

$\therefore \text{O}_2$  is limiting

b) How many grams of the **EXCESS** reactant will be left over after the reaction is complete?

$$4.54\text{g O}_2 \times \frac{1\text{mol O}_2}{32.0\text{g O}_2} \times \frac{2\text{mol Fe}_2\text{S}_3}{9\text{mol O}_2} \times \frac{207.9\text{g Fe}_2\text{S}_3}{1\text{mol Fe}_2\text{S}_3} = 6.55\text{g Fe}_2\text{S}_3 \text{ used up}$$

$$\therefore 6.92\text{g} - 6.55\text{g} = 0.37\text{g Fe}_2\text{S}_3 \text{ left over}$$

c) How many grams of  $\text{Fe}_2\text{O}_3$  can be formed in this reaction?

$$0.0315\text{mol Fe}_2\text{O}_3 \times \frac{159.6\text{g Fe}_2\text{O}_3}{1\text{mol Fe}_2\text{O}_3} = 5.03\text{g Fe}_2\text{O}_3$$

2. What mass of  $\text{P}_4$  will be produced when 41.5g of  $\text{Ca}_3(\text{PO}_4)_2$ , 26.3g of  $\text{SiO}_2$ , and 7.80g of C are reacted according to the following balanced equation?

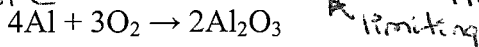


$$41.5\text{g Ca}_3(\text{PO}_4)_2 \times \frac{1\text{mol Ca}_3(\text{PO}_4)_2}{310.3\text{g Ca}_3(\text{PO}_4)_2} \times \frac{1\text{mol P}_4}{2\text{mol Ca}_3(\text{PO}_4)_2} = 0.0669\text{mol}$$

$$26.3\text{g SiO}_2 \times \frac{1\text{mol SiO}_2}{60.1\text{g SiO}_2} \times \frac{1\text{mol P}_4}{6\text{mol SiO}_2} = 0.0729\text{mol}$$

$$7.80\text{g C} \times \frac{1\text{mol C}}{12.0\text{g C}} \times \frac{1\text{mol P}_4}{10\text{mol C}} = 0.0650\text{mol} \times \frac{124.0\text{g P}_4}{1\text{mol P}_4} = \boxed{8.06\text{g P}_4}$$

3.



a) How many grams of aluminum oxide,  $\text{Al}_2\text{O}_3$ , would be expected to form in the reaction of 15.0g Al with 18.43g of oxygen gas?

$$15.0\text{g Al} \times \frac{1\text{mol Al}}{27.0\text{g Al}} \times \frac{2\text{mol Al}_2\text{O}_3}{4\text{mol Al}} \times \frac{102.0\text{g Al}_2\text{O}_3}{1\text{mol Al}_2\text{O}_3} = 28.3\text{g Al}_2\text{O}_3$$

$\uparrow$  limiting, so this much is made!

$$18.43\text{g O}_2 \times \frac{1\text{mol O}_2}{32.0\text{g O}_2} \times \frac{2\text{mol Al}_2\text{O}_3}{3\text{mol O}_2} \times \frac{102.0\text{g Al}_2\text{O}_3}{1\text{mol Al}_2\text{O}_3} = 39.2\text{g Al}_2\text{O}_3$$

b) If the actual yield of  $\text{Al}_2\text{O}_3$  produced in the reaction was only 22.4g  $\text{Al}_2\text{O}_3$ , what would the **PERCENT YIELD** of the reaction be?

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\% = \frac{22.4\text{g}}{28.3\text{g}} \times 100\% = 79.2\% \text{ yield}$$