Solve the following problems in the space provided. Show your work to receive full credit.

1. The compound tin(II) fluoride, or stannous fluoride, once was a common ingredient in toothpaste. It is produced according to the following reaction:
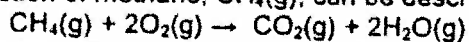
   $$Sn(s) + 2HF(g) \rightarrow SnF_2(s) + H_2(g)$$
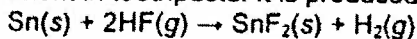
   If 22 grams of HF react with Sn, how many grams of stannous fluoride, SnF_2, are produced?

   $$\frac{22g\ HF}{} \left| \frac{1\ mol\ HF}{20.1g} \right| \frac{1\ mol\ SnF_2}{2\ mol\ HF} \left| \frac{156.7g\ SnF_2}{1mol} \right. = \boxed{86\ g\ SnF_2}$$

   Sn 118.7
   F   19

2. The combustion of methane, $CH_4(g)$, can be described by the following equation:

   $$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

   Calculate the mass of methane required to form 34 moles of carbon dioxide.

   $$\frac{34\ mol\ CO_2}{} \left| \frac{1\ mol\ CH_4}{1\ mol\ CO_2} \right| \frac{16.05g}{1mol\ CH_4} = 545.7g\ CH_4 = \boxed{550\ g\ CH_4}$$

3. Calculate the number of liters of oxygen gas needed to produce 13.0 L of sulfur dioxide gas at STP according to the following reaction?

   $$2H_2S(g) + 3O_2(g) \rightarrow 2SO_2(g) + 2H_2O(g)$$
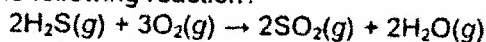
   $$\frac{13 L\ SO_2}{} \left| \frac{1\ mol}{22.4 L} \right| \frac{3\ mol\ O_2}{2\ mol\ SO_2} \left| \frac{22.4 L}{1 mol} \right. \boxed{19.5 L\ O_2}$$

4. Heating an ore of antimony (Sb_2S_3) in the presence of iron gives the element antimony and iron(II) sulfide. If the reaction proceeds with a 94% yield and 45g of iron is used, what is the actual and theoretical yield of iron(II) sulfide?

   $$Sb_2S_3(s) + 3Fe(s) \rightarrow 2Sb(s) + 3FeS(s)$$
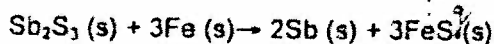
   $$\frac{45g\ Fe}{} \left| \frac{1\ mol}{55.85g} \right| \frac{3\ mol\ FeS}{3\ mol\ Fe} \left| \frac{87.75g}{1\ mol} \right. \boxed{71g\ FeS} \atop theor$$

   $$94\% = \frac{A}{71} \times 100$$

   $$\boxed{A = 66\ g\ FeS}$$

5. What is conserved in a chemical reaction? **Mass**

6. If the percent yield is equal to 100%, then the actual yield __=__ the theoretical yield.

7. What do the coefficents in a balanced chemical reaction tell you? the ~~relationship~~ relative # of moles of reactant to product

8. If 17.00 g aluminum sulfide and 9.00 g water react according to the following equation:

$$Al_2S_3 + 6H_2O \rightarrow 2Al(OH)_3 + 3 H_2S$$

17g   9g

a) What is the limiting reagent?

LR: H_2O

$$\frac{9 \text{ g } H_2O}{} \left|\frac{1 \text{ mol}}{18.02g}\right|\frac{3 \text{ mol } H_2S}{6 \text{ mol } H_2O}\left|\frac{34.12g \, H_2S}{1 \text{ mol}}\right| = 8.5g \, H_2S$$

b) What is the maximum mass of H₂S that can be formed?

$$\frac{17g \, Al_2S_3}{} \left|\frac{1 \text{ mol } Al_2S_3}{150.26g}\right|\frac{3 \text{ mol } H_2S}{1 \text{ mol}}\left|\frac{34.12g \, H_2S}{1 \text{ mol}}\right| = 11.6g \, H_2S$$

c) How much of the excess reactant remains after the reaction stops?

$$\frac{9g \, H_2O}{} \left|\frac{1 \text{ mol } H_2O}{18.02g}\right|\frac{1 \text{ mol } Al_2S_3}{6 \text{ mol } H_2O}\left|\frac{150.26g \, Al_2S_3}{1 \text{ mol}}\right| = 12.5g \, Al_2S_3 \text{ used}$$

17g −12.5g = 4.5g Al_2S_3 left over

Balance the following equations.

9) 3 CuO(s) + 2NH₃(aq) → 3 Cu(s) + 3H₂O(l) + N₂(g)

10) 4 NH₃(g) + 5O₂(g) → 4NO(g) + 6 H₂O(g)

11) 2 KClO₃(s) → 2 KCl(s) + 3 O₂(g)
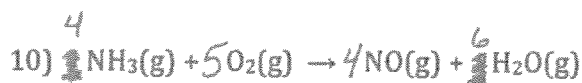
Finish the following reactions and put the type of reaction that is occurring.

S   12)   Na + O₂ →   Na₂O

DR   13)   Pb(NO₃)₂ + KCl→   PbCl₂ + KNO₃

C   14)   C₂H₆ + O₂ →   CO₂ + H₂O

Answer the following questions.

15)   Why is it not correct to balance an equation by changing the subscripts in the formulas in a chemical equation?

the subscripts are determined by the charge

16)   What is the molar volume of any gas at STP? (How many liters of gas are in one mole of gas at STP?)

1 mole = 22.4 L @ STP

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$$1 \text{ mol} = 22.4 L \quad @ \text{ STP}$$

17) A solution of NaCl has a molarity of 0.549 M. How many moles are in 350. mL of this solution? NOTE: Molarity is <u>MOLES per LITER</u>. The volume in milliliters must be converted to Liters.

$$\frac{.350 L}{} \cdot \frac{.549 \, mol}{1 L} = .192 \, mol \, NaCl$$

18. Which of the following is NOT an empirical formula?
         a. Na_2SO_4 c. $Sn_3(PO_4)_4$
         b. C_6H_5Cl (d.) N_2H_4

19. The chemical formula of aspirin is $C_9H_8O_4$. What is the mass of 0.200 mol of aspirin?

$$\frac{.2 \, mol \, asp}{} \cdot \frac{180.17g}{1 \, mol} = 36.0g \; C_9H_8O_4$$

20. How many moles of SO_3 are in 2.4×10^{24} molecules of SO_3?

$$\frac{2.4 \times 10^{24} \, molec}{} \cdot \frac{1 \, mol}{6.02 \times 10^{23} \, molec} = 4.0 \, mol \, SO_3$$

21. What is the volume in liters of 2.50 moles of carbon monoxide at STP?

$$\frac{2.5 \, mol \, CO}{} \cdot \frac{22.4 L}{1 \, mol} = 56 \, L$$

22) How many water molecules are in 127.3 grams of water (H_2O)?

$$\frac{127.3g \, H_2O}{} \cdot \frac{1 \, mol}{18.02g} \cdot \frac{6.02 \times 10^{23} \, molec}{1 \, mol} = 4.253 \times 10^{24} \, molec \, H_2O$$

23) Calculate the percentage composition of nitric acid (HNO_3).

$$\% H = \frac{1.01}{63.02} = 1.6\% \, H$$

$$\% N = \frac{14.01}{63.02} = 22.2\% \, N$$

$$\% O = \frac{3(16)}{63.02} = 76.2\% \, O$$

24) Calculate the mass percentage of water in $CoCl_2 \cdot 6 \, H_2O$.

$$\frac{6(18.02)}{237.95} = 45.4\% \, H_2O$$

25) Answer the following question.

    a. A compound is composed of 54.05% Ca, 43.24% O, 2.71% H. Find the empirical formula.

$$\frac{54.05 g\ Ca \mid 1\ mol}{\mid 40.08 g} = 1.35\ mol\ Ca \rightarrow 1\ Ca$$

$$\frac{43.24 g\ O \mid 1\ mol}{\mid 16 g} = 2.70\ mol\ O \rightarrow 2\ O \qquad Ca(OH)_2$$

$$\frac{2.71 g\ H \mid 1\ mol}{\mid 1.01 g} = 2.70\ mol\ H \rightarrow 2\ H$$

    b. If the substance from Part (a) has a molecular formula mass of 222 g/mol, find its molecular formula.

$$\frac{222}{74.1} \sim 3 \qquad Ca_3(OH)_6$$

26) In a chemical reaction, the mass of the products:
    a. is less than the mass of the reactants.
    b. is greater than the mass of the reactants.
    ⓒ is equal to the mass of the reactants.
    d. has no relationship to the mass of the reactants.

27) How many liters of oxygen are required to react completely with 1.2 liters of hydrogen to form water?

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$
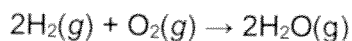
    a. 1.2 L   c. 2.4 L
    ⓑ 0.6 L   d. 4.8 L

$$\frac{1.2 L\ H_2 \mid 1\ mol}{\mid 2\ mol} = 0.6\ L\ O_2$$

28) The amount of product formed when a reaction is carried out in the laboratory is called:
    a. theoretical yield   c. percent yield
    b. excess reagent   ⓓ actual yield

29) A reaction that has been calculated to produce 60.0 g of $CuCl_2$ produced 50.0 g of $CuCl_2$ when performed in the lab. What is the percent yield?
    a. 0.833%   ⓒ 83.3%
    b. 96.1%   d. 120%

$$\frac{50}{60} \times 100 = 83.3\%$$

30) In any chemical reaction, what is conserved?
    a. the number of moles
    b. the number of molecules
    ⓒ mass
    d. volume

31) In the reaction, $N_2 + 3H_2 \rightarrow 2NH_3$, what is the mole ratio of nitrogen to ammonia?
    a. 1:1   ⓒ 1:2
    b. 1:3   d. 2:3

$$1:2$$