Summer Assignment 5

1. An element "E" is present as 10E with a mass value of 10.01 amu, and as 11E with a mass value of 11.01 amu. The natural abundances of 10E and 11E are 19.78% and 80.22% respectively. What is the average atomic mass of the element? What is the element?

2. Naturally occurring sulfur consists of four isotopes, 32S (95.0%), 33S (0.76%), 34S(4.22%), and 36S(0.014%). Using these data, calculate the atomic mass of naturally occurring sulfur. The masses of the isotopes are given in the table below.

isotope Atomic mass (amu's)

32S 31.97

33S 32.97

34S 33.97

36S 35.97

3. An unknown sample of mystery element "T" is injected into the mass spectrometer. According to the mass spectrum, 7.42% of the element is present as 6T and 92.58% is present as 7T. The mass value for 6T is 6.02 amu and 7.02 amu for 7T. Calculate the average atomic mass and identify the mystery element:

4. A noble gas consists of three isotopes of masses 19.99 amu, 20.99 amu, and 21.99 amu. The relative abundance of these isotopes is 90.92%, 0.257%, and 8.82% respectively. What is the average atomic mass of this noble gas? What noble gas is this?

5. Chlorine has two stable isotopes. The mass of one isotope is 34.97 amu. It's relative abundance is 75.53%. What is the mass of the other stable isotope?

6. Gallium has two stable isotopes of masses 68.93 amu (69Ga) and 70.92 amu (71Ga). What are the relative abundances of the two isotopes?

7. Magnesium exists as three isotopes in nature. One isotope (25Mg) has a mass of 24.99 amu and a relative abundance of 10.13%. The other two isotopes have masses of 23.99 amu (24Mg) and 25.98 amu (26Mg). What are their relative abundances? (atomic mass Mg = 24.305 amu).

8. How many moles are in a sample of 300 atoms of Nitrogen (N)? How many grams?

9. How many atoms of gold (Au) does it take to make 1 gram of gold?

10. If you buy 38.9 moles of M&M's how many M&M's do you have? (1 mole of M&M's® =6.022 X 10^{23} M&M's)

11. A sample of sulfur (S) has a mass of 5.37 g. How many moles are in the sample? How many atoms?

12. Give the number of moles of each element present in 1.0 mol of each of the following substances:

a. Hg_2I_2 d. $Ba_3(AsO_4)_2$

b. LiH   e.$RbOH..2H_2O$

c. $PbCO_3$ f. H_2SiF_6

13. How many grams of zinc are in 1.16 x 10^{22} atoms of zinc (Zn)?

14. How many amu are in 3.68 moles of iron (Fe)?

15. Calculate the molar masses of each of the following:

a. Cu_2SO_4 d. $Zr(SeO_3)_2$

b. NH_4OH e. $Ca_2Fe(CN)_6.12H_2O$

c. $C_{10}H_{16}O$ f. $Cr_4(P_2O_7)_3$

16. What is the mass of 4.28 x 10^{22} molecules of water (H_2O)?

17. How many milligrams of Br_2 are in 4.8 x 10^{20} molecules of Br_2?

18. Determine the molar mass of $KAl(SO_4)_2.12H_2O$.

19. How many moles of cadmium bromide ($CdBr_2$) are in a 39.25 g sample?

20. A sample of calcium chloride ($CaCl_2$) has a mass of 23.8 g. How many moles of calcium chloride is this?

21. If 1.72 moles of baking soda $NaHCO_3$ were used to bake a chocolate cherry cake, how many grams of baking soda would the recipe call for?

22. How many moles are there in a sample of barium sulfate ($BaSO_4$) weighting 9.90×10^7g?

23. How many grams are there in 0.36 moles of cobalt (III) acetate ($Co(C_2H_3O_2)_3$)? How many grams of cobalt are in this sample? How many atoms of cobalt?

24. How many milligrams of chlorine are there in a sample of 3.9×10^{19} molecules of chlorine gas (Cl_2)? How many atoms of chlorine?

25. Bauxite, the principle ore used in the production of aluminum cans, has a molecular formula of $Al_2O_3.2H_2O$.

a. Determine the molar mass of bauxite.

b. How many grams of Al are in 0.58 moles of bauxite?

c. How many atoms of Al are in 0.58 moles of bauxite?

d. What is the mass in grams of 2.1×10^{24} molecules of bauxite?

26. Calculate the mass percent of Cl in each of the following compounds:

a. ClF

b. $HClO_2$

c. $CuCl_2$

d. PuOCl

27. Calculate the mass percent of each element in C_5H_{10}.

28. Calculate the mass percent of each element in barium sulfite ($BaSO_3$).

29. Calculate the mass percent of each element in natural lucite ($KAlSi_2O_6$).

30. Calculate the mass percent of silver (Ag) in each of the following compounds:

a. AgCl   b. AgCN   c. $AgNO_3$

31. Chlorophyll a is essential for photosynthesis. It contains 2.72% magnesium (Mg) by mass. What is the molar mass of chlorophyll a assuming there is one atom of magnesium in every molecule of chlorophyll a?

32. Which of the following formulas can be empirical?

a. CH_4 e. B_2H_6 f. NH_4Cl

b. CH_2 g. Sb_2S_3

c. $KMnO_4$ h. N_2O_4

d. N_2O_5 i. CH_2O

33. Determine the empirical and molecular formulas of a compound that has a mass of 31.04 g/mole and contains the following percentages of elements by mass:

C = 38.66%, H = 16.24%, N = 45.10%

34. A compound is found, by mass spectral analysis, to contain the following percentages of elements by mass:

C = 49.67%, Cl = 48.92%, H = 1.39%

The molar mass of the compound is 289.9 g/mole. Determine the empirical and molecular formulas of the compound.

35. Vanillin, the pleasant smelling ingredient used to bake chocolate chip cookies (my favorite), is often used in the production of vanilla extract. Vanillin has a mass of 152.08 g/mol

and contains the following percentages of elements by mass:
C = 63.18%, H = 5.26%, O = 31.56%
Determine the empirical and molecular formula of vanillin.
36. Determine the empirical formula of a compound that contains the following percentages of elements by mass:
Mo = 43.95%, O = 7.33%, Cl = 48.72%
37. How many grams of product are formed in each of the following reactions?
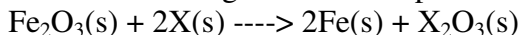a. Two moles of H_2 react with one mole of O_2.
b. One mole of silver nitrate reacts with one mole of sodium chloride.
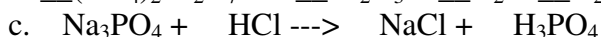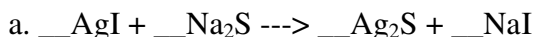c. Three moles of sodium hydroxide react with one mole of phosphoric acid.
38. Calculate the mass percent of each of the elements in Nicotine ($C_{10}H_{14}N_2$).
39. The following reaction was performed:
$Fe_2O_3(s) + 2X(s) ----> 2Fe(s) + X_2O_3(s)$
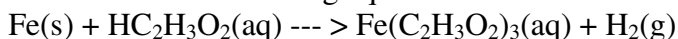It was found that 79.847 g of Fe_2O_3 reacted with "X" to form 55.847 g of Fe and 50.982 g of X2O3. Identify element X.
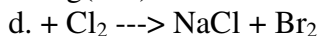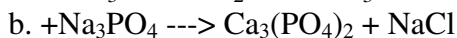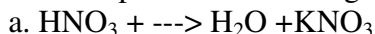40. Fill in the blanks to balance the following chemical equations:
a. __AgI + __Na_2S ---> __Ag_2S + __NaI
b. __$(NH_4)_2Cr_2O_7$---> __Cr_2O_3 + __N_2 + __H_2O
c.__Na_3PO_4 + __HCl ---> __NaCl + __H_3PO_4
d.__$TiCl_4$ + __H_2O ---> __TiO_2 + __HCl
e.__Ba_3N_2 + __H_2O --->__$Ba(OH)_2$ + NH_3
f.__HNO_2--->__HNO_3+ __NO+__H_2O
41. Balance the following equation:
$NH_4OH(l) + KAl(SO_4)_2. 12H_2O ----> Al(OH)_3(s) + (NH_4)_2SO_4(aq) + KOH(aq) + H_2O(l)$
44. Balance the following equation:
$Fe(s) + HC_2H_3O_2(aq) --- > Fe(C_2H_3O_2)_3(aq) + H_2(g)$
42. Complete the following reactions: (Make sure they are balanced.)
a. HNO_3 + ---> H_2O +KNO_3
b. +Na_3PO_4 ---> $Ca_3(PO_4)_2$ + NaCl
c. $Mg(OH)_2$ + HCl --->$MgCl_2$ +
d. + Cl_2 ---> NaCl + Br_2
43. How many grams of water vapor can be generated from the combustion of 18.74 g of ethanol?
$C_2H_6O(g) + O_2(g) ----> CO_2(g) + H_2O(g)$ (unbalanced)
44. How many grams of sodium hydroxide are required to form 51.63 g of lead hydroxide?
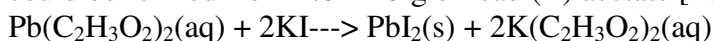$Pb(NO_3)_2(aq) + NaOH(aq) ----> Pb(OH)_2(s) + NaNO_3(aq)$ (unbalanced)
45. How many grams of potassium iodide are necessary to completely react with 20.61 g of mercury (II) chloride?
$HgCl_2 + KI(aq) ----> HgI_2(s) + KCl(aq)$ (unbalanced)
46. What mass of calcium carbonate ($CaCO_3$) would be formed if 248.6 g of carbon dioxide (CO_2) were exhaled into limewater, $Ca(OH)_2$? How many grams of calcium would be needed to form that amount of calcium carbonate? Assume 100% yield in each reaction.
47. The following reaction is used to form lead iodide crystals. What mass of crystal (PbI_2) could be formed from 1.0×10^3g of lead (II) acetate [$Pb(C_2H_3O_2)_2$]?
$Pb(C_2H_3O_2)_2(aq) + 2KI---> PbI_2(s) + 2K(C_2H_3O_2)_2(aq)$
48. How many grams of precipitate (Hg2Cl2) would be formed in the following reaction if you
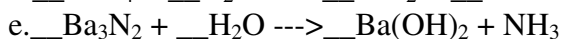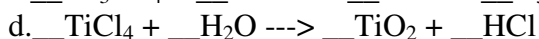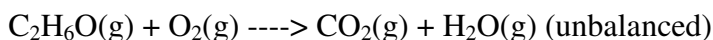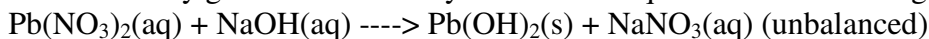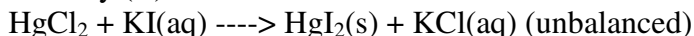
were given 102.9 g of mercury to begin with?

$2Hg^+(aq) + 2Cl^-(aq) ---> Hg_2Cl_2(s)$
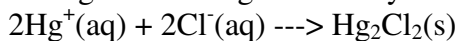
49. You were hired by a laboratory to recycle 6 moles of silver ions. You were given 150 g of copper (Cu). How many grams of silver (Ag) can you recover? Is this enough copper to recycle 6 moles of silver ions?

$2Ag^+ + Cu ---> 2Ag + Cu^{2+}$
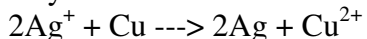
50. Fermentation converts sugar into ethanol and carbon dioxide. If you were to ferment a bushel of apples containing 235 g of sugar, what is the maximum amount of ethanol in grams that would be produced?

$C_6H_{12}O_6 ---> 2C_2H_6O + 2CO_2$
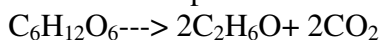
51. The reaction between potassium chlorate and red phosphorus is highly exothermic and takes place when you strike a match on a matchbox. If you were to react 52.9 g of potassium chlorate ($KClO_3$) with red phosphorus, how many grams of tetraphosphorus decaoxide (P_4O_{10}) would be produced?

$KClO_3(s) + P_4(s) ---> P_4O_{10}(s) + KCl(s)$ (unbalanced)
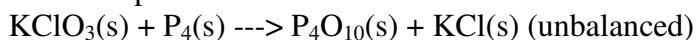
52. A reaction combines 113.484 g of lead (II) nitrate with 45.010 g of sodium hydroxide (see problem 47).
a. How much lead (II) hydroxide is formed?
b. Which reactant is limiting? Which is in excess?
c. How much of the excess reactant is left over?
d. If the actual yield of lead (II) hydroxide were 80.02 g, what was the percent yield?

53. A reaction combines 64.81 grams of silver nitrate with 92.67 grams of potassium bromide.

$AgNO_3(aq) + KBr(aq) ----> AgBr(s) + KNO_3(aq)$
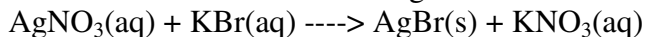
a. How much silver bromide is formed?
b. Which reactant is limiting? Which is in excess?
c. How much of the excess reactant is left over?
d. If the actual yield of silver bromide were 14.77 g, what was the percent yield?

54. A reaction proceeds between 94.6 g of $KClO_3$ and 65.3 g of P_4 (see problem #54).
a. How much potassium chloride is formed?
b. Which reactant is limiting? Which is in excess?
c. How much of the excess reactant is left over?
d. If the actual yield of potassium chloride were 21.0 g, what was the percent yield?

55. DDT, an insecticide harmful to fish birds and humans, is produced by the following reaction:

$2C_6H_5C1 + C_2HOCl_3 ---> C_{14}H_9Cl_5 + H_2$
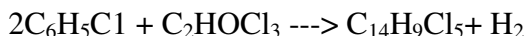
chlorobenzene chloral DDT

In a government lab 1142 g of chlorobenzene were reacted with 485 g of chloral.
a. How much DDT is formed?
b. Which reactant is limiting? Which is in excess?
c. How much of the excess reactant is left over?
d. If the actual yield of DDT is 2000 g, what was the percent yield?