Assignment #2  CHAPTERS 2 and 3

1.  {10} How many protons, neutrons, and electrons are in the following atoms? What element symbols do Q, X, Y, Z, and @ represent?

   a)  \( ^{14}_{7}Q \)  
      7 protons, 7 neutrons, 7 electrons, N

   b)  \( ^{41}_{20}X \)  
      20 protons, 21 neutrons, 20 electrons, Ca

   c)  \( ^{53}_{29}Y \)  
      53 protons, 78 neutrons, 53 electrons, I

   d)  \( ^{30}_{14}Z \)  
      14 protons, 16 neutrons, 14 electrons, Si

   e)  \( ^{17}_{8}@ \)  
      8 protons, 9 neutrons, 8 electrons, O

2.  {5} Silver (Ag; Z=47) has two naturally occurring isotopes, \(^{107}\text{Ag}\) (106.90509 amu) and \(^{109}\text{Ag}\) (108.90476 amu). Calculate the fractional abundance of the isotopes if the average atomic mass of silver is 107.8682 amu.

   \[
   107.8682 \text{ amu} = 106.90509 \text{ amu} \times X + 108.90476 \text{ amu} \times (1-X)
   \]

   \[
   107.8682 - 108.90476 = 106.90509X - 108.90476X
   \]

   \[
   -1.0366 = -1.9997X; X = 0.5184; 1-X = 0.4816
   \]

   0.5184 of light isotope (107) and 0.4816 of heavy isotope (109)

3.  {10} Locate iodine, mercury, bromine, silicon, and argon on the periodic table. Give the atomic symbol, atomic number, and label each as a metal, metalloid or nonmetal. Indicate physical state common for these elements (solid (s), liquid (l) of gas (g)).

   \( ^{53}_{131}\text{I} \), nonmetal; \( ^{80}_{199}\text{Hg} \), metal; \( ^{35}_{71}\text{Br} \), (l), nonmetal; \( ^{14}_{14}\text{Si} \), metalloid, (s); \( ^{18}_{18}\text{Ar} \), nonmetal, (g).

   Note: atomic number as a superscript is also acceptable, e.g., \(^{53}\text{I}\).

4.  {5} Name the following groups in the periodic table:

   1A  2A  6A  7A  8A
Alkali metals, alkaline earths metals, chalcogens, halogens, noble gases.

5. {5} What monoatomic ions do the following elements form? Give the atomic symbol and the charge.

(a) Bromine  \( \text{Br}^- \)
(b) Magnesium  \( \text{Mg}^{2+} \)
(c) Sodium  \( \text{Na}^+ \)
(d) Phosphorus  \( \text{P}^{3-} \)
(e) Aluminum  \( \text{Al}^{3+} \)

6. {5} Write empirical formulas and name the ionic compound formed from the following pairs of elements:

(a) sodium and chlorine  \( \text{NaCl} \)  sodium chloride
(b) calcium and fluorine  \( \text{CaF}_2 \)  calcium fluoride
(c) iodine and aluminum  \( \text{AlI}_3 \)  aluminum iodide
(d) sulfur and potassium  \( \text{K}_2\text{S} \)  potassium sulfide
(e) lithium and oxygen  \( \text{Li}_2\text{O} \)  lithium oxide.

7. {15} Give the systematic names for the formulas or the formulas for the names of the following compounds:

(a) chromium (II) nitrate  \( \text{Cr(NO}_3\text{)}_2 \)
(b) \( \text{FeI}_2 \)  ferrous iodide or iron (II) iodide
(c) Ferric oxide  \( \text{Fe}_2\text{O}_3 \)
(d) \( \text{ScS} \)  scandium (II) sulfide
(e) sodium dihydrogen phosphate  \( \text{NaH}_2\text{PO}_4 \)
(f) \( \text{Ag}_2\text{S} \)  Silver (I) sulfide
(g) \( \text{FeCl}_3 \)  iron (III) chloride or ferric chloride
(h) Mercurous fluoride  \( \text{Hg}_2\text{F}_2 \)
(i) \( \text{Cu(ClO}_4\text{)}_2 \)  cupper (II) perchlorate or cupric perchlorate
(j) Potassium dichromate \( \text{K}_2\text{Cr}_2\text{O}_7 \)

(k) Dichlorine trioxide \( \text{Cl}_2\text{O}_3 \)

(l) \( \text{SF}_4 \)

(m) Dinitrogen pentoxide \( \text{N}_2\text{O}_5 \)

(n) Sulfuric acid \( \text{H}_2\text{SO}_4 \)

(o) Nitrous acid \( \text{HNO}_2 \)

8. \{5\} How many grams of oxygen are in 65 g of \( \text{C}_2\text{H}_2\text{O}_2 \)?

\[
\text{mol C}_2\text{H}_2\text{O}_2 = 65 \frac{\text{g}}{58 \text{g/mol}} = 1.12 \text{ mol;}
\]
\[
\text{mol O} = 2 \times 1.12 = 2.24 \text{ mol;}
\]
\[
\text{g O} = 2.24 \text{ mol} \times 16 \text{g/mol} = 36 \text{g}
\]

9. \{15\} A compound is composed of only C, H, and O. The combustion of a 0.519 g sample of the compound yields 1.24 g of \( \text{CO}_2 \) and 0.255 g of \( \text{H}_2\text{O} \). What is the empirical formula of the compound?

\[
\text{mol C:} \quad 1.24 \text{ g} \times 1 \frac{\text{mol}}{12.01 + 32} = 0.02818 \text{ mol C; g C: } 0.02818 \text{ mol} \times 12.01 \text{g/mol} = 0.3384 \text{ g C}
\]
\[
\text{mol H:} \quad 0.255 \text{ g} \times 1 \frac{\text{mol}}{2 \times 1.008 + 16} \times 2 = 0.02831 \text{ mol H; } = 0.02853 \text{ g H}
\]
\[
\text{mol O:} \quad 0.515 \text{ g} - 0.3384 \text{ g} - 0.02853 \text{ g} = 0.149 \text{ g O; } 0.149 \text{ g} / 16 = 0.00928 \text{ mol}
\]
\[
0.02818/0.00928 = 3.04; \quad 0.02831/0.00928 = 3.05
\]

\( \text{C}_3\text{H}_3\text{O} \)

10. \{10\} Sulfur and fluorine react in a combination reaction to produce sulfur hexafluoride:

\[
\text{S(s) + 3 F}_2 \text{(g)} \rightarrow \text{SF}_6 \text{(g)}
\]
You run this reaction in the lab using 2.0 g of S and 2.0 g of F₂ and obtained 1.5 g of SF₆. What is the percent yield of this reaction?

\[ \text{mol S} = \frac{2.0}{32.1} = 0.0623 \text{ mol}; \quad \text{mol F}_2 = \frac{2.0}{38} = 0.0526 \text{ mol}; \quad \text{F}_2 \text{ is limiting} \]

Theoretical yield: \( 0.0526 \text{ mol} / 3 = 0.0175 \text{ mol SF}_6 = 0.0175 \times (32 + 6 \times 19) = 2.56 \text{ g} \)

\[ \% \text{ yield} = \frac{1.5}{2.56} \times 100 = 58.6\% = 59\% \]

11. What is the empirical formula of a compound, which contains 29% Na, 41% S, and 30% O by mass?

Assume 100 g of compound

\[ \text{mol Na: } \frac{29}{23} = 1.26 \text{ mol} \]
\[ \text{mol S: } \frac{41}{32} = 1.28 \text{ mol} \]
\[ \text{mol O: } \frac{30}{16} = 1.88 \text{ mol} \]

\[ \frac{1.28}{1.26} = 1.01; \quad \frac{1.88}{1.26} = 1.5 \quad 1, 1, 1.5 \quad \text{multiply by 2} \]

\[ 2:2:3 \]

\[ \text{Na}_2\text{S}_2\text{O}_3 \]

12. GeF₃H is formed from GeH₄ and GeF₄ in the combination reaction:

\[ \text{GeH}_4 + 3\text{GeF}_4 \rightarrow 4\text{GeF}_3\text{H} \]

If the reaction yield is 92.6%, how many grams of GeF₄ are needed to produce 8.00 moles of GeF₃H?

Theoretically, for 8 mol of GeF₃H, 6 mol GeF₄ are needed

Actually: \( 6 \text{ mol} / 0.926 = 6.48 \text{ mol of GeF}_4 \); \( 6.48 \text{ mol} \times (72.6 + 4 \times 19) \text{ g/mol} = 962.9 \text{ g} \)