Chapters 6 Study Questions

1. Glycerol ($C_3H_8O_3$) is sold in drug stores as glycerine and is commonly found in soaps and shampoos.
   a) What is the molar mass of glycerol?
   b) What is the mass in grams of 1.00 mole of glycerol?
   c) How many molecules are in one mole of glycerol?
   d) How many grams are in 0.217 moles of glycerol?
   e) How many moles are in 783 grams of glycerol?

2. Ammonia (NH_3) is the active ingredient in many kitchen cleansers. How many atoms are in
   a) one molecule of ammonia?
   b) one mole of ammonia?
   c) 3.40 grams of ammonia?

3. How many oxygen atoms are in 4.5 g calcium phosphate?

4. A compound consists of 40.7% C, 5.1% H, and 54.2% O? What is its empirical formula?

5. A 25.0 gram sample of a compound made up of magnesium, carbon and oxygen contains 7.20 grams magnesium and 3.55 grams carbon.
   a) Find the empirical formula of this compound.
   b) Find the mass percentage of each element in this compound.
   c) What is the mass of magnesium in a 13.9 gram sample of this compound?
   d) What is the mass of this compound that contains 0.290 moles of carbon?

6. A sample of zinc is heated in air to form zinc oxide. Assuming all of the zinc is converted to the oxide, use the data table below to calculate the empirical formula of zinc oxide.

mass of crucible	= 32.00 g
mass of crucible + zinc (before heating)	= 33.64 g
mass of crucible + oxide (after heating)	= 34.04 g

Summary of Chapter 6: Chemical Composition

atomic mass
mole
Avogadro's number
molar mass (molecular mass, formula weight)
calculations: # particles $\leftrightarrow$ moles $\leftrightarrow$ mass
percentage composition (mass percent)
empirical formula
molecular formula
calculating empirical formula from percentage composition
finding empirical formula from molecular formula
calculating empirical formula from experimental data

Answers to Chapters 6 Study Questions

1. a) 3(12.0) + 8(1.01) + 3(16.0) = 92.1 g/mole b) 92.1 g c) 6.02 x 10^{23} molecules

   d) 0.217 moles x $\frac{92.1\,g}{1\,mole}$ = 20.0 g e) 783 g x $\frac{1\,mole}{92.1\,g}$ = 8.50 moles

2. a) 4 atoms (one N + 3 H)

   b) 1 mole NH_3 x $\frac{6.02\,x\,10^{23}\,molecules}{1\,mole\,NH_3}$ x $\frac{4\,atoms}{1\,molecule}$ = 2.41 x 10^{24} atoms

   c) 3.40 g NH_3 $x\,\frac{1\,mole\;NH_3}{17.0\;g\;NH_3}\times\frac{6.02\times10^{23}molecules}{1\;mole\;NH_3}\times\frac{4\;atoms}{1\;molecule}$ = 4.82 x 10^{23} atoms

3. 4.5 g $Ca_3(PO_4)_2$ $\times\frac{1\;mol\;Ca_3(PO_4)_2}{310.18\;g\;Ca_3(PO_4)_2}\times\frac{8\;mol\;O}{1\;mol\;Ca_3(PO_4)_2}\times\frac{6.022\times10^{23}atoms}{1\;mol\;O}$

   = 7.0 x 10^{22} atoms O

4. In 100 g of this compound, there are 40.7 g C, 5.1 g H, and 54.2 g O

   40.7 g C x $\frac{1\,mole\,C}{12.0\,g\,C}$ = 3.39 moles C 3.39/3.39 = 1 x 2 = 2

   5.1 g H x $\frac{1\,mole\,H}{1.0\,g\,H}$ = 5.1 moles H 5.1/3.39 = 1.5 x 2 = 3

   54.2 g O x $\frac{1\,mole\,O}{16.0\,g\,O}$ = 3.39 moles O 3.39/3,39 = 1 x 2 = 2

   empirical formula = $C_2H_3O_2$

5. a) In 25.0 g of compound, there are 7.20 g Mg, 3.55 g C and 25.0-(7.20+3.55) = 14.25 g O.

   7.20 g Mg x $\frac{1\,mole\,Mg}{24.3\,g\,Mg}$ = 0.296 moles Mg 0.296/0.296 = 1

   3.55 g C x $\frac{1\,mole\,C}{12.0\,g\,C}$ = 0.296 moles C 0.296/0.296 = 1

   14.25 g O x $\frac{1\,mole\,O}{16.0\,g\,O}$ = 0.891 moles O 0.891/0.296 = 3

   formula = $MgCO_3$

b) % Mg = 7.20/25.0 = 28.8% Mg; %C = 3.55/25.0 = 14.2 % C; % O = 14.25/25.0 = 57.0% O.

28.8% Mg, 14.2 % C and 57.0% O.

(You should get the same result if you used molar mass and atomic masses.)

c) 13.9 g compound x $\frac{28.8\,g\,Mg}{100\,g\,compound}$ = 4.00 g Mg

d) 0.290 mol C x $\frac{12.0\ g\ C}{1\ mole\ C}$ x $\frac{100\ g\ compound}{14.2\ g\ C}$ = 24.5 g compound

6. mass of Zn = 33.64 g - 32.00 g = 1.64 g Zn
mass of O = 34.04 g - 33.64 g = 0.40 g O.

moles Zn: 1.64 g Zn x $\frac{1\ mole\ Zn}{65.4\ g\ Zn}$ = 0.0251 moles Zn 0.251/0.25 = 1

moles O: 0.40 g O x $\frac{1\ mole\ O}{16.0\ g\ O}$ = 0.025 moles O 0.25/0.25 = 1

formula = ZnO