Part A: Mass Percent Composition

An element's *mass percent composition* is constant for each compound no matter how much of the compound you have. For example, whether you have a teaspoon of H_2O or a whole swimming pool of H_2O, the percent of the total mass of the sample that is due to the hydrogen is always the same. The mass percent of any element in a compound can be found as follows:

$$\text{Mass percent of element X} = \frac{\text{Mass of element X in 1 mol of compound}}{\text{Mass of 1 mol of compound}} \times 100\%$$

The following mass percent problem below is broken into steps.

1) Ammonium sulfate is added to some pesticides to increase their effectiveness. It is also commonly used as a fertilizer because it acts as a source for nitrogen.

   a) What is the formula for ammonium sulfate?

   b) What is the mass of 1 mol of ammonium sulfate?

   c) What is the mass of nitrogen in 1 mol of ammonium sulfate?

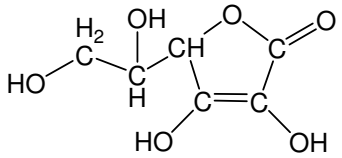
   d) Plug your answers from questions 1b and 1c into the equation for mass percent (see above) to find the mass percent of nitrogen in ammonium sulfate.

Now that we know the mass % of nitrogen in ammonium sulfate, it will never change (due to the law of constant composition) and can be applied to any sample of the compound.

   e) If you have 5.0 kg bag of ammonium sulfate fertilizer, what mass of nitrogen (in g) is available?

Part B: Empirical and Molecular Formulas

2) Below is the formula for vitamin C (ascorbic acid); it is an essential nutrient for humans.



a) What is the molecular formula for vitamin C?

b) What is the empirical formula for vitamin C?

Now let's practice using experimental data to determine the empirical and molecular formulas for methyl benzoate which is used in perfumes. We'll break the calculation down into several steps.

3) A sample of methyl benzoate is found to contain 70.6% C, 5.9% H, and 23.5% O.
   a) If we assume a 100.0-g sample of methyl benzoate, how many grams of each element would be present?

   b) Convert each of the masses you just found in question 3a to moles of each element.

   c) Divide each of the moles by the smallest number of moles to find the whole number ratio of moles.

   d) What is the empirical formula for methyl benzoate?

   e) If the molar mass of methyl benzoate is 136.1 g/mol, what is its molecular formula?

4) A compound was found to be made of only H, I, and O. Analysis indicates that the compound contains 0.57% H and 72.14% I. The remainder of the mass is due to the O.

   a) What is the empirical formula of the compound?

   b) If the molar mass of the compound is 175.91 g/mol, what is the molecular formula of the compound?

   c) What is the name of this compound? Hint: It's an acid

Part C: Harder examples (additional practice if you have time)

5) On the next page we'll do a harder example where we don't get nice mole ratios when we divide by the smallest number of moles. While it is fine to round off numbers like 3.97 mol (to 4 mol) or 1.02 mol (to 1 mol), sometimes the mole ratios aren't close enough to round off. To get us ready for that type of problem, complete the following table showing what whole number you should multiply each of the following moles by (rather than rounding off) in order to get a final number of moles that is either a whole number or close enough to round off to a whole number. The first one is done for you. Step 5 on page 185 of your textbook has more examples.

Number of moles	What to multiply it by	Final number of moles (round to nearest whole number)
1.24 moles	x 4	= 4.96 moles, which is now close enough to round off to our answer = 5 moles
3.10 moles		
2.34 moles		
1.48 moles		

6) Diethylene glycol (used in antifreeze blending) has the composition: 45.27% C, 9.50 % H, and 45.23% O by mass. Its molar mass is 106.12 g/mol. What is the molecular formula of diethylene glycol?

7) The heme portion of hemoglobin contains iron ions that carry oxygen around the blood stream. The mass percent composition of heme is 66.2% C, 5.23% H, 9.06% Fe, 9.09% N and 10.4% O. If the heme portion of hemoglobin has a molar mass of 616.49 g/mol, what are the empirical and molecular formulas for heme?