Part A: Mass percent composition from a chemical formula

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:

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

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 mole of ammonium sulfate?

   c) What is the mass of nitrogen in 1 mole 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 ammonium sulfate.

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

Part B: Mass percent composition from experimental data

Sometimes we don't know a compound's formula or aren't sure if two samples are actually the same compound. In those cases, we can use experimental data to calculate the mass percent as follows:

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

2) Chlorofluorocarbons (CFCs) are compounds that contain only carbon, chlorine and fluorine. They were once widely used as refrigerants and as propellants in aerosol cans. However, because CFCs contribute to ozone depletion in the upper atmosphere, a U.S. ban was imposed on the use of CFCs in aerosol-spray dispensers in the late 1970s.

   a) A 49.0-g sample of chlorofluorocarbon is found to contain 5.63 g of carbon. What is the mass % of C in this compound?

   b) A second sample of the same compound from question 2a is found to contain 145 g combined of chlorine and fluorine. How many grams of carbon are in this second sample?

   c) A new 64.5-g sample of an unknown chlorofluorocarbon is found to contain 6.41 g of carbon. Is this new sample the same compound that was analyzed in questions 2a and 2b above? Explain.

Part C: Additional practice

3) Which of the following five compounds has the smallest mass percent of sodium? Briefly explain your answer. [See if you can come up with an answer without doing any calculations.]

$NaNO_3$ Na_2SO_3 NaF Na_2PO_3 $NaNO_2$
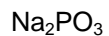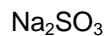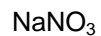
4) What is the mass percent of carbon in caffeine, $C_8H_{10}N_4O_2$?

5) One form of iron in the earth's crust is called magnetite. Magnetite is 72.4% iron by mass. How many kg of magnetite are required in order to produce 2.5×10^4 kg of iron?