

# Percent Composition

## *Why?*

Congratulations! On your last chemistry exam you answered 38 of 40 questions correctly. You achieved a grade of 95%! The percentage grade on your exam indicates the part of the exam you answered correctly. The part of the exam that you answered incorrectly is only 5%, or 2 questions. Percentage is also a useful tool in chemistry. The percent composition by mass of a compound represents the percent that each element in a compound contributes to the total mass of the compound. A chemist often compares the percent composition of an unknown compound with the percent composition calculated from the formula of a known compound. If the percentages agree it may confirm the identity of the unknown.

## *Learning Objectives*

- Understand what is meant by percent composition by mass of a compound.
- Ability to determine the percent composition by mass of a compound.

## *Success Criteria*

- Calculate the percent composition by mass of the elements in a variety of chemical compounds.
- Explain the procedure used to determine the percent composition of a compound.
- Use percent composition to arrive at conclusions regarding compounds.

## *Prerequisites and Vocabulary*

- Symbols and names of elements
- Atomic mass
- Molar mass
- Chemical formulas
- Hydrated crystal

**Task 1**

Using the students present in class today, complete the data table in Model 1.  
 [Note that Percent = (part/total) x 100.]

**Model 1**

Item	Total # of Students	Total # of Girls	Total # of Boys	Percent Girls	Percent Boys
Students					

**Key Questions**

1. Describe how one could calculate the percent of boys present today using the data in the chart.
2. What is the percent of boys present today, based on the data in the chart?

**Task 2**

When you chew a piece of gum, mass is lost as the sugar dissolves. After the sweetness is gone, only the 'gum' remains. Given a piece of gum to chew, each student will collect data to complete the data table in Model 2.

As a team, propose and describe below an experimental procedure that will permit you to collect the data needed to determine the percent of sugar in the gum. Do not proceed with the experiment until your instructor has approved your procedure.

Use the space below to collect your data. Enter your final data in the table below.

### **Model 2**

Item	Total Mass	Mass of sugar	Mass of gum	Percent sugar	Percent gum
Chewing Gum					

### **Key Questions**

1. Show the set-up used to determine the percent by mass of sugar in the chewing gum.
2. What is the percent of sugar in the chewing gum?
3. At the end of this experiment the gum is wet with saliva. How does the presence of the saliva influence the percentage reported in Question 2?
4. What method could be used to eliminate the error introduced by the presence of the saliva?

**Model 3**

Item	Total Mass	Mass of carbon	Mass of hydrogen	Percent carbon	Percent hydrogen
CH <sub>4</sub> , methane	16.0 g	12.0 g	4.0 g	75.0%	25.0%

**Key Question**

1. What is the mass of carbon in 16.0 g of methane?
2. Show the set-up that would be used to determine the percent by mass of carbon in methane in order to arrive at the answer shown in the Model 3 table.
3. What information do you need in order to determine the percent composition by mass of sodium in sodium chloride?

**Exercises**

Show set-up used to solve each exercise. Round atomic masses to the nearest tenth.

1. Write the general mathematical formula that can be used to calculate the percent composition by mass of any substance?
2. Use the atomic masses of the elements to determine the percent composition by mass of sodium and chlorine in sodium chloride.
3. Use the atomic masses of the elements to find the percent composition of hydrogen in H<sub>2</sub>O.
4. Determine the percent composition of oxygen in potassium chlorate, KClO<sub>3</sub>

- Determine the percent composition of phosphorus in calcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ .
- Copper (II) sulfate pentahydrate, with the formula  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , has a deep blue color. When heated to remove the water, the crystals crumble and turn white. What is the percentage, by mass, of water in copper (II) sulfate pentahydrate crystals?

### **Problems**

**Show set-up used to solve each problem.**

- The percent of oxygen in a colorless liquid is determined to be 94.1%. Is this liquid water or hydrogen peroxide ( $\text{H}_2\text{O}_2$ )?
- What is the percent composition of a compound that contains 8.1 grams of nickel and 2.2 grams of oxygen in a 10.3-gram sample?
- Nicotine, the addictive drug in cigarettes, contains 74.0% carbon, 8.6% hydrogen, and 17.3% nitrogen. What mass of each element can be recovered from a 55.0-gram sample of nicotine?