LESSON MAKER PRO

Formula Detectives

Use mass data to find formulas and percentages.

HIGH SCHOOL · CHE.4

CHE.4 "Students will demonstrate an understanding of the types of bonds and resulting atomic structures for the classification of chemical compounds. Develop and use models (e.g., Lewis dot, 3-D ball-stick, 3-D printing..."

NAME _____ DATE _____

FROM MASS TO FORMULA

To find an empirical formula, divide each element's mass by its atomic mass, then divide all the results by the smallest result. Use the simplest whole-number ratio as the formula's subscripts. To find a mass percent, divide the element's mass by the compound's total mass and multiply by 100. Use these atomic masses in g/mol: H 1, C 12, N 14, O 16, Mg 24, S 32, Ca 40.

WORKED EXAMPLE

A compound contains 28 g N and 6 g H. Find its empirical formula.

1. Divide each mass by its atomic mass: N, 28/14 = 2; H, 6/1 = 6.
2. Divide both results by the smaller result, 2: N, 2/2 = 1; H, 6/2 = 3.
3. Use the ratio 1:3 as the subscripts.

Answer: NH_3

PRACTICE 6 problems

1 A compound contains 12 g C and 2 g H. Find its empirical formula.

ANSWER _____

2 A compound contains 12 g C and 32 g O. Find its empirical formula.

ANSWER _____

3 A compound contains 32 g S and 48 g O. Find its empirical formula.

ANSWER _____

4 What percent of the mass of CH_4 is carbon?

ANSWER _____

5 What percent of the mass of MgO is oxygen?

ANSWER _____

6 What percent of the mass of $CaCO_3$ is oxygen?

ANSWER _____

APPLY IT Show your work

1 A 300 g sports drink contains 15 g of sugar. What percent of the drink's mass is sugar?

WORK SPACE

ANSWER _____

2 A lab isolates a pure vitamin C sample from a supplement. The sample contains 36 g C, 4 g H, and 48 g O. What is its empirical formula?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A sample contains 24 g C, 4 g H, and 32 g O. A student says its empirical formula is $C_2H_4O_2$ because those are the mole amounts. Is the student correct? Give the empirical formula and carbon's mass percent. Explain using the mole ratio.

WORK SPACE AND ANSWER

Formula Detectives

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A compound contains 12 g C and 2 g H. Find its empirical formula.	**CH_2**
2	A compound contains 12 g C and 32 g O. Find its empirical formula.	**CO_2**
3	A compound contains 32 g S and 48 g O. Find its empirical formula.	**SO_3**
4	What percent of the mass of CH_4 is carbon?	**75%**
5	What percent of the mass of MgO is oxygen?	**40%**
6	What percent of the mass of $CaCO_3$ is oxygen?	**48%**

PART 2 · APPLY IT

1. **5%** Divide the sugar mass by the total drink mass: 15/300 × 100 = 5%.
2. **$C_3H_4O_3$** Dividing by atomic masses gives 3 mol C, 4 mol H, and 3 mol O. The ratio 3:4:3 is already in simplest whole-number form.

CHALLENGE

No. The mole ratio 2:4:2 simplifies to 1:2:1, so the empirical formula is CH_2O. Carbon makes up 24/60 × 100 = 40% of the sample's mass.

Accept equivalent calculations that show the simplest whole-number mole ratio. Mass percentages should be based on the mass of the entire sample or compound.