LESSON MAKER PRO

Formula Forensics

Use mass data to uncover formulas and percent composition.

HIGH SCHOOL · CHE.4.6

CHE.4.6 "Use mathematical and computational analysis to determine the empirical formula and the percent composition of compounds."

NAME _____ DATE _____

FROM MASS TO FORMULA

To find an empirical formula, divide each element's mass by its atomic mass. Divide the mole amounts by the smallest amount, then multiply if needed to make all ratios whole numbers. To find percent by mass, divide an element's mass in the formula by the total formula mass and multiply by 100.

WORKED EXAMPLE

A sample contains 12 g carbon and 4 g hydrogen. Find its empirical formula and percent carbon by mass. Use C = 12 g/mol and H = 1 g/mol.

1. Carbon: 12/12 = 1 mol. Hydrogen: 4/1 = 4 mol.
2. Divide both amounts by 1 to get C:H = 1:4.
3. The empirical formula is CH_4.
4. Percent carbon = 12/(12 + 4) × 100 = 75%.

Answer: CH_4; 75% carbon

PRACTICE 6 problems

1 A sample contains 28 g nitrogen and 6 g hydrogen. Find its empirical formula. Use N = 14 g/mol and H = 1 g/mol.

ANSWER _____

2 A sample contains 24 g carbon and 2 g hydrogen. Find its empirical formula. Use C = 12 g/mol and H = 1 g/mol.

ANSWER _____

3 A sample contains 112 g iron and 48 g oxygen. Find its empirical formula. Use Fe = 56 g/mol and O = 16 g/mol.

ANSWER _____

4 What percent of MgO is magnesium by mass? Use Mg = 24 g/mol and O = 16 g/mol.

ANSWER _____

5 What percent of C_2H_6 is carbon by mass? Use C = 12 g/mol and H = 1 g/mol.

ANSWER _____

6 What percent of SO_3 is sulfur by mass? Use S = 32 g/mol and O = 16 g/mol.

ANSWER _____

APPLY IT Show your work

1 A sports drink lists glucose, $C_6H_{12}O_6$, as an ingredient. Find glucose's empirical formula and percent carbon by mass. Use C = 12 g/mol, H = 1 g/mol, and O = 16 g/mol.

WORK SPACE

ANSWER _____

2 White paint on a skateboard helmet contains titanium dioxide. A sample of the compound contains 48 g titanium and 32 g oxygen. Find its empirical formula and percent titanium by mass. Use Ti = 48 g/mol and O = 16 g/mol.

WORK SPACE

ANSWER _____

CHALLENGE One step up

A sample contains 14 g nitrogen and 40 g oxygen. A student divides by the atomic masses and gets a mole ratio of 1:2.5, then rounds it to 1:3. Explain why rounding is incorrect and find the empirical formula. Use N = 14 g/mol and O = 16 g/mol.

WORK SPACE AND ANSWER

ANSWER KEY # Formula Forensics

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A sample contains 28 g nitrogen and 6 g hydrogen. Find its empirical formula. Use N = 14 g/mol and H = 1 g/mol.	**NH_3**
2	A sample contains 24 g carbon and 2 g hydrogen. Find its empirical formula. Use C = 12 g/mol and H = 1 g/mol.	**CH**
3	A sample contains 112 g iron and 48 g oxygen. Find its empirical formula. Use Fe = 56 g/mol and O = 16 g/mol.	**Fe_2O_3**
4	What percent of MgO is magnesium by mass? Use Mg = 24 g/mol and O = 16 g/mol.	**60% magnesium**
5	What percent of C_2H_6 is carbon by mass? Use C = 12 g/mol and H = 1 g/mol.	**80% carbon**
6	What percent of SO_3 is sulfur by mass? Use S = 32 g/mol and O = 16 g/mol.	**40% sulfur**

PART 2 · APPLY IT

1. **CH_2O; 40% carbon** Divide the subscripts by 6 to get CH_2O. Carbon contributes 72 g to the 180 g formula mass, so 72/180 × 100 = 40%.
2. **TiO_2; 60% titanium** The amounts are 1 mol Ti and 2 mol O, giving TiO_2. Titanium makes up 48/80 × 100 = 60% of its mass.

CHALLENGE

Rounding changes the mole ratio. Multiply both parts of 1:2.5 by 2 to get 2:5, so the empirical formula is N_2O_5.

Accept equivalent calculation methods. In the challenge, the explanation must preserve the 1:2.5 ratio rather than round it.