

Formula Mass and Percent Composition

Answer key with worked solutions

A. Understanding

1. What percent composition tells you.

The percentage of the compound's **mass** that comes from each element.

2. Why hydrogen is only about 25% of methane's mass.

Percent composition is by mass, not number of atoms. Hydrogen atoms (1.008 u) are much lighter than carbon (12.01 u): $\% \text{ H} = 4(1.008) \div 16.04 \times 100\% = \mathbf{25.13\%}$.

B. Formula mass

3. Formula masses.

(a) H_2SO_4 : $2(1.008) + 32.06 + 4(16.00) = \mathbf{98.08 \text{ u}}$

(b) $\text{Mg}(\text{OH})_2$: $24.31 + 2(16.00 + 1.008) = \mathbf{58.33 \text{ u}}$

(c) $(\text{NH}_4)_2\text{SO}_4$: $2(14.01) + 8(1.008) + 32.06 + 4(16.00) = \mathbf{132.14 \text{ u}}$

C. Percent composition

4. Percent composition of NaOH (formula mass 40.00 u).

$\% \text{ Na} = 22.99 \div 40.00 \times 100 = \mathbf{57.48\%}$; $\% \text{ O} = 16.00 \div 40.00 \times 100 = \mathbf{40.00\%}$; $\% \text{ H} = 1.008 \div 40.00 \times 100 = \mathbf{2.52\%}$ (total 100.00%)

5. $\% \text{ N}$ in NH_4NO_3 .

Formula mass = $2(14.01) + 4(1.008) + 3(16.00) = 80.05 \text{ u}$. $\% \text{ N} = 28.02 \div 80.05 \times 100 = \mathbf{35.00\%}$

6. Percent composition of ethanol (formula mass 46.07 u).

$\% \text{ C} = 24.02 \div 46.07 \times 100 = \mathbf{52.14\%}$; $\% \text{ H} = 6.048 \div 46.07 \times 100 = \mathbf{13.13\%}$; $\% \text{ O} = 16.00 \div 46.07 \times 100 = \mathbf{34.73\%}$ (total 100.00%)

D. Mass of an element in a sample

7. Copper in 25.0 g of CuSO_4 .

$$\text{Formula mass} = 63.55 + 32.06 + 4(16.00) = 159.61 \text{ u. Mass of Cu} = \frac{63.55}{159.61} \times 25.0 = \mathbf{9.95 \text{ g}}$$

8. Oxygen in 50.0 g of CaCO_3 .

$$\text{Formula mass} = 100.09 \text{ u; O contributes } 3(16.00) = 48.00 \text{ u. Mass of O} = \frac{48.00}{100.09} \times 50.0 = \mathbf{24.0 \text{ g}}$$

E. Challenge

9. Which fertiliser has more nitrogen by mass?

$$\text{NH}_3: 14.01 \div 17.03 \times 100 = \mathbf{82.25\% \text{ N.}} \quad (\text{NH}_4)_2\text{SO}_4: 28.02 \div 132.14 \times 100 = \mathbf{21.20\% \text{ N.}}$$

Ammonia has the higher mass percent of nitrogen.

10. Percentage of water in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

$$\text{Formula mass} = 159.61 + 5(18.016) = 249.69 \text{ u. \% water} = 90.08 \div 249.69 \times 100 = \mathbf{36.08\%}$$