

PERCENTAGE COMPOSITION (MASS)

EXAMPLE

Calculate the percentage composition of each element in ethanoic acid, CH_3COOH .

$M(\text{C}) = 12.0 \text{ g mol}^{-1}$, $M(\text{H}) = 1.00 \text{ g mol}^{-1}$ and $M(\text{O}) = 16.0 \text{ g mol}^{-1}$

PROCESS

STEP ONE

Find the total molar mass

$$\begin{aligned} M(\text{CH}_3\text{COOH}) &= (2 \times \text{C}) + (4 \times \text{H}) + (2 \times \text{O}) \\ &= (2 \times 12.0) + (4 \times 1.00) + (2 \times 16.0) \\ &= 60.0 \text{ g mol}^{-1} \end{aligned}$$

STEP TWO

Find the combined molar masses for each type of atom

2 C atoms	4 H atoms	2 O atoms
2×12.0	4×1.00	2×16.0
$= 24.0 \text{ g mol}^{-1}$	$= 4.00 \text{ g mol}^{-1}$	$= 32.0 \text{ g mol}^{-1}$

STEP THREE

Divide by the total molar mass and x100

$\frac{24}{60} \times 100$	$\frac{4}{60} \times 100$	$\frac{32}{60} \times 100$
$= 40.0\%$	$= 6.67\%$	$= 53.3\%$

STEP FOUR

Show the percentage composition

CH_3COOH is made of 40.0% carbon, 6.67% hydrogen and 53.3% oxygen by mass

HORIZONTAL LAYOUT/FAST APPROACH

$$M(\text{CH}_3\text{COOH}) = (2 \times \text{C}) + (4 \times \text{H}) + (2 \times \text{O}) = (2 \times 12.0) + (4 \times 1.00) + (2 \times 16.0) = 60.0 \text{ g mol}^{-1}$$

$$\% \text{C}_2 = \frac{2(12.0)}{60} \times 100 = 40.0\%$$

$$\% \text{H}_4 = \frac{4(1.00)}{60} \times 100 = 6.67\%$$

$$\% \text{O}_2 = \frac{2(16.0)}{60} \times 100 = 53.3\%$$

CH_3COOH is made of 40.0% carbon, 6.67% hydrogen and 53.3% oxygen by mass

HOW IT LOOKS ON PAPER

Calculate the percentage composition of methyl ethanoate. Methyl ethanoate has a molecular formula of $\text{C}_3\text{H}_6\text{O}_2$

$M(\text{C}) = 12.0 \text{ g mol}^{-1}$, $M(\text{H}) = 1.00 \text{ g mol}^{-1}$ and $M(\text{O}) = 16.0 \text{ g mol}^{-1}$

$$\begin{aligned} M(\text{C}_3\text{H}_6\text{O}_2) &= (3 \times 12.0) + (6 \times 1.00) + (2 \times 16.0) \\ &= 74.0 \text{ g mol}^{-1} \end{aligned}$$

$$\begin{aligned} M(3\text{C}) &= 3 \times 12.0 \\ &= 36.0 \text{ g mol}^{-1} \end{aligned}$$

$$\begin{aligned} M(6\text{H}) &= 6 \times 1.00 \\ &= 6.00 \text{ g mol}^{-1} \end{aligned}$$

$$\begin{aligned} M(2\text{O}) &= 2 \times 16.0 \\ &= 32.0 \text{ g mol}^{-1} \end{aligned}$$

$$\begin{aligned} \% \text{C} &= \frac{36.0}{74.0} \times 100 \\ &= 48.6\% \end{aligned}$$

$$\begin{aligned} \% \text{H} &= \frac{6.00}{74.0} \times 100 \\ &= 8.11\% \end{aligned}$$

$$\begin{aligned} \% \text{O} &= \frac{32.0}{74.0} \times 100 \\ &= 43.2\% \end{aligned}$$

∴ methyl ethanoate has a percentage mass composition of 48.6% carbon, 8.11% hydrogen and 43.2% oxygen.

