Relative Atomic Mass

- Atoms are too small to be weighed, therefore isotopes $^{12}\text{C}$ has been assigned a mass of exactly 12 g for comparison purpose.

- Relative atomic mass is the weighted average mass of naturally occurring atoms of an element on a scale where an atom of carbon-12 has a mass exactly 12 units.

$$A_r = \frac{\text{average mass of one atom of element Y \times 12}}{\text{mass of one atom of carbon-12}}$$
Ammount of Substance

- A mole of any substances has a mass in grams numerically equal to its $A_r$ or $M_r$

- Mass of 1 mole of $^{12}\text{C}$ atoms = 12 g

- Mass of 1 mole of $\text{H}_2\text{O}$ molecules = \([2(1) + 16] \text{ g} = 18 \text{ g}\)

- Mass of 1 mole of $\text{CO}_3^{2-}$ ions = \([12 + 3(16)] \text{ g} = 60 \text{ g}\)
Use of the Data Booklet is relevant to this question.

Q2: Analytical chemists can detect very small amounts of amino acids down to $3 \times 10^{-21}$ mol. How many molecules of an amino acid ($M_r = 200$) would this be?

A. 9
B. 200
C. 1800
D. 360 000

• [AS Nov 2003 Paper I Q1]
Example 2.

Calculate the percentage by mass of iron in iron (III) oxide, Fe$_2$O$_3$.

Example 3.

Calculate the percentage by mass of carbon in ethanol, C$_2$H$_5$OH.
Steps to follow:

1. Change percentage composition to mass, \( m \) (in g)

2. Divide the mass of each element by its respective atomic mass to get the number of moles of each.

3. Divide the number of moles of each element by the smallest number of moles.
Example 5

10 cm³ of a 3 moldm⁻³ sulfuric acid is diluted with water to give a volume of 250 cm³, what is the concentration of the diluted solution?
Q1: N\textsubscript{2}O\textsubscript{4} is a poisonous gas. It can be disposed of safely by reaction with sodium hydroxide.

• N\textsubscript{2}O\textsubscript{4} (g) + 2NaOH (aq) → NaNO\textsubscript{3} (aq) + NaNO\textsubscript{2} (aq) + H\textsubscript{2}O (l)

What is the minimum volume of 0.5mol dm\textsuperscript{-3} NaOH (aq) needed to dispose of 0.02mol of N\textsubscript{2}O\textsubscript{4}?

A. 8cm\textsuperscript{3}
B. 12.5cm\textsuperscript{3}
C. 40cm\textsuperscript{3}
D. 80cm\textsuperscript{3}

• [AS June 2006 Paper I Q1]
Calculation using Combustion Data

The molecular formula of hydrocarbon can be determined by combustion in excess oxygen (to form carbon dioxide and steam). A gaseous hydrocarbon, \( \text{C}_x\text{H}_y \), explodes with excess \( \text{O}_2 \) according to the general equation.

\[
\text{C}_x\text{H}_y + (x + \frac{y}{4}) \text{O}_2 \rightarrow x\text{CO}_2 + \frac{y}{2}\text{H}_2\text{O}
\]
Example 3:

20 cm³ of an unknown hydrocarbon, CₓHᵧ, was mixed with 80 cm³ of oxygen (an excess) in a graduated tube. A spark was passed through the mixture, and the resulting gases were allowed to cool back to room temperature. 60 cm³ of gas was left. When this gas was exposed to sodium hydroxide solution, the volume fell to 40 cm³. Write the equation for the combustion, and so find the formula of the hydrocarbon.
Q2: 0.200mol of a hydrocarbon undergo complete combustion to give 35.2g of carbon dioxide and 14.4g of water as the only products.

What is the molecular formula of the hydrocarbon?

A. C₂H₄
B. C₂H₆
C. C₄H₄
D. C₄H₈