Exercise walk-through

The mole and the Avogadro constant ▪ 2.2

eXercise

You must be able to

- define the mole in terms of the Avogadro constant
- convert between mass, moles and number of particles

Method — The mole

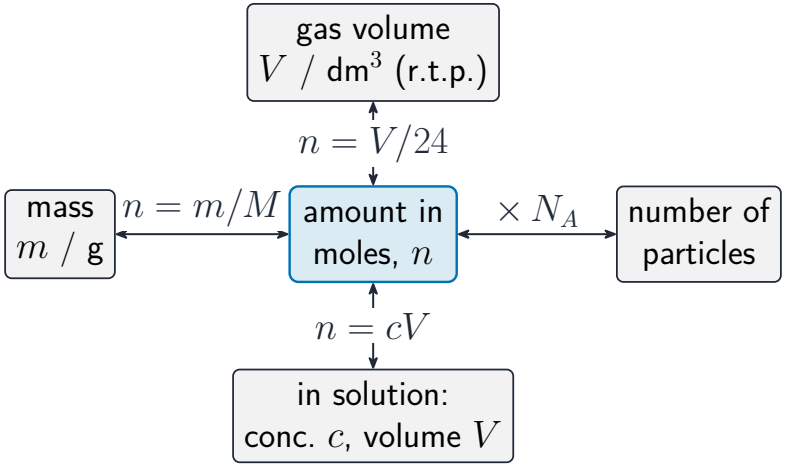
One **mole** is the amount of substance containing $N_A = 6.02 \times 10^{23}$ particles (the **Avogadro constant**). The particles may be atoms, molecules or ions — always say which.

The mass of one mole equals the relative mass — the **molar mass** M (g mol^{-1}):

$$n = \frac{m}{M}$$

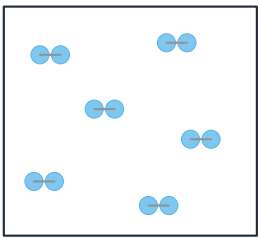
Example. Moles in 8.0 g of CH_4 ($M = 16$): $n = 8.0/16 = 0.50$ mol.

Method — The mole

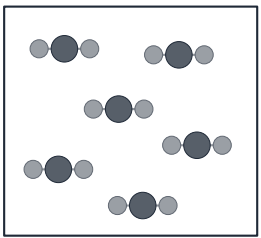


Method — The mole

same volume, same temperature and pressure



hydrogen, H_2



carbon dioxide, CO_2

the same **number** of molecules (6 each), even though CO_2 is bigger

Equal volumes of gas contain equal numbers of molecules

Practice 2.1 ▪ 2 marks

State the value of the Avogadro constant and what it counts.

Solution 2.1

Method: The mole

Worked steps

6.02×10^{23} mol^{-1} B1; the number of particles (atoms/molecules/ions) in one mole B1.

Practice 2.2 ▪ 1 mark

Calculate the number of moles in 36 g of water, H_2O ($M = 18$).

Solution 2.2

Method: The mole

Worked steps

$n = 36/18 = 2.0$ mol B1.

Exam-style 3.1 ▪ 1 mark

How many molecules are in 2.0 mol of carbon dioxide?

A 3.0×10^{23}

B 6.02×10^{23}

C 1.2×10^{24}

D 2.0×10^{23}

Solution 3.1

A 3.0×10^{23}

B 6.02×10^{23}

C 1.2×10^{24} ✓

D 2.0×10^{23}

Worked steps

C. $2.0 \times 6.02 \times 10^{23} = 1.2 \times 10^{24}$.

Exam-style 3.2 ▪ 1 mark

The mass of 0.25 mol of a compound is 22 g. Its molar mass is:

A 5.5 g mol^{-1}

B 44 g mol^{-1}

C 88 g mol^{-1}

D 5.5×10^{23} g mol^{-1}

Solution 3.2

Method: The mole

A 5.5 g mol ^{1}

B 44 g mol ^{1}

C 88 g mol ^{1} ✓

D 5.5 $\times$ 10^{23} g mol ^{1}

Worked steps

C. $M = m/n = 22/0.25 = 88$ g mol^{-1}.

Exam-style 3.3 ▪ 2 marks

Calculate the number of moles in 5.85 g of sodium chloride, NaCl ($M = 58.5$).

Solution 3.3

Method: The mole

Worked steps

$n = m/M = 5.85/58.5 = 0.100$ mol M1 A1.

Exam-style 3.4 ▪ 2 marks

Calculate the number of chloride ions in 5.85 g of NaCl ($N_A = 6.02 \times 10^{23}$).

Solution 3.4

Method: The mole

Worked steps

moles of NaCl $= 0.100$, so moles of Cl $= 0.100$ (M1); number $= 0.100 \times 6.02 \times 10^{23} = 6.02 \times 10^{22}$ (A1).