# Mole Calculations Map

Cambridge International AS & A Level Chemistry · Topic 2 Atoms, molecules and stoichiometry

## 1 Relative masses 2.1

- **u** = 1/12 of a $^{12}C$ atom; $\mathbf{A_r}$: weighted mean in u
- $\mathbf{M_r}$: add the $A_r$ of every atom
- Giant structures: **formula mass**
- Brackets multiply everything inside
- Hydrates: add n × 18.0



## 2 The mole 2.2.1

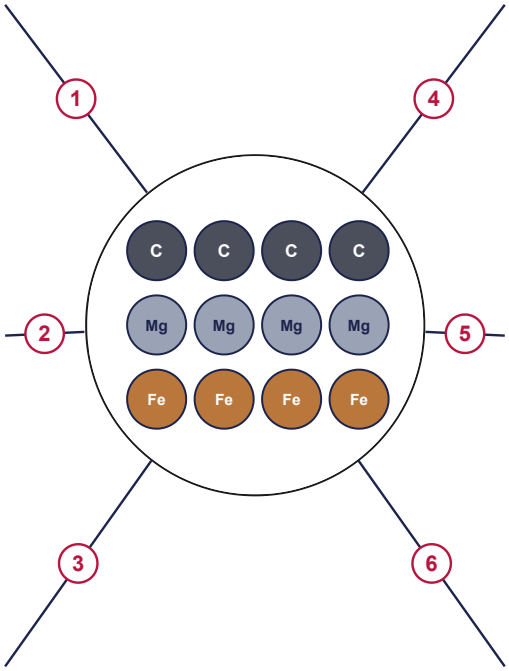
- **Mole**: the unit of amount
- **n = m ÷ M**; m = n × M
- M in g $mol^{-1}$
- **L = 6.02 × $10^{23}$ $mol^{-1}$**
- Particles = n × L



## 3 Counting particles 2.2.1

- Read the formula first
- $CaCl_2$: 3 ions per formula
- $H_2O$: 3 atoms per molecule
- Multiply moles by the count
- 1.00 g $H_2$ has 4 × the atoms of 1.00 g He





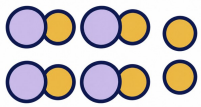

## 4 Reacting masses 2.4.1(a), (e)

- **Moles** of what you know
- **Ratio** from the equation
- **Mass** of what you want
- Masses → moles → ratio: the **stoichiometry**
- Fe 0.100, $Cl_2$ 0.150: **2Fe + 3$Cl_2$**



## 5 Limiting and excess reagents 2.4.1(d)

- Find moles of **both** reactants
- Compare with the equation ratio
- **Limiting reagent**: used up first
- **Excess reagent**: some left over
- Product from the limiting reagent



## 6 Percentage yield 2.4.1(a)

- **% yield** = actual ÷ theoretical × 100
- Theoretical: from the limiting reagent
- Losses: incomplete, side reactions, transfers
- Several steps: **multiply** the yields
- 90 % then 70 %: 63 % overall



## The equations of mole calculations

n in mol, m in g, M in g $mol^{-1}$, L = 6.02 × $10^{23}$ $mol^{-1}$

| Quantity | Equation | Worked example |
|---|---|---|
| Amount from mass | n = m ÷ M | 4.40 g $CO_2$: 4.40 ÷ 44.0 = 0.100 mol |
| Mass from amount | m = n × M | 0.250 mol NaOH: 0.250 × 40.0 = 10.0 g |
| Number of particles | N = n × L | 0.200 mol $H_2O$: 1.20 × $10^{23}$ molecules |
| Percentage yield | actual ÷ theoretical × 100 | 5.04 g of 5.60 g CaO: 89.9 % |
| Overall yield | product of the step yields | 0.90 × 0.70 = 0.63: 63 % |
| Relative isotopic mass | mass of one atom ÷ u | $^{12}C$ is exactly 12 |

## Worked examples

### Reacting mass

- 25.0 g $CaCO_3$: 0.250 mol
- 1 : 1, so 0.250 mol CaO
- **14.0 g CaO**

### Limiting reagent

- 0.200 mol Mg, 0.150 mol HCl
- Mg needs 0.400: HCl limits
- **0.0750 mol $H_2$**

### Yield from a limit

- 2.70 g Al + 9.60 g S: Al limits
- $Al_2S_3$ in theory: 7.52 g
- 6.00 g made: **79.8 %**

Moles link to empirical formulae and hydrated salts, and to solutions and gases.

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