Atomic Structure and Isotopes Map

OCR A Level Chemistry A · 2.1.1 Atomic structure and isotopes

1 Sub-atomic particles

2.1.1 (b)

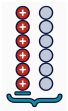
- **Protons** and **neutrons** in a tiny nucleus
- **Electrons** in shells around it
- Proton: mass 1, charge +1
- Neutron: mass 1, charge 0
- Electron: mass 1/1840, charge −1



2 Atoms and ions

2.1.1 (b)

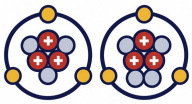
- **Atomic number Z**: protons
- **Mass number A**: protons + neutrons
- Neutrons = A − Z
- Atom: electrons = Z
- Ion: electrons = Z − charge (S^{2-}: 18)

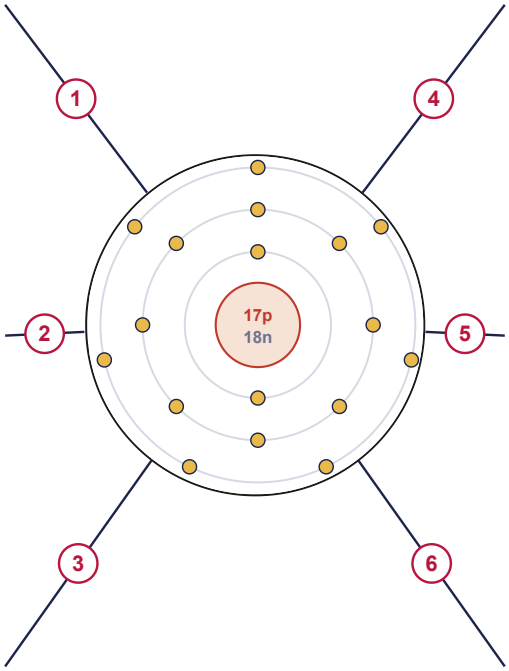


3 Isotopes

2.1.1 (a)

- Same element: **same number of protons**
- **Different numbers of neutrons**
- So **different masses**
- Same electrons: **same chemistry**
- ^{35}Cl and ^{37}Cl; ^{12}C, ^{13}C and ^{14}C

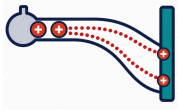




4 Mass spectrometry

2.1.1 (d)

- Atoms become **1+ ions**, sorted by **m/z**
- One peak per **isotope**
- Peak m/z = **relative isotopic mass**
- Peak height = **relative abundance**
- A_r = Σ(m/z × abundance) ÷ 100



5 The carbon-12 scale

2.1.1 (c)

- Standard: **1/12 of the mass of a ^{12}C atom**
- **Relative isotopic mass**: one isotope on that scale
- **A_r**: the **weighted mean** mass of an atom
- No units: they are ratios
- A_r is rarely a whole number



6 M_r and formula mass

2.1.1 (e)

- **M_r**: add the A_r of every atom in a molecule
- H_2SO_4: 2.0 + 32.1 + 64.0 = 98.1
- Giant structures: **relative formula mass**
- NaCl = 58.5 (no molecules)
- Hydrates: add n × 18.0 for nH_2O



Isotopes and relative atomic masses

abundances in %; A_r = Σ(m/z × abundance) ÷ 100

Element	Isotopes	Abundances	A_r	Notes
Chlorine	^{35}Cl, ^{37}Cl	75, 25	35.5	two peaks, 3 : 1
Magnesium	^{24}Mg, ^{25}Mg, ^{26}Mg	79.0, 10.0, 11.0	24.3	three peaks
Copper	^{63}Cu, ^{65}Cu	69.2, 30.8	63.6	two peaks, about 2 : 1
Gallium	^{69}Ga, ^{71}Ga	60.1, 39.9	69.8	two peaks, 3 : 2
Lithium	^{6}Li, ^{7}Li	7.5, 92.5	6.9	^{7}Li dominates
Neon	^{20}Ne, ^{22}Ne	90.5, 9.5	20.2	^{20}Ne dominates

Working with relative masses

A_r from a spectrum

- Multiply each m/z by its abundance
- Add the products
- Divide by the total abundance

Abundances from A_r

- Call one abundance x, the other 100 − x
- $x \times m_1 + (100 - x) \times m_2 = 100 \times A_r$
- Solve for x

Formula masses

- Brackets: multiply everything inside
- Hydrates: + n × 18.0
- $Mg(NO_3)_2$ = 148.3

Electrons are arranged in shells, sub-shells and orbitals (2.2.1); removing them is ionisation (3.1.1).

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