Atoms and Mass Spectrometry Map

Edexcel International A Level Chemistry · Unit 1 · Topic 2A Atoms and Mass Spectrometry

1 Sub-atomic particles

2.1–2.2

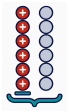
- **Protons** and **neutrons** in a tiny nucleus
- **Electrons** in shells around it
- Proton: mass 1, charge +1
- Neutron: mass 1, charge 0
- Electron: mass 1/1840, charge −1



2 Atomic and mass numbers

2.3–2.4

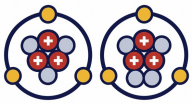
- **Atomic number Z**: protons
- **Mass number A**: protons + neutrons
- Neutrons = A − Z
- Atom: electrons = Z
- Ion: electrons = Z − charge (Al^{3+}: 10)

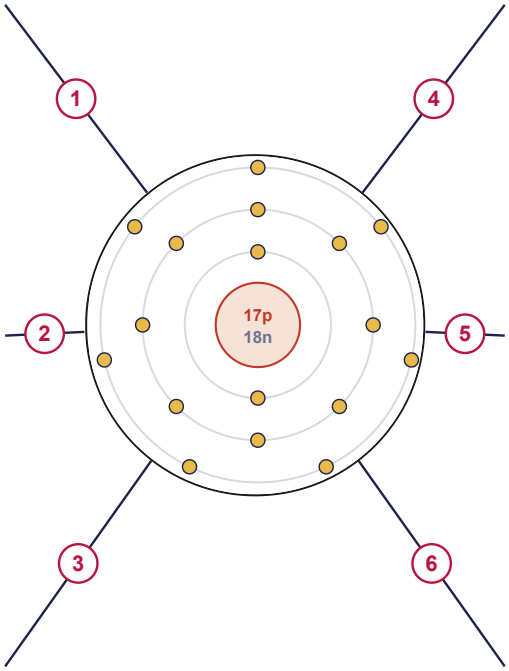


3 Isotopes

2.5

- Same element: **same Z**
- **Different neutrons**: different A
- Same electrons: **same chemistry**
- Physical properties that depend on mass differ
- ^{35}Cl and ^{37}Cl; ^{12}C, ^{13}C and ^{14}C

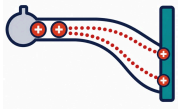




4 The mass spectrometer

2.6 i, iv

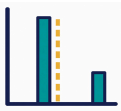
- Atoms or molecules become **positive ions**
- Ions separated by **m/z**
- Peak position: m/z of each isotope
- Peak height: **relative abundance**
- A **2+** ion appears at half its mass



5 Relative atomic mass

2.6 ii

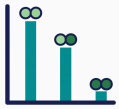
- **A_r**: weighted mean mass relative to 1/12 of ^{12}C
- $A_r = \Sigma(m/z \times \text{abundance}) \div 100$
- Cl: (35 × 75 + 37 × 25) ÷ 100 = 35.5
- Reverse: from A_r to abundances
- Not whole numbers: a mixture of isotopes



6 Spectra of molecules

2.6 iii, 2.7

- **Molecular ion M^+**: molecule less one electron
- Its m/z gives **M_r**: identifies the molecule
- Cl_2: m/z **70, 72, 74**
- Ratio **9 : 6 : 1** from 3 : 1 isotopes
- Multiply the abundances; ×2 for the mixed pair



Isotopes and relative atomic masses

abundances in %; $A_r = \Sigma(m/z \times \text{abundance}) \div 100$

Element	Isotopes	Abundances	A_r	Notes
Chlorine	^{35}Cl, ^{37}Cl	75, 25	35.5	Cl_2 peaks 70, 72, 74
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	$^{20}Ne^{2+}$ at m/z 10

Reading a mass spectrum

Isotopes of an element

- One peak per isotope
- m/z = mass number (1+ ions)
- Heights give the % abundances

Doubly charged ions

- Lose two electrons: 2+
- m/z = mass ÷ 2
- Small extra peaks at half values

Molecules

- Peak at highest m/z: M^+ (ignore isotope extras)
- M^+ m/z = M_r
- Compare with candidate formulae

Electrons are arranged in shells, sub-shells and orbitals (Topic 2B); removing them is ionisation (Topic 2C).

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