Atoms and Mass Spectrometry Map

Edexcel A Level Chemistry · Topic 1 Atomic Structure · Atoms and Mass Spectrometry

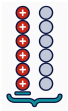
1 Sub-atomic particles 1.1–1.2

- **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



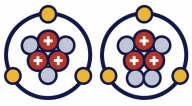
2 Atomic and mass numbers 1.3–1.4

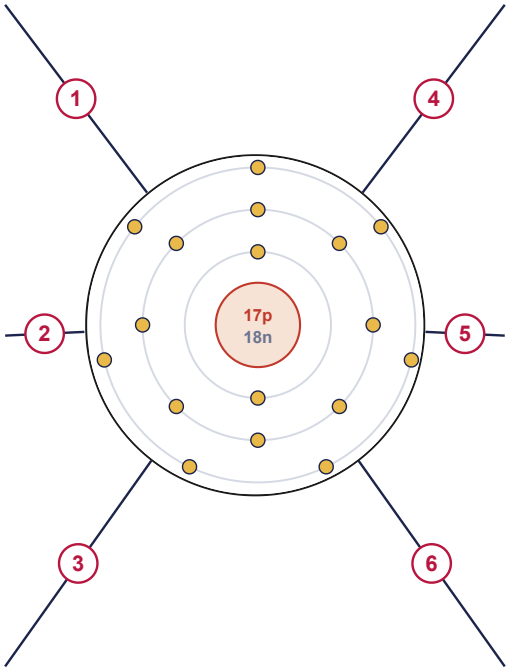
- **Atomic number Z**: protons
- **Mass number A**: protons + neutrons
- Neutrons = A − Z
- Atom: electrons = Z
- Ion: electrons = Z − charge (Al^{3+}: 10)



3 Isotopes 1.5

- 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





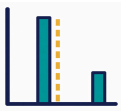
4 The mass spectrometer 1.8

- Atoms or molecules become **positive ions**
- Ions separated by **m/z**
- Peak position: m/z of each isotope
- Peak height: **relative abundance**
- **Relative isotopic mass**: one isotope on the ^{12}C scale



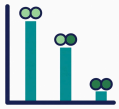
5 Relative atomic mass 1.6, 1.8

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



6 Spectra of molecules 1.7, 1.9, 1.10

- **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 %; $A_r = \Sigma(m/z \times abundance) \div 100$

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	relative isotopic masses 20 and 22

Reading a mass spectrum

Isotopes of an element

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

Relative masses

- Isotopic: one isotope vs 1/12 of ^{12}C
- M_r: add the A_r values
- Giant structures: relative formula mass

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 (the Electronic Configuration section); removing them is ionisation (the Ionisation Energies section).

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