

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 = $Z - \text{charge}$ (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

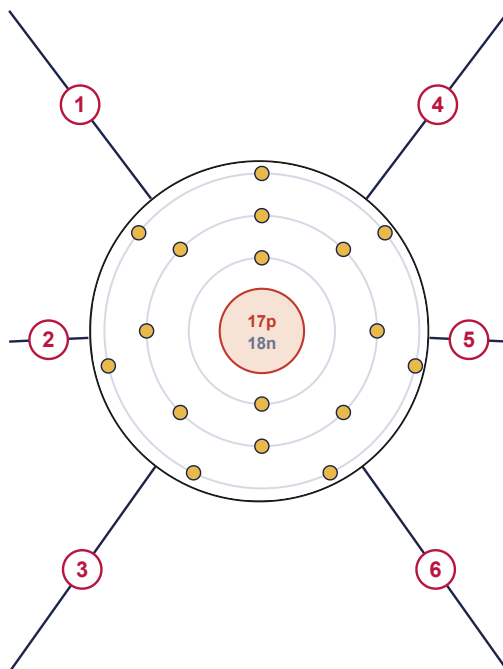
1.6, 1.8

- **A_r** : weighted mean mass relative to 1/12 of ^{12}C
- $A_r = \Sigma(m/z \times \text{abundance}) \div 100$
- 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
- Cl₂: m/z **70, 72, 74**
- Ratio **9 : 6 : 1** from 3 : 1 isotopes
- Multiply the abundances; $\times 2$ 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	^6Li , ^7Li	7.5, 92.5	6.9	^7Li 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).

