

Exercise walk-through

1.2

Atomic structure and the periodic table (Topic 2)

Pearson Edexcel · International A-Level · Chemistry

Count pairs before naming shape

- 1** NH_4^+ and CH_4 : four bonding regions, tetrahedral, 109.5° .
- 2** NH_3 : three bonds and one lone pair, pyramidal, about 107° . H_2O : two bonds and two lone pairs, bent, about 104.5° .
- 3** Lone pairs repel more strongly; the angle reduction is not a fixed amount per pair.

Compare fuels using their whole pathway

- 1** Cracking makes smaller hydrocarbons including alkenes; balance atoms in proposed products.
- 2** CO reduces oxygen transport; nitrogen/sulfur oxides can contribute to acid pollution.
- 3** Bioethanol growth can absorb CO₂, but processing and transport still emit. Hydrogen production also matters.

Choose reagents and conditions

- 1 **1** H_2/Ni adds hydrogen; steam/acid catalyst adds water; Br_2 adds bromine across $\text{C}=\text{C}$.
- 2 **2** Cold dilute acidified manganate(VII) gives a diol. Bromine decolourisation supports unsaturation, not a unique identity.
- 3 **3** Addition polymerisation opens $\text{C}=\text{C}$, retains side groups and loses no small molecule.

Exercises 2.1·2.3

2.1 State what is meant by an isotope. [2]

2.2 Boron has A_r 10.8 from isotopes ^{10}B and ^{11}B . Calculate the percentage abundance of each. [2]

2.3 Give the electronic configuration of a Cr^{3+} ion. (Cr: $[\text{Ar}] 3d^5 4s^1$) [1]

3 Exam-style questions

Exercises 2.1·2.3

2.1 State what is meant by an isotope. [2]

2.1 Atoms of the same element with the same number of protons but different numbers of neutrons.

2.2 Boron has A_r 10.8 from isotopes ^{10}B and ^{11}B . Calculate the percentage abundance of each. [2]

2.2 Let $x = \%$ of ^{11}B : $(10(100-x) + 11x)/100 = 10.8 \rightarrow x = 80$. So 20% ^{10}B , 80% ^{11}B .

2.3 Give the electronic configuration of a Cr^{3+} ion. (Cr: $[\text{Ar}] 3d^5 4s^1$) [1]

3 Exam-style questions

2.3 $[\text{Ar}] 3d^3$ – the 4s electron is lost first, then two of the 3d.

Exercises 3.1·3.2

3.1 The first seven ionisation energies of an element are 578, 1817, 2745, 11577, 14842, 18379, 23326 kJ mol⁻¹. Deduce its group from the jump. State whether the jump alone establishes its period, and explain why. [3]

3.2 Explain why the first ionisation energy of sulfur is lower than that of phosphorus, even though sulfur has the greater nuclear charge. [3]

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3.1 The large jump is between the 3rd and 4th ionisation energies ($11577 \gg 2745$): three electrons in the outer shell, so Group 3; these seven values show the number of outer electrons but do not by themselves count all occupied shells, so the jump alone does not establish the period. These are aluminium values, but identifying a familiar dataset is additional knowledge.

3.2 Explain why the first ionisation energy of sulfur is lower than that of phosphorus, even though sulfur has the greater nuclear charge. [3]

3.2 Sulfur's fourth 3p electron is the first to pair in an orbital; the inter-electron repulsion of the pair makes that electron easier to remove; the removed electrons are in the same 3p subshell with similar shielding by inner electrons. The extra repulsion explains the dip despite sulfur's larger nuclear charge.

Exercise 3.3

3.3 Bromine has isotopes ^{79}Br and ^{81}Br in approximately equal abundance. Predict the m/z values and relative heights of the peaks in the mass spectrum of Br_2 molecules, showing how you obtain the ratio. [4]

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3.3 Combinations: $79+79 = 158$, $79+81 = 160$, $81+81 = 162$. With a 1:1 abundance, $P(158) = 1/4$, $P(160) = 1/2$, $P(162) = 1/4$; peaks at m/z 158, 160, 162 in the ratio 1 : 2 : 1.