

Exercise walk-through

1.2.2

Periodic blocks, first-36 ionisation graphs and Period-2 structures

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.

Exercise 2.1

2.1 Classify K, Sc, As and He into s, p or d blocks using the configurations above. Explain why helium's noble-gas column does not make it a p-block element. [4]

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2.1 K s-block, Sc d-block and As p-block. He is s-block because its electrons occupy $1s^2$; the column reflects its full outer shell and chemical behaviour, not a p-electron configuration.

Setup for exercise 2.2

2.2 The following supplied first-ionisation energies are rounded to whole kJ mol^{-1} . Plot all 36 against atomic number, once with a linear energy axis and once with a $\log_{10}$ energy axis. Label axes and identify the noble-gas peaks. [6]

Element	Z	E / kJ mol^{-1}	Element	Z	E / kJ mol^{-1}
H	1	1312	K	19	419
He	2	2372	Ca	20	590
Li	3	520	Sc	21	633
Be	4	900	Ti	22	659
B	5	801	V	23	651
C	6	1086	Cr	24	653
N	7	1402	Mn	25	717
O	8	1314	Fe	26	763
F	9	1681	Co	27	760
Ne	10	2081	Ni	28	737
Na	11	496	Cu	29	746
Mg	12	738	Zn	30	906
Al	13	578	Ga	31	579
Si	14	787	Ge	32	762
P	15	1012	As	33	947
S	16	1000	Se	34	941
Cl	17	1251	Br	35	1140
Ar	18	1521	Kr	36	1351

Exercise 2.2

3 Exam-style questions

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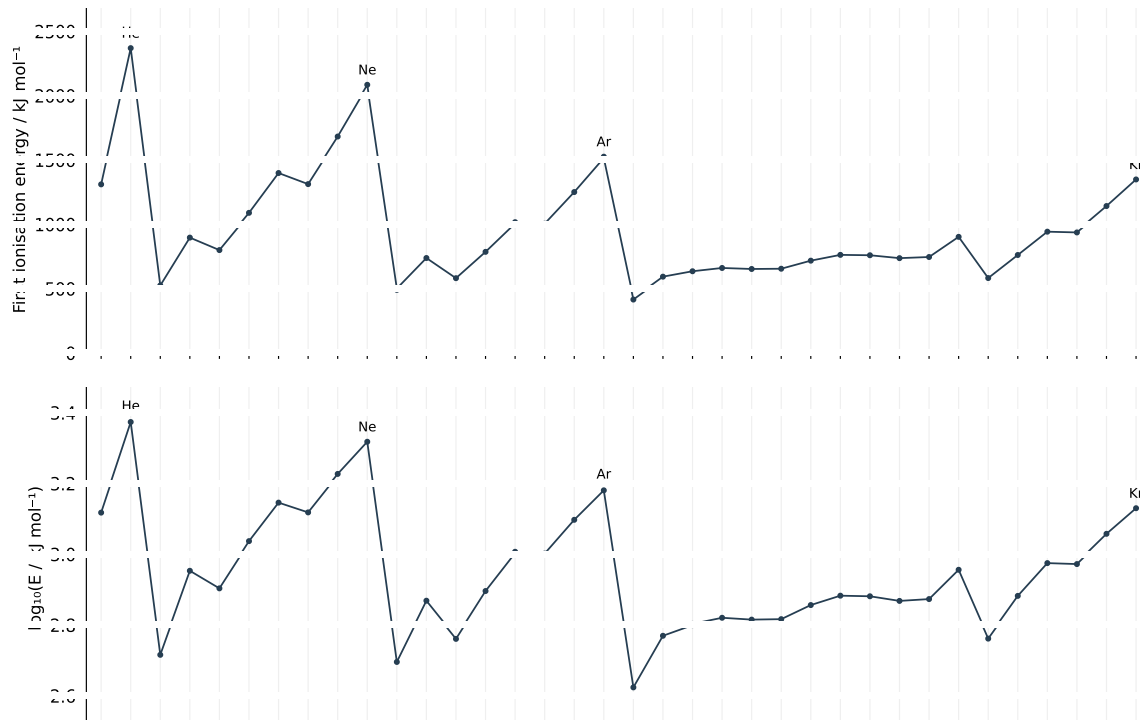
2.2



Full solution on next slide

Full solution 2.2 (1/2)

2.2



Full solution 2.2 (2/2)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Atomic number Z (hydrogen to krypton)

Linear axes labelled with Z and energy/unit and a consistent scale; all linear points correctly placed. Log axis labelled and scaled, all transformed points correctly placed. He, Ne, Ar and Kr identified as the noble-gas peaks; same ordered data on both plots with no substitution of successive ionisations for different atoms. Accept a correctly labelled logarithmically scaled energy axis.

Exercises 3.1·3.2

3.1 Use your graphs to identify three decreases that mark the start of a new occupied outer shell. Explain the general decrease using distance, shielding and nuclear charge. State one advantage of the logarithmic representation. [4]

3.2 Explain why the first-ionisation energy falls from Be to B and from N to O, although nuclear charge increases in each case. Give the relevant outer configurations. [4]

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3.1 He→Li, Ne→Na and Ar→K. The new outer shell puts the electron further from the nucleus with increased shielding; this outweighs the increase in nuclear charge, so less energy removes it. A log axis compresses the large numerical range and makes proportional changes easier to compare.

3.2 Explain why the first-ionisation energy falls from Be to B and from N to O, although nuclear charge increases in each case. Give the relevant outer configurations. [4]

3.2 Be [He]2s²; B [He]2s²2p¹: the B electron is removed from the higher-energy 2p sub-shell, outweighing increased nuclear charge. N [He]2s²2p³ has singly occupied p orbitals; O [He]2s²2p⁴ has a first pair, whose repulsion makes one electron easier to remove. No new occupied shell is added in these comparisons.

Exercises 3.3·3.4

3.3 Classify Li/Be, B/C, N₂/O₂/F₂ and Ne by their Period-2 solid structures. Explain why carbon has a much higher melting temperature than nitrogen, and why melting nitrogen does not break its N≡N bonds. [5]

3.4 A student describes the first 36 elements as a smooth rise interrupted only after noble gases. Evaluate this claim using two counterexamples from the table. Explain why this graph alone cannot predict every element's melting temperature. [3]

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3.3 Li/Be metallic; B/C giant covalent; N₂/O₂/F₂ simple molecular and Ne monatomic. Carbon melting requires overcoming many strong covalent bonds in its giant structure. Melting nitrogen overcomes attractions between N₂ molecules, retaining the covalent triple bonds inside each molecule. The diagram of a molecule does not imply a giant covalent lattice.

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3.4 Valid internal decreases include Be→B, N→O, Mg→Al, P→S, Ti→V, Fe→Co, Co→Ni, Zn→Ga and As→Se. Melting involves the solid's bonding/structure and attractions be-

tween its particles, rather than removal of one electron from gaseous atoms; first ionisation alone does not determine it.