

Exercise walk-through

2.2.1

Intermolecular forces: drawings and evidence transfer

Pearson Edexcel · International A-Level · Chemistry

Opposite solubility trends explain the evidence

- 1 **Set up** $\text{Ba}(\text{OH})_2$ is more soluble: its equal saturated volume contains more OH^- and needs more acid.
- 2 **Reason** BaSO_4 is less soluble: equal initial cation amounts give more solid with excess sulfate.
- 3 **Conclude** Solubility controls dissolved amount; it is different from dissociation strength.

Controls distinguish chemical evidence from contamination

- 1 Set up** Match measured amounts, particle size, apparatus and heating rate; compare sample temperature at a consistent decomposition criterion.
- 2 Reason** CO_2 : milky limewater; O_2 : glowing splint relights; NO_2 : brown and acidic.
- 3 Conclude** Clean flame-test wire and keep the flame region/loading consistent. Na yellow, K lilac, Ca brick-red, Sr crimson-red; sodium carry-over can mask another colour.

Independent identification

Your turn

$\text{C}_3\text{H}_6\text{O}$ has a carbonyl IR absorption and gives a positive Fehling's test. Which structure fits all evidence?

- A. CH_3COCH_3
- B. $\text{CH}_3\text{CH}_2\text{CHO}$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D. CH_3COOH

Exercises 2.1·2.2

2.1 Compare pure propanal, $\text{CH}_3\text{CH}_2\text{CHO}$, and propane, $\text{CH}_3\text{CH}_2\text{CH}_3$. State the attractions each has, identify which has permanent dipole–dipole attractions, and explain why neither forms a hydrogen-bond network with its own molecules. [4]

2.2 Predict whether pure methanamide, HCONH_2 , can hydrogen-bond to itself. Identify a donor and an acceptor. Compare pure propanone, CH_3COCH_3 , and its ability to accept a hydrogen bond from water. [4]

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2.1 Both have London forces; propanal also has permanent dipole–dipole attractions from its polar carbonyl. Propane lacks a suitable donor/acceptor pair; propanal has an oxygen acceptor but no H bonded to N/O/F to donate.

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2.2 Methanamide can form intermolecular hydrogen bonds: N–H is a donor and the carbonyl oxygen lone pair is an acceptor. Propanone lacks an N/O/F–H donor for its own network but its oxygen can accept from water.

Exercise 2.3

2.3 Explain why boiling temperatures generally rise from methane to pentane. Then explain why a three-carbon alcohol usually boils above a similar-size alkane. State the type of bond or attraction chiefly overcome in each case. [4]

3 Exam-style questions

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3 Exam-style questions

2.3 More electrons/more polarisable clouds in longer chains strengthen London attractions. The alcohol also hydrogen-bonds. Boiling mainly overcomes intermolecular attractions, preserving the molecules and their covalent bonds.

Exercise 3.1

3.1 Draw a pair of molecules joined by one hydrogen bond for each liquid: H_2O , NH_3 and HF . Include every atom and covalent bond, all acceptor-atom lone pairs, the donor/acceptor partial charges and a distinct hydrogen-bond line. [6]

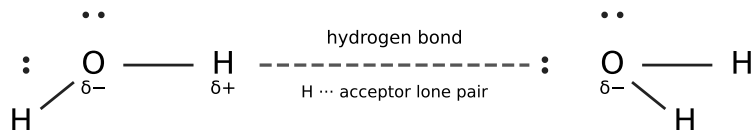
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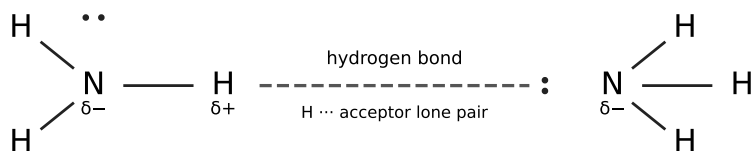
3.1

Solid line: covalent bond Dashed line: hydrogen bond

Water



Ammonia



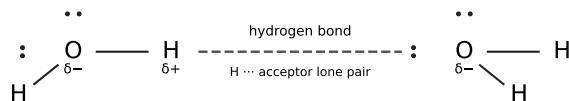
Full solution on next slide

Full solution 3.1

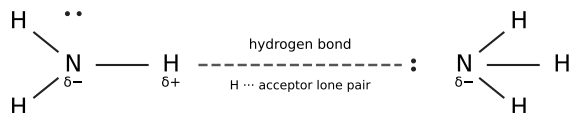
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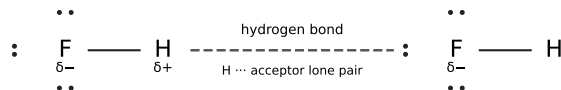
Water



Ammonia



Hydrogen fluoride



Original marking guidance: for each pair, B1 for complete molecules/acceptor lone pairs and B1 for donor $\text{H}\delta+ \cdots$ acceptor $\delta-$ attraction distinguished from covalent bonds (six marks total).

Exercises 3.2·3.3

3.2 Rounded boiling temperatures in °C are HCl -85 , HBr -67 , HI -35 and HF $+20$. Explain the trend HCl $\rightarrow$ HI and the HF exception. Separately, compare water with the similar simple molecule H₂S (boiling -60 °C): Water melts at 0 °C, while H₂S melts at -85 °C. Explain water's high melting and boiling temperatures, then why ice is less dense than liquid water near 0 °C. [6]

3.3 Choose water or hexane as the more suitable solvent in each case: sodium chloride, ethanol, iodine. Explain the particle attractions. State how a water molecule orients toward Na⁺ and Cl⁻, and explain why a polar halogenoalkane may dissolve poorly in water. [6]

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3.2 From HCl to HI, more electrons/more polarisable clouds give stronger London attractions and higher boiling temperatures. HF has H bonded to F and F lone pairs, enabling hydrogen bonds. Water also hydrogen-bonds whereas H₂S does not form the same strong network. More energy is needed to disrupt water's hydrogen-bonded intermolecular network during melting or boiling. Ice has an open hydrogen-bonded structure with molecules further apart, so lower density.

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3.3 NaCl: water, which hydrates its ions. O δ^- faces Na⁺ and H δ^+ faces Cl⁻. Ethanol: