2.2 Intermolecular forces and solvent choice

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS hydrogen bond

Objective

Explain boiling, water anomalies and solubility using actual molecular attractions. All questions and marking guidance are original.

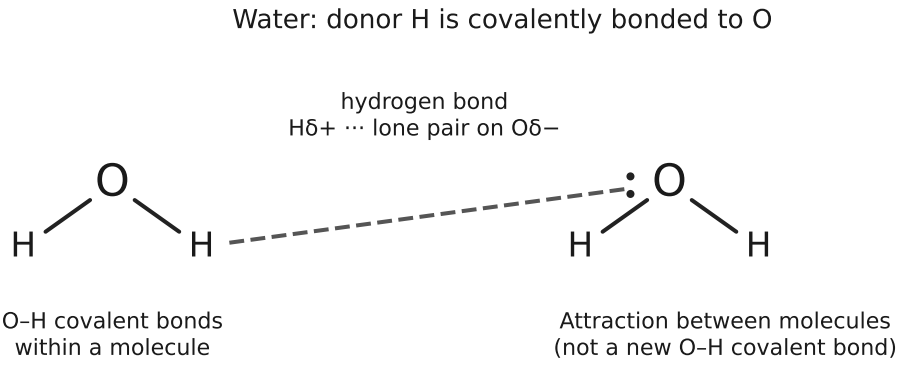
1 Key knowledge and worked examples

All molecules have London forces. Polar molecules also have permanent dipole attractions. Hydrogen bonding needs H bonded to N, O or F and a suitable lone pair on a neighbouring molecule. Boiling separates molecules; it does not break all bonds inside them.

■ Worked explanation

Ethanol boils at a higher temperature than a similar-size alkane. Both have London forces. Ethanol also forms hydrogen bonds through its O–H groups. More energy is needed to overcome the attractions between its molecules. Do not compare covalent O–H and C–H bond strengths to explain boiling.

Branching can reduce effective contact between isomeric alkanes. Water hydrates ions and hydrogen-bonds with small alcohols. The balance of attractions broken and formed controls dissolution.



2 Practice

2.1 Name the attraction present in every molecular substance and state its origin. [2]

2.2 Compare whether pure CH_3OH and pure CH_3OCH_3 can hydrogen-bond to their own molecules. Explain. [3]

2.3 Explain why boiling temperature generally increases from HCl to HBr to HI. [2]

3 Exam-style questions

3.1 Pentane and 2,2-dimethylpropane are isomers. Predict which usually has the lower boiling temperature and explain why equal electron counts do not make their attractions identical. [3]

3.2 Explain why ice floats on liquid water near 0 °C and why a polar halogenoalkane can still dissolve poorly in water. [4]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 London forces: instantaneous dipoles induce dipoles in neighbouring particles.

2.2 Methanol can: it has an O–H donor and oxygen lone pairs. The ether lacks H bonded to N/O/F, so its pure molecules cannot form this hydrogen-bond network; it can accept hydrogen bonds from water.

2.3 Larger, more polarisable electron clouds/more electrons give stronger London attractions requiring more energy to overcome.

3.1 2,2-dimethylpropane is more compact and has less effective intermolecular contact, so London attractions between molecules are weaker.

3.2 An open hydrogen-bonded arrangement keeps ice molecules further apart, giving lower density than liquid water. Halogenoalkane molecules cannot replace the water hydrogen-bond network effectively; bond polarity alone does not guarantee sufficiently favourable new attractions.