

Exercise walk-through

1.1

Water: a molecular cause for a biological property

International Baccalaureate · IB Diploma · Biology · HL

1.1 Water: a molecular cause for a biological property

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS cohesion • adhesion

Objective

Water: a molecular cause for a biological property. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

■ What would explain this observation?

- A water droplet holds together on a leaf. Its behaviour comes from interactions between molecules, not a skin made of solid water.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Water molecules are polar. Attraction between the partially positive hydrogen of one molecule and a partially negative oxygen of another gives hydrogen bonding. **Cohesion** is attraction between water molecules; **adhesion** is attraction to another surface.
- cohesion: Attraction between molecules of the same substance; adhesion: Attraction

between different substances.





■ **Choose evidence that can test it**

- The same intermolecular interactions help explain surface tension and the energy needed to change temperature. Heating changes molecular motion and interactions; it does not normally break the covalent O-H bonds.
- Compare equal drops on clean surfaces under fixed temperature. Measure contact angle or spreading consistently. A detergent changes the system, so record concentration rather than treating all liquids as equivalent.

■ **Work from known quantities**

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: 0.100 kg of water warms by 5.0 K; specific heat capacity is 4,180 J/(kg K). $Q = mc\Delta T = 0.100 \times 4,180 \times 5.0 = 2,090$ J. This calculation excludes energy absorbed by the container and lost to the surroundings.

Example:

Use $c = 4,180$ J/(kg K). Calculate Q for 0.200 kg water heated through 5.0 K. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ **Check the conclusion and its limits**

- Hydrogen bonds between molecules differ from covalent bonds within a water molecule. Polarity alone does not make every substance dissolve well in water.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Boiling water normally breaks its O-H covalent bonds. This claim is false: Hydrogen bonds between molecules differ from covalent bonds within a water molecule. Polarity alone does not make every substance dissolve well in water.

Key:

Water: a molecular cause for a biological property: The same intermolecular interactions help explain surface tension and the energy needed to change temperature. Heating changes molecular motion and interactions; it does not normally break the covalent O–H bonds.

Exercises 2.1·2.3

2.1 What accounts for cohesion in liquid water? Choose one answer.

- **A** Covalent bonds joining every molecule into one giant molecule
- **B** Intermolecular attractions including hydrogen bonding
- **C** Water having no molecular motion

[1]

2.2 Use $c = 4,180 \text{ J/(kg K)}$. Calculate Q for 0.200 kg water heated through 5.0 K. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Boiling water normally breaks its O–H covalent bonds.

[2]

Exercises 2.1-2.3

2.1 What accounts for cohesion in liquid water? Choose one answer.

- **A** Covalent bonds joining every molecule into one giant molecule
- **B** Intermolecular attractions including hydrogen bonding
- **C** Water having no molecular motion

[1]

2.1 B The same intermolecular interactions help explain surface tension and the energy needed to change temperature. Heating changes molecular motion and interactions; it does not normally break the covalent O–H bonds.

2.2 Use $c = 4,180 \text{ J/(kg K)}$. Calculate Q for 0.200 kg water heated through 5.0 K. Show the relation, substitution and units.

[2]

2.2 $Q = mc\Delta T = (0.200 \text{ kg}) \times (4,180 \text{ J/(kg K)}) \times (5.0 \text{ K}) = 4,180 \text{ J}$.

2.3 Decide whether this claim is true and justify: Boiling water normally breaks its O–H covalent bonds.

[2]

2.3 False. Hydrogen bonds between molecules differ from covalent bonds within a water molecule. Polarity alone does not make every substance dissolve well in water.

Exercises 2.4-3.1

2.4 Attraction between molecules of the same substance: write the technical term. [1]

3 Exam-style questions

3.1 A fictional 0.200 kg water sample gains 4,180 J but the observed rise is 4.0 K. Compare with the no-loss prediction and identify what the discrepancy can and cannot show. [4]

Exercises 2.4·3.1

2.4 Attraction between molecules of the same substance: write the technical term. [1]

3 Exam-style questions

2.4 cohesion. cohesion means Attraction between molecules of the same substance.

3.1 A fictional 0.200 kg water sample gains 4,180 J but the observed rise is 4.0 K. Compare with the no-loss prediction and identify what the discrepancy can and cannot show. [4]

3.1 Ideal rise $Q/(mc) = 5.0$ K. The observed rise is lower; container heating or loss can explain it. It does not prove which contribution dominates without measurements.