

2.4 Water

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS solvent • latent heat of vaporisation • specific heat capacity
 • hydrogen bonding • polar

Objective

Build the skills to answer exam questions on **water** – how **hydrogen bonding** arises, and how it explains water's roles as a **solvent**, its high **specific heat capacity**, and its **latent heat of vaporisation**.

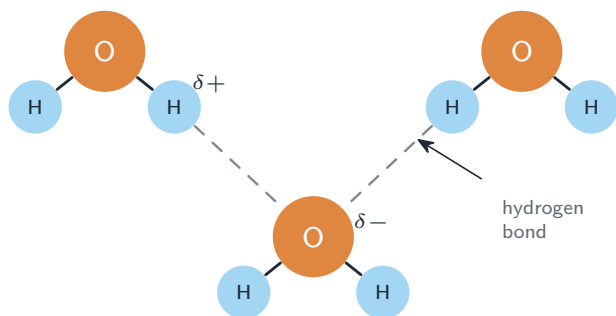
You must be able to:

- explain how hydrogen bonds form between water molecules
- relate hydrogen bonding to solvent action, high specific heat capacity and latent heat of vaporisation

1 Key knowledge and worked examples

■ Why water is polar and forms hydrogen bonds

Water's O–H bonds are **polar**: the oxygen is slightly negative (δ^-) and the hydrogens slightly positive (δ^+). So the δ^+ hydrogen of one molecule attracts the δ^- oxygen of its neighbour – a weak **hydrogen bond**. Each molecule can bond to several others.



Water is polar (δ^- oxygen, δ^+ hydrogens), so its molecules attract each other by hydrogen bonds

■ Relating the property to the role

Always link the property back to **hydrogen bonding** and then to a use in living things:

- **solvent action** – polar water surrounds and dissolves other polar/charged molecules, so reactions can happen and substances can be transported (e.g. in blood).
- **high specific heat capacity** – many hydrogen bonds must gain energy before the temperature rises, so water (and organisms) stays at a steady temperature.
- **latent heat of vaporisation** – much energy is needed to break enough hydrogen bonds to evaporate water, so sweating/transpiration removes a lot of heat and cools the organism.

2 Practice

2.1 State which atom in a water molecule is slightly negative, and which is slightly positive. [2]

2.2 Name the property of water that allows it to act as a transport medium in blood. [1]

3 Exam-style questions

3.1 Explain how a hydrogen bond forms between two water molecules. [2]

3.2 Water has a high specific heat capacity.

(a) Explain, in terms of hydrogen bonds, why water's temperature changes only slowly. [2]

(b) Explain why this property is useful to living organisms. [1]

3.3 When an animal sweats, water evaporates from its skin and the animal cools down. Use the idea of **latent heat of vaporisation** and hydrogen bonds to explain why evaporation has a strong cooling effect. [3]

Solutions

Each answer shows the steps, then the **result**.

2.1

- oxygen is slightly negative ($\delta-$); the hydrogens are slightly positive ($\delta+$)

2.2

- solvent action / it is a (good) solvent

3.1

- the $\delta+$ hydrogen of one water molecule is attracted to the $\delta-$ oxygen of another; this attraction is the hydrogen bond

3.2

(a)

- energy must be absorbed to break/loosen many hydrogen bonds before the molecules move faster, so the temperature rises only slowly

(b)

- it keeps the temperature of cells/organisms or aquatic habitats stable

3.3

- evaporation needs much energy to break the hydrogen bonds holding water molecules together; this energy (latent heat) is taken from the skin/body, so the body loses heat and cools