

Exercise walk-through

Water ■ 2.4

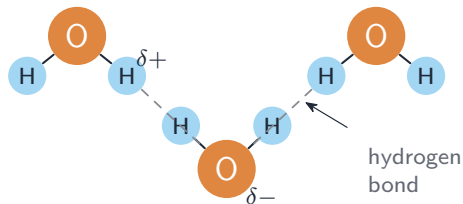
eXercise

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

Method — Why water is polar and forms hydrogen bonds

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



Method — 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.

Practice 2.1 ■ 2 marks

State which atom in a water molecule is slightly negative, and which is slightly positive.

Solution 2.1

Method: Why water is polar and forms hydrogen bonds

Worked steps

oxygen is slightly negative ($\delta-$) **B1**; the hydrogens are slightly positive ($\delta+$) **B1**.

Practice 2.2 ■ 1 mark

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

Solution 2.2

Method: Relating the property to the role

Worked steps

solvent action / it is a (good) solvent **B1**.

Exam-style 3.1 ■ 2 marks

Explain how a hydrogen bond forms between two water molecules.

Solution 3.1

Method: Why water is polar and forms hydrogen bonds

Worked steps

the $\delta+$ hydrogen of one water molecule is attracted to the $\delta-$ oxygen of another **B1**; this attraction is the hydrogen bond **B1**.

Exam-style 3.2 ■ 2 marks

Water has a high specific heat capacity.

- (a) Explain, in terms of hydrogen bonds, why water's temperature changes only slowly.
- (b) Explain why this property is useful to living organisms.

Solution 3.2

Method: Relating the property to the role

Worked steps

- (a) energy must be absorbed to break/loosen many hydrogen bonds before the molecules move faster **M1**, so the temperature rises only slowly **A1**.
- (b) it keeps the temperature of cells/organisms or aquatic habitats stable **B1**.

Exam-style 3.3 ■ 3 marks

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.

Solution 3.3

Method: Relating the property to the role

Worked steps

evaporation needs much energy to break the hydrogen bonds holding water molecules together **M1**; this energy (latent heat) is taken from the skin/body **M1**, so the body loses heat and cools **A1**.