

2.4 Water

Name: _____ Class: _____ Date: _____

Total: 11 marks

Objective

Build the skills to answer exam questions on **water** —how **hydrogen bonding** 氢键 arises, and how it explains water's roles as a **solvent** 溶剂, its high **specific heat capacity** 比热容, and its **latent heat of vaporisation** 汽化潜热.

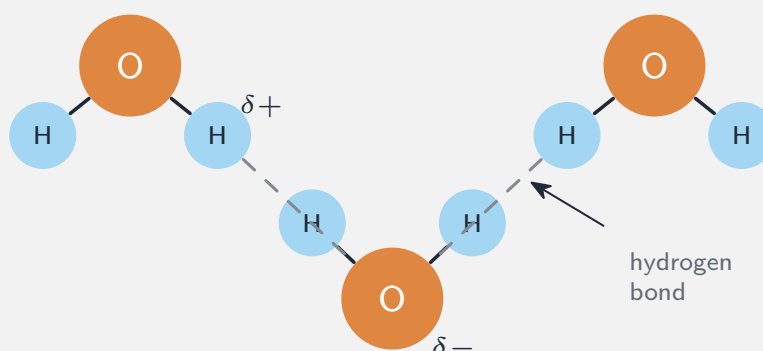
You must be able to:

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

1 Worked examples

■ Why water is polar and forms hydrogen bonds

Water's O–H bonds are **polar** 极性: 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]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **2.4 Water** past-paper sheet in the Library (where available), or practise water questions in **Practice mode**. Water properties also appear inside transport and homeostasis questions (topics 7, 8 and 14).

Solutions

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.