

### Chapter 3: Water and the Fitness of the Environment

1. Study the water molecules at the right. On the central molecule, label oxygen and hydrogen. ✓

2. What is a polar molecule? Why is water considered polar?

Since oxygen is more electronegative than hydrogen, the electrons of the covalent bonds between them are more strongly attracted to oxygen's than hydrogen's nucleus. This unequal distribution of electrons makes water a polar molecule, meaning that the two ends of the molecule have opposite charges.

3. Add + and - signs to indicate the charged regions of each molecule. Indicate the hydrogen bonds. ✓

4. Explain hydrogen bonding. How many hydrogen bonds can a single water molecule form?

Hydrogen bonds occur when H bonds with F, O, or N and the partially positive H of one molecule is attracted to the partially negative F, O, or N of a nearby molecule. A single water molecule can form four hydrogen bonds.

5. Distinguish between cohesion and adhesion.

Cohesion is the attraction water molecules have towards each other due to hydrogen bonding; adhesion is their attraction to molecules of another substance.

6. What is demonstrated when you see beads of water on a waxed car hood?

The beads have not stretched or broken because of water's high surface tension.

7. Which property explains the ability of a water strider to walk on water?

The point at which the surface of the water interacts with air is an ordered molecular arrangement, causing the water to behave as though coated with an invisible film. This is attributable to water's high surface tension.

8. The calorie is a unit of heat.

A calorie is the amount of heat needed to raise the temperature of 1g of water by 1°C and also the amount of heat released by 1g of water when it cools by 1°C. One calorie is equal to 4.184J.

9. Water has high specific heat. What does this mean? How does water's specific heat compare to alcohol's?

A substance's specific heat is the amount of heat that must be absorbed or lost for 1g of that substance to change its temperature by 1°C. Water's specific heat is 1 cal/g/°C, unusually high compared to other substances. Ethyl alcohol, found in alcoholic beverages, only requires 0.6 calories to raise 1g by 1°C.

10. Explain how hydrogen bonding contributes to water's high specific heat.

Heat must be absorbed in order to break hydrogen bonds, and heat is released when hydrogen bonds form. Specific heat indicates how well a substance resists changing its temperature when it absorbs or releases heat. Due to its molecular structure, water resists temperature change, and absorbs or loses a relatively large quantity of heat for each degree of change.

11. Summarize how water's high specific heat contributes to the moderation of temperature. How is this property important to life?

Large bodies of water can absorb a tremendous amount of heat from the sun while only warming up by a few degrees, while gradually cooling water can warm the air when sunlight is scarce. Thus, in controlling the range of temperature fluctuations through water's high specific heat, bodies of water allow for milder climates on nearby land and stable ocean temperatures, conditions which favor the sustenance of life.

12. Define evaporation. What is heat of vaporization? Explain at least three effects of this property on living organisms.

Evaporation is a substance's transformation from a liquid to a gaseous state. Heat of vaporization is the quantity of heat a liquid must absorb for 1g of it to evaporate. Relative to other liquids, water has a relatively high heat of vaporization due

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**Thomas Rivers**



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