



AP Bio

FRQ Fridays

2009B #3
Water Properties

FRQ Friday #2

2009B #3

Water is essential to all living things.

(a) **Discuss** THREE properties of water.

(b) **Explain** each of the following in terms of the properties of water. You are not limited to the three properties discussed in part (a):

- the role of water as a medium for the metabolic processes of cells
- the ability of water to moderate temperature within living organisms and in organisms' environments
- the movement of water from the roots to the leaves of plants



FRQ Friday #2

2009B #3

(a) **Discuss** THREE properties of water.

Name of property **and** correct description (2 points). Points **MUST** provide both property and description.

Property	and Description (2 points jointly)
Polarity of water	Polar covalent bonds created by unequal sharing of electrons between O and H within the molecule
Specific heat/high heat capacity	Heat absorption without temperature change
High heat of vaporization	Water molecules absorb energy as it changes state/breaking of bonds by absorbing energy
Adhesion	Attraction to other molecules that are polar or have charge
Cohesion	Attraction to other water molecules due to polar nature of water/ surface tension
Three states of matter	Ice-liquid-gas (vapor) Kinetic energy differences Expands at 4°C to become less dense
Repels hydrophobic material	Moves aside nonpolar substances



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(a) **Discuss** THREE properties of water.

a) Water is known as the universal solvent. Its polar nature allows it to break down ionic bonds as well as polar covalent bonds. No other known substance is able to dissolve the same variety of substances as water. Water also has a high heat capacity due to its hydrogen bonds between hydrogen atoms of one molecule to oxygen atoms of other molecules. This results in a large amount of energy required to raise ~~oxygen~~ water's temperature by just 1 degree Celsius. Cohesion and adhesion are other properties of water that result from hydrogen bonds. Cohesion refers to water's ability to attach to other ^{water} molecules while adhesion refers to water molecules' ability to ~~the~~ bond to other substances such as the walls of tracheids in the xylem tissue of plants. Water also exhibits surface tension where water molecules at the surface bind to each other and ~~the~~ ~~water~~ ~~preventing~~ ~~the~~ ~~water~~ ~~from~~ ~~penetrating~~ ~~the~~ ~~surface~~ ~~is~~ ~~difficult~~. This results in being able to fill a glass slightly over the top without ~~any~~ any water spilling out.



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(b) Explain each of the following in terms of the properties of water. You are not limited to the three properties discussed in part (a):

- the role of water as a medium for the metabolic processes of cells
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Water's role as a medium for the metabolic processes of cells (2 points maximum):

- Diffusion—allows for movement of materials through an aqueous solution down the concentration gradient
- Osmosis—movement of water across membranes due to water potential differences (down the gradient)
- Solvent—dissociation/ionization of materials
- Buffer—explanation of role water plays in formation of bicarbonate ion



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b) Water serves an important role in the metabolic processes of the cell. In plants, water is essential for photosynthesis and glucose production because it provides the electrons necessary in order to capture a photon of light and excite it into a state where it can be harnessed to make ATP. Water also plays an important role in the cytoplasm where it acts as a dissolver of the various substrates present. Osmosis through the plasma membrane must be carefully regulated by substrate levels in order to maximize cell functioning.



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Water's ability to moderate temperature within living organisms/environments (2 points maximum):

- Specific heat—moderates climates, maintains stable temperature in cells, constant internal environment
- High heat of vaporization—perspiration cooling, evaporative cooling
- Ice forming and acting as insulator for lakes, keeping water in liquid state



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Water is also able to moderate temperature in both living organisms and the environment. Water's high specific heat enables it to function as an ~~is~~ absorber of heat inside an organism's body. Water's high heat of vaporization allows the body to cool by ~~sweating~~ perspiration. When the water evaporates off the skin, a lot of heat is ~~released~~ absorbed.



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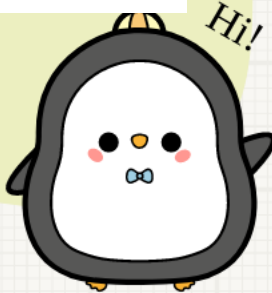
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Water from the roots to the leaves of plants (2 points maximum):

- Transpiration—moving water away from leaves due to water potential differences/evaporation through stomata
- Capillary action of water due to adhesion and cohesion
- Root pressure—driven by osmosis/movement of water into roots
- Negative pressure potential—caused by surface tension of water as it is pulled up xylem



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The movement of water from roots to the leaves of plants is hinged upon vaporisation and cohesion and adhesion. As water enters the roots it is pushed up ~~the~~ a short distance by root pressure because of the concentration gradient between the ground and the roots. Water forms a continuous pillar from leaf to roots because of cohesion. When a water molecule evaporates off a leaf by transpiration, the next molecule is pulled up and ~~off~~ the whole pillar inches upward because of cohesion. This allows water to reach its destination against gravity.

