Advanced Biology Practice Exam:

4. Which of the following statements is false?

a. Electrons are unequally shared in polar covalent bonds.
b. Electrons are equally shared in nonpolar covalent bonds.
c. Hydrogen bonds are weak bonds based on electrostatic forces.
d. In solution, ionic bonds are generally stronger than covalent bonds.

Solution: The solution is (D). Ionic bonds are generally stronger than covalent bonds. This question is messing with you a little because the general order of bond strength from strongest → weakest is Ionic > Covalent > Hydrogen > LDF | van der Waals. The trick to this question is the phrase 'in solution'. The examiner wants to recognize that in a solution, a molecule like NaCl will dissociate into its 2 ions: Na^+ and Cl^-. The Na and the Cl will not be joined together but will be surrounded by the polar water molecules. In air, however, the ionic Na-Cl bond is stronger

9. Explain why the bonds within a water molecule are described as polar covalent bonds.

a. Hydrogen is more electronegative than oxygen, generating a partial negative charge near the hydrogen atom.
b. Hydrogen is more electronegative than oxygen, generating a partial positive charge near the hydrogen atom.
c. Oxygen is more electronegative than hydrogen, generating a partial negative charge near the oxygen atoms.
d. Oxygen is more electronegative than hydrogen, generating a partial positive charge near the oxygen atoms.

The solution is (C). The oxygen atom nucleus is more attractive to the electrons of a hydrogen atom than the hydrogen nucleus is to the oxygen's electrons. Therefore, the hydrogen atom acquires a partial positive charge while the oxygen atom acquires a partial negative charge.

Anything highlighted red is a false statement

20. Why are hydrogen bonds and van der Waals interactions necessary for cells?

a. Hydrogen bonds and van der Waals interactions form weak associations between and/or within molecules, providing the necessary shape and structure of DNA and proteins to function in the body.
b. Hydrogen bonds and van der Waals interactions form strong associations between molecules, providing the necessary shape and structure of DNA and proteins to function in the body.
c. Hydrogen bonds and van der Waals interactions form weak associations between different molecules, providing the necessary shape and structure for acids to function in the body.
d. Hydrogen bonds and van der Waals interactions form strong associations between same molecules, providing the necessary shape and structure for acids to function in the body.

The solution is (A). Hydrogen bonds and van der Waals interactions form weak associations between different molecules or within different regions of the same molecule. They provide the structure and shape necessary for proteins and DNA within cells so that they function properly.

An **acid** is a molecule or ion capable of either donating a proton (i.e., hydrogen ion, H^+), known as a Brønsted–Lowry acid, or, capable of forming a covalent bond with an electron pair, known as a Lewis acid. Regardless, acids do not require Hydrogen bonds to function

22. Why can some insects walk on water?

a. Insects can walk on water because of its high heat of vaporization.
b. Insects can walk on water because water is a polar solvent.
c. Insects can walk on water because they have hydrophobic hairs on their legs.
d. Insects can walk on water because they are denser than water.

The solution is (C). Some insects can walk on water, although they are denser than water, because of the surface tension of water. Surface tension is a result of cohesion, or the attraction between water molecules at the surface of the body of water (the liquid-air/gas interface). (A) Heat of vaporization has to do with water going from the liquid to the gas phase (we aren't boiling here). (B) Water is a polar solvent but its ability to dissolve substances is unrelated to the question. (D) We would expect a more dense object to sink when placed in a less dense object.

24. What are three examples of how the characteristics of water are important in maintaining life?

a. First, the lower density of water as a solid versus a liquid allows ice to float, forming an insulating surface layer for aquatic life. Second, the high specific heat capacity of water insulates aquatic life or bodily fluids from temperature changes. Third, the high heat of vaporization of water allows animals to cool themselves by sweating.
b. First, the higher density of water as a solid versus a liquid allows ice to float, forming an insulating surface layer for aquatic life. Second, the high specific heat capacity of water insulates aquatic life or bodily fluids from temperature changes. Third, the low heat of vaporization of water allows animals to cool themselves by sweating.
c. First, the lower density of water as a solid versus a liquid allows ice to float, forming an insulating surface layer for aquatic life. Second, the low specific heat capacity of water insulates aquatic life or bodily fluids from temperature changes. Third, the high heat of vaporization of water allows animals to cool themselves by sweating.
d. First, the lower density of water as a solid versus a liquid allows ice to float, forming an insulating surface layer for aquatic life. Second, the low specific heat capacity of water insulates aquatic life or bodily fluids from temperature changes. Third, the low heat of vaporization of water allows animals to cool themselves by sweating.

The solution is (A). The lower density of ice compared to liquid water allows it to float on water. In lakes and ponds, ice will form on the surface of water creating an insulating barrier that protects the animals and plant life in the pond from freezing. Water's lower density in its solid form is due to the orientation of hydrogen bonds as it freezes: the water molecules are pushed farther apart compared to liquid water.

Water is used by warm-blooded animals to more evenly disperse heat in their bodies. Water has the highest specific heat capacity of any liquid, a property caused by hydrogen bonding between water molecules.

In many living organisms, the evaporation of sweat allows organisms to cool to maintain homeostasis of body temperature. This is because water has a high heat of vaporization. As liquid water heats up, hydrogen bonding makes it difficult to separate the liquid water molecules from each other.

Other examples include water's solvent properties as well as water's cohesive and adhesive properties.

Incorrect statements are highlighted red

29. Why can water be a good insulator within the body of endothermic (warm-blooded) animals?

a. adhesive properties
b. surface tension
c. heat of vaporization
d. specific heat capacity

The solution is (D). Specific heat is defined as the amount of heat one gram of a substance must absorb or lose to change its temperature by 1 °C Therefore, warm-blooded animals use water to more evenly disperse heat in their bodies. It takes a large amount of energy to heat or cool water.

30. The unique properties of water are important in biological processes. For the following three properties of water, define the property and give one example of how the property affects living organisms:

1. cohesion 2.Adhesion 3.high heat of vaporization

a. Cohesion is the attraction between the water molecules, which helps create surface tension. Insects can walk on water because of cohesion. Adhesion is the attraction between water molecules and other molecules. Water moving up from the roots of plants to the leaves as a result of capillary action is because of adhesion. Heat of vaporization is the amount of energy required to convert liquid into gas. This property helps humans maintain homeostasis of body temperature by evaporation.
b. Cohesion is the attraction between water and other molecules, which help create surface tension. Insects can walk on water because of cohesion. Adhesion is the attraction between water molecules. Water moving up from the roots of plants to the leaves as a result of capillary action is because of adhesion. Heat of vaporization is the amount of energy required to convert liquid into gas. This property helps humans maintain homeostasis of body temperature by evaporation.
c. Cohesion is the attraction between the water molecules, which helps create surface tension. Insects can walk on water because of cohesion. Adhesion is the attraction between water molecules and other molecules. Water moving up from the roots of plants to the leaves as a result of capillary action is because of adhesion. Heat of vaporization is the amount of energy required to convert solid into gas. This property helps humans maintain homeostasis of body temperature by evaporation.
d. Cohesion is the attraction between the water molecules, which helps create surface tension. Water moving up from the roots of plants to the leaves as a result of capillary action is because of cohesion. Adhesion is the attraction between water molecules and other molecules. Some insects can walk on water because of adhesion. Heat of vaporization is the amount of energy required to convert solid into gas. This property helps humans maintain homeostasis of body temperature by evaporation.

The solution is (A). Cohesion is the attraction between water molecules, which helps create surface tension. Insects can walk on water because of cohesion. Adhesion is the attraction between water molecules and other molecules. Water moving up from the roots of plants to the leaves as a result of capillary action is because of adhesion. Heat of vaporization is the amount of energy required to convert liquid into gas. This property helps humans maintain homeostasis of body temperature by evaporation.

Free Response:

1. For any **<u>one</u>** life supporting property of water, such as *high heat of vaporization, cohesion and adhesion, versatile solvent, surface tension*, ***among others***, briefly summarize

- how the **polarity** of the water molecule's covalent bonds, and
- how **hydrogen bonding** between water molecules contributes to the life supporting property you have chosen.

*Be sure to include **one example of how the life-supporting property benefits life**.*

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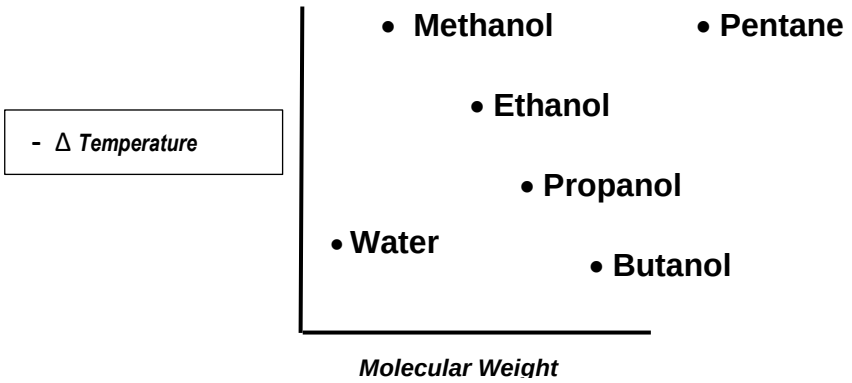
2. Regarding our **lab examining water as an evaporative coolant**, examine the graph of the data:

<u>The Evaporation Rates of Water, 4 Alcohols, and Pentane</u>



Answer the following 3 questions:

a) Why does **water** have a much *slower* evaporation rate than **methanol**, even though their molecular weights are similar?

b) Why does **pentane** have a much *faster* evaporation rate than **butanol**, even though their molecular weights are similar?

c) Why do **water** and **propanol** have *similar* evaporation rates, even though their molecular weights are so different?

<u>In your answer</u>

- *Specific numerical values need <u>not</u> be known.*
- *Both **H-bonds** <u>and</u> **LDFs** should be included as you describe the different data generated by the 2 molecules.*