CRITICAL THINKING QUESTIONS

19 What are the mass number and atomic number of carbon-12 and carbon-13, respectively?

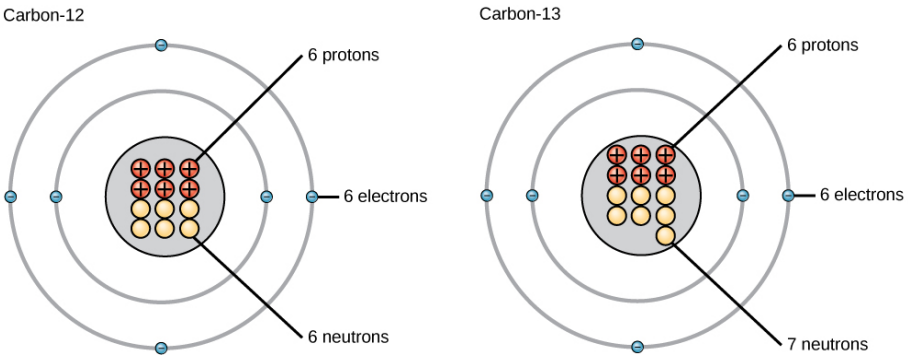
A The mass number and atomic numbers of carbon-12 are 12 and 6, while those of carbon-13 are 13 and 6.

B The mass number and atomic numbers of carbon-12 are 12 and 6, while those of carbon-13 are 13 and 12.

C The mass number and atomic numbers of carbon-12 are 12 and 6, while those of carbon-12 are 13 and 13.

D The mass number and atomic numbers of carbon-12 are 12 and 12, while those of carbon-13 are 13 and 12.

Solution The solution is (A). The mass number and atomic number of carbon-12 are 12 and 6, while those of carbon-13 are 13 and 6. Use the figure to determine the mass and atomic numbers.



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 molecules, providing the necessary shape and structure for DNA and proteins to function in the body.

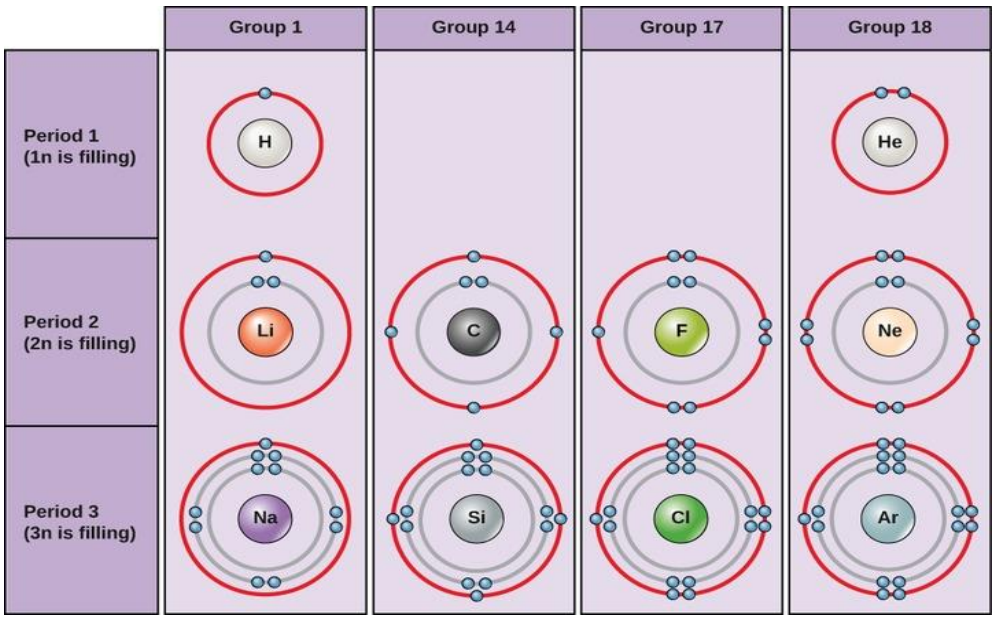
B Hydrogen bonds and van der Waals interactions form strong associations between molecules, providing the necessary shape and structure for DNA and proteins to function in the body.

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 the same molecules, providing the necessary shape and structure for acids to function in the body.

Solution 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.

21 Using the figure, which two groups will form a strong ionic bond?



A Group 1 and Group 17

B Group 1 and Group 14

C Group 14 and Group 18

D Group 1 and Group 18

Solution The solution is (A). Group 1 and Group 17 will form a strong ionic bond. Group 1 has one valence electron, so to obtain a stable configuration, it will donate the electron readily. Group 17 has 7 electrons in its valence shell. In order to obtain a stable configuration, it will accept one electron readily.

22 Why can some insects walk on water?

A Insects can walk on water because of its high surface tension.

B Insects can walk on water because it is a polar solvent.

C Insects can walk on water because they are less dense than water.

D Insects can walk on water because they are denser than water.

Solution The solution is (A). 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).

23 Which statement describes how buffers help prevent drastic swings in pH?

A Buffers absorb excess hydrogen and hydroxide ions to prevent increases or decreases in pH. An example is the bicarbonate system in the human body.

B Buffers absorb excess hydrogen ions to prevent increases or decreases in pH. An example is the bicarbonate system in the human body.

C Buffers absorb excess hydroxide ions to prevent increases or decreases in pH. An example is the bicarbonate system in the human body.

D Buffers absorb excess hydrogen and hydroxide ions to prevent increases or decreases in pH. An example is carbonate system in the human body.

Solution The solution is (A). Buffers absorb the free hydrogen ions and hydroxide ions produced by chemical reactions. Because they can bond to these ions, they prevent increases or decreases in pH. An example of a buffer system is the bicarbonate system in the human body. This system is able to absorb hydrogen and hydroxide ions to prevent changes in pH and keep cells functioning properly.

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.

Solution 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.

25 What is the pH scale, and how does it relate to living systems? Give an example of how drastic pH changes are prevented in living systems.

A The pH scale ranges from 0 to 14, where anything below 7 is acidic and above 7 is alkaline. The bicarbonate system in the human body buffers the blood.

B The pH scale ranges from 0 to 14, where anything below 7 is alkaline and above 7 is acidic. The bicarbonate system in the human body buffers the blood.

C The pH scale ranges from 0 to 7, where anything below 7 is acidic and above 7 is alkaline. Water in the human body buffers the blood.

D pH scale ranges from 0 to 7, where anything below 4 is acidic and above 4 is alkaline. Water in the human body buffers the blood.

Solution The solution is (A). The pH scale ranges from zero to 14. Pure water has a pH of seven, which is known as neutral pH. The pH of human cells and blood is maintained at pH seven. Anything below pH seven is acidic and anything above seven is alkaline. Extreme pH is usually considered inhospitable for life. Buffers maintain pH homeostasis. For example, the bicarbonate system in the human body absorbs hydrogen and hydroxide ions to prevent changes in pH.

26 What property of carbon makes it essential for organic life?

A Carbon can form up to four covalent bonds, allowing it to form long chains.

B Carbon can form more than four covalent bonds, allowing it to form long chains.

C Carbon can form more than four covalent bonds, but it can only form short chains.

D Carbon can form up to four covalent bonds, but it can only form short chains.

Solution The solution is (A). Carbon is found in all living things because it can form up to four covalent bonds. These strong covalent bonds allow the formation of long chains that combine to form proteins and DNA.

27 What property of carboxyl makes carboxyl-containing molecules hydrophilic? Which macromolecules contain carboxyl?

A Carboxyl groups release H^+, making its parent molecule hydrophilic. It is found in amino acids and fatty acids.

B Carboxyl groups absorb H^+, making its parent molecule hydrophilic. It is found in phospholipids and triglycerides.

C Carboxyl groups release OH^-, making its parent molecule hydrophilic. It is found in phospholipids, phosphates, and triglycerides.

D Carboxyl groups release OH^-, making its parent molecule hydrophilic. It is found in phospholipids and DNA.

Solution The solution is (A). The carboxyl group is found in amino acids, some amino acid side chains, and the fatty acids that form triglycerides and phospholipids. This carboxyl group ionizes to release hydrogen ions (H^+) from the $COOH$ group, resulting in the negatively charged COO^- group, which contributes to the hydrophilic nature of whatever molecule it is found on.

28 Compare and contrast saturated and unsaturated triglycerides.

A Saturated triglycerides contain single bonds and are solid at room temperature, while unsaturated triglycerides contain double bonds and are liquid at room temperature.

B Saturated triglycerides contain double bonds and are solid at room temperature, while unsaturated triglycerides contain single bonds and are liquids at room temperature.

C Saturated triglycerides contain single bonds and are liquid at room temperature, while unsaturated triglycerides contain double bonds and are solid at room temperature.

D Saturated triglycerides contain double bonds and are liquid at room temperature, while unsaturated triglycerides contain single bonds and are solid at room temperature.

Solution The solution is (A). Saturated triglycerides contain no double bonds between carbon atoms; they are usually solid at room temperature. Unsaturated triglycerides contain at least one double bond between carbon atoms; they are usually liquid at room temperature.