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GATE – LIFE SCIENCE

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MULTIPLE CHOICE QUESTIONS (MCQ)

- Which of the following is not a condensation reaction?
 - (1) ADP + inorganic phosphate to ATP + H₂O
 - (2) R-OH + inorganic phosphate to phosphate ester + H₂O
 - (3) R-COOH + inorganic phosphate to Acyl phosphate + H₂O
 - (4) 6CO₂ + 6 H₂O to C₆H₁₂O₆ + 6CO₂
- Consider the following reaction, in the presence of light

$$2H_2O + 2X \rightarrow O_2 + 2XH_2$$
 Which of the following statements is true?
 - (1) X is electron-accepting specie
 - (2) X is electron-donating specie
 - (3) Water is an electron acceptor
 - (4) Water neither donates nor accepts any electron
- What does it mean when we say that water acts as a "heat buffer"?
 - (1) It keeps the temperature of an organism relatively constant as the temperature of the surroundings fluctuates
 - (2) It increases the temperature of an organism as the temperature of the surroundings increases
 - (3) It decreases the temperature of an organism as the temperature of the surroundings increases
 - (4) It increases the temperature of an organism as the temperature of the surroundings decreases
- Which of the statement about hydrogen bond is not true?
 - (1) H-bonds account for the anomalously high boiling point of water
 - (2) In liquid water, the average water molecule forms H-bonds with 3 to 4 other water molecules
 - (3) Individual H-bonds are much weaker than covalent bonds
 - (4) Individual H-bonds in liquid water exist for many seconds and sometimes for minutes
- A true statement about hydrophobic interactions is that they:
 - (1) are the driving force in the formation of micelles of amphipathic compounds in water.
 - (2) do not contribute to the structure of water-soluble proteins.
 - (3) involve the ability of water to denature proteins.
 - (4) primarily involve the effect of polar solutes on the entropy of aqueous systems.
- Which of the following is not a property of water?
 - (1) It has a low boiling point compared with other molecules.
 - (2) Its molecules resist separation, a property called cohesion.
 - (3) It has the property of adhesion, the ability to stick to charged and polar groups in molecules.
 - (4) It can form hydrogen bonds to molecules below but not above its surface.
- Water has a high specific heat because
 - (1) hydrogen bonds must be broken to raise its temperature
 - (2) hydrogen bonds must be formed to raise its temperature
 - (3) it is a poor insulator
 - (4) it has low density considering the size of the molecule
- Which of the following compounds would you expect to be most soluble in water?
 - (1) CH₃-CH₂-OH
 - (2) CH₃-CH₂-CH₂-CH₂-OH
 - (3) CH₃-CH₂-CH₂-CH₂-CH₂-CH₂-OH
 - (4) CH₃-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-OH
- Proteins 1 and 2 interact strongly. A significant part of the interaction is between the amino acid side chains shown below.

Arginine

Protein 1 - CH₂-CH₂-CH₂-NH-C(=NH₂)⁺

Glutamic acid

Protein 2 - CH₂-CH₂-COO⁻

EXPLANATIONS

1. **Correct Answer is (4):** Condensation reaction mainly involves the elimination of water molecules and thus results in the formation of new covalent bond between two molecules. Among the given options only option (4) is not showing the elimination of water molecules.
2. **Correct Answer is (1):**
In the given reaction

$$2H_2O + 2X \rightarrow O_2 + 2XH$$
 To determine which species is donating and which one is accepting electrons, here we observe changes in the oxidation states:
 - For H₂O: initial oxidation state for H is +1, for O is -2. Final oxidation state for H: +1 (in XH₂), for O is 0 (in O₂)
Therefore, water gets oxidized by losing electrons.
 - For X: Initial oxidation state for X is unknown. Final oxidation state for X is -1 (in XH₂)
Therefore, X gets reduced by gaining electrons.
3. **Correct Answer is (1):** In biological species water resists change in its temperature. Water can help keep the temperature of an organism relatively constant even when the temperature of the surroundings fluctuates.
4. **Correct Answer is (4):** Among the given options (1), (2) and (3) are correct as to break the hydrogen bond a lot of energy is required, hence we observe that the boiling point of water is 100°C. H₂O has the ability to form 4 H-bonds with other neighboring water molecules. Two H-bonds can be formed with the 2 H atoms and two H-bonds can be formed with one oxygen molecule (contains 2 lone pairs of electrons).
5. **Correct Answer is (1):** Hydrophobic interactions are non-polar in nature. When the non-polar molecules (hydrophobes) are suspended in water, they form micelle. In water, the hydrophobic tails cluster together to avoid contact with the polar water molecules, while the hydrophilic heads face outwards, interacting with water. This aggregation of hydrophobic tails makes the primary driving force behind micelle formation.
6. **Correct Answer is (1):** Water has an anomalously high boiling point of 100°C. It is due to the strong intermolecular forces created by hydrogen bonds.
7. **Correct Answer is (1):** Water has a high specific heat means it requires a lot of energy to raise its temperature. This property is due to the presence of strong hydrogen bonds between water molecules. Thus, to raise the temperature of water, the hydrogen bond must be broken.
8. **Correct Answer is (1):** The hydrophobicity of the molecule increases as the number of carbon atoms increases in the alcohol chain and its ability to form hydrogen bonds with water decreases and among the given options, Ethanol has the minimum number of carbon atoms in its structure.
9. **Correct Answer is (4):**
Before mutation: **Protein 1-** Arginine (Arg); **Protein 2-** Glutamic acid (Glu).
After mutation: **Protein 1-** Arginine (Arg); **Protein 2-** Aspartic acid (Asp), Lysine (Lys), Serine (Ser), Leucine (Leu)
Here, the disrupting factors could be charge and hydrophobicity.
 1. **Charge:** Arg, Lys is positively charged, Asp is negatively charged, Ser is neutral, and Leu is nonpolar so no charge.
 2. **Hydrophobicity:** Arg is relatively polar, Ser is slightly polar, Asp & Lys are polar and Leu is non polar. Least disruption is observed in case of Arg-Asp interaction both Glu and Asp are negatively charged and polar in nature, while most disruptive in case of Arg-Lys as both are oppositely charged amino acids and both are polar.
10. **Correct Answer is (1):** Inosine monophosphate (IMP) is a key intermediate in the purine biosynthesis pathway, which is responsible for the production of purine nucleotides. Ornithine is a precursor to L-arginine in the urea cycle. The urea cycle is responsible for converting ammonia, a toxic by-product of protein metabolism, into urea, which is excreted in urine. Chorismate is a branching point in the aromatic amino acid biosynthesis pathway. It is a common precursor to L-tryptophan, L-tyrosine, and L-phenylalanine. Homocysteine is a key