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| 1. Molecules that are readily soluble in water are considered:   |  |  |  | | --- | --- | --- | |  | a. | nonpolar. | |  | b. | polar. | |  | c. | zwitterionic. | |  | d. | volatile. | |  | e. | dielectric. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 2. The interaction that is described by Coulomb's law is called:   |  |  |  | | --- | --- | --- | |  | a. | hydrophobic. | |  | b. | weak. | |  | c. | electrostatic. | |  | d. | hydrogen. | |  | e. | physical. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 3. What would be the solubility of a salt in a solvent with a low dielectric constant?   |  |  |  | | --- | --- | --- | |  | a. | excellent | |  | b. | good | |  | c. | suitable | |  | d. | poor | |  | e. | exclusive |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 4. Hydrophobic molecules are driven together by:   |  |  |  | | --- | --- | --- | |  | a. | entropy. | |  | b. | enthalpy. | |  | c. | van der Waals interactions. | |  | d. | affinity. | |  | e. | hydrogen bonds. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 5. The protein that interacts with both water and the hydrophobic regions of the membrane is considered:   |  |  |  | | --- | --- | --- | |  | a. | polar. | |  | b. | nonpolar. | |  | c. | amphibious. | |  | d. | anabolic. | |  | e. | amphipathic. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 6. Protonation of a base yields its:   |  |  |  | | --- | --- | --- | |  | a. | conjugate molecule. | |  | b. | conjugate base. | |  | c. | conjugate acid. | |  | d. | ionized derivative. | |  | e. | ionized base. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 7. An organic acid ionizes to form a conjugate base and:   |  |  |  | | --- | --- | --- | |  | a. | hydrogen. | |  | b. | water. | |  | c. | a hydroxyl ion. | |  | d. | a proton. | |  | e. | hydrogen peroxide. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 8. Gastroesophageal reflux disease is a common example of a pathological change in:   |  |  |  | | --- | --- | --- | |  | a. | p*K*a of acetic acid. | |  | b. | hydrogen bonds in a key digestive enzyme. | |  | c. | protein structure. | |  | d. | water content in cells. | |  | e. | pH level. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 9. What is the pH of human blood?   |  |  |  | | --- | --- | --- | |  | a. | 5.5 | |  | b. | 7.0 | |  | c. | 9.4 | |  | d. | 6.4 | |  | e. | 7.4 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 10. Choose the functional group that CANNOT form a hydrogen bond with water.   |  |  |  | | --- | --- | --- | |  | a. | carbonyl group | |  | b. | amino group | |  | c. | aromatic ring | |  | d. | alcohol group | |  | e. | sulfhydryl group |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 11. Which combination can associate to form a hydrogen bond?   |  |  |  | | --- | --- | --- | |  | a. | N–H and O | |  | b. | N–H and S | |  | c. | O–H and P | |  | d. | C=O and S | |  | e. | C=O and P |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 12. What is the typical length of noncovalent bonds?   |  |  |  | | --- | --- | --- | |  | a. | 0.4 angstroms | |  | b. | 4 angstroms | |  | c. | 40 angstroms | |  | d. | 4 nm | |  | e. | 0.04 nm |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 13. In a typical cell, the water content is about:   |  |  |  | | --- | --- | --- | |  | a. | 60%. | |  | b. | 70%. | |  | c. | 80%. | |  | d. | 90%. | |  | e. | 99%. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 14. Oxygen is an electronegative atom. That means that in a molecule of water the:   |  |  |  | | --- | --- | --- | |  | a. | electrons of covalent bonds spend more time near the oxygen atom than near the hydrogen atoms. | |  | b. | electrons of covalent bonds spend more time near the hydrogen atoms than near the oxygen atom. | |  | c. | electrons of bonds are located closely to the hydrogen atoms. | |  | d. | electrons of bonds are located closely to the oxygen atom. | |  | e. | bonds joining the hydrogen atoms to the oxygen atom are noncovalent. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 15. What does it mean that liquid water has a partly ordered structure?   |  |  |  | | --- | --- | --- | |  | a. | There are van der Waals interactions between water molecules. | |  | b. | Hydrogen-bonded clusters of molecules are continually being formed and broken apart in liquid water. | |  | c. | In the physiological range of temperatures liquid water can undergo phase transition to gas that is completely unordered and to ice that is completely ordered. | |  | d. | There is Brownian motion of water molecules. | |  | e. | Water molecules can form hydrogen bonds with polar molecules but not with nonpolar molecules. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 16. How many neighboring water molecules are hydrogen-bonded on average to one water molecule in a sample of pure water?   |  |  |  | | --- | --- | --- | |  | a. | 1.4 | |  | b. | 2.4 | |  | c. | 3.4 | |  | d. | 4.4 | |  | e. | 5.4 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 17. What type of interactions is NOT a weak interaction?   |  |  |  | | --- | --- | --- | |  | a. | nuclear interactions | |  | b. | salt bridges | |  | c. | van der Waals interactions | |  | d. | ionic bonds | |  | e. | hydrogen bonds |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 18. What is the amount of energy needed to apply a 1-newton force over a distance of 1 angstrom?   |  |  |  | | --- | --- | --- | |  | a. | 1010 J | |  | b. | 10–10 J | |  | c. | 1 J | |  | d. | 10 J | |  | e. | 1 kcal |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 19. What is the amount of energy needed to raise the temperature of 2 kilograms of water from 14.5°C to 15.5°C?   |  |  |  | | --- | --- | --- | |  | a. | 2 J | |  | b. | 2 kJ | |  | c. | 2 cal | |  | d. | 20 cal | |  | e. | 2 kcal |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 20. How does Coulomb's energy depend on the distance (*r*) between the two interacting corpuscles?   |  |  |  | | --- | --- | --- | |  | a. | directly proportional to *r* | |  | b. | directly proportional to *r*2 | |  | c. | inversely proportional to *r* | |  | d. | inversely proportional to *r*2 | |  | e. | directly proportional to 2*r* |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 21. What factor does NOT affect electrostatic interaction according to Coulomb's law?   |  |  |  | | --- | --- | --- | |  | a. | the charges on the two interacting atoms | |  | b. | a change in entropy if the interaction occurs | |  | c. | the distance between the two interacting atoms | |  | d. | the dielectric constant of the medium | |  | e. | presence and concentration of other charged corpuscles in the medium |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 22. How much weaker are hydrogen bonds as compared to covalent bonds?   |  |  |  | | --- | --- | --- | |  | a. | from 2 to 10 times | |  | b. | from 20 to 50 times | |  | c. | from 100 to 1000 times | |  | d. | from 1000 to 10,000 times | |  | e. | from 10,000 to a million times |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 23. What is the difference in length between a typical hydrogen bond and a covalent bond?   |  |  |  | | --- | --- | --- | |  | a. | They are equal in length. | |  | b. | A hydrogen bond is somewhat shorter than a covalent bond. | |  | c. | A hydrogen bond is much shorter than a covalent bond. | |  | d. | A hydrogen bond is somewhat longer than a covalent bond. | |  | e. | A hydrogen bond is much longer than a covalent bond. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 24. What group in nucleotide bases is a hydrogen-bond donor?   |  |  |  | | --- | --- | --- | |  | a. | N–H | |  | b. | S–H | |  | c. | P–O | |  | d. | C=O | |  | e. | C–H |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 25. Van der Waals interactions do not depend on:   |  |  |  | | --- | --- | --- | |  | a. | the distance between the two interacting atoms. | |  | b. | the distribution of electrons around the nuclei. | |  | c. | the presence of other charged corpuscles in the medium. | |  | d. | a transient asymmetry in electrical charge of atoms. | |  | e. | the geometry of the large molecules. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 26. What amino acids are most likely to be found in the core of a water-soluble globular protein?   |  |  |  | | --- | --- | --- | |  | a. | nonpolar | |  | b. | polar but uncharged | |  | c. | positively charged | |  | d. | negatively charged | |  | e. | random |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 27. Choose the molecule around which in an aqueous solution water molecules are most ordered.   |  |  |  | | --- | --- | --- | |  | a. | alcohol | |  | b. | aliphatic amino acid | |  | c. | aromatic amino acid | |  | d. | hydrocarbon chain | |  | e. | carboxylic acid |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 28. HCl is a strong acid that is easily and completely hydrolyzed in an aqueous solution. What is the concentration of hydroxyl ions in a 50 mM aqueous HCL solution?   |  |  |  | | --- | --- | --- | |  | a. | 2 × 10–7 M | |  | b. | 5 × 10–6 M | |  | c. | 2 × 10–12 M | |  | d. | 2 × 10–13 M | |  | e. | 5 × 10–4 M |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 29. What is the net charge of a glycine molecule in human blood at pH 7.4, for an amino group of glycine p*K*a = 9.6 and for a carboxyl group p*K*a = 2.3?   |  |  |  | | --- | --- | --- | |  | a. | –2 | |  | b. | –1 | |  | c. | 0 | |  | d. | +1 | |  | e. | +2 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 30. Choose the correct name for the plot of pH changes in a weak acid solution under stepwise addition of a strong acid or base.   |  |  |  | | --- | --- | --- | |  | a. | van der Waals curve | |  | b. | Michaelis–Menten curve | |  | c. | Henderson–Hasselbalch curve | |  | d. | compensatory respiratory alkalosis curve | |  | e. | titration curve |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 31. Tris buffers are commonly used in biochemistry because they buffer within the physiological range of pH due to a p*K*a of 8.1. What is the [A–]/[HA] ratio in a 0.1 M tris solution with pH 9.1?   |  |  |  | | --- | --- | --- | |  | a. | 1:100 | |  | b. | 1:10 | |  | c. | 10:1 | |  | d. | 2:1 | |  | e. | 1:2 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 32. What organ in the human body is crucial for blood pH regulation by compensatory respiratory alkalosis?   |  |  |  | | --- | --- | --- | |  | a. | heart | |  | b. | kidneys | |  | c. | liver | |  | d. | lungs | |  | e. | muscles |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 33. Tris buffers are commonly used in biochemistry because they buffer within the physiological range of pH due to a p*K*a of 8.1. What is the concentration of the conjugate base in a 0.1 M tris solution with pH 5.1?   |  |  |  | | --- | --- | --- | |  | a. | 0.1 M | |  | b. | 0.01 M | |  | c. | 0.05 M | |  | d. | 0.5 nM | |  | e. | 0.1 mM |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 34. What is the concentration of acetate in a 0.1 M acetic acid solution at pH near to p*K*a = 4.76?   |  |  |  | | --- | --- | --- | |  | a. | 0.5 M | |  | b. | nearly 0.1 M | |  | c. | 0.05 M | |  | d. | 0.01 M | |  | e. | almost 0 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 35. What is the [A–]/[HA] ratio when a weak acid is in a solution two pH units below its p*K*a?   |  |  |  | | --- | --- | --- | |  | a. | 1:100 | |  | b. | 1:10 | |  | c. | 10:1 | |  | d. | 2:1 | |  | e. | 1:2 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 36. What is the hydroxyl ion concentration in a urine sample that has a pH of 6?   |  |  |  | | --- | --- | --- | |  | a. | 10–6 M | |  | b. | 10–8 M | |  | c. | 106 M | |  | d. | 10–14 M | |  | e. | 6 M |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 37. What is the molar concentration of water in pure water?   |  |  |  | | --- | --- | --- | |  | a. | 1 M | |  | b. | 100 M | |  | c. | 55.5 M | |  | d. | 5.55 M | |  | e. | 1 mM |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 38. What is the H+ concentration in a urine sample that has a pH of 6?   |  |  |  | | --- | --- | --- | |  | a. | 10–6 M | |  | b. | 10–8 M | |  | c. | 106 M | |  | d. | 10–14 M | |  | e. | 8 M |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 39. Typical van der Waals energies are about:   |  |  |  | | --- | --- | --- | |  | a. | 4–20 kJ/mol. | |  | b. | 2–4 kJ/mol. | |  | c. | 200–400 kJ/mol. | |  | d. | 2–4 J/mol. | |  | e. | 200–400 MJ/mol. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 40. Nonpolar molecules in water:   |  |  |  | | --- | --- | --- | |  | a. | dissolve independently. | |  | b. | aggregate together. | |  | c. | precipitate. | |  | d. | dissociate to ions. | |  | e. | form hydrogen bonds with water molecules. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 41. What is the [A–]/[HA] ratio when a weak acid is in a solution one pH unit above its p*K*a?   |  |  |  | | --- | --- | --- | |  | a. | 1:1 | |  | b. | 1:10 | |  | c. | 10:1 | |  | d. | 2:1 | |  | e. | 1:2 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 42. What are the primary chemical components present in a phosphate buffer at pH 7.4?   |  |  |  | | --- | --- | --- | |  | a. | H3PO4 and PO43– | |  | b. | H2PO4– and PO43– | |  | c. | HPO42– and PO43– | |  | d. | H2PO4– and HPO42– | |  | e. | H3PO4 and HPO42– |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 43. What is the concentration of acetic acid in 250 ml of a 100 mM acetate buffer at pH 4.76?   |  |  |  | | --- | --- | --- | |  | a. | 250 mM | |  | b. | 100 mM | |  | c. | 50 mM | |  | d. | 75 mM | |  | e. | 25 mM |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 44. Citric acid is an important intermediate in glucose metabolism and is synthesized in the mitochondrial matrix. The p*K*a values for each of the three carboxylic groups of the citric acid are 3.1, 4.8, and 6.4. What is the charge on a citrate molecule formed in the mitochondrial matrix where the pH is 7.8?   |  |  |  | | --- | --- | --- | |  | a. | +3 | |  | b. | +2 | |  | c. | –3 | |  | d. | –2 | |  | e. | +1 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 45. A student observes that when an unknown molecule is added to water, it forms micelles, which under the right conditions can form membranes. What can this student infer about this phenomenon?   |  |  |  | | --- | --- | --- | |  | a. | The unknown molecule is amphipathic. | |  | b. | The micelle formation is driven by the resulting decrease in entropy of water. | |  | c. | The unknown molecule forms many van der Waals interactions with water. | |  | d. | The micelle formation is driven by the hydrophilic effect. | |  | e. | The unknown molecule dissociates to ions in water. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 46. What is the term for the movement of particles due to the random fluctuations of energy content of the environment?   |  |  |  | | --- | --- | --- | |  | a. | dissociation | |  | b. | Brownian motion | |  | c. | hydrophobic interaction | |  | d. | van der Waals interaction | |  | e. | entropy |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 47. What is the term for the electrostatic interactions between atoms with opposite electrical charges?   |  |  |  | | --- | --- | --- | |  | a. | salt bridges | |  | b. | Brownian motion | |  | c. | hydrophobic interactions | |  | d. | hydrogen bonds | |  | e. | van der Waals interactions |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 48. Water weakens the electrostatic interaction of ions due to its:   |  |  |  | | --- | --- | --- | |  | a. | ionic bonds or salt bridges. | |  | b. | Brownian motion. | |  | c. | entropy. | |  | d. | ion product of water. | |  | e. | dielectric constant. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 49. What is the contact distance when two atoms no longer repulse each other yet have the strongest attraction?   |  |  |  | | --- | --- | --- | |  | a. | amphipathic | |  | b. | Brownian | |  | c. | hydrophobic | |  | d. | hydrogen | |  | e. | van der Waals |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 50. Which type of amino acid is responsible for increasing entropy as a protein folds?   |  |  |  | | --- | --- | --- | |  | a. | nonpolar | |  | b. | polar but uncharged | |  | c. | charged positively | |  | d. | charged negatively | |  | e. | amphipathic |  |  |  | | --- | --- | | *ANSWER:* | a | |