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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. Molecules that are readily soluble in water are considered:

|  |  |  |
| --- | --- | --- |
|   | a.  | nonpolar. |
|   | b.  | polar. |
|   | c.  | zwitterionic. |
|   | d.  | volatile. |
|   | e.  | dielectric. |

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| --- | --- |
| *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 |

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| --- | --- |
| *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. |

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| --- | --- |
| *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. |

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| *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. |

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| *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. |

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| *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. |

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| *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 |

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| *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 |

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| *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 |

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| *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 |

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| *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%. |

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| *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. |

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| *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. |

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| *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 |

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| *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 |

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| *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 |

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| *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 |

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| *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* |

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| *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 |

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| *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 |

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| *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. |

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| *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 |

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| --- | --- |
| *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. |

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| *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 |

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| *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 |

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| *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 |

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| *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 |

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| *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 |

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| *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 |

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| *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 |

|  |  |
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| *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 |

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| *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 |

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| *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 |

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| *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 |

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| *ANSWER:* | c |

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| 38. What is the H+ concentration in a urine sample that has a pH of 6?

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|   | a.  | 10–6 M |
|   | b.  | 10–8 M |
|   | c.  | 106 M |
|   | d.  | 10–14 M |
|   | e.  | 8 M |

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| *ANSWER:* | a |

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| 39. Typical van der Waals energies are about:

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| --- | --- | --- |
|   | 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. |

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| *ANSWER:* | b |

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| 40. Nonpolar molecules in water:

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|   | a.  | dissolve independently. |
|   | b.  | aggregate together. |
|   | c.  | precipitate. |
|   | d.  | dissociate to ions. |
|   | e.  | form hydrogen bonds with water molecules. |

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| *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?

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| --- | --- | --- |
|   | a.  | 1:1 |
|   | b.  | 1:10 |
|   | c.  | 10:1 |
|   | d.  | 2:1 |
|   | e.  | 1:2 |

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| *ANSWER:* | c |

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| 42. What are the primary chemical components present in a phosphate buffer at pH 7.4?

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| --- | --- | --- |
|   | a.  | H3PO4 and PO43– |
|   | b.  | H2PO4– and PO43– |
|   | c.  | HPO42– and PO43– |
|   | d.  | H2PO4– and HPO42– |
|   | e.  | H3PO4 and HPO42– |

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| *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?

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| --- | --- | --- |
|   | a.  | 250 mM |
|   | b.  | 100 mM |
|   | c.  | 50 mM |
|   | d.  | 75 mM |
|   | e.  | 25 mM |

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| *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 |

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| *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?

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| --- | --- | --- |
|   | 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. |

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| *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?

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|   | a.  | dissociation |
|   | b.  | Brownian motion |
|   | c.  | hydrophobic interaction |
|   | d.  | van der Waals interaction |
|   | e.  | entropy |

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| *ANSWER:* | b |

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| 47. What is the term for the electrostatic interactions between atoms with opposite electrical charges?

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| --- | --- | --- |
|   | a.  | salt bridges |
|   | b.  | Brownian motion |
|   | c.  | hydrophobic interactions |
|   | d.  | hydrogen bonds |
|   | e.  | van der Waals interactions |

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| *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. |

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| *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 |

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| *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 |

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| *ANSWER:* | a |

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