

Chapter 2 Water: The Medium of Life

MULTIPLE CHOICE

1. Which of the following is NOT a property of water that renders it so suited to its role as a medium of life?
- unrivalled ability to form hydrogen bonds
 - unusually high dielectric constant, which explains its ability to surround ions and increase the ions' attraction for one another
 - unparalleled ability to orient around non-polar solutes to promote hydrophobic interactions
 - a small, but significant, tendency to form H^+ and OH^{2-} ions

ANS: B

PTS: 1

REF: 32-33

BLM: Higher Order

2. Which of the following is NOT a characteristic of water?
- high surface tension
 - high dielectric constant
 - positive volume of melting
 - high capacity to form hydrogen bonds

ANS: C

PTS: 1

REF: 33-34

BLM: Higher Order

3. How many hydrogen bonds can a single liquid water molecule make?
- 2
 - 3
 - 4
 - 5

ANS: C

PTS: 1

REF: 34

BLM: Remember

4. Which of the following is NOT soluble in water?
- salts
 - sugars
 - aldehydes
 - hydrocarbons

ANS: D

PTS: 1

REF: 33-35

BLM: Higher Order

5. Which of the following solvents has the highest dielectric constant?
- water
 - acetic acid
 - ethanol
 - hexane

ANS: A

PTS: 1

REF: 33-34

BLM: Higher Order

6. Which of the following is a trait of hydrogen bonds in ice?
- weak
 - non-directional
 - straight
 - responsibility for the higher density of ice over liquid water

ANS: C PTS: 1 REF: 34-35 BLM: Higher Order

7. Which of the following is a characteristic of pure liquid H₂O molecules?
- They are held in a rigid 3-dimensional network.
 - They have local preference for linear geometry.
 - They have large numbers of strained or broken hydrogen bonds.
 - They do not switch H bonds readily.

ANS: C PTS: 1 REF: 34-35 BLM: Higher Order

8. Which of the following specifies the average lifetime of a hydrogen bond connection in water?
- 10 milliseconds
 - 10 microseconds
 - 10 nanoseconds
 - 10 picoseconds

ANS: D PTS: 1 REF: 35 BLM: Remember

9. Which of the following is the strongest type of bonding that occurs between water and the polar functional groups on non-ionic polar solutes?
- ionic
 - hydrophobic
 - electrostatic
 - hydrogen

ANS: D PTS: 1 REF: 35-36 BLM: Higher Order

10. Which of the following types of interactions occur between hydrogen bonded water and non-polar solutes?
- hydrophobic
 - hydrophilic
 - ionic
 - van der Waals

ANS: A PTS: 1 REF: 36 BLM: Higher Order

11. Which of the following compounds is included in amphiphilic molecules?
- salts of fatty acids
 - sugars
 - acidic amino acids
 - inorganic salts

ANS: A PTS: 1 REF: 37-38 BLM: Higher Order

12. Which of the following is a feature of micelles?
- Hydrocarbon tails form hydrophobic interactions with water.
 - Polar ends form hydrophobic interactions with water.
 - Hydrocarbon tails are excluded from the water into hydrophobic domains.
 - Polar ends are hydrophobic, and non-polar ends are hydrophilic.

ANS: C PTS: 1 REF: 38 BLM: Higher Order

13. Which of the following effects do solutes have on a water solvent?
- They enhance the dynamic interplay among H₂O molecules.
 - They increase the orientation that neighbouring water molecules can assume.
 - They have no effect.
 - They give order to the solvent.

ANS: D PTS: 1 REF: 38 BLM: Higher Order

14. Which of the following explains how cells store substances such as amino acids and sugars in order to minimize the osmotic pressure created by the contents of their cytosol?
- in monomeric form
 - in dimeric form
 - in trimeric form
 - in polymeric form

ANS: D PTS: 1 REF: 39 BLM: Remember

15. Which of the following is reason for the ionization of water?
- The smaller electronegative oxygen atom strips the electron from one of its hydrogen atoms, leaving the proton to dissociate.
 - The larger electronegative oxygen atom strips the electron from one of its hydrogen atoms, leaving the proton to dissociate.
 - The smaller electropositive oxygen atom strips the electron from one of its hydrogen atoms, leaving the proton to dissociate.
 - The larger electropositive oxygen atom strips the electron from one of its hydrogen atoms, leaving the proton to dissociate.

ANS: B PTS: 1 REF: 39-40 BLM: Higher Order

16. How many times more H⁺ does grapefruit juice at pH 3.2 contain compared to orange juice at pH 4.3?
- $10^{-7.5}$
 - 10^{-2}
 - 0.9
 - 12

ANS: D PTS: 1 REF: 40-41 BLM: Higher Order

17. Which of the following acids is NOT a weak electrolyte?
- hydrochloric acid
 - acetic acid
 - lactic acid
 - phosphoric acid

ANS: A

PTS: 1

REF: 41-42

BLM: Higher Order

18. The pK_a s of phosphoric acid are 2.1, 7.2, and 12.4. Which of the following values is the resulting pH if equal amounts of Na_2HPO_4 and NaH_2PO_4 are mixed in water?
- 2.1
 - 4.65
 - 7.2
 - 9.8

ANS: B

PTS: 1

REF: 41-44

BLM: Higher Order

19. The pK_a s of phosphoric acid are 2.1, 7.2, and 12.4. Which of the following values is the correct estimate of the pH of the resulting solution prepared by mixing 1.0 mole of solid disodium phosphate (Na_2HPO_4) and 1.25 moles of hydrochloric acid?
- $pH < 2.1$
 - $pH = 2.1$
 - $2.1 < pH < 7.2$
 - $pH = 7.2$

ANS: C

PTS: 1

REF: 43-44

BLM: Higher Order

20. Which of the following pairs would be the best buffer at pH 10.0?
- acetic acid and sodium acetate ($pK_a = 4.76$)
 - H_2CO_3 and $NaHCO_3$ (pK_a s are 3.77 and 10.4)
 - lactic acid and sodium lactate ($pK_a = 3.86$)
 - NaH_2PO_4 and Na_2HPO_4 (pK_a s are 2.1, 7.2, 12.4)

ANS: B

PTS: 1

REF: 43-44/46

BLM: Higher Order

21. The pK_a s of phosphoric acid are 2.1, 7.2, and 12. Which of the following ionic form(s) of phosphoric acid is/are present at pH 7.0?
- HPO_4^{2-}
 - $H_2PO_4^-$
 - HPO_4^{2-} and PO_4^{3-}
 - $H_2PO_4^-$ and HPO_4^{2-}

ANS: D

PTS: 1

REF: 45

BLM: Higher Order

22. A plasma pH of 6.8 does not seem too far away from a normal pH of 7.4. How many times greater is the H^+ concentration at pH 6.8 compared to pH 7.4?
- 0.1
 - 0.6
 - 4
 - 10

ANS: C

PTS: 1

REF: 4

BLM: Higher Order

23. Under which of these conditions does $pH = pK_a$?

- $\log ([A^-]/[HA]) = 1$
- $[A^-] \gg [HA]$
- $[A^-] = [HA]$
- $\log ([HA]/[A^-]) = 1$

ANS: B

PTS: 1

REF: 43

BLM: Higher Order

24. Which of the following characteristics does NOT apply to buffers?

- They have relatively flat titration curves at the pH(s) where they buffer.
- They resist changes in their pH as acid or base is added.
- They are typically composed of a weak acid and its conjugate base.
- They buffer best for polyprotic acids half-way between the 2 pK_a values.

ANS: D

PTS: 1

REF: 46-47

BLM: Higher Order

25. At what pH are buffer systems most effective?

- within 1 pH unit of the pK_a value
- within 2 pH units of the pK_a value
- within 3 pH units of the pK_a value
- within 4 pH units of the pK_a value

ANS: A

PTS: 1

REF: 46-47

BLM: Higher Order

26. Which of the following buffer systems primarily maintain intracellular pH?

- $HPO_4^{2-}/H_2PO_4^-$; HCO_3^-/H_2CO_3
- $H_3PO_4/H_2PO_4^-$; histidine
- HCO_3^-/H_2CO_3 ; $H_3PO_4/H_2PO_4^-$
- $HPO_4^-/H_2PO_4^-$; histidine

ANS: D

PTS: 1

REF: 46-47

BLM: Higher Order

27. Which of the following values is the pK_a for a weak acid that is 25% deprotonated at pH 4?

- 3.40
- 3.52
- 4.48
- 4.60

ANS: C

PTS: 1

REF: 43|46-47

BLM: Higher Order

28. Which of the following is the purpose of the physiological mechanism of hyperventilation?
- to lower $[\text{CO}_2(\text{g})]$ in the blood and increase blood pH
 - to raise $[\text{CO}_2(\text{g})]$ in the blood and increase blood pH
 - to lower $[\text{CO}_2(\text{g})]$ in the blood and decrease blood pH
 - to raise $[\text{CO}_2(\text{g})]$ in the blood and decrease blood pH

ANS: A PTS: 1 REF: 48-49 BLM: Higher Order

29. Water is particularly suited as a solvent for biosystems. Which of the following is NOT a characteristic of water?
- Water is a medium for ionization, enhancing the variety of chemical species.
 - Water is innocuous, yet a powerful solvent.
 - Water is an excellent solvent for non-polar substances.
 - Water is relatively chemically inert, yet dissolves a variety of solutes.

ANS: C PTS: 1 REF: 50 BLM: Higher Order

30. Which of the following weak acids would make the best buffer at pH = 5.0?
- acetic acid ($K_a = 1.74 \times 10^{-5}$, $\text{p}K_a = 4.76$)
 - bicarbonate ($K_a = 6.3 \times 10^{-11}$, $\text{p}K_a = 10.24$)
 - tris*-hydroxymethyl aminomethane ($K_a = 8.32 \times 10^{-9}$, $\text{p}K_a = 8.07$)
 - lactic acid ($K_a = 1.38 \times 10^{-4}$, $\text{p}K_a = 3.86$)

ANS: A PTS: 1 REF: 49 BLM: Higher Order

31. The enzyme fumarase has a pH optimum of about 7.6. Which of the following would be the buffer of choice to study this enzyme?
- tris*-hydroxymethyl aminomethane ($K_a = 8.32 \times 10^{-9}$, $\text{p}K_a = 8.07$)
 - lactic acid ($K_a = 1.38 \times 10^{-4}$, $\text{p}K_a = 3.86$)
 - bicarbonate ($K_a = 6.3 \times 10^{-11}$, $\text{p}K_a = 10.24$)
 - acetic acid ($K_a = 1.74 \times 10^{-5}$, $\text{p}K_a = 4.76$)

ANS: A PTS: 1 REF: 49 BLM: Higher Order

32. We are preparing an acetate buffer at pH 4.5 with 0.01 M solutions of acetic acid ($\text{p}K_a = 4.8$) and sodium acetate. Which of the following should the volume of acetic acid be compared to the volume of sodium acetate solution?
- less than half
 - exactly half
 - equal to
 - about twice

ANS: D PTS: 1 REF: 43-44 BLM: Higher Order

33. Hypoventilation is characterized by inability to excrete CO₂ rapidly enough. Which of the following is NOT a cause of hypoventilation?
- a. depressant drugs
 - b. encephalitis
 - c. narcotics
 - d. lung diseases

ANS: B

PTS: 1

REF: 48-49

BLM: Higher Order

34. Which of the following will occur if an abundance of an organic acid with a pK_a of 3.9 is found in the bloodstream?
- a. It will be mostly protonated.
 - b. It will be mostly deprotonated.
 - c. It will form an effective buffer.
 - d. It will cause metabolic alkalosis.

ANS: B

PTS: 1

REF: 43-46

BLM: Higher Order

35. Aspirin contains a carboxylic acid with a pK_a of 3.5. Which of the following regarding its structure is correct?
- a. It will be mostly protonated in the bloodstream.
 - b. It will be mostly protonated in the stomach.
 - c. It will be easily absorbed in the stomach due to its negative charge.
 - d. It will be easily transported in the bloodstream due to its neutral charge.

ANS: A

PTS: 1

REF: 43-44

BLM: Higher Order