Ch. 3 Water and the Fitness of the Environment

Questions for Chapter 3

1) In a single molecule of water, the two hydrogen atoms are bonded to a single oxygen atom by
   A) hydrogen bonds.
   B) nonpolar covalent bonds.
   C) polar covalent bonds.
   D) ionic bonds.
   E) van der Waals interactions.

2) The partial negative charge at one end of a water molecule is attracted to the partial positive charge of another water molecule. What is this attraction called?
   A) a covalent bond
   B) a hydrogen bond
   C) an ionic bond
   D) a hydrophilic bond
   E) a hydrophobic bond

3) Which of the following is an example of a hydrogen bond?
   A) the bond between C and H in methane
   B) the bond between the H of one water molecule and the O of another water molecule
   C) the bond between Na and Cl in salt
   D) the bond between two hydrogen atoms
   E) the bond between Mg and Cl in $MgCl_2$

4) Water is able to form hydrogen bonds because
   A) oxygen has a valence of 2.
   B) the water molecule is shaped like a tetrahedron.
   C) the water molecule is polar.
   D) the oxygen atom in a water molecule has a strong positive charge.
   E) the hydrogen atoms in a water molecule are weakly negative in charge.

5) What is the maximum number of hydrogen bonds a water molecule can form with neighboring water molecules?
   A) one B) two C) three D) four E) five

6) What determines the cohesiveness of water molecules?
   A) hydrophobic interactions
   B) high specific heat
   C) covalent bonds
   D) hydrogen bonds
   E) ionic bonds

7) What do cohesion, surface tension, and adhesion have in common with reference to water?

A) All increase when temperature increases.

B) All are produced by covalent bonding.

C) All are properties related to hydrogen bonding.

D) All have to do with nonpolar covalent bonds.

E) Both A and C are correct.

8) Water is transported in plant tissues against gravity due to which of the following properties?

A) cohesion

B) adhesion

C) hydrogen bonding

D) two of the above

E) all of the above

9) Which of the following is possible due to the surface tension of water?

A) Lakes don't freeze solid in the winter, despite low temperatures.

B) A waterstrider can walk across a small pond.

C) Organisms resist temperature changes although they give off heat due to chemical reactions.

D) Water can act as a solvent.

E) The pH remains neutral.

10) When an ice cube cools a drink 1°C, which of the following is *true*?

A) Molecule collisions in the drink increase.

B) Kinetic energy in the drink decreases.

C) A kilocalorie of heat is transferred to the water.

D) A kilocalorie of heat is transferred to the ice.

E) Evaporation of the water increases.

11) Which of the following is a *correct* definition of a kilocalorie?

A) The amount of heat energy required to raise 1 g of water by 1°F.

B) The amount of heat energy required to raise 1 g of water by 1°C.

C) The amount of heat energy required to raise 1 kg of water by 1°C.

D) A measure of the average kinetic energy of 1 L of water.

E) The amount of energy in 1 kg of glucose.

12) The nutritional information on a cereal box shows that one serving of dry cereal has 90 calories (actually kilocalories). If one were to burn a serving of cereal, the amount of heat given off would be sufficient to raise the temperature of 1 kg of water how many degrees Celsius?

A) 0.9°C B) 9.0°C C) 90.0°C D) 900.0°C E) 9000.0°C

13) Water's high specific heat is mainly a consequence of the

A) small size of the water molecules.

B) high specific heat of oxygen and hydrogen atoms.

C) absorption and release of heat when hydrogen bonds break and form.

D) fact that water is a poor heat conductor.

E) inability of water to dissipate heat into dry air.

14) Which bonds must be broken for water to vaporize?

A) ionic bonds

B) nonpolar covalent bonds

C) polar covalent bonds

D) hydrogen bonds

E) Both C and D are correct.

15) The formation of ice during colder weather helps temper the seasonal transition to winter. This is mainly because

A) the formation of hydrogen bonds releases heat.

B) the formation of hydrogen bonds absorbs heat.

C) there is less evaporative cooling of lakes.

D) ice melts each autumn afternoon.

E) ice is warmer than the winter air.

16) Temperature usually increases when water condenses. Which behavior of water is most directly responsible for this phenomenon?

A) change in density when it condenses to form a liquid or solid

B) reactions with other atmospheric compounds

C) release of heat by the formation of hydrogen bonds

D) release of heat by the breaking of hydrogen bonds

E) high surface tension

17) Desert rabbits are adapted to the warm climate because their large ears aid in the removal of heat by

A) the high surface tension of water.

B) the high heat of vaporization of water.

C) the high specific heat of water.

D) the buffering capacity of water.

E) the dissociation of water molecules.

18) At what temperature is water at its densest?

A) 0°C B) 4°C C) 32°C D) 100°C E) 212°C

19) Ice is lighter and floats in water because it is a crystalline structure held together by

A) ionic bonds only.

B) hydrogen bonds only.

C) covalent bonds only.

D) Both A and C are correct.

E) A, B, and C are correct.

20) Why does ice float in liquid water?

A) The liquid water molecules have more energy and can push up the ice.

B) The ionic bonds between the molecules in ice prevent the ice from sinking.

C) Ice always has air bubbles that keep it afloat.

D) Hydrogen bonds keep the molecules of ice farther apart than in liquid water.

E) The crystalline lattice of ice causes it to be denser than liquid water.

21) Life on Earth is dependent on all the properties of water as well as the abundance of water. Which property of water is probably *most* important for the functioning of organisms at the molecular level?

A) cohesion and high surface tension

B) high specific heat

C) high heat of vaporization

D) expansion upon freezing

E) versatility as a solvent

The following question is based on Figure 3.1: solute molecules surrounded by a hydration shell of water.

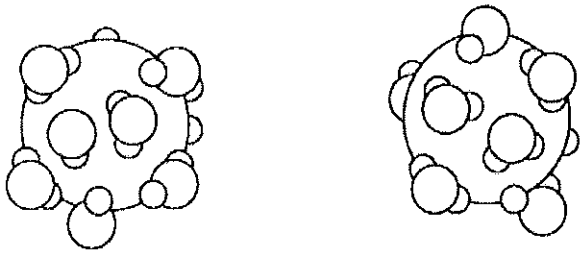

Figure 3.1

22) Based on your knowledge of the polarity of water, the solute molecule is most likely

A) positively charged.

B) negatively charged.

C) neutral in charge.

D) hydrophobic.

E) nonpolar.

23) Hydrophobic substances like vegetable oil are

A) non-ionic or nonpolar substances that repel water.

B) non-ionic or nonpolar substances that have an affinity for water.

C) ionic or polar substances that repel water.

D) ionic or polar substances that have an affinity for water.

E) ionic substances that readily dissolve in water.

24) One mole (mol) of a substance is equal to

A) 6.02×10^{23} molecules of the substance.

B) 1 g of the substance dissolved in 1 L of solution.

C) the largest amount of the substance that can be dissolved in 1 L of solution.

D) the molecular weight of the substance expressed in grams. One mol of glucose ($C_6H_{12}O_6$) is equivalent to 180 g of glucose.

E) Answers A and D are correct.

25) How many molecules of sucrose ($C_{12}H_{22}O_{11}$) molecular weight, 342, would be present in one mole of sucrose?

A) 45 molecules

B) 342 molecules

C) 1×10^{14} molecules

D) 6.02×10^{14} molecules

E) 6.02×10^{23} molecules

26) How many molecules of glycerol ($C_3H_8O_3$) would be present in 1 L of a 1 *M* glycerol solution?

A) 1 B) 14 C) 92 D) 1×10^7 E) 6.02×10^{23}

27) Recall that when sodium chloride (NaCl) is placed in water the component atoms of the NaCl crystal dissociate into individual sodium ions (Na+) and chloride ions (Cl-). In contrast, the atoms of covalently bonded molecules (for example: glucose, sucrose, glycerol) do not generally dissociate when placed in aqueous solution. Which of the following solutions would be expected to contain the greatest number of particles (molecules or ions)?

A) 0.5 *M* NaCl

B) 0.5 *M* glucose

C) 1.0 *M* NaCl

D) 1.0 *M* glucose

E) 1.0 *M* $MgCl_2$

28) The molecular weight of glucose is 180 g. To make a 1 *M* solution of glucose, you should do which of the following?

A) Dissolve 1 g of glucose in 1 L of water.

B) Dissolve 100 g of glucose in 1 L of water.

C) Dissolve 180 g of glucose in 100 g of water.

D) Dissolve 180 mg (milligrams) of glucose in 1 L of water.

E) Dissolve 180 g of glucose in water, and then add more water until the total volume of the solution is 1 L.

29) The molecular weight of glucose ($C_6H_{12}O_6$) is 180 g. To make a 0.5 *M* solution of glucose, you should

A) dissolve 0.5 g of glucose in 1 L of water.

B) dissolve 12 g of glucose in 1 L of water.

C) dissolve 24 g of glucose in 1 L of water.

D) dissolve 90 g of glucose in a small volume of water and then add more water until the total volume of solution is 1 L.

E) dissolve 180 g of glucose in a small volume of water, and then add more water until the total volume of the solution is 1 L.

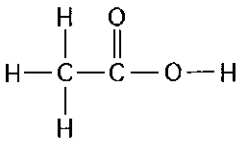

Figure 3.2

30) How many grams of the molecule in Figure 3.2 would be required to make 1 L of a 0.2 *M* solution of the molecule? (Carbon = 12, Oxygen = 16, Hydrogen = 1)

A) 8 B) 12 C) 24 D) 32 E) 60

31) How many grams of the molecule in Figure 3.2 would be required to make 1 L of a 1.5 *M* solution of the molecule? (Carbon = 12, Oxygen = 16, Hydrogen = 1)

A) 37 B) 55 C) 60 D) 74 E) 90

32) A given solution is found to contain 0.0001 mol of hydrogen ions (H^+) per liter. Which of the following best describes this solution?

A) acidic: H^+ acceptor

B) basic: H^+ acceptor

C) acidic: H^+ donor

D) basic: H^+ donor

E) neutral

33) A solution is found to contain 0.000001 mol of hydroxide ions (OH^-) per liter. Which of the following best describes this solution?

A) acidic: H^+ acceptor

B) basic: H^+ acceptor

C) acidic: H^+ donor

D) basic: H^+ donor

E) neutral

34) Which of the following ionizes completely in solution and is therefore a strong acid?

A) NaOH B) H_2CO_3 C) CH_3COOH D) NH_2 E) HCl

35) Which of the following ionizes completely in solution and is therefore a strong base?

A) NaOH B) HCl C) NH_3 D) H_2CO_3 E) NaCl

36) Which of the following statements is *completely* correct?

A) H_2CO_3 is a weak acid, and NaOH is a weak base.

B) H_2CO_3 is a strong acid, and NaOH is a strong base.

C) NH_3 is a weak base, and H_2CO_3 is a strong acid.

D) NH_3 is a strong base, and HCl is a weak acid.

E) NH_3 is a weak base, and HCl is a strong acid.

37) Assume that acid rain has lowered the pH of a particular lake to pH 5.0. What is the hydroxide ion concentration of this lake?

A) 1×10^{-5} mol of hydroxide ion per liter of lake water

B) 1×10^{-9} mol of hydroxide ion per liter of lake water

C) 5.0 *M* with regard to hydroxide ion concentration

D) 9.0 *M* with regard to hydroxide ion concentration

E) Both B and D are correct.

38) What would be the pH of a solution with a hydroxide ion concentration $[OH^-]$ of 10^{-10} *M*?

A) 2 B) 4 C) 8 D) 10 E) 14

39) What would be the pH of a solution with a hydrogen ion concentration $[H^+]$ of 10^{-8} *M*?

A) pH 2 B) pH 4 C) pH 6 D) pH 8 E) pH 10

40) Which of the following solutions has the greatest concentration of hydrogen ions $[H^+]$?

A) gastric juice at pH 2

B) vinegar at pH 3

C) tomato juice at pH 4

D) black coffee at pH 5

E) household bleach at pH 12

41) Which of the following solutions has the greatest concentration of hydroxide ions $[OH^-]$?

A) lemon juice at pH 2

B) vinegar at pH 3

C) tomato juice at pH 4

D) urine at pH 6

E) seawater at pH 8

42) If the pH of a solution is decreased from 7 to 6, it means that the

A) concentration of H^+ has decreased to 10 times of what it was at pH 7.

B) concentration of H^+ has increased to 10 times what it was at pH 7.

C) concentration of OH^- has increased to 10 times what it was at pH 7.

D) concentration of OH^- has decreased 10 times what it was at pH 7.

E) Both B and D are correct.

43) If the pH of a solution is increased from pH 8 to pH 9, it means that the

A) concentration of H^+ is 10 times greater than what it was at pH 8.

B) concentration of H^+ is 100 times less than what it was at pH 8.

C) concentration of OH^- is 10 times greater than what it was at pH 8.

D) concentration of OH^- is 100 times less than what it was at pH 8.

E) concentration of H^+ is greater and the concentration of OH^- is less than at pH 8.

44) One liter of a solution with a pH of 3 has how many more H^+ than 1 L of a solution with a pH of 6?

A) 3 times more

B) 10 times more

C) 100 times more

D) 300 times more

E) 1,000 times more

45) One liter of a solution with a pH of 11 has how many more OH^- than 1 L of a solution with a pH of 6?

A) 5 times more

B) 10 times more

C) 50 times more

D) 10,000 times more

E) 100,000 times more

46) Which of the following statements is *true* about buffer solutions? They

A) will always have a pH of 7.

B) tend to maintain a relatively constant pH.

C) maintain a constant pH when bases are added to them but not when acids are added to them.

D) cause a lowering of pH when acids are added to them.

E) are rarely found in living systems.

47) Buffers are substances that help resist shifts in pH by

A) releasing H^+ in acidic solutions.

B) releasing H^+ in basic solutions.

C) releasing OH^- in basic solutions.

D) combining with OH^- in acidic solutions.

E) combining with H^+ in basic solutions.

48) One of the buffers that contribute to pH stability in human blood is carbonic acid (H_2CO_3). Carbonic acid is a weak acid that dissociates into a bicarbonate ion (HCO_3^-) and a hydrogen ion (H^+). Thus,

$$H_2CO_3 \Leftrightarrow HCO_3^- + H^+$$

If the pH of the blood drops, one would expect

A) a decrease in the concentration of H_2CO_3 and an increase in the concentration of HCO_3^-.

B) the concentration of hydroxide ion (OH^-) to increase.

C) the concentration of bicarbonate ion (HCO_3^-) to increase.

D) the HCO_3^- to act as a base and remove excess H+ with the formation of H_2CO_3.

E) the HCO_3^- to act as an acid and remove excess H+ with the formation of H_2CO_3.

49) One of the buffers that contribute to pH stability in human blood is carbonic acid (H_2CO_3). Carbonic acid is a weak acid that when placed in an aqueous solution dissociates into a bicarbonate ion (HCO_3^-) and a hydrogen ion (H^+). Thus,

$$H_2CO_3 \Leftrightarrow HCO_3^- + H^+$$

If the pH of the blood increases, one would expect:

A) a decrease in the concentration of H_2CO_3 and an increase in the concentration of H_2O.

B) an increase in the concentration of H_2CO_3 and a decrease in the concentration of H_2O.

C) a decrease in the concentration of HCO_3^- and an increase in the concentration of H_2O.

D) an increase in the concentration of HCO_3^- and a decrease in the concentration of H_2O.

E) a decrease in the concentration of HCO_3^- and an increase in the concentration of both H_2CO_3 and H_2O.

The following questions refer to the terms below.

A. calorie
B. temperature
C. heat of vaporization
D. buffer
E. mole

50) A measure of the average kinetic energy of the molecules in a body of matter

51) The number of grams of a substance that equals its molecular mass in daltons

52) A weak acid or base that combines reversibly with hydrogen ions

53) Recent research indicates that acid precipitation can damage life by

A) buffering aquatic systems such as lakes and streams.

B) decreasing the H^+ concentration of lakes and streams.

C) changing the solubility of soil minerals.

D) altering the structures of biological molecules required for essential life processes.

E) Both C and D are true.