

## CHAPTER 2—CHEMISTRY OF LIFE

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### MULTIPLE CHOICE

1. Atoms are composed of
- protons with a positive charge.
  - neutrons with no charge.
  - electrons with a negative charge.
  - All of the above

ANS: D                      DIF: 1                      OBJ: 2-1.3

2. The smallest particle of carbon that can retain the chemical properties of carbon is
- a carbon molecule.
  - a carbon macromolecule.
  - a carbon atom.
  - the nucleus of a carbon atom.

ANS: C                      DIF: 1                      OBJ: 2-1.2

3. A substance that is composed of only one type of atom is called a(n)
- nucleus.
  - cell.
  - element.
  - molecule.

ANS: C                      DIF: 1                      OBJ: 2-1.2

4. All matter in the universe is composed of
- cells.
  - molecules.
  - atoms.
  - carbon.

ANS: C                      DIF: 1                      OBJ: 2-1.1

5. The electrons of an atom
- are found in the nucleus along with the protons.
  - orbit the nucleus in various energy levels.
  - have a positive charge.
  - are attracted to the positive charge of neutrons.

ANS: B                      DIF: 1                      OBJ: 2-1.3

6. Atoms that have gained energy
- have protons and neutrons that move farther apart.
  - lose neutrons from the nucleus.
  - have electrons that move to higher energy levels.
  - absorb electrons into the nucleus.

ANS: C                      DIF: 1                      OBJ: 2-1.3

7. Which of the following states of matter contain(s) particles that are tightly linked together in a definite shape?
- solid
  - liquid
  - gas
  - solid and liquid

ANS: A                      DIF: 2                      OBJ: 2-2.1

8. Because carbon has four electrons in its outer energy level,
- it can form bonds with carbon atoms only.
  - these atoms are naturally chemically stable.
  - it can react with up to four other atoms to form covalent bonds.
  - it cannot react with anything other than organic molecules.

ANS: C                      DIF: 2                      OBJ: 2-1.5

9. The bond formed when two atoms share a pair of electrons is called a
- hydrogen bond.
  - nonpolar bond.
  - covalent bond.
  - water bond.

ANS: C                      DIF: 1                      OBJ: 2-1.5

10. Sharing of electrons between atoms of two or more elements
- results in the formation of an ion.
  - results in the formation of a compound.
  - results in the formation of noble gases.
  - results in destabilization of the atoms involved.

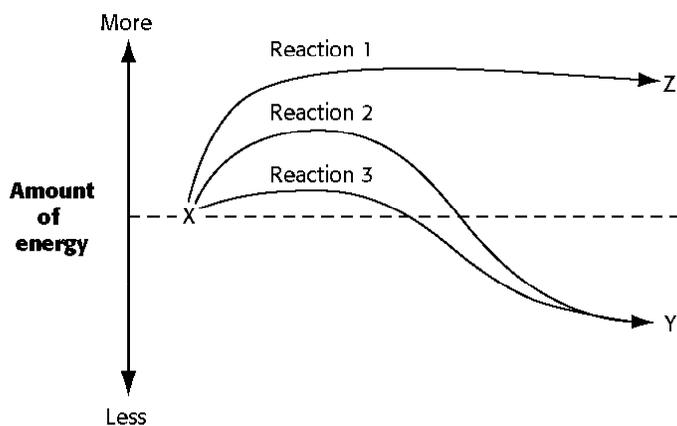
ANS: B                      DIF: 1                      OBJ: 2-1.4

11. An atom that has gained or lost electrons is called a(n)
- molecule.
  - nucleon.
  - ion.
  - element.

ANS: C                      DIF: 1                      OBJ: 2-1.5

12. Which of the following statements most accurately describes the difference between an ionic bond and a covalent bond?
- Atoms held together by ionic bonds separate when placed in water, while atoms held together by covalent bonds do not separate in water.
  - Ionic bonds hold together atoms of two different types, while covalent bonds hold together atoms of the same type.
  - Electrons are exchanged between atoms held together by an ionic bond, but they are shared between atoms held together by a covalent bond.
  - Ionic bonds form between atoms that carry opposite charges, while covalent bonds form between uncharged atoms.

ANS: C                      DIF: 1                      OBJ: 2-1.5



13. Refer to the graph above. Reaction 1 in the graph
- is an energy-storing reaction.
  - requires a greater activation energy than reaction 2.
  - may use the same initial reactant condition needed to form product Y.
  - All of the above

ANS: D                      DIF: 2                      OBJ: 2-2.3

14. Refer to the graph above. Reaction 3 in the graph
- probably occurred in the presence of a catalyst.
  - requires a greater activation energy than reaction 2.
  - is the same as reaction 1, but faster.
  - takes longer than reaction 2.

ANS: A                      DIF: 2                      OBJ: 2-2.3

15. Refer to the graph above. Which of these statements regarding the graph is true?
- Reaction 2 occurs faster than reaction 3 because reaction 2 requires more energy than reaction 3.
  - The difference in the graphs shown for reaction 2 and reaction 3 is due to a difference in the activation energy needed for these reactions.
  - Reactant X contains more energy at the beginning of the reaction than product Z has after the reaction.
  - All of the above

ANS: B                      DIF: 2                      OBJ: 2-2.3

16. Changing the course or pathway of a chemical reaction so that it requires less activation energy
- is a violation of the laws of nature.
  - requires higher temperatures than those found within cells.
  - occurs only when reactants are quickly added to the reaction mixture.
  - is accomplished by the action of catalysts on reactants.

ANS: D                      DIF: 1                      OBJ: 2-2.3

17. Enzymes
- are able to heat up molecules so that they can react.
  - provide CO<sub>2</sub> for chemical reactions.
  - are biological catalysts.
  - absorb excess heat so that reactions occur at low temperatures.

ANS: C                    DIF: 1                    OBJ: 2-2.3

18. A single organism may contain
- thousands of different enzymes, each one specific to a different chemical reaction.
  - one enzyme that plays a role in thousands of different chemical reactions.
  - approximately 100 kinds of enzymes, each one specific to a different chemical reaction.
  - one enzyme that is specific to photosynthesis and one enzyme that is specific to cellular respiration.

ANS: A                    DIF: 1                    OBJ: 2-2.3

19. When a molecule gains an electron, it has been
- oxidized.
  - reduced.
  - digested.
  - inactivated.

ANS: B                    DIF: 1                    OBJ: 2-2.4

20. Oxidation-reduction reactions are important in organisms because they
- allow the passage of energy from molecule to molecule.
  - prevent nuclear reactions from occurring.
  - allow the creation and destruction of energy.
  - None of the above; oxidation-reduction reactions do not occur in living organisms.

ANS: A                    DIF: 1                    OBJ: 2-2.4

21. The concentration of a solution is
- the number of particles of a substance in a solvent.
  - the amount of a solvent that is dissolved in a fixed amount of a solution.
  - the amount of a solute that is dissolved in a fixed amount of a solution.
  - the ratio of solute to solvent in a solution.

ANS: C                    DIF: 1                    OBJ: 2-3.4

22. A neutral solution has an equal number of
- hydrogen and hydronium ions.
  - hydroxide and hydronium ions.
  - hydrogen and hydroxide ions.
  - oxygen and hydrogen ions.

ANS: B                    DIF: 2                    OBJ: 2-3.5

23. The terms *base* and *alkaline* refer to solutions that
- contain dissolved sodium hydroxide.
  - contain more hydronium ions than hydroxide ions.
  - contain more hydroxide ions than hydronium ions.
  - contain more hydroxide ions than hydrogen ions.

ANS: C                    DIF: 2                    OBJ: 2-3.5

24. A solution with a pH of 11 is

- a. acidic.
- b. alkaline.
- c. neutral.
- d. a buffer.

ANS: B                      DIF: 1                      OBJ: 2-3.5

25. Acidic solutions have a pH that is

- a. less than 7.
- b. between 0 and 14.
- c. a negative number.
- d. more than 7.

ANS: A                      DIF: 1                      OBJ: 2-3.5

26. Buffers

- a. are of relatively little importance in living things.
- b. are formed when a large number of hydroxide ions are released in a solution.
- c. are formed when a large number of hydronium ions are released in a solution.
- d. tend to prevent great fluctuations in pH.

ANS: D                      DIF: 2                      OBJ: 2-3.5

27. Atoms become more stable when they form compounds because

- a. they always lose electrons when they form compounds.
- b. their outer orbitals become filled when they form compounds.
- c. they always gain electrons when they form compounds.
- d. their nucleus loses extra protons when they form compounds.

ANS: B                      DIF: 1                      OBJ: 2-1.4

28. A water molecule is polar because its hydrogen and oxygen atoms

- a. both lose electrons.
- b. become ions.
- c. both gain electrons.
- d. do not share the electrons equally.

ANS: D                      DIF: 1                      OBJ: 2-3.1

29. Polar molecules such as water have

- a. no negative or positive poles.
- b. both negative and positive poles.
- c. only a negative pole.
- d. only a positive pole.

ANS: B                      DIF: 1                      OBJ: 2-3.1

30. A molecule that has a partial positive charge on one side and a partial negative charge on the other side is called a

- a. nonpolar molecule.
- b. polar molecule.
- c. charged molecule.
- d. bipolar molecule.

ANS: B                      DIF: 1                      OBJ: 2-3.1

31. Water is a polar molecule because
- it contains two hydrogen atoms for each oxygen atom.
  - it has a charge.
  - different parts of the molecule have slightly different charges.
  - it does not have a charge.

ANS: C                      DIF: 1                      OBJ: 2-3.1

32. Water molecules break up other polar substances
- such as salts.
  - because of the uneven charge distribution that exists in water molecules.
  - thus freeing ions in these substances for use by the body.
  - All of the above

ANS: D                      DIF: 2                      OBJ: 2-3.2

33. Which of the following characteristics of water is *not* a result of hydrogen bonding?
- adhesive strength
  - capillarity
  - cohesive strength
  - All of the above are a result of hydrogen bonding.

ANS: D                      DIF: 1                      OBJ: 2-3.3

## COMPLETION

1. Substances that are changed when they become involved in chemical reactions are called \_\_\_\_\_, while the new substances that are formed are called \_\_\_\_\_.

ANS: reactants, products

DIF: 1                      OBJ: 2-2.2

2. The energy needed to break existing chemical bonds during the initiation of a chemical reaction is called \_\_\_\_\_.

ANS: activation energy

DIF: 1                      OBJ: 2-2.3

3. Chemical reactions in the body can be speeded up by adding a(n) \_\_\_\_\_, which lowers the amount of activation energy required to start the reaction.

ANS: enzyme

DIF: 1                      OBJ: 2-2.3

4. The loss of electrons from a molecule is called \_\_\_\_\_, while the gain of electrons by a molecule is called \_\_\_\_\_.

ANS: oxidation, reduction

DIF: 1                      OBJ: 2-2.4

5. A substance that dissolves in another is called a(n) \_\_\_\_\_.

ANS: solute

DIF: 1                      OBJ: 2-3.4

6. \_\_\_\_\_ is the most common solvent in cells.

ANS: Water

DIF: 1                      OBJ: 2-3.4

7. \_\_\_\_\_ and \_\_\_\_\_ ions form when water dissociates.

ANS:

Hydroxide, hydrogen

Hydrogen, hydroxide

DIF: 1                      OBJ: 2-3.2

8. An acidic solution is one that has more \_\_\_\_\_ than \_\_\_\_\_ ions.

ANS: hydronium, hydroxide

DIF: 1                      OBJ: 2-3.5

9. A solution with a pH of 3 has \_\_\_\_\_ times more hydronium ions than a solution with a pH of 6.

ANS:

1,000

1000

a thousand

one thousand

DIF: 2                      OBJ: 2-3.5

10. Buffers are important because body fluids must be maintained within a relatively narrow range of \_\_\_\_\_.

ANS: pH

DIF: 1                      OBJ: 2-3.5

11. Water is very effective at dissolving other polar substances because of its \_\_\_\_\_.

ANS: polarity

DIF: 1                      OBJ: 2-3.2

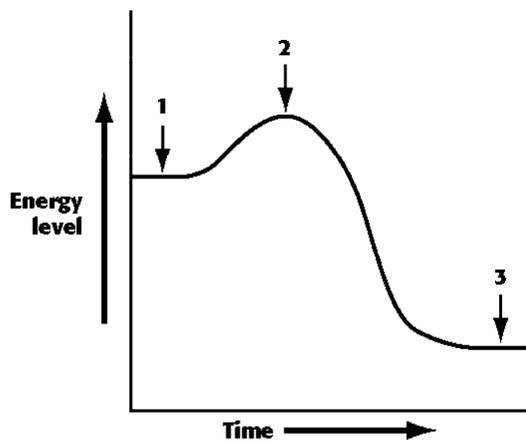
12. Breaking of \_\_\_\_\_ bonds is the first thing that happens when water is heated, which means that it takes a great deal of thermal energy to raise the temperature of water.

ANS: hydrogen

DIF: 2                      OBJ: 2-3.3

### PROBLEM

1.



Refer to the illustration above. The graph depicts the relative energy levels of the products and reactants for the following chemical reaction:  $A + B \rightleftharpoons C + D$ . Write your answers to the following in the spaces below.

- Which substances, A, B, C, and/or D, are present at point 1 on the graph?
- Which substances, A, B, C, and/or D, are present at point 3 on the graph?
- Why is point 2 at a higher energy level than point 1?
- Why is point 3 at a lower energy level than point 1?
- Draw a dashed line on the graph indicating how the energy level of this reaction over time would be different if the enzyme that catalyzes the reaction were not present.

ANS:

- A and B
- C and D
- An input of energy, called the activation energy, is required in order to get the reaction going.
- The products contain less energy than the reactants and energy is given off in the reaction.
- The graph should be the same except that the energy level at point 2 should be higher.

DIF: 3                      OBJ: 2-2.2

## ESSAY

1. Plant growers often use sprinkler irrigation to protect crops they are growing from frost damage. The water that lands on the leaves turns to ice. How does this protect the plants from frost damage? Write your answer in the space below.

ANS:

Water, like any other form of matter, requires an input of thermal energy to change from a solid to a liquid state. It therefore must also give off thermal energy when it changes from a liquid to a solid state. When liquid water turns to ice on plant leaves, it gives off thermal energy that warms the leaves.

DIF: 3                      OBJ: 2-2.1

2. Define *enzyme*, and describe how an enzyme can function in speeding up a chemical reaction within a cell. Write your answer in the space below.

ANS:

Enzymes are biological catalysts. They are protein or RNA molecules that lower the activation energy that would otherwise be required for a reaction to occur.

DIF: 2                      OBJ: 2-2.3

3. How does water's polar nature affect its ability to dissolve different substances? Write your answer in the space below.

ANS:

A weaker attraction exists between polar and nonpolar molecules than between two polar molecules, so a water molecule cannot pull a nonpolar molecule into solution.

DIF: 1                      OBJ: 2-3.2

4. Explain the relationship between hydrogen bonding and the observation that a full sealed bottle of water breaks when it freezes. Write your answer in the space below.

ANS:

When water freezes, multiple hydrogen bonds form between the molecules. This hydrogen bonding causes water molecules to form a rigid array with large amounts of open space between the molecules relative to liquid water. Because water molecules move farther apart when they freeze, the ice took up more volume than the liquid water and the bottle broke.

DIF: 3                      OBJ: 2-3.3