

## Chapter 2 The Chemical Basis of Life

### Multiple Choice Questions

1. Which of the following is not one of the most common elements in living things?
  - A. carbon
  - B. oxygen
  - C. hydrogen
  - D. iron
  - E. nitrogen
  
2. Which one of the following is the smallest unit of matter that has all the properties of an element?
  - A. molecule
  - B. element
  - C. atom
  - D. compound
  - E. electron
  
3. Elements differ from each other in their \_\_\_\_\_.
  - A. physical properties only
  - B. atomic number only
  - C. type of subatomic particles
  - D. physical properties and atomic number
  - E. type of electrons

4. Regarding atoms, identify which statement below is correct.

- A. An element may be composed of several types of atoms.
- B. The nucleus of an atom contains protons and electrons.
- C. The number and arrangement of electrons in an atom governs its chemical activity.
- D. The positive charges of an element are carried by the electrons.
- E. The neutral charges of an element are carried by the protons.

5. Isotopes of an element differ in their \_\_\_\_\_.

- A. proton number
- B. electron number
- C. neutron number
- D. type of bonds
- E. atomic number

6. An atom's outermost electron shell

- A. is filled when it has three electrons.
- B. determines its chemical reactivity.
- C. determines its atomic mass.
- D. is filled with positively charged particles.
- E. is filled identically for every element.

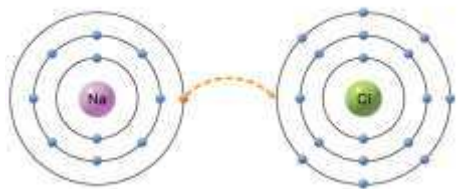
7. An atom that has an electrical charge is called a(n)

- A. ion.
- B. molecule.
- C. isotope.
- D. element.
- E. proton.

8. A covalent bond occurs when \_\_\_\_\_.

- A. protons are transferred from one atom to another
- B. neutrons are shared between two atoms to form an isotope
- C. electrons are shared between two atoms to complete their octets
- D. the hydrogen of one water molecule is attracted to the oxygen of another water molecule
- E. electrons are transferred from one atom to another

9. The type of bond that would form from the transfer of an electron from one atom to another, as depicted in the figure, is a



- A. covalent.
- B. ionic.
- C. hydrogen.
- D. atomic.
- E. isotope.

10. Which of these does not occur when a sodium atom transfers an electron to a chlorine atom?

- A. The sodium atom becomes a positively charged ion.
- B. The positive and negative ions will attract each other, forming a crystal if no water is present.
- C. The ions will separate in the presence of water.
- D. There is a sharing of the electrons between the sodium and chlorine atoms.
- E. The chlorine atom becomes a negatively charged ion.

11. Which of the following is NOT a compound?

- A.  $\text{H}_2\text{O}$
- B.  $\text{O}_2$
- C.  $\text{NaCl}$
- D.  $\text{CO}_2$
- E.  $\text{MgCl}_2$

12. Glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ , is best described as a(n) \_\_\_\_\_.

- A. element
- B. isotope
- C. compound
- D. ion
- E. charged atom

13. A water molecule, as shown here, is polar because of \_\_\_\_\_.



- A. transfer of electrons
- B. unequal sharing of electrons
- C. its ability to freeze
- D. its hydrogen bonds
- E. its change in density when frozen

14. The figure below is depicting the interaction of water molecules with one another which involves the use of \_\_\_\_\_.



- A. covalent bonds
  - B. hydrogen bonds
  - C. ionic bonds
  - D. valence shells
  - E. solvents
15. Which of the following is NOT a property of water?
- A. It is a good solvent.
  - B. It is denser when frozen than when liquid.
  - C. It is cohesive.
  - D. It resists temperature changes.
  - E. It can be found as a solid, liquid, or gas.
16. Bases can \_\_\_\_\_.
- A. release only hydrogen ions
  - B. take up only hydrogen ions
  - C. release only hydroxide ions
  - D. both take up hydrogen ions and release hydroxide ions
  - E. release hydrogen and release hydroxide

17. The pH scale is a mathematical indicator of \_\_\_\_\_.

- A. the concentration of  $H^+$  present in a solution
- B. the concentration of  $OH^-$  present in a solution
- C. the total amount of all ions in a solution
- D. the ability of a solution to buffer
- E. the ability to dissolve in water

18. After drinking a great deal of coffee (pH 5), a human's blood buffering system would need to \_\_\_ as the coffee was digested to lower the level of acid present in the blood stream.

- A. release  $OH^-$
- B. take up  $H^+$
- C. release  $H^+$
- D. take up  $OH^-$
- E. release  $OH^-$  and take up  $H^+$

19. The term to describe any substance which can prevent the pH of a solution from changing by either releasing or absorbing  $H^+$  in a solution is

- A. equalizer.
- B. solute.
- C. buffer.
- D. acid.
- E. base.

20. Which of the following would be an example of the value of water's heat capacity?
- A. Water is able to travel up a 100 foot tree.
  - B. Water expands as it freezes causing ice to float on the surface of a lake.
  - C. Living organisms are better able to maintain their internal body temperature because the temperature of their environment changes very slowly.
  - D. Small insects can walk on water.
  - E. Ice cubes float.
21. What property of water causes sugar to dissolve in coffee?
- A. Water has high heat capacity.
  - B. Water is less dense as ice.
  - C. Water is a good solvent.
  - D. Water is cohesive.
  - E. Water is able to change states.
22. Which of the following explains the events occurring when water boils?
- A. Hydrogen bonds are broken between neighbor water molecules.
  - B. Covalent bonds are broken between oxygen and hydrogen atoms.
  - C. Ionic bonds are broken when the minerals in water are heated.
  - D. The bond between one water molecule and another is strengthened.
  - E. The hydrogen atoms break away from the oxygen and escape as vapor.

23. What is the steam being given off when water boils?

- A. oxygen molecules
- B. hydrogen molecules
- C. water molecules
- D. hydroxide (OH<sup>-</sup>) ions
- E. hydrogen (H<sup>+</sup>) ion

24. Which property of water would help to account for how an individual who is exercising and producing excessive heat can maintain a constant body temperature?

- A. Water has high heat capacity.
- B. Water is less dense as ice.
- C. Water is a good solvent.
- D. Water is cohesive.
- E. Water molecules form by covalent bonding.

25. If average temperatures from South Dakota were compared to temperatures from Oregon it would show that Oregon has warmer winters and cooler summers than South Dakota does. Account for why this could be when they are at similar latitudes?

- A. South Dakota has less trees.
- B. The Pacific ocean makes Oregon temperatures more moderate.
- C. Oregon receives more rainfall.
- D. South Dakota has fewer lakes and rivers.
- E. South Dakota has more prevailing winds from the west.



26. How do a strong acid and a weak acid differ?
- A. A strong acid has less  $H^+$  in solution.
  - B. A weak acid dissociates only partially in water.
  - C. A strong acid is less likely to remain dissociated.
  - D. A weak acid dissociates nearly completely in water.
  - E. A strong acid dissociates only partly in water.
27. Baking soda is sometimes used as an antacid. The chemical name for baking soda is Sodium Bicarbonate. What is the bicarbonate doing to help with stomach upset?
- A. It is serving as a buffer to take up excess  $H^+$  ion from stomach acid.
  - B. It is able to coat the stomach lining.
  - C. The bicarbonate helps to create more acid in the stomach.
  - D. The bicarbonate acts as a strong acid quickly dissociating into  $H^+$  ion.
  - E. It relaxes the stomach muscles.
28. Which of the following is not a contributing event in the formation of acid rain?
- A. Fossil fuels consume oxygen removing it from the atmosphere.
  - B. Coal & oil emit sulfur dioxide and nitrogen oxide when they are burned.
  - C. Fossil fuel emission gases combine with water in the atmosphere.
  - D. A solution of sulfuric acid and nitric acid forms.
  - E. Precipitation containing sulfuric acid and nitric acid fall to the Earth.

29. What do lemons, tomatoes, and coffee all have in common chemically?
- A. They are all foods that people consume.
  - B. They all produce ( $H^+$ ) in solution, making them acids.
  - C. They all are fruits.
  - D. They all taste bitter.
  - E. They are all slippery to the touch.
30. Of the following examples which best demonstrates the property of water cohesion?
- A. Water can move up a 100 foot pine tree from the roots to the leaves.
  - B. A rock skipping across the surface of a lake.
  - C. Water requires a great deal of heat to reach the point of vaporizing.
  - D. A soda can bursts when it is placed in the freezer.
  - E. A large body of fresh water takes a long time to warm up after the winter season.
31. When hot chocolate mix is added to water the hot chocolate is the \_\_\_\_\_ and the water is the \_\_\_\_\_.
- A. solvent; solute
  - B. molecule; compound
  - C. solute; solvent
  - D. compound; molecule
  - E. element; compound
32. A coke has a pH of 3.5. This means that it has an excess of \_\_\_\_\_ ions and would be called a(n) \_\_\_\_\_.
- A.  $H^+$ ; acid
  - B.  $OH^-$ ; acid
  - C.  $H^+$ ; base
  - D.  $OH^-$ ; base
  - E.  $H^+$ ; neutral solution

33. Isotopes of an atom differ in their

- A. atomic number.
- B. atomic mass.
- C. number of electrons.
- D. atomic radius.
- E. number of protons.

34. Which of the following is a property of acids?

- A. release hydrogen ions when dissolved in a liquid
- B. feel slippery when touched
- C. taste bitter
- D. release hydroxide ions when dissolved in a liquid
- E. have a pH reading above 7.0

### Matching Questions

35. Use the following terms to match the statements provided.

- |   |          |       |
|---|----------|-------|
| 1. Their number and arrangement determine which chemical reactions an element can take part in            | Ion      | _____ |
| 2. Their number in an atom is the atomic number of the element  | Atom     | _____ |
| 3. The smallest particle of an element that retains the properties of that element                        | Electron | _____ |
| 4. Their numbers will vary in isotopes of the same element  | Proton   | _____ |
| 5. Created when an atom either loses or gains electrons in a reaction, resulting in an overall net charge | Neutron  | _____ |

## Multiple Choice Questions

36. An element has an atomic number of 78. The number of protons and electrons in a neutral atom of the element are
- A. 156 protons and 78 electrons.
  - B. 39 protons and 39 electrons.
  - C. 78 protons and 0 electrons.
  - D. 78 protons and 78 electrons.
  - E. 78 protons and 39 electrons.
37. All atoms of the same element have the same
- A. number of neutrons.
  - B. atomic number.
  - C. number of electrons.
  - D. atomic mass.
  - E. number of ions.
38. In what ways are radioactive isotopes potentially harmful?
- A. Unmonitored release into the environment can make changes in a cell's DNA.
  - B. They are used to trace molecular changes.
  - C. They are used to destroy abnormal cells.
  - D. They are used to determine the age of biological specimens.
  - E. They are used to trace the path of materials throughout the body.

39. The number of neutrons in the nucleus of an average atom of an element is best estimated by
- A. adding the number of electrons and protons together.
  - B. subtracting the number of electrons from the number of protons.
  - C. adding the mass number to the number of electrons.
  - D. subtracting the number of protons from the mass number.
  - E. adding the atomic number and atomic mass together.
40. Students were studying properties of water. One student placed a cup containing 80 mL of water in a freezer. Another student placed an identical cup containing 40 mL of water in the same freezer. Which of the following will be the same for both cups of water?
- A. the temperature at which the water freezes
  - B. the mass of the frozen water
  - C. the time it takes the water to freeze
  - D. the volume of the frozen water
  - E. the space it occupies in the cups
41. Engineers design city sidewalks using blocks of concrete separated by a small gap to prevent them from cracking. What property of water is being taken into account for this design? Water
- A. is a good solvent.
  - B. is less dense when it is frozen.
  - C. is cohesive.
  - D. is resistant to temperature changes.
  - E. has a high heat capacity.

42. An atom with a neutral charge has

- A. equal numbers of neutrons and electrons.
- B. more neutrons making it more neutral.
- C. the same number of protons and neutrons.
- D. equal numbers of protons and electrons.
- E. more protons than it does electrons.

43. The atomic structure of water satisfies the octet rule by

- A. having electrons shared between the two oxygen atoms.
- B. having electrons from hydrogen transferred to the oxygen atom.
- C. having electrons from oxygen transferred to the hydrogen atoms.
- D. having oxygen share electrons with two hydrogen atoms.
- E. having electrons shared between the two hydrogen atoms.

44. Which of the following would not be a valuable use for radioactive isotopes?

- A. carbon-14 dating
- B. destroying abnormal cells as a type of cancer treatment
- C. tracing the path of various chemicals in the body for imaging
- D. determining the age of biological specimens
- E. damaging DNA of healthy cells.

45. In the reaction  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$  carbon dioxide is one of the \_\_\_\_\_.

- A. reactants
- B. products
- C. enzymes
- D. elements
- E. catalysts

46. Why do cells need buffering agents?
- A. to minimize the changes in pH of their internal environment
  - B. to operate at a constant pH of 2.0
  - C. to carry out life functions in extremely acidic conditions
  - D. to help transfer electrons from one atom to another
  - E. to increase the amount of OH<sup>-</sup> in their surroundings
47. Which of the following is not a way in which chemical bonds can be formed?
- A. sharing electrons
  - B. losing electrons
  - C. splitting electrons
  - D. gaining electrons
  - E. attractions of opposite charge
48. Sulfur has an atomic number of 16. What would be the valence number of this element?
- A. One
  - B. Two
  - C. Three
  - D. Four
  - E. Six
49. Some insects can stride on the surface of water because water
- A. has a high specific heat.
  - B. has lower density when frozen.
  - C. is a good solvent.
  - D. has surface tension.
  - E. resists temperature changes.

50. The pH of pure water is \_\_\_\_\_ because \_\_\_\_\_.
- A. 7.0; water dissociates an equal number of  $H^+$  ions and  $OH^-$
  - B. 14.0; water dissociates and more  $OH^-$  is formed because there are more hydrogen atoms in water
  - C. 1.0; water dissociates and more  $H^+$  is formed since hydrogen is smaller and can separate from the oxygen easily
  - D. 7.0; there are no ions formed in pure water
  - E. acidic; there are more  $H^+$  ions than  $OH^-$  ions present
51. Which of the following best describes the structure of how water molecules form and interact?
- A. Hydrogen atoms bond with each other to create stable outer shell of electrons. Then they form a hydrogen bond to an oxygen atom to create the water molecule.
  - B. Oxygen atoms transfer one electron to each of the hydrogen atoms forming an ionic bond that attracts other water molecules to it.
  - C. The oxygen atom and hydrogen atoms form a covalent bond with one another to create stable outer shells of electrons. The electrons are shared unequally resulting in a polar molecule whose slight charges form weak hydrogen bond attractions with other water molecules.
  - D. Hydrogen bonds are formed between the two hydrogen atoms and the oxygen atom. This water molecule then forms a covalent bond with adjacent water molecules.
  - E. The oxygen atom is more electronegative than the two hydrogen atoms. Due to this, it removes the electron from each hydrogen atom. This satisfies the outer shell of oxygen. Then hydrogen bonds form between the two remaining hydrogen atoms to hold them near to the oxygen atom.
52. The particles that are found in the nucleus of an atom are the
- A. protons and electrons.
  - B. neutrons and protons.
  - C. electrons only.
  - D. protons only.
  - E. electrons and neutrons.



53. Which of these is a property of isotopes that make it useful in cell biology?

- A. they never breakdown
- B. they behave the same chemically
- C. they behave differently chemically
- D. the molecules they are part of break down more easily
- E. the molecules they are part of are more stable

54. Radioactive isotopes are useful in biological studies because

- A. an organism will take in a molecule with the isotope and use it normally but the radioactive decay can be detected.
- B. an organism will take in a molecule with the isotope but will only use it in a few specific reactions not the normal ones.
- C. an organism will take in the molecule with the isotope and then remove the isotope and send it through the excretory system while replacing the isotope with a normal atom.
- D. they are easily visible and normal atoms are not.
- E. they are easy and inexpensive to use in studies.

55. The reactivity of an atom depends on

- A. the number of protons.
- B. the number of neutrons.
- C. the number of electrons.
- D. the number of valence electrons.
- E. the number of protons and neutrons in the nucleus.

56. Chemical bonds involve

- A. the giving and taking of electrons.
- B. the giving and taking of protons.
- C. the giving, taking or sharing of electrons.
- D. the giving, taking or sharing of protons.
- E. the sharing of electrons.

57. The electron arrangement for argon, which has 18 electrons, is

- A. 2 in the inner energy shell, 8 in the second energy shell and 8 in the outer energy shell
- B. 8 in the inner energy shell, 8 in the second energy shell and 2 in the outer energy shell
- C. 6 in the inner energy shell, 6 in the second energy shell and 6 in the outer energy shell
- D. 5 in the inner energy shell, 6 in the second energy shell and 7 in the outer energy shell
- E. 7 in the inner energy shell, 6 in the second energy shell and 5 in the outer energy shell

58. Inside a living cell, which type of bond would be the most stable?

- A. hydrogen
- B. ionic
- C. covalent
- D. polar
- E. all bonds are equally stable in a living system

59. An ionic bond forms when

- A. an atom gives away or takes in an electron.
- B. an atom gives away or takes in a proton.
- C. a negatively charged ion is attracted to one with a positive charge.
- D. two atoms come close enough to share one or more electrons.
- E. two atoms come close enough to share one or more protons.

60. A covalent bond involves the sharing of

- A. electrons.
- B. protons.
- C. pairs of protons.
- D. at least 3 electrons.
- E. pairs of electrons.

61. Which of the following describe how an acid disrupts the chemical bonds of molecules in a cell?

- A. the  $H^+$  ions can disrupt hydrogen bonds as the slightly negative portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- B. the  $H^+$  ions can disrupt hydrogen bonds as the slightly positive portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- C. the  $OH^-$  ions can disrupt hydrogen bonds as the slightly positive portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- D. the  $OH^-$  ions can disrupt hydrogen bonds as the slightly negative portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- E. The  $H^+$  ions disrupt the covalent bonds that hold the molecule together.

62. You are caring for the freshwater aquarium of a friend while they are on vacation. You are told to check the pH of the tank and make sure that it stays between 6.5 and 7.0. When you check the water the pH is 8.0. The water in the tank is

- A. 1 to 1.5 times more basic than it should be.
- B. 1 to 1.5 times more acidic than it should be.
- C. 10 to 15 times more basic than it should be.
- D. 10 to 15 times more acidic than it should be.
- E. 100 to 150 times more basic than it should be.

63. You are caring for the freshwater aquarium of a friend while they are on vacation. You are told to check the pH of the tank and make sure that it stays between 6.5 and 7.0. In order to assure that you do not have to worry about the pH you

A. treat the fish and the tank with aspirin.

B. add NaOH so that changes in the tank are calculated.

C. add HCl so that you can track the changes in the tank's pH.

D. do nothing since the pH will not change unless you do something wrong and you plan to follow the directions exactly.

E. add a buffer so changes in pH are minimized.

## Chapter 2 The Chemical Basis of Life **Key**

### Multiple Choice Questions

1. Which of the following is not one of the most common elements in living things?
- A. carbon
  - B. oxygen
  - C. hydrogen
  - D. iron**
  - E. nitrogen

Six elements of matter make up the majority of body weight of most organisms. Their presence and properties are essential to the uniqueness of living things.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #1*

*Section: 02.01*

*Topic: Chemistry*

2. Which one of the following is the smallest unit of matter that has all the properties of an element?

- A. molecule
- B. element
- C. atom**
- D. compound
- E. electron

Elements are comprised of one kind of atom. These atoms all bear the same atomic number having a characteristic number or sub atomic particles that govern the properties of that element. Molecules have more than one atom present, so they are not in their simplest form. Compounds are comprised of two or more different elements.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #2*

*Section: 02.01*

*Topic: Chemistry*

3. Elements differ from each other in their \_\_\_\_\_.

- A. physical properties only
- B. atomic number only
- C. type of subatomic particles
- D. physical properties and atomic number**
- E. type of electrons

The number of protons in an element creates its atomic number. Different elements will have different numbers of these particles and thus different atomic numbers. However, all elements have the same type of subatomic particles, those being protons, neutrons and electrons.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #3*

*Section: 02.01*

4. Regarding atoms, identify which statement below is correct.

- A. An element may be composed of several types of atoms.
- B. The nucleus of an atom contains protons and electrons.
- C.** The number and arrangement of electrons in an atom governs its chemical activity.
- D. The positive charges of an element are carried by the electrons.
- E. The neutral charges of an element are carried by the protons.

An atom is comprised of subatomic particles. The protons bear a positive charge, are found in the nucleus, and their number creates the atomic number assigned to that element. The neutrons are found in the nucleus as well and they with the protons create the majority of an atom's mass. The electrons bear a negative charge and govern the elements reactivity.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #4*

*Section: 02.01*

*Topic: Chemistry*

5. Isotopes of an element differ in their \_\_\_\_\_.

- A. proton number
- B. electron number
- C.** neutron number
- D. type of bonds
- E. atomic number

Isotopes are atoms of the same element that differ in the number of neutrons. They have the same number of protons, but they have different mass numbers.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #5*

6. An atom's outermost electron shell
- A. is filled when it has three electrons.
  - B.** determines its chemical reactivity.
  - C. determines its atomic mass.
  - D. is filled with positively charged particles.
  - E. is filled identically for every element.

The negatively charged electrons are so small that their mass is negligible to the overall mass of the atom. Atoms with fewer than eight electrons in the outer shell react with other atoms in such a way that each has a completed outer shell after the reaction.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #6*

*Section: 02.01*

*Topic: Chemistry*

7. An atom that has an electrical charge is called a(n)
- A.** ion.
  - B. molecule.
  - C. isotope.
  - D. element.
  - E. proton.

When an atom either loses or gains electrons in a reaction, the resulting atom now bears an overall net charge. This state is called an ion.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #7*



8. A covalent bond occurs when \_\_\_\_\_.

- A. protons are transferred from one atom to another
- B. neutrons are shared between two atoms to form an isotope
- C. electrons are shared between two atoms to complete their octets**
- D. the hydrogen of one water molecule is attracted to the oxygen of another water molecule
- E. electrons are transferred from one atom to another

A covalent bond results when two atoms share electrons in order to have a completed outer shell (octet).

*Bloom's Level: 2. Understand*

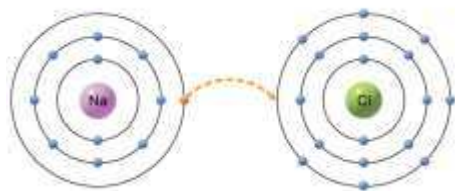
*Learning Outcome: 02.01.03 Relate how the arrangement of electrons determines an element's reactivity.*

*Mader - Chapter 02 #8*

*Section: 02.01*

*Topic: Chemistry*

9. The type of bond that would form from the transfer of an electron from one atom to another, as depicted in the figure, is a



- A. covalent.
- B. ionic.**
- C. hydrogen.
- D. atomic.
- E. isotope.

Ionic bonds are formed when two atoms are held together by an attraction between opposite charges. In this diagram, sodium is transferring a negatively charged electron over to chlorine. The result is sodium having a positive charge ( $\text{Na}^+$ ) and chlorine now having a negative charge ( $\text{Cl}^-$ ). These ions have an attraction that creates the ionic bond that holds them together.

*Bloom's Level: 2. Understand*

*Figure: 02.07a*

*Learning Outcome: 02.01.04 Contrast ionic and covalent bonds.*

*Mader - Chapter 02 #9*

*Section: 02.01*

*Topic: Chemistry*

10. Which of these does not occur when a sodium atom transfers an electron to a chlorine atom?

- A. The sodium atom becomes a positively charged ion.
- B. The positive and negative ions will attract each other, forming a crystal if no water is present.
- C. The ions will separate in the presence of water.
- D.** There is a sharing of the electrons between the sodium and chlorine atoms.
- E. The chlorine atom becomes a negatively charged ion.

Ionic bonds are formed when two atoms are held together by an attraction between ions. Sodium transfers a negatively charged electron over to chlorine. The result is sodium having a positive charge ( $\text{Na}^+$ ) and chlorine now having a negative charge ( $\text{Cl}^-$ ). These ions have an attraction that creates the ionic bond that holds them together.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.04 Contrast ionic and covalent bonds.*

*Mader - Chapter 02 #10*

*Section: 02.01*

*Topic: Chemistry*

11. Which of the following is NOT a compound?

- A.  $\text{H}_2\text{O}$
- B.**  $\text{O}^{2-}$
- C.  $\text{NaCl}$
- D.  $\text{CO}_2$
- E.  $\text{MgCl}_2$

Only when a molecule contains atoms of more than one element, can it be called a compound.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.05 Relate how bonding leads to the formation of molecules and compounds.*

*Mader - Chapter 02 #11*

*Section: 02.01*

*Topic: Chemistry*

12. Glucose,  $C_6H_{12}O_6$ , is best described as a(n) \_\_\_\_\_.

- A. element
- B. isotope
- C. compound**
- D. ion
- E. charged atom

The presence of three different kinds of elements; carbon, hydrogen, and oxygen, determine that it is not an element. An isotope is a unique type of single element that has a varied number of neutrons. An ion is a charged atom. The glucose molecule is a compound made up of more than one element.

*Bloom's Level: 2. Understand*

*Figure: 02.09a*

*Learning Outcome: 02.01.05 Relate how bonding leads to the formation of molecules and compounds.*

*Mader - Chapter 02 #12*

*Topic: Chemistry*

13. A water molecule, as shown here, is polar because of \_\_\_\_\_.



- A. transfer of electrons
- B. unequal sharing of electrons**
- C. its ability to freeze
- D. its hydrogen bonds
- E. its change in density when frozen

Atoms differ in their affinity for electrons in a covalent bond (electronegativity). Oxygen is more electronegative than hydrogen. Consequently the shared electrons spend more time near the oxygen nucleus than the hydrogen nuclei. This unequal sharing of electrons makes it a polar molecule.

*Bloom's Level: 2. Understand*

*Figure: 02.09a*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #13*

*Section: 02.02*

*Topic: Chemistry*

14. The figure below is depicting the interaction of water molecules with one another which involves the use of \_\_\_\_\_.



- A. covalent bonds
- B. hydrogen bonds**
- C. ionic bonds
- D. valence shells
- E. solvents

The positive hydrogen forms a hydrogen bond with the negative oxygen from a nearby molecule. No electron transfer or sharing is occurring in this type of bond. It is a weak attraction between polar molecules.

*Bloom's Level: 2. Understand*

*Figure: 02.09b*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #14*

*Section: 02.02*

*Topic: Chemistry*

15. Which of the following is NOT a property of water?

- A. It is a good solvent.
- B.** It is denser when frozen than when liquid.
- C. It is cohesive.
- D. It resists temperature changes.
- E. It can be found as a solid, liquid, or gas.

Water has four key properties that support life: solvency, cohesion, surface tension, high heat capacity, and varying density.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #15*

*Section: 02.02*

*Topic: Chemistry*

16. Bases can \_\_\_\_\_.

- A. release only hydrogen ions
- B. take up only hydrogen ions
- C. release only hydroxide ions
- D.** both take up hydrogen ions and release hydroxide ions
- E. release hydrogen and release hydroxide

Bases are substances that either take up hydrogen ions ( $H^+$ ) or release hydroxide ions ( $OH^-$ ).

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.01 Distinguish between an acid and a base.*

*Mader - Chapter 02 #16*

*Section: 02.03*

*Topic: Chemistry*

17. The pH scale is a mathematical indicator of \_\_\_\_\_.

- A. the concentration of  $H^+$  present in a solution
- B. the concentration of  $OH^-$  present in a solution
- C. the total amount of all ions in a solution
- D. the ability of a solution to buffer
- E. the ability to dissolve in water

pH indicates the number of hydrogen ions in a solution. It is used to indicate the acidity or basicity of a solution.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.02 Interpret the pH scale.*

*Mader - Chapter 02 #17*

*Section: 02.03*

*Topic: Chemistry*

18. After drinking a great deal of coffee (pH 5), a human's blood buffering system would need to \_\_\_ as the coffee was digested to lower the level of acid present in the blood stream.

- A. release  $OH^-$
- B. take up  $H^+$
- C. release  $H^+$
- D. take up  $OH^-$
- E. release  $OH^-$  and take up  $H^+$

A pH below 7 is acidic. In this case the acid dissociates in water, releasing hydrogen ions to the solution.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.03.03 Explain the purpose of a buffer.*

*Mader - Chapter 02 #18*

*Section: 02.03*

*Topic: Chemistry*



19. The term to describe any substance which can prevent the pH of a solution from changing by either releasing or absorbing  $H^+$  in a solution is

- A. equalizer.
- B. solute.
- C.** buffer.
- D. acid.
- E. base.

A buffer is a chemical that serves to neutralize an acid or a base in solution. They help to resist pH changes because they can take up excess hydrogen ion ( $H^+$ ) or hydroxide ion ( $OH^-$ )

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.03.03 Explain the purpose of a buffer.*

*Mader - Chapter 02 #19*

*Section: 02.03*

*Topic: Chemistry*

20. Which of the following would be an example of the value of water's heat capacity?

- A. Water is able to travel up a 100 foot tree.
- B. Water expands as it freezes causing ice to float on the surface of a lake.
- C.** Living organisms are better able to maintain their internal body temperature because the temperature of their environment changes very slowly.
- D. Small insects can walk on water.
- E. Ice cubes float.

Water has the ability to absorb heat without greatly changing in temperature. Because the temperature of water rises and falls slowly, organisms are better able to maintain their normal internal temperatures and are also protected from rapid temperature changes.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #20*

*Section: 02.02*

21. What property of water causes sugar to dissolve in coffee?

- A. Water has high heat capacity.
- B. Water is less dense as ice.
- C.** Water is a good solvent.
- D. Water is cohesive.
- E. Water is able to change states.

The polarity of water makes it a good solvent. The water forms H bonds with the sugar promoting its ability to dissolve in the coffee.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #21*

*Section: 02.02*

*Topic: Chemistry*

22. Which of the following explains the events occurring when water boils?

- A.** Hydrogen bonds are broken between neighbor water molecules.
- B. Covalent bonds are broken between oxygen and hydrogen atoms.
- C. Ionic bonds are broken when the minerals in water are heated.
- D. The bond between one water molecule and another is strengthened.
- E. The hydrogen atoms break away from the oxygen and escape as vapor.

Hydrogen bonds link water molecules together. As they absorb heat the bonds begin to break causing water to enter into gaseous state and evaporate into the environment.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #22*

*Section: 02.02*

*Topic: Chemistry*

23. What is the steam being given off when water boils?

- A. oxygen molecules
- B. hydrogen molecules
- C. water molecules**
- D. hydroxide (OH<sup>-</sup>) ions
- E. hydrogen (H<sup>+</sup>) ion

Hydrogen bonds link water molecules together. As they absorb heat the bonds begin to break causing water to enter into gaseous state and evaporate into the environment.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #23*

*Section: 02.02*

*Topic: Chemistry*

24. Which property of water would help to account for how an individual who is exercising and producing excessive heat can maintain a constant body temperature?

- A. Water has high heat capacity.**
- B. Water is less dense as ice.
- C. Water is a good solvent.
- D. Water is cohesive.
- E. Water molecules form by covalent bonding.

Water has a high heat capacity. Blood plasma is primarily comprised of water which provides the ability to moderate temperature changes even under rigorous exercise. This feature of water allows organisms to better maintain their internal temperatures.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #24*

*Section: 02.02*

*Topic: Chemistry*

25. If average temperatures from South Dakota were compared to temperatures from Oregon it would show that Oregon has warmer winters and cooler summers than South Dakota does. Account for why this could be when they are at similar latitudes?
- A. South Dakota has less trees.
  - B.** The Pacific ocean makes Oregon temperatures more moderate.
  - C. Oregon receives more rainfall.
  - D. South Dakota has fewer lakes and rivers.
  - E. South Dakota has more prevailing winds from the west.

Because of water's high heat capacity and high heat of vaporization, temperatures along the Earth's coasts are moderate. During the summer the ocean absorbs and stores solar heat, and during the winter, the ocean releases it slowly.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #25*

*Section: 02.02*

*Topic: Chemistry*

26. How do a strong acid and a weak acid differ?

- A. A strong acid has less  $H^+$  in solution.
- B.** A weak acid dissociates only partially in water.
- C. A strong acid is less likely to remain dissociated.
- D. A weak acid dissociates nearly completely in water.
- E. A strong acid dissociates only partly in water.

A strong acid dissociates nearly completely in water. A weak acid dissociates only partially. Since a strong acid dissociates nearly completely, the concentration of hydrogen ( $H^+$ ) is said to have a higher acidity.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.01 Distinguish between an acid and a base.*

*Mader - Chapter 02 #26*

27. Baking soda is sometimes used as an antacid. The chemical name for baking soda is Sodium Bicarbonate. What is the bicarbonate doing to help with stomach upset?

- A. It is serving as a buffer to take up excess  $H^+$  ion from stomach acid.
- B. It is able to coat the stomach lining.
- C. The bicarbonate helps to create more acid in the stomach.
- D. The bicarbonate acts as a strong acid quickly dissociating into  $H^+$  ion.
- E. It relaxes the stomach muscles.

Bicarbonate acts as a buffer re-forming carbonic acid. This takes up the excess hydrogen ion ( $H^+$ ) in the stomach. Lowering the acidity of the stomach acid.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.03.03 Explain the purpose of a buffer.*

*Mader - Chapter 02 #27*

*Section: 02.03*

*Topic: Chemistry*

28. Which of the following is not a contributing event in the formation of acid rain?

- A. Fossil fuels consume oxygen removing it from the atmosphere.
- B. Coal & oil emit sulfur dioxide and nitrogen oxide when they are burned.
- C. Fossil fuel emission gases combine with water in the atmosphere.
- D. A solution of sulfuric acid and nitric acid forms.
- E. Precipitation containing sulfuric acid and nitric acid fall to the Earth.

The burning of fossil fuels sends out emissions including sulfur dioxide and nitrogen oxides. When these gases combine with water in the atmosphere they form sulfuric acid and nitric acid.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.01 Distinguish between an acid and a base.*

*Mader - Chapter 02 #28*

29. What do lemons, tomatoes, and coffee all have in common chemically?

- A. They are all foods that people consume.
- B.** They all produce (H<sup>+</sup>) in solution, making them acids.
- C. They all are fruits.
- D. They all taste bitter.
- E. They are all slippery to the touch.

Acidic solutions have a sour taste and are often associated with indigestion. These are all acidic substances that dissociate in water, releasing hydrogen ions (H<sup>+</sup>).

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.03.01 Distinguish between an acid and a base.*

*Mader - Chapter 02 #29*

*Section: 02.03*

*Topic: Chemistry*

30. Of the following examples which best demonstrates the property of water cohesion?

- A.** Water can move up a 100 foot pine tree from the roots to the leaves.
- B. A rock skipping across the surface of a lake.
- C. Water requires a great deal of heat to reach the point of vaporizing.
- D. A soda can bursts when it is placed in the freezer.
- E. A large body of fresh water takes a long time to warm up after the winter season.

Cohesion refers to the ability of water molecules to cling to each other due to hydrogen bonding. Water evaporating from the leaves is immediately replaced with water molecules below it pulling a column of water up from the roots.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #30*

31. When hot chocolate mix is added to water the hot chocolate is the \_\_\_\_\_ and the water is the \_\_\_\_\_.

- A. solvent; solute
- B. molecule; compound
- C. solute; solvent**
- D. compound; molecule
- E. element; compound

Water dissolves many polar nonionic substances by forming H bonds with them. The water is doing the dissolving function (the solvent) and the hot chocolate is being dissolved (solute).

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #31*

*Section: 02.02*

*Topic: Chemistry*

32. A coke has a pH of 3.5. This means that it has an excess of \_\_\_\_\_ ions and would be called a(n) \_\_\_\_\_.

- A. H<sup>+</sup>; acid**
- B. OH<sup>-</sup>; acid
- C. H<sup>+</sup>; base
- D. OH<sup>-</sup>; base
- E. H<sup>+</sup>; neutral solution

A pH below 7 is acidic. In this case the acid dissociates in water, releasing hydrogen ions to the solution.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.02 Interpret the pH scale.*

*Mader - Chapter 02 #32*

*Section: 02.03*

*Topic: Chemistry*

33. Isotopes of an atom differ in their

- A. atomic number.
- B.** atomic mass.
- C. number of electrons.
- D. atomic radius.
- E. number of protons.

Isotopes are atoms of the same element that differ in the number of neutrons. They have the same number of protons, but they have different mass numbers.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #33*

*Section: 02.01*

*Topic: Chemistry*

34. Which of the following is a property of acids?

- A.** release hydrogen ions when dissolved in a liquid
- B. feel slippery when touched
- C. taste bitter
- D. release hydroxide ions when dissolved in a liquid
- E. have a pH reading above 7.0

Acids have a sharp sour taste, pH below 7.0, and release hydrogen ions in water. Bases have a bitter taste, feel slippery, pH above 7.0, and release hydroxide ions when dissolved in water.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.01 Distinguish between an acid and a base.*

*Mader - Chapter 02 #34*

*Section: 02.03*

*Topic: Chemistry*



## Matching Questions

35. Use the following terms to match the statements provided.

- |   |          |          |
|---|----------|----------|
| 1. Their number and arrangement determine which chemical reactions an element can take part in            | Ion      | <u>5</u> |
| 2. Their number in an atom is the atomic number of the element  | Atom     | <u>3</u> |
| 3. The smallest particle of an element that retains the properties of that element                        | Electron | <u>1</u> |
| 4. Their numbers will vary in isotopes of the same element  | Proton   | <u>2</u> |
| 5. Created when an atom either loses or gains electrons in a reaction, resulting in an overall net charge | Neutron  | <u>4</u> |

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #35*

*Section: 02.01*

*Topic: Chemistry*

## Multiple Choice Questions

36. An element has an atomic number of 78. The number of protons and electrons in a neutral atom of the element are
- A. 156 protons and 78 electrons.
  - B. 39 protons and 39 electrons.
  - C. 78 protons and 0 electrons.
  - D. 78 protons and 78 electrons.**
  - E. 78 protons and 39 electrons.

The number of protons an element has is called the atomic number. In a neutral atom, there are the same number of protons and electrons.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #36*

*Section: 02.01*

*Topic: Chemistry*

37. All atoms of the same element have the same
- A. number of neutrons.
  - B. atomic number.**
  - C. number of electrons.
  - D. atomic mass.
  - E. number of ions.

The number of protons an element has is called the atomic number, and is constant for all atoms of an element. In a neutral atom, there are the same number of protons and electrons, while the number of neutrons can vary creating what are known as isotopes and consequently producing varying atomic mass.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #37*

*Section: 02.01*

*Topic: Chemistry*

38. In what ways are radioactive isotopes potentially harmful?

- A. Unmonitored release into the environment can make changes in a cell's DNA.
- B. They are used to trace molecular changes.
- C. They are used to destroy abnormal cells.
- D. They are used to determine the age of biological specimens.
- E. They are used to trace the path of materials throughout the body.

Radioactive isotopes are important in biology and medicine. They can be used to trace molecular changes, destroy abnormal cells, and play a significant role in the ability to determine the age of biological specimens. Their danger comes in their unmonitored release into the environment where they can make changes in cells, damage DNA, cause cancer, or at their worst be lethal.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.02 Explain how isotopes are useful in the study of biology.*

*Mader - Chapter 02 #38*

*Section: 02.01*

*Topic: Chemistry*

39. The number of neutrons in the nucleus of an average atom of an element is best estimated by

- A. adding the number of electrons and protons together.
- B. subtracting the number of electrons from the number of protons.
- C. adding the mass number to the number of electrons.
- D. subtracting the number of protons from the mass number.
- E. adding the atomic number and atomic mass together.

To determine the usual number of neutrons, subtract the number of protons from the mass number.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #39*

*Section: 02.01*

*Topic: Chemistry*

40. Students were studying properties of water. One student placed a cup containing 80 mL of water in a freezer. Another student placed an identical cup containing 40 mL of water in the same freezer. Which of the following will be the same for both cups of water?

- A. the temperature at which the water freezes
- B. the mass of the frozen water
- C. the time it takes the water to freeze
- D. the volume of the frozen water
- E. the space it occupies in the cups

Water expands as it freezes. Due to the hydrogen bonding of water molecules when water freezes, air is trapped between molecules. This will cause the water to occupy more space when frozen, and change its mass. The time for the two water samples to freeze is dependent on their volumes, but the temperature that it occurs at is a standard.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #40*

*Section: 02.02*

*Topic: Chemistry*

41. Engineers design city sidewalks using blocks of concrete separated by a small gap to prevent them from cracking. What property of water is being taken into account for this design? Water
- A. is a good solvent.
  - B. is less dense when it is frozen.**
  - C. is cohesive.
  - D. is resistant to temperature changes.
  - E. has a high heat capacity.

Water expands as it freezes. Due to the hydrogen bonding of water molecules when water freezes, air is trapped between molecules. This will cause the water to occupy more space when frozen. The gap in the sidewalks helps to accommodate for this expansion.

*Bloom's Level: 3. Apply*  
*Mader - Chapter 02 #41*  
*Section: 02.02*  
*Topic: Chemistry*

42. An atom with a neutral charge has
- A. equal numbers of neutrons and electrons.
  - B. more neutrons making it more neutral.
  - C. the same number of protons and neutrons.
  - D. equal numbers of protons and electrons.**
  - E. more protons than it does electrons.

The number of protons an element has is called the atomic number. In a neutral atom, there are the same number of protons and electrons, while the number of neutrons can vary creating what are known as isotopes.

*Bloom's Level: 1. Remember*  
*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*  
*Mader - Chapter 02 #42*  
*Section: 02.01*  
*Topic: Chemistry*

43. The atomic structure of water satisfies the octet rule by
- A. having electrons shared between the two oxygen atoms.
  - B. having electrons from hydrogen transferred to the oxygen atom.
  - C. having electrons from oxygen transferred to the hydrogen atoms.
  - D. having oxygen share electrons with two hydrogen atoms.
  - E. having electrons shared between the two hydrogen atoms.

Two hydrogen atoms share their lone electrons by way of a covalent bond with an oxygen atom. By this sharing, oxygen completes its octet, and hydrogen atoms outer shell is complete with two electrons.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #43*

*Section: 02.01*

*Topic: Chemistry*

44. Which of the following would not be a valuable use for radioactive isotopes?
- A. carbon-14 dating
  - B. destroying abnormal cells as a type of cancer treatment
  - C. tracing the path of various chemicals in the body for imaging
  - D. determining the age of biological specimens
  - E. damaging DNA of healthy cells.

Radioactive isotopes are important in biology and medicine. They can be used to trace molecular changes, destroy abnormal cells, and play a significant role in the ability to determine the age of biological specimens. Their danger comes in their unmonitored release into the environment where they can make changes in cells, damage DNA, cause cancer, or at their worst be lethal.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.02 Explain how isotopes are useful in the study of biology.*

*Mader - Chapter 02 #44*

*Section: 02.01*

*Topic: Chemistry*

45. In the reaction  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$  carbon dioxide is one of the \_\_\_\_\_.

- A. reactants
- B. products
- C. enzymes
- D. elements
- E. catalysts

The reactants are the molecules that participate in the reaction and are shown on the left side of the reaction arrow. The products are the molecules that are formed by the reaction and are shown on the right.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #45*

*Section: 02.01*

*Topic: Chemistry*

46. Why do cells need buffering agents?

- A. to minimize the changes in pH of their internal environment
- B. to operate at a constant pH of 2.0
- C. to carry out life functions in extremely acidic conditions
- D. to help transfer electrons from one atom to another
- E. to increase the amount of  $\text{OH}^-$  in their surroundings

Living organisms need to be kept within narrow pH ranges in order to maintain homeostasis. A buffer is able to keep pH within their normal limits by taking up excess hydrogen ions ( $\text{H}^+$ ) or hydroxide ions ( $\text{OH}^-$ ) in solution.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.03 Explain the purpose of a buffer.*

*Mader - Chapter 02 #46*

*Section: 02.03*

*Topic: Chemistry*

47. Which of the following is not a way in which chemical bonds can be formed?

- A. sharing electrons
- B. losing electrons
- C. splitting electrons**
- D. gaining electrons
- E. attractions of opposite charge

Compounds and molecules are formed when atoms form either ionic or covalent bonds. These two result from either the sharing of outer shell electrons or the transfer of the electrons from one atom to another.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.01.04 Contrast ionic and covalent bonds.*

*Mader - Chapter 02 #47*

*Section: 02.01*

*Topic: Chemistry*

48. Sulfur has an atomic number of 16. What would be the valence number of this element?

- A. One
- B. Two**
- C. Three
- D. Four
- E. Six

Sulfur has two electrons in the first shell, eight electrons in the second shell, leaving six electrons in its outer valence shell and consequently a valence number of two.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #48*

*Section: 02.01*

*Topic: Chemistry*



49. Some insects can stride on the surface of water because water

- A. has a high specific heat.
- B. has lower density when frozen.
- C. is a good solvent.
- D.** has surface tension.
- E. resists temperature changes.

Because the water molecules at the surface are more strongly attracted to each other than to the air above, water molecules at the surface cling tightly to each other (surface tension). The hydrogen bonds between water molecules creates the property of cohesion that makes it possible to have this high surface tension.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #49*

*Section: 02.02*

*Topic: Chemistry*

50. The pH of pure water is \_\_\_\_\_ because \_\_\_\_\_.

- A.** 7.0; water dissociates an equal number of  $H^+$  ions and  $OH^-$
- B. 14.0; water dissociates and more  $OH^-$  is formed because there are more hydrogen atoms in water
- C. 1.0; water dissociates and more  $H^+$  is formed since hydrogen is smaller and can separate from the oxygen easily
- D. 7.0; there are no ions formed in pure water
- E. acidic; there are more  $H^+$  ions than  $OH^-$  ions present

Water's pH is 7.0. This is due to the fact that water dissociates an equal number of hydrogen ( $H^+$ ) ions and hydroxide ( $OH^-$ ).

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.03.02 Interpret the pH scale.*

*Mader - Chapter 02 #50*

*Section: 02.03*

*Topic: Chemistry*

51. Which of the following best describes the structure of how water molecules form and interact?
- A. Hydrogen atoms bond with each other to create stable outer shell of electrons. Then they form a hydrogen bond to an oxygen atom to create the water molecule.
  - B. Oxygen atoms transfer one electron to each of the hydrogen atoms forming an ionic bond that attracts other water molecules to it.
  - C. The oxygen atom and hydrogen atoms form a covalent bond with one another to create stable outer shells of electrons. The electrons are shared unequally resulting in a polar molecule whose slight charges form weak hydrogen bond attractions with other water molecules.
  - D. Hydrogen bonds are formed between the two hydrogen atoms and the oxygen atom. This water molecule than forms a covalent bond with adjacent water molecules.
  - E. The oxygen atom is more electronegative than the two hydrogen atoms. Due to this, it removes the electron from each hydrogen atom. This satisfies the outer shell of oxygen. Then hydrogen bonds form between the two remaining hydrogen atoms to hold them near to the oxygen atom.

In a water molecule, the oxygen atom and hydrogen atoms form a covalent bond with one another to create stable outer shells of electrons. The oxygen is more electronegative than hydrogen. Consequently the shared electrons spend more time near the oxygen nucleus than the hydrogen nuclei. This unequal sharing of electrons make it a polar molecule. With this polarity, water molecules form weak attractions called hydrogen bonds. These create qualities of water that include the following: solvency, cohesion, surface tension, high heat capacity and varying density.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.02.01 Explain how the properties of water make life possible.*

*Mader - Chapter 02 #51*

*Section: 02.02*

*Topic: Chemistry*

52. The particles that are found in the nucleus of an atom are the

- A. protons and electrons.
- B. neutrons and protons.**
- C. electrons only.
- D. protons only.
- E. electrons and neutrons.

An atom is comprised of subatomic particles. The protons bear a positive charge, are found in the nucleus, and their number creates the atomic number assigned to that element. The neutrons are found in the nucleus as well and they with the protons create the majority of an atom's mass. The electrons bear a negative charge and govern the elements reactivity.

*Bloom's Level: 1. Remember*

*Learning Outcome: 02.01.01 Distinguish among the types, location, and charge of subatomic particles.*

*Mader - Chapter 02 #52*

*Section: 02.01*

*Topic: Chemistry*

53. Which of these is a property of isotopes that make it useful in cell biology?

- A. they never breakdown
- B. they behave the same chemically**
- C. they behave differently chemically
- D. the molecules they are part of break down more easily
- E. the molecules they are part of are more stable

The number of neutrons does not influence the chemical reactivity of the atom so they will form the same molecules allowing living organisms to take them in and use them as they would normally.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.01.02 Explain how isotopes are useful in the study of biology.*

*Mader - Chapter 02*

*Section: 02.01*

*Topic: Chemistry*

54. Radioactive isotopes are useful in biological studies because

- A. an organism will take in a molecule with the isotope and use it normally but the radioactive decay can be detected.
- B. an organism will take in a molecule with the isotope but will only use it in a few specific reactions not the normal ones.
- C. an organism will take in the molecule with the isotope and then remove the isotope and send it through the excretory system while replacing the isotope with a normal atom.
- D. they are easily visible and normal atoms are not.
- E. they are easy and inexpensive to use in studies.

The number of neutrons does not influence the chemical reactivity of the atom so they will form the same molecules allowing living organisms to take them in and use them as they would normally but it is also possible to trace the atom through the processes that occur in the organism.

*Bloom's Level: 4. Analyze*

*Learning Outcome: 02.01.02 Explain how isotopes are useful in the study of biology.*

*Mader - Chapter 02*

*Section: 02.01*

*Topic: Chemistry*

55. The reactivity of an atom depends on

- A. the number of protons.
- B. the number of neutrons.
- C. the number of electrons.
- D. the number of valence electrons.
- E. the number of protons and neutrons in the nucleus.

The bonds between different atoms arise from the giving, taking or sharing of the electrons in the outer energy level (valence electrons).

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.03 Relate how the arrangement of electrons determines an elements reactivity.*

56. Chemical bonds involve
- A. the giving and taking of electrons.
  - B. the giving and taking of protons.
  - C.** the giving, taking or sharing of electrons.
  - D. the giving, taking or sharing of protons.
  - E. the sharing of electrons.

As atoms give away, take or share electrons so that the valence level of the atom is full they form bonds with the other atom(s) involved in the exchange.

*Bloom's Level: 2. Understand*

*Learning Outcome: 02.01.03 Relate how the arrangement of electrons determines an element's reactivity.*

*Mader - Chapter 02*

*Section: 02.01*

*Topic: Chemistry*

57. The electron arrangement for argon, which has 18 electrons, is
- A.** 2 in the inner energy shell, 8 in the second energy shell and 8 in the outer energy shell
  - B. 8 in the inner energy shell, 8 in the second energy shell and 2 in the outer energy shell
  - C. 6 in the inner energy shell, 6 in the second energy shell and 6 in the outer energy shell
  - D. 5 in the inner energy shell, 6 in the second energy shell and 7 in the outer energy shell
  - E. 7 in the inner energy shell, 6 in the second energy shell and 5 in the outer energy shell

With 18 electrons, argon has all three electron levels filled. The most that the one closest to the nucleus can hold is 2, the most that the 2<sup>nd</sup> one can hold is 8 and the final one can also hold at most 8.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.03 Relate how the arrangement of electrons determines an element's reactivity.*

*Mader - Chapter 02*

*Section: 02.01*

58. Inside a living cell, which type of bond would be the most stable?

- A. hydrogen
- B. ionic
- C. covalent**
- D. polar
- E. all bonds are equally stable in a living system

The interior of a living cell is an aqueous solution and the water molecules are capable of disrupting hydrogen and ionic bonds. The only bonds that are not affected by water's polarity are covalent bonds.

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.01.04 Contrast ionic and covalent bonds.*

*Mader - Chapter 02*

*Section: 02.01*

*Topic: Chemistry*

59. An ionic bond forms when

- A. an atom gives away or takes in an electron.
- B. an atom gives away or takes in a proton.
- C. a negatively charged ion is attracted to one with a positive charge.**
- D. two atoms come close enough to share one or more electrons.
- E. two atoms come close enough to share one or more protons.

Ions form when an atom gives away or takes in an electron but the actual bond does not form until the charged atoms are attracted to one another.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.05 Relate how bonding leads to the formation of molecules and compounds.*

*Mader - Chapter 02*

*Section: 02.01*

*Topic: Chemistry*

60. A covalent bond involves the sharing of

- A. electrons.
- B. protons.
- C. pairs of protons.
- D. at least 3 electrons.
- E. pairs of electrons.**

In order to form covalent bonds each atom must contribute an equal number of electrons so, electrons are shared in pairs.

*Bloom's Level: 3. Apply*

*Learning Outcome: 02.01.05 Relate how bonding leads to the formation of molecules and compounds.*

*Mader - Chapter 02*

*Section: 02.01*

*Topic: Chemistry*

61. Which of the following describe how an acid disrupts the chemical bonds of molecules in a cell?

- A.** the  $H^+$  ions can disrupt hydrogen bonds as the slightly negative portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- B. the  $H^+$  ions can disrupt hydrogen bonds as the slightly positive portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- C. the  $OH^-$  ions can disrupt hydrogen bonds as the slightly positive portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- D. the  $OH^-$  ions can disrupt hydrogen bonds as the slightly negative portion of the molecule is more attracted to it than to the hydrogen that was part of the bond.
- E. The  $H^+$  ions disrupt the covalent bonds that hold the molecule together.

The positive charge of the  $H^+$  ion is stronger than the slight positive charge of a hydrogen atom in a hydrogen bond and can, therefore, break the hydrogen bond as the slightly negative part of the polar molecule is attracted to it.

*Bloom's Level: 5. Evaluate*

62. You are caring for the freshwater aquarium of a friend while they are on vacation. You are told to check the pH of the tank and make sure that it stays between 6.5 and 7.0. When you check the water the pH is 8.0. The water in the tank is
- A. 1 to 1.5 times more basic than it should be.
  - B. 1 to 1.5 times more acidic than it should be.
  - C. 10 to 15 times more basic than it should be.**
  - D. 10 to 15 times more acidic than it should be.
  - E. 100 to 150 times more basic than it should be.

Since the pH scale is a logarithmic scale each change from one whole number to the next is a tenfold change. The larger the number the more basic the solution.



63. You are caring for the freshwater aquarium of a friend while they are on vacation. You are told to check the pH of the tank and make sure that it stays between 6.5 and 7.0. In order to assure that you do not have to worry about the pH you

- A. treat the fish and the tank with aspirin.
- B. add NaOH so that changes in the tank are calculated.
- C. add HCl so that you can track the changes in the tank's pH.
- D. do nothing since the pH will not change unless you do something wrong and you plan to follow the directions exactly.
- E. add a buffer so changes in pH are minimized.

Adding a buffer to a solution will prevent large, sudden changes in the pH so adding it to the tank will make it more unlikely that you will see changes

*Bloom's Level: 5. Evaluate*

*Learning Outcome: 02.03.03 Explain the purpose of a buffer.*

*Mader - Chapter 02*

*Section: 02.03*

*Topic: Chemistry*

## Chapter 2 The Chemical Basis of Life Summary

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