

1. Which of the following statements best describes the difference between an element and a molecule?
  - A) An element is composed of atoms; a molecule is not.
  - B) An element is composed of only one kind of atom; molecules can be composed of more than one kind of atom.
  - C) An element is unstable; molecules are stable.
  - D) Elements always have lower atomic weights than molecules.
  - E) Elements exist in nature only as parts of molecules.
  
2. Isotopes of an element
  - A) are always unstable and radioactive.
  - B) have different numbers of protons.
  - C) have the same atomic weight.
  - D) have different numbers of neutrons.
  - E) have different numbers of electrons.
  
3. The reactivity of an atom arises from the
  - A) energy difference between the *s* and *p* orbitals.
  - B) potential energy of the outermost shell.
  - C) average distance of the outermost shell from the nucleus.
  - D) sum of the potential energies of all electron shells.
  - E) existence of unpaired electrons in the outermost shell.
  
4. An element that contains ten protons and ten electrons is likely to
  - A) form covalent bonds with another element.
  - B) form ionic bonds with another element.
  - C) be chemically inert (stable).
  - D) be radioactive.
  - E) be toxic.
  
5. Covalent bond formation depends on the ability of atoms to
  - A) share electrons with other atoms.
  - B) donate electrons to other atoms.
  - C) receive electrons from other atoms.
  - D) Both a and b
  - E) All of the above

6. Which of the following interactions between atoms is the *strongest*?
- A) Hydrophobic
  - B) Ionic
  - C) Covalent
  - D) van der Waals
  - E) Hydrogen bonds
7. Rank the elements carbon (C), hydrogen (H), oxygen (O), and phosphorus (P) in *decreasing* order of the number of covalent bonds they usually form.
- A)  $C > P > N > O > H$
  - B)  $P > O > C > N > H$
  - C)  $P > C > N > O > H$
  - D)  $P > C > O > N > H$
  - E)  $P > C > O > H > N$
8. Which of the following structures molecules is *incorrect*?
- A)  $\text{CH}_3\text{—NH}_3$
  - B)  $\text{CH}_2=\text{CH}_2$
  - C)  $\text{CH}_3\text{—NH}_2$
  - D)  $\text{CH}_3\text{—NH}_3^+$
  - E)  $\text{CH}_3\text{—CH}_3$
9. For a covalent bond to be polar, the two atoms that form the bond must have
- A) differing atomic weights.
  - B) differing numbers of neutrons.
  - C) differing melting points.
  - D) differing electronegativities.
  - E) similar electronegativities.
10. Polar molecules
- A) have bonds with an unequal distribution of electric charge.
  - B) must form ions in water solution.
  - C) have bonds with an equal distribution of electrical charge.
  - D) have bonds with an overall negative charge.
  - E) have bonds with an overall positive charge.

11. Solid salt, NaCl, is neutral. When dissolved in water, NaCl
- A) remains as NaCl (does not dissociate).
  - B) dissociates to form  $\text{Na}^-$  and  $\text{Cl}^+$ .
  - C) dissociates to form  $\text{Na}^+$  and  $\text{Cl}^-$  ions that do not interact with water molecules.
  - D) dissociates to form  $\text{Na}^+$  and  $\text{Cl}^-$  ions that interact with water molecules.
  - E) does not dissociate, but interacts with water molecules.
12. Hydrocarbons are \_\_\_\_\_ and \_\_\_\_\_, whereas salts are \_\_\_\_\_ and \_\_\_\_\_.
- A) nonpolar; hydrophobic; polar; hydrophilic
  - B) nonpolar; hydrophilic; polar; hydrophobic
  - C) polar; hydrophilic; nonpolar; hydrophobic
  - D) polar; hydrophobic; nonpolar ; hydrophilic
  - E) None of the above
13. Propane ( $\text{CH}_3\text{—CH}_2\text{—CH}_3$ ), is considered a nonpolar molecule because
- A) it does not contain oxygen.
  - B) carbon and hydrogen have similar electronegativities.
  - C) it is a gas.
  - D) it is flammable.
  - E) it forms hydrogen bonds.
14. Which of the following statements about chemical reactions is *false*?
- A) They occur when atoms combine or change their bonding partners.
  - B) Energy may be created or destroyed in a chemical reaction.
  - C) Reactions may go to completion.
  - D) Changes in forms of energy may accompany chemical reactions.
  - E) The products of a chemical reaction are formed from the reactants.
15. Water is essential to life. Which of the following physical properties of water affect(s) life in some beneficial way?
- A) Cohesiveness
  - B) High heat capacity
  - C) High heat of vaporization
  - D) Ice is less dense than liquid water
  - E) All of the above

16. What property of water contributes most to the ability of fish in lakes to survive very cold winters?
- A) Water is cohesive.
  - B) Water has a high heat capacity.
  - C) Frozen water is more dense than liquid water.
  - D) Frozen water is less dense than liquid water.
  - E) Water forms hydrogen bonds.
17. The molecular weight of acetic acid is 60. How many grams of acetic acid would be required to prepare 10 ml of a 0.001 *M* (1.0 *mM*) solution?
- A) 6.0
  - B) 0.6
  - C) 0.0006
  - D) 0.06
  - E) 0.006
18. Given that Avagadro's number is  $6.02 \times 10^{23}$ , how many molecules of KCl would there be in  $10^{-13}$  liter of a 1 *M* KCl solution?
- A)  $6.02 \times 10^{36}$
  - B)  $6.02 \times 10^{10}$
  - C)  $6.02 \times 10^{-10}$
  - D)  $6.02 \times 10^3$
  - E)  $6.02 \times 10^{13}$
19. Why is the pH of a 0.1 *M* solution of acetic acid in water higher than that of a 0.1 *M* solution of HCl in water?
- A) HCl is a weaker acid than acetic acid.
  - B) The acetic acid does not fully ionize in water, but HCl does.
  - C) HCl does not fully ionize in water, but acetic acid does.
  - D) Acetic acid is a better buffer than HCl.
  - E) Acetate (ionized acetic acid) is a strong base.
20. The pH of coffee is close to 5 and that of pure water is 7. This means that
- A) coffee is more basic than water.
  - B) water is more acidic than coffee.
  - C) the  $H^+$  concentration of coffee is seven-fifths that of water.
  - D) the  $H^+$  concentration of water is one-one hundredth that of coffee.
  - E) the  $H^+$  concentration of water is one-hundred times that of coffee.

## Answer Key

1. B
2. D
3. E
4. C
5. A
6. C
7. C
8. A
9. D
10. A
11. D
12. A
13. B
14. B
15. E
16. D
17. C
18. B
19. B
20. D

1. The atomic number of an element refers to the number of \_\_\_\_\_ in an atom.
  - A) protons and neutrons
  - B) protons
  - C) electrons
  - D) neutrons
  - E) atomicrons
  
2. Which of the following statements concerning electrons is *false*?
  - A) Electrons orbit the nucleus of an atom in defined orbitals.
  - B) The outer shell of all atoms must contain eight electrons.
  - C) An atom may have more than one valence shell.
  - D) Electrons are negatively charged particles.
  - E) All of the above are true.
  
3. The element with which of the following atomic numbers would be most stable?
  - A) 1
  - B) 3
  - C) 12
  - D) 15
  - E) 18
  
4. What is the difference between an element and a molecule?
  - A) Molecules may be composed of different types of atoms, whereas elements are always composed of only one type of atom.
  - B) Molecules are composed of only one type of atom, whereas elements are composed of different types of atoms.
  - C) Molecules are elements.
  - D) Molecules always have larger atomic weights than elements.
  - E) Molecules do not have electrons, whereas elements do.
  
5. The strongest chemical bonds occur when
  - A) two atoms share electrons in a covalent bond.
  - B) two atoms share electrons in an ionic bond.
  - C) hydrogen bonds are formed.
  - D) van der Waals forces are in effect.
  - E) there are hydrophobic interactions.

6. You have discovered that a molecule is hydrophilic. What else do you know about this molecule?
- A) It cannot form hydrogen bonds.
  - B) It is a polar molecule.
  - C) It is a nonpolar molecule.
  - D) It has a partial positive region and a partial negative region.
  - E) Both b and d
7. The stability of the three-dimensional shape of many large molecules is dependent on
- A) covalent bonds.
  - B) ionic bonds.
  - C) hydrogen bonds.
  - D) van der Waals attractions.
  - E) hydrophobic interactions.
8. The molecular weight of glucose is 180. If you added 180 grams of glucose to a 0.5 liter of water, what would be the molarity of the resulting solution? (See Figure 2.2 for the periodic table.)
- A) 18
  - B) 1
  - C) 9
  - D) 2
  - E) 0.5
9. Why does ice float in water?
- A) Ice is less dense than water.
  - B) There are no hydrogen bonds in ice.
  - C) Ice is denser than water.
  - D) Water has a higher heat capacity than ice.
  - E) Ice has more covalent bonds than water.
10. Cola has a pH of 3; blood plasma has a pH of 7. The hydrogen ion concentration of cola is \_\_\_\_\_ than the hydrogen ion concentration of blood plasma.
- A) 4 times greater
  - B) 4 times smaller
  - C) 400 times greater
  - D) 10,000 times greater
  - E) 30,000 times greater

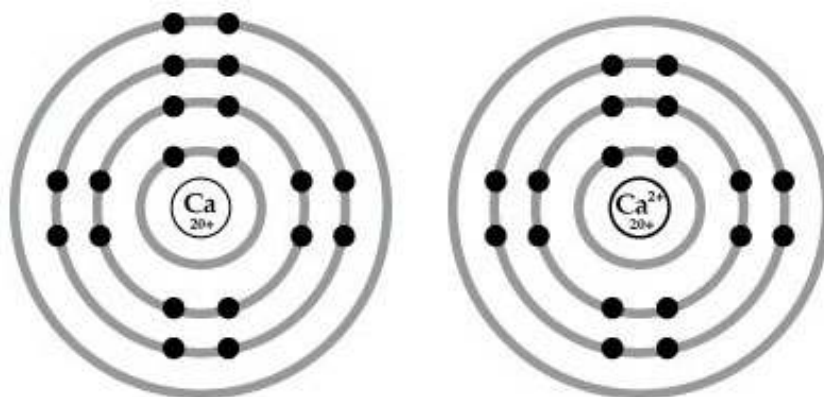
11. If solution A has a pH of 2 and solution B has a pH of 8, which of the following statements is true?
- A) A is basic and B is acidic.
  - B) A is acidic and B is basic.
  - C) A is a base and B is an acid.
  - D) A has a greater  $[\text{OH}^-]$  than B.
  - E) None of the above
12. One mole of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) weighs
- A) 180 grams.
  - B) 42 atomic mass units.
  - C) 96 grams.
  - D) 342 grams.
  - E) 6.02 grams.
13. The role of a buffer is to
- A) allow the pH of a solution to vary widely.
  - B) make a solution basic.
  - C) maintain pH homeostasis.
  - D) disrupt pH homeostasis.
  - E) make a solution more acidic.
14. Which of the following statements about water is true?
- A) Water has a low heat of vaporization.
  - B) Water has a high specific heat.
  - C) When water freezes, it gains energy from the environment.
  - D) All of the above
  - E) None of the above
15. Which of the following statements about chemical reactions is true?
- A) The bonding partners of atoms remain constant.
  - B) All reactions release energy as they proceed.
  - C) The bonding partners of atoms change.
  - D) All reactions consume energy as they proceed.
  - E) None of the above
16. Calcium has an atomic number of 20. Draw structures for Ca and  $\text{Ca}^{2+}$ . What is the difference between these structures? Why is the most common ion of lithium  $\text{Li}^+$ ?



17. Nitrogen atoms can form triple bonds with each other. What is a triple bond? How many electrons are shared between two N atoms?
  
18. Water is a polar molecule. This property contributes to cohesion and surface tension. Draw six water molecules. In your drawing, indicate how hydrogen bonding between molecules contributes to cohesion and surface tension. (Be sure to include appropriate covalent bonds in each molecule.)
  
19. Rank the following solutions in order from the most acidic to the most basic: lemon juice, pH = 2; Mylanta, pH = 10; Sprite, pH = 3; drain cleaner, pH = 15; seawater, pH = 8. Of the preceding, which has the highest concentration of H<sup>+</sup> ions? Which has the lowest concentration of H<sup>+</sup> ions?
  
20. If you have 12 moles of a substance, how many molecules do you have of that substance? Suppose the substance has a molecular weight of 342. How many grams of that substance would you have to dissolve in a liter of water to make a 12 M solution?

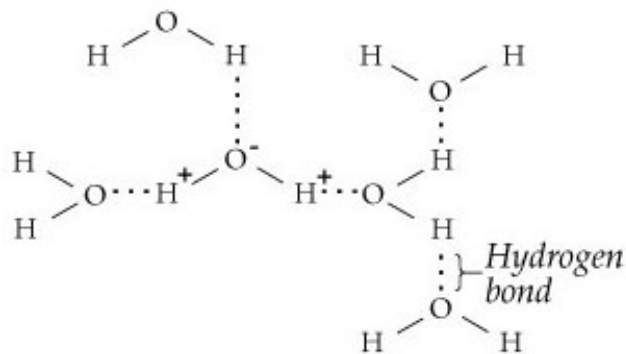
## Answer Key

1. B
2. B
3. E
4. A
5. A
6. E
7. C
8. D
9. A
10. D
11. B
12. A
13. C
14. B
15. C
- 16.



The difference between these structures is that calcium (Ca) has two electrons in its outer shell. Calcium ion ( $\text{Ca}^{2+}$ ) has lost its two outer electrons and therefore has a positive charge of 2 because it has two more protons than electrons. Lithium has only one electron in its outer shell; when that electron is lost, the ion gains a positive charge of only 1.

17. Three pairs of electrons are shared between two N atoms in a triple bond.
- 18.



The partially positive hydrogens of one water molecule are attracted to the partially negative oxygens of another molecule of water. This attraction tends to cause water molecules to “stick” together, creating surface tension.

19. Lemon juice, pH = 2 (highest concentration of  $H^+$  ions); Sprite, pH = 3; seawater, pH = 8; Mylanta, pH = 10; drain cleaner, pH = 15 (lowest concentration of  $H^+$  ions).
20. You would multiply Avogadro's number ( $6.02 \times 10^{23}$ ) times 12 to determine the number of molecules. This gives you  $7.224 \times 10^{24}$  molecules of this substance. A 12 M solution would be made by multiplying the formula weight of the molecule times 12 and adding that many grams of the substance to one liter of water. The formula weight of this molecule is 342, so you would need 4104 g.

1. A human hair is found to have a high ratio of  $^{18}\text{O}$  to  $^{16}\text{O}$ . From this information it can be assumed that
  - A) the person is suffering from a chronic disease such as diabetes.
  - B) the person has experienced prolonged exposure to radioactivity.
  - C) the person lives in a region where “heavy” water is consumed.
  - D) the person regularly uses a protein-rich hair conditioner.
  - E) the person eats a diet high in cholesterol-rich meat.
  
2. The part of the atom that determines how the atom behaves chemically is the
  - A) proton.
  - B) electron.
  - C) neutron.
  - D) innermost shell.
  - E) nucleus.
  
3. Which component of an atom does *not* significantly add to its mass?
  - A) Proton
  - B) Neutron
  - C) Electron
  - D) Both a and b
  - E) All of the above
  
4. What is the difference between an atom and an element?
  - A) An atom is made of protons, electrons, and sometimes neutrons; an element is a substance composed of only one kind of atom.
  - B) An element is made of protons, electrons, and sometimes neutrons; an atom is a substance composed of only one kind of element.
  - C) An atom does not contain electrons, whereas an element does.
  - D) An atom contains protons and electrons, whereas an element contains protons, electrons, and neutrons.
  - E) None of the above
  
5. The number of protons in a neutral atom equals the number of
  - A) neutrons.
  - B) electrons.
  - C) electrons plus neutrons.
  - D) neutrons minus electrons.
  - E) isotopes.

6. Which of the following statements about atoms is true?
- A) The negative charge of an electron is larger than the positive charge of a proton. This is the reason that there are usually more protons than electrons in an atom.
  - B) Neutrons add mass to an atom without influencing other properties.
  - C) When the number of protons equals the number of electrons, an atom has a neutral charge.
  - D) Atoms of an element are radioactive whenever they vary in their number of neutrons.
  - E) The energy level of electrons is higher in shells close to the nucleus.
7. An atom that is neutrally charged contains
- A) only neutrons.
  - B) the same number of neutrons and electrons.
  - C) the same number of neutrons and protons.
  - D) the same number of protons and electrons.
  - E) no charged particles.
8. The number of different elements found in the universe is closest to
- A) 12.
  - B) 24.
  - C) 48.
  - D) 100.
  - E) 192.
9. The best reference source for the atomic number and mass number of elements is
- A) a good chemistry text.
  - B) a dictionary.
  - C) the periodic table.
  - D) a general physics book.
  - E) a good biology text.

Use the following to answer questions 10-12:

Refer to the periodic table (Figure 2.2) in the textbook.

10. Which of the following has the same number of outer-shell (valence) electrons as oxygen has?
- A) Sulfur
  - B) Nitrogen
  - C) Fluorine
  - D) Sodium
  - E) Calcium
11. The compounds that sulfur forms with hydrogen are most like the compounds found in which of the following?
- A) CH<sub>4</sub>
  - B) NH<sub>3</sub>
  - C) H<sub>2</sub>O
  - D) NaCl
  - E) CaCl<sub>2</sub>
12. Compared to carbon, silicon has the same number of
- A) protons.
  - B) valence (outer-shell) electrons.
  - C) neutrons.
  - D) electrons.
  - E) Both a and c
13. The atomic number of an element is the same as the number of \_\_\_\_\_ in each atom.
- A) neutrons
  - B) protons plus electrons
  - C) protons
  - D) neutrons plus protons
  - E) neutrons plus electrons
14. Which of the following elements is contained by all living things?
- A) Nitrogen
  - B) Phosphorus
  - C) Sulfur
  - D) Carbon
  - E) All of the above

15. The four elements most common in organisms are
- A) calcium, iron, hydrogen, and oxygen.
  - B) water, carbon, hydrogen, and oxygen.
  - C) carbon, oxygen, hydrogen, and nitrogen.
  - D) nitrogen, carbon, iron, and hydrogen.
  - E) phosphorus, water, carbon, and oxygen.
16. Which of the following pairs has similar chemical properties?
- A)  $^1\text{H}$  and  $^{22}\text{Na}$
  - B)  $^{12}\text{C}$  and  $^{28}\text{Si}$
  - C)  $^{16}\text{O}$  and  $^8\text{S}$
  - D)  $^{12}\text{C}$  and  $^{14}\text{C}$
  - E)  $^8\text{H}$  and  $^2\text{He}$
17. Phosphorus has an atomic number of 15 and an atomic mass of 31. How many neutrons does phosphorus have?
- A) 5
  - B) 16
  - C) 30
  - D) 31
  - E) 47
18.  $^{31}_{15}\text{P}$  and  $^{32}_{15}\text{P}$  have virtually identical chemical and biological properties because they have the same
- A) half-life.
  - B) number of neutrons.
  - C) atomic weight.
  - D) mass number.
  - E) number of electrons.
19. Because atoms can have the same number of protons but a different number of neutrons, elements have
- A) isotopes.
  - B) more than one atomic mass listed on the periodic table.
  - C) more than one atomic number.
  - D) various means of forming chemical bonds.
  - E) isomers.

20. An element has a weight of 131.3. The reason the number is not a whole number is that
- A) the atomic weight includes the weight of electrons.
  - B) atomic weight is the average of the mass numbers of all the element's isotopes.
  - C) the neutrons do not have a single unit weight.
  - D) the atomic weight does not include the weight of protons.
  - E) the number of electrons may vary.
21. Why is the atomic weight of hydrogen 1.008 and not exactly its mass number, 1.000?
- A) Atomic weight does not take into account the weight of rare isotopes of an element.
  - B) Atomic weight is the average of the mass numbers of a representative sample of the element, including all its isotopes.
  - C) The atomic weight includes the weight of the electrons.
  - D) The atomic weight does not include the weight of the protons.
  - E) The mass number of an element is always lower than its atomic weight.
22. The mass number of an atom is determined primarily by the \_\_\_\_\_ it contains.
- A) number of electrons
  - B) number of protons
  - C) sum of the number of protons and electrons
  - D) sum of the number of protons and neutrons
  - E) number of charges
23. Hydrogen, deuterium, and tritium all have the same
- A) atomic weight.
  - B) atomic number.
  - C) mass.
  - D) density.
  - E) nuclear composition.
24. An atom with \_\_\_\_\_ has an atomic mass of 14.
- A) 14 neutrons
  - B) 14 electrons
  - C) 7 neutrons and 7 electrons
  - D) 7 protons and 7 electrons
  - E) 6 protons and 8 neutrons



25. The ability of atoms to combine with other atoms is determined by
- A) the atom's atomic weight.
  - B) the number and distribution of electrons.
  - C) the atom's ability to form isomers.
  - D) the atom's nucleus.
  - E) pH.
26. Phosphorus has an atomic number of 15 and an atomic weight of 30.974. From this information it can be determined that this element
- A) has isotopes.
  - B) forms isomers.
  - C) has a pH of 7.
  - D) is an ion.
  - E) is radioactive.
27. The atomic mass of an element is the same as the number of \_\_\_\_\_ in each atom.
- A) electrons
  - B) protons
  - C) neutrons
  - D) protons plus neutrons
  - E) electrons plus neutrons
28. Carbon-12 is the most abundant isotope of carbon on Earth. Carbon-13 makes up about 1 percent of Earth's carbon atoms, and is useful for radioimaging. Which of the following is true?
- A) Carbon-13 has more protons than carbon-12.
  - B) Carbon-13 has more neutrons than carbon-12.
  - C) Carbon-13 has more electrons than carbon-12.
  - D) Carbon-13 has an electronic configuration that is different from that of carbon-12.
  - E) Carbon-13 has an equal number of protons and neutrons.
29. Nitrogen-14 and nitrogen-15 are isotopes. Nitrogen-15 is used to determine protein structure. Which of the following is true?
- A) Nitrogen-15 has more protons than nitrogen-14.
  - B) Nitrogen-15 has more neutrons than nitrogen-14.
  - C) Nitrogen-15 has more electrons than nitrogen-14.
  - D) Nitrogen-15 has an electronic configuration that is different from that of nitrogen-14.
  - E) Nitrogen-15 has an equal number of protons and neutrons.

30. Which of the following elements is the most chemically reactive?
- A) Hydrogen
  - B) Helium
  - C) Neon
  - D) Argon
  - E) They all have the same chemical reactivity.
31. Which of the elements listed below does *not* follow the octet rule?
- A) Sodium
  - B) Chlorine
  - C) Carbon
  - D) Hydrogen
  - E) Nitrogen
32. Which of the following statements about the difference between ionic bonds and covalent bonds is true?
- A) An ionic bond is stronger.
  - B) Electron sharing is more equal in the covalent bond.
  - C) An ionic bond occurs more often in aqueous solutions.
  - D) An ionic bond occurs only in acids.
  - E) A covalent bond occurs only in nonpolar molecules.
33. In a hydrogen molecule, the two atoms are held together by
- A) hydrogen bonds.
  - B) a shared pair of electrons.
  - C) van der Waals forces.
  - D) ionic attractions.
  - E) gravity.
34. Which of the following is the correct order (in decreasing order) for the relative strengths of chemical bonds?
- A) Covalent, ionic, hydrogen, van der Waals forces
  - B) Ionic, covalent, hydrogen, van der Waals forces
  - C) van der Waals forces, covalent, ionic, hydrogen
  - D) Hydrogen, covalent, van der Waals forces, ionic
  - E) Ionic, covalent, van der Waals forces, hydrogen

35. A single covalent chemical bond represents the sharing of how many electrons?
- A) One
  - B) Two
  - C) Three
  - D) Four
  - E) Six
36. Which of the following atoms usually has the greatest number of covalent bonds with other atoms?
- A) Carbon
  - B) Oxygen
  - C) Sulfur
  - D) Hydrogen
  - E) Nitrogen
37. Oxygen forms \_\_\_\_\_ covalent bond(s), carbon forms \_\_\_\_\_, and hydrogen forms \_\_\_\_\_.
- A) one; four; one
  - B) four; four; four
  - C) two; four; none
  - D) two; four; one
  - E) two; two; two
38. What determines if a molecule is polar, nonpolar, or ionic?
- A) The number of protons
  - B) The bond distances
  - C) The differences in the electronegativities of the atoms
  - D) The ionic charges
  - E) The distance of the electrons from the nucleus
39. Two atoms are held together in four covalent bonds because of forces between the
- A) electrons and protons.
  - B) electrons.
  - C) protons and neutrons.
  - D) protons.
  - E) electrons and neutrons.

40. Two carbon atoms held together in a double covalent bond share \_\_\_\_\_ electron(s).
- A) one
  - B) two
  - C) four
  - D) six
  - E) eight
41. A covalent bond is the sharing of \_\_\_\_\_ between atoms, whereas an ionic bond is the \_\_\_\_\_.
- A) neutrons; sharing of electrons
  - B) electrons; electric attraction between two atoms
  - C) protons; electric attraction between two atoms
  - D) protons; sharing of electrons
  - E) electrons; transfer of electrons from one atom to another
42. Chemical bonds formed by electrical attractions are
- A) covalent bonds.
  - B) ionic bonds.
  - C) hydrogen bonds.
  - D) van der Waals forces.
  - E) Both b and c
43. All of the following are nonpolar *except*
- A) O<sub>2</sub>.
  - B) N<sub>2</sub>.
  - C) CH<sub>4</sub>.
  - D) NaCl.
  - E) H<sub>2</sub>.
44. When magnesium (Mg) bonds with another element, you would expect that it would
- A) gain two electrons from the other element.
  - B) share four electrons with the other element.
  - C) lose two electrons to the other element.
  - D) form a hydrogen bond.
  - E) gain six electrons from the other element.

45. Ionic bonds are
- A) attractions between oppositely charged ions.
  - B) the result of electron sharing.
  - C) the strongest of the chemical bonds.
  - D) caused by partial electrical charges.
  - E) dependent upon hydrophobic interactions.
46. Particles having a net negative charge are called
- A) electronegative.
  - B) cations.
  - C) anions.
  - D) acids.
  - E) bases.
47. Which of the following molecules is held together primarily by ionic bonds?
- A)  $\text{H}_2\text{O}$
  - B)  $\text{C}_6\text{H}_{12}\text{O}_6$
  - C)  $\text{NaCl}$
  - D)  $\text{H}_2$
  - E)  $\text{NH}_3$
48. Hydrogen bonds
- A) form between two hydrogen atoms.
  - B) form only between hydrogen and oxygen atoms within a molecule.
  - C) form between a strong electronegative atom and hydrogen.
  - D) involve a transfer of electrons.
  - E) are the strongest bonds because of their length.
49. Cholesterol is composed primarily of carbon and hydrogen atoms. Therefore, one would expect cholesterol to be
- A) insoluble in water.
  - B) a polar molecule.
  - C) a base.
  - D) an acid.
  - E) a buffer.

50. The hydrogen bond between two water molecules arises because water is
- A) polar.
  - B) nonpolar.
  - C) a liquid.
  - D) a small molecule.
  - E) hydrophobic.
51. A van der Waals interaction is an attraction between
- A) variations in electron distributions in two adjacent nonpolar molecules.
  - B) the electrons of one molecule and the nucleus of the same molecule.
  - C) the electrons of one molecule and the electrons of a nearby molecule.
  - D) nonpolar molecules, due to the exclusion of water.
  - E) nonpolar molecules, because they are surrounded by water molecules.
52. In addition to covalent and ionic bonds, which of the following interactions are important in biological systems?
- A) van der Waals interactions
  - B) Hydrogen bonds
  - C) Hydrophobic interactions
  - D) Both a and b
  - E) All of the above
53. Which of the following correctly states an unusual property of water?
- A) Water will not react with other atoms.
  - B) Water's solid state is denser than its liquid state.
  - C) Energy is not required to change water from a solid to a liquid.
  - D) Little heat energy is needed to raise the temperature of water.
  - E) The hydrogen bonds between water molecules continually form and break.
54. Two characteristics of water make it different from most other compounds: Its solid state is \_\_\_\_\_ its liquid state and it takes up \_\_\_\_\_ heat to change to its gaseous state.
- A) less dense than; large amounts of
  - B) more dense than; small amounts of
  - C) less dense than; small amounts of
  - D) more dense than; large amounts of
  - E) just as dense as; no

55. Sweating is a useful cooling device for humans because water
- A) takes up a great deal of heat in changing from its liquid state to its gaseous state.
  - B) takes up a great deal of heat in changing from its solid state to its liquid state.
  - C) can exist in three states at temperatures common on Earth.
  - D) is an outstanding solvent.
  - E) ionizes readily.
56. When exposed to extreme heat, the human body relies on \_\_\_\_\_ to absorb excess calories of heat and maintain normal body temperature.
- A) evaporation
  - B) condensation
  - C) respiration
  - D) transpiration
  - E) All of the above
57. Which characteristic of water contributes to the relatively constant temperatures of the oceans?
- A) Water ionizes only slightly.
  - B) It takes a small amount of heat energy to raise the temperature of water.
  - C) Water can contain large amounts of salt.
  - D) Water has the ability to ionize readily.
  - E) It takes a large amount of heat energy to raise the temperature of water.
58. Ice floats because
- A) the crystal takes up more space than the liquid.
  - B) substances expand when cooled.
  - C) heat is released and heat makes water expand.
  - D) hydrogen bonds must break.
  - E) heat is absorbed.
59. Ice is used in beverages primarily because
- A) it is composed only of water.
  - B) it floats.
  - C) it dilutes the taste.
  - D) people like to chew it.
  - E) it absorbs a lot of heat when it melts.

60. If you place a paper towel in a dish of water, the water will move up the towel by capillary action because water
- A) molecules ionize.
  - B) is a good solvent.
  - C) molecules have hydrophobic interactions.
  - D) can form hydrogen bonds.
  - E) takes up large amounts of heat when it vaporizes.
61. Surface tension and capillary action occur in water because it
- A) is wet.
  - B) is dense.
  - C) has hydrogen bonds.
  - D) is nonpolar.
  - E) has ionic bonds.
62. The molecular weight of water is 18.0154. One mole of water weighs \_\_\_\_\_ grams.
- A) 9
  - B) 18
  - C) 20
  - D) 36.031
  - E)  $6.023 \times 10^{23}$
63. When sodium hydroxide (NaOH) is added to water, it ionizes, releasing  $\text{OH}^-$  and  $\text{Na}^+$  ions. The resulting solution is
- A) acidic.
  - B) basic.
  - C) neutral.
  - D) molar.
  - E) a buffer.
64.  $\text{H}_2\text{SO}_4$  can ionize to yield two  $\text{H}^+$  ions and one  $\text{SO}_4^{2-}$  ion.  $\text{H}_2\text{SO}_4$  is therefore
- A) molar.
  - B) a base.
  - C) a buffer.
  - D) a solution.
  - E) an acid.



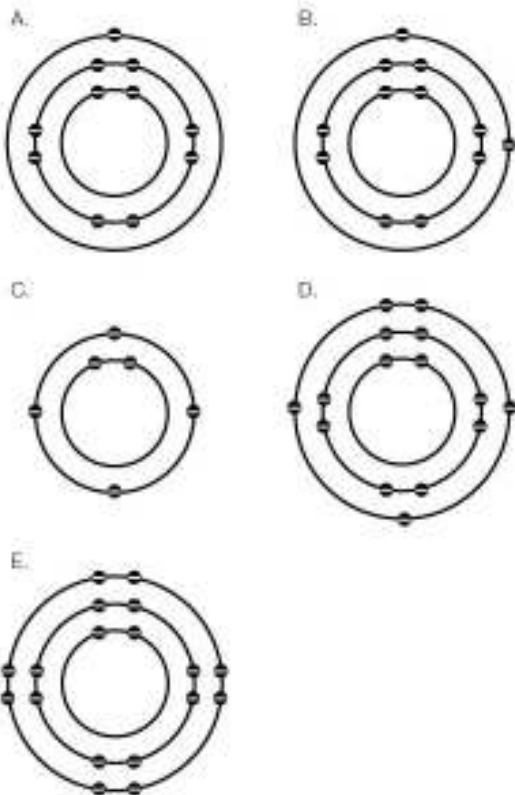
65. Which contains more molecules, a mole of hydrogen or a mole of carbon?
- A) A mole of carbon
  - B) A mole of hydrogen
  - C) Both contain the same number of molecules.
  - D) Inadequate information is provided.
  - E) It depends on atmospheric pressure.
66. The difference between an acid and a base is that an acid \_\_\_\_\_, whereas a base \_\_\_\_\_.
- A) undergoes a reversible reaction; does not
  - B) releases  $\text{OH}^-$  ions in solution; accepts  $\text{OH}^-$  ions
  - C) releases  $\text{H}^+$  ions in solution; releases  $\text{OH}^-$  ions
  - D) releases  $\text{OH}^-$  ions in solution; releases  $\text{H}^+$  ions
  - E) releases  $\text{H}^+$  ions in solution; accepts  $\text{H}^+$  ions
67. To determine the number of molecules in a teaspoon of sugar you have to know
- A) the density of the sugar.
  - B) the weight of the sugar.
  - C) the molecular weight of the sugar.
  - D) Avogadro's number.
  - E) the weight and molecular weight of the sugar, and Avogadro's number.
68. How would you make 100 ml of an aqueous solution with a 0.25 *M* concentration of a compound that has a molecular weight of 200 daltons?
- A) Add 0.25 grams of the compound to 100 ml of water.
  - B) Add 250 grams of the compound to 100 ml of water.
  - C) Take 250 grams of the compound and add water until the volume equals 100 ml.
  - D) Take 50 grams of the compound and add water until the volume equals 100 ml.
  - E) Take 5 grams of the compound and add water until the volume equals 100 ml.
69. Of the following compounds containing  $^1\text{H}$ ,  $^{12}\text{C}$ , and  $^{16}\text{O}$ , the one with the greatest number of molecules in a sample with a mass of 2 grams would be
- A)  $\text{CO}$ .
  - B)  $\text{CO}_2$ .
  - C)  $\text{HCOOH}$ .
  - D)  $\text{C}_2\text{H}_5\text{OH}$ .
  - E)  $\text{C}_6\text{H}_{12}\text{O}_6$ .

70. A basic solution contains
- A) more  $\text{OH}^-$  ions than  $\text{H}^+$  ions.
  - B) more  $\text{H}^+$  ions than  $\text{OH}^-$  ions.
  - C) the same number of  $\text{OH}^-$  ions and  $\text{H}^+$  ions.
  - D) no  $\text{OH}^-$  ions.
  - E) None of the above
71. A 1.0 M solution of HCl has a pH of
- A) 1.0.
  - B) 7.0.
  - C) 14.0.
  - D) 11.2.
  - E) 14.
72. A substance with a pH of 6.0 contains
- A)  $10^6$  hydrogen ions.
  - B)  $6^{10}$  hydrogen ions.
  - C)  $6^{10}$  moles of hydrogen ions.
  - D) more  $\text{OH}^-$  than  $\text{H}^+$ .
  - E)  $10^{-6}$  moles of hydrogen ions.
73. The more acidic of two solutions has
- A) more hydroxyl ions per liter.
  - B) more hydrogen acceptors per liter.
  - C) more  $\text{H}^+$  ions per liter.
  - D) a higher pH.
  - E) None of the above
74. Acid rain is a serious environmental problem. A sample of rainwater collected in the Adirondack Mountains had an  $\text{H}^+$  concentration of  $10^{-4}$  mol/L. The pH of this sample was
- A) .0001.
  - B) -4.
  - C) 4.
  - D) 0.
  - E) 10,000.

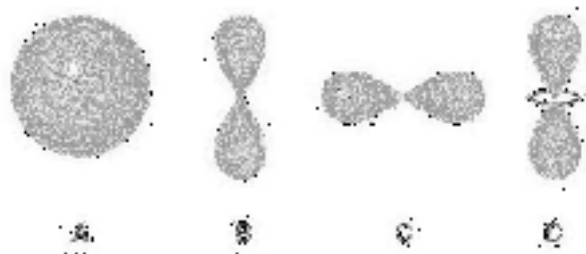
75. The notation  $[H^+]$  refers to the
- A) number of  $H^+$  ions present in a solution.
  - B) number of protons in an  $H^+$  ion.
  - C) charge of an  $H^+$  ion.
  - D) concentration of  $H^+$  ions in moles per liter.
  - E) chemical reactivity of  $H^+$  ions.
76. Which of the following has the greatest concentration of hydrogen ions?
- A) Household ammonia at pH 11
  - B) Baking soda at pH 9
  - C) Human blood at pH 7
  - D) Black coffee at pH 5
  - E) Cola at pH 3
77. The optimum pH for growing strawberries is 6.5, whereas the optimum pH for growing blueberries is 4.5. Therefore, the number of hydrogen ions needed to grow strawberries is \_\_\_\_\_ times the number needed for blueberries.
- A) 2
  - B) 10
  - C) 100
  - D) 1,000
  - E) 1,000,000
78. Carbonic acid and sodium bicarbonate act as buffers in the blood. When a small amount of acid is added to this buffer, the  $H^+$  ions are used up as they combine with the bicarbonate ions. When this happens, the pH of the blood
- A) becomes basic.
  - B) becomes acidic.
  - C) does not change.
  - D) is reversible.
  - E) ionizes.
79. Solutions that contain buffers tend to resist pH changes because buffers
- A) are bases.
  - B) change from ionic to nonionic in solution.
  - C) change from nonionic to ionic in response to changes in pH and release or absorb  $H^+$ .
  - D) are weak acids or bases.
  - E) are ionic polar molecules that add or absorb  $H^+$  in solutions.

80. One dalton is the same as the mass of one \_\_\_\_\_.
81. Oxygen and carbon are defined as different elements because they have atoms with a different number of \_\_\_\_\_.
82. Every atom except for \_\_\_\_\_ has one or more neutrons in its nucleus.
83. The sum of the atomic weights in any given molecule is called its \_\_\_\_\_.
84. The chemical properties of an element are determined by the number of \_\_\_\_\_ its atoms contain.
85. \_\_\_\_\_ occurs when one atom, such as  $^{14}\text{C}$ , is transformed into another atom, such as  $^{14}\text{N}$ , with an accompanying emission of energy.
86. The tendency of atoms in stable molecules to have eight electrons in their outermost shells is known as the \_\_\_\_\_.
87. A \_\_\_\_\_ is two or more atoms linked by chemical bonds.
88. The molecular weight of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) is \_\_\_\_\_.
89. The electronegativity of an atom depends upon the number of \_\_\_\_\_ and how far the \_\_\_\_\_ are from the nucleus.
90. Molecules that have an unequal distribution of electric charge are called \_\_\_\_\_ molecules.
91. Of the different types of chemical bonds, the strongest bond in biological systems is the \_\_\_\_\_ bond.
92. The attraction between a slight positive charge on a hydrogen atom and the slight negative charge of a nearby electronegative atom is a \_\_\_\_\_.

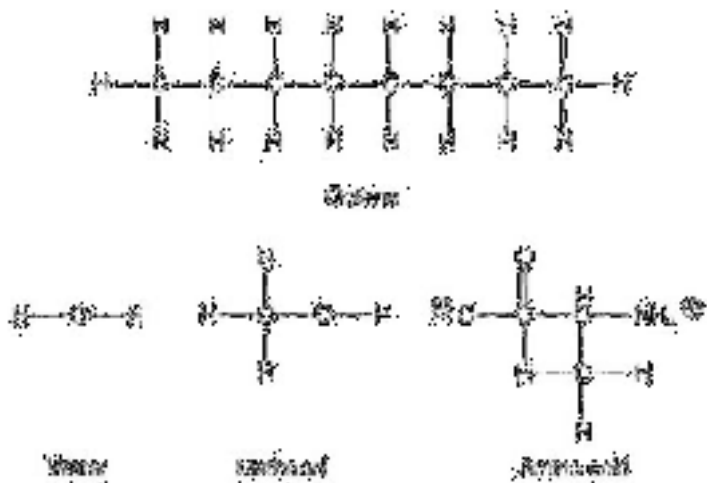
93. In the equation  $C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O$ ,  $C_6H_{12}O_6$  is the \_\_\_\_\_.
94. The water strider skates along the surface of water due to a property of liquids called \_\_\_\_\_.
95. The amount of heat needed to raise one gram of a substance  $1^\circ C$  is known as \_\_\_\_\_.
96. One mole of a substance contains  $6.02 \times 10^{23}$  molecules. This number is known as \_\_\_\_\_.
97. A chemical reaction that can proceed in either direction is called a \_\_\_\_\_.
98. Which of the diagrams below is the Bohr model for magnesium (Mg)?



99. Which of the following orbitals is an *s* orbital?



100. Which of the following are most likely to be miscible (soluble in each other)?



- A) Octane and water
- B) Water and methanol
- C) Amino acid and octane
- D) Water and octane
- E) Amino acid and water

## Answer Key

1. C
2. B
3. C
4. A
5. B
6. C
7. D
8. D
9. C
10. A
11. A
12. B
13. C
14. E
15. C
16. D
17. B
18. E
19. A
20. B
21. B
22. D
23. B
24. E
25. B
26. A
27. D
28. B
29. B
30. A
31. D
32. B
33. B
34. A
35. B
36. A
37. D
38. C
39. B
40. C
41. E
42. E
43. D
44. C

45. A
46. C
47. C
48. C
49. A
50. A
51. A
52. E
53. E
54. A
55. A
56. A
57. E
58. A
59. E
60. D
61. C
62. B
63. B
64. E
65. C
66. E
67. E
68. E
69. A
70. A
71. A
72. E
73. C
74. C
75. D
76. E
77. C
78. C
79. C
80. proton
81. protons
82. hydrogen
83. mass number
84. valance electrons
85. Radioactive decay
86. octet rule
87. molecule
88. 108
89. protons; electrons
90. polar



91. covalent
92. hydrogen bond
93. reactant
94. surface tension
95. specific heat
96. Avogadro's number
97. reversible reaction
98. B
99. A
100. B

1. The atomic number of an element
  - A) equals the number of neutrons in an atom.
  - B) equals the number of protons in an atom.
  - C) equals the number of protons minus the number of neutrons.
  - D) equals the number of neutrons plus the number of protons.
  - E) depends on the isotope.
  
2. The atomic weight (atomic mass) of an element
  - A) equals the number of neutrons in an atom.
  - B) equals the number of protons in an atom.
  - C) equals the number of electrons in an atom.
  - D) equals the number of neutrons plus the number of protons.
  - E) depends on the relative abundances of its electrons and neutrons.
  
3. Which of the following statements about the isotopes of an element is *not* true?
  - A) They all have the same atomic number.
  - B) They all have the same number of protons.
  - C) They all have the same number of neutrons.
  - D) They all have the same number of electrons.
  - E) They all have identical chemical properties.
  
4. Which of the following statements about covalent bonds is *not* true?
  - A) A covalent bond is stronger than a hydrogen bond.
  - B) A covalent bond can form between atoms of the same element.
  - C) Only a single covalent bond can form between two atoms.
  - D) A covalent bond results from the sharing of electrons by two atoms.
  - E) A covalent bond can form between atoms of different elements.
  
5. Hydrophobic interactions
  - A) are stronger than hydrogen bonds.
  - B) are stronger than covalent bonds.
  - C) can hold two ions together.
  - D) can hold two nonpolar molecules together.
  - E) are responsible for the surface tension of water.

6. Which of the following statements about water is *not* true?
- A) It releases a large amount of heat when changing from liquid into vapor.
  - B) Its solid form is less dense than its liquid form.
  - C) It is the most effective solvent for polar molecules.
  - D) It is typically the most abundant substance in a living organism.
  - E) It takes part in some important chemical reactions.
7. The reaction  $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$  in the human stomach is an example of the
- A) cleavage of a hydrophobic bond.
  - B) formation of a hydrogen bond.
  - C) elevation of the pH of the stomach.
  - D) formation of ions by dissolving an acid.
  - E) formation of polar covalent bonds.
8. The hydrogen bond between two water molecules arises because water is
- A) polar.
  - B) nonpolar.
  - C) a liquid.
  - D) small.
  - E) hydrophobic.
9. When table salt ( $\text{NaCl}$ ) is added to water,
- A) a covalent bond is broken.
  - B) an acidic solution is formed.
  - C) the  $\text{Na}^+$  and  $\text{Cl}^-$  ions are separated.
  - D) the  $\text{Na}^+$  ions are attracted to the hydrogen atoms of water.
  - E) water molecules surround the  $\text{Na}^+$  (but not  $\text{Cl}^-$ ) ions.
10. The three most abundant elements in a human skin cell are
- A) calcium, carbon, and oxygen.
  - B) carbon, hydrogen, and oxygen.
  - C) carbon, hydrogen, and sodium.
  - D) carbon, nitrogen, and potassium.
  - E) nitrogen, hydrogen, and argon.

## Answer Key

1. B
2. D
3. C
4. C
5. D
6. A
7. D
8. A
9. C
10. B