

Campbell Biology: Concepts and Connections, Cdn. Ed. (Reece et al.)
Chapter 2 The Essential Chemistry of Life

2.1 Multiple-Choice Questions

1) The four most common elements in living organisms are

- A) C, H, O, Fe.
- B) C, H, O, Na.
- C) C, H, O, N.
- D) C, N, O, Na.

Answer: C

Topic: 2.1

Skill: Knowledge/Comprehension

2) Which of the following is a trace element in the human body?

- A) nitrogen
- B) zinc
- C) oxygen
- D) hydrogen

Answer: B

Topic: 2.1

Skill: Knowledge/Comprehension

3) Which of the following statements regarding matter is *false*?

- A) All life is composed of matter.
- B) All matter has mass.
- C) All matter is composed of elements.
- D) All matter exists in the form of compounds.

Answer: D

Topic: 2.1

Skill: Knowledge/Comprehension

4) Which of the following statements best describes a compound?

- A) A compound is a pure element.
- B) A compound contains two or more different elements in a fixed ratio.
- C) A compound is exemplified by sodium.
- D) A compound is a solution.

Answer: B

Topic: 2.1

Skill: Knowledge/Comprehension

5) In the equation $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$,

- A) H_2 , O_2 , and H_2O are all compounds.
- B) H_2 , O_2 , and H_2O are all elements.
- C) only H_2O is a compound.
- D) only H_2 and O_2 are compounds.

Answer: C

Topic: 2.1

Skill: Application/Analysis

6) Which of the following trace elements needed by humans is commonly added to table salt?

- A) iodine
- B) iron
- C) magnesium
- D) fluoride

Answer: A

Topic: 2.2

Skill: Knowledge/Comprehension

7) In some areas, fluoride is added during the municipal water treatment process in order to help

- A) prevent goiter.
- B) prevent the growth of bacteria.
- C) prevent the development of mental retardation.
- D) reduce tooth decay.

Answer: D

Topic: 2.2

Skill: Knowledge/Comprehension

8) Which of the following particles are found in the nucleus of an atom?

- A) protons and neutrons
- B) protons and electrons
- C) only protons
- D) only electrons

Answer: A

Topic: 2.3

Skill: Knowledge/Comprehension

9) Electrons move about the nucleus of an atom in the same way that

- A) insects fly around a bright lamp at night.
- B) cars are parked along the sides of a street.
- C) boats cross a lake.
- D) birds migrate to a new winter home.

Answer: A

Topic: 2.3

Skill: Application/Analysis

10) What is the atomic mass of an atom that has 6 protons, 6 neutrons, and 6 electrons?

- A) 6
- B) 8
- C) 12
- D) 18

Answer: C

Topic: 2.3

Skill: Knowledge/Comprehension

11) An uncharged atom of boron has an atomic number of 5 and an atomic mass of 11. How many electrons does boron have?

- A) 11
- B) 15
- C) 5
- D) 2

Answer: C

Topic: 2.3

Skill: Application/Analysis

12) Which of the following is another term used for atomic mass?

- A) darwin
- B) mendel
- C) dalton
- D) calvin

Answer: C

Topic: 2.3

Skill: Knowledge/Comprehension

13) The sodium atom contains 11 electrons, 11 protons, and 12 neutrons. What is the mass number of sodium?

- A) 11
- B) 22
- C) 23
- D) 34

Answer: C

Topic: 2.3

Skill: Application/Analysis

14) Which of the following best describes the atomic number of an atom?

- A) the number of protons in the atom
- B) the number of electrons in the atom
- C) the number of neutrons in the atom
- D) the number of protons, electrons, and neutrons in the atom

Answer: A

Topic: 2.3

Skill: Knowledge/Comprehension

15) Typically, nitrogen atoms are composed of electrons, protons, and neutrons. An isotope of nitrogen could

- A) be positively charged.
- B) be negatively charged.
- C) have more protons than the usual nitrogen atom.
- D) have more neutrons than the usual nitrogen atom.

Answer: D

Topic: 2.3

Skill: Knowledge/Comprehension

16) A radioactive isotope is an isotope that

- A) is stable.
- B) decays.
- C) has more protons than the common variant of the element.
- D) has the same atomic mass, but a different atomic number than the common variant of the element.

Answer: B

Topic: 2.3

Skill: Knowledge/Comprehension

17) If you found a fossilized dinosaur bone, what method could be used to determine the age of the fossil?

- A) electrophoresis
- B) DNA fingerprinting
- C) isotope analysis
- D) radial immunodiffusion

Answer: C

Topic: 2.3

Skill: Application/Analysis

18) Which of the following statements about radioactive isotopes is *true*?

- A) The nuclei of radioactive isotopes are unusually stable, but the atoms tend to lose electrons.
- B) When given a choice between radioactive and nonradioactive isotopes of the same atom, living cells are more likely to incorporate the radioactive isotopes into their structures.
- C) The energy emitted by radioactive isotopes can break chemical bonds and cause molecular damage in cells.
- D) Radioactive elements are natural and therefore not harmful.

Answer: C

Topic: 2.4

Skill: Knowledge/Comprehension

19) Radioactive isotopes

- A) are frequently added to foods as nutritional supplements.
- B) can be used in conjunction with PET scans to diagnose diseases.
- C) do not occur naturally.
- D) are never incorporated into organic compounds.

Answer: B

Topic: 2.4

Skill: Knowledge/Comprehension

20) When full, the innermost electron shell of argon contains _____ electrons, and the outermost shell contains _____ electrons.

- A) 2; 2
- B) 2; 8
- C) 4; 8
- D) 8; 8

Answer: B

Topic: 2.5

Skill: Knowledge/Comprehension

21) What happens to an atom if the electrons in the outer shell are altered?

- A) The atom becomes radioactive.
- B) The atom will disintegrate.
- C) The properties of the atom will change.
- D) The atom's characteristics change and it becomes a different element.

Answer: C

Topic: 2.5

Skill: Knowledge/Comprehension

22) A(n) _____ forms when two atoms share electrons.

- A) ion
- B) covalent bond
- C) ionic bond
- D) hydrogen bond

Answer: B

Topic: 2.6

Skill: Knowledge/Comprehension

23) A bond in which two atoms share electrons equally is a(n)

- A) polar covalent bond.
- B) hydrogen bond.
- C) ionic bond.
- D) nonpolar bond.

Answer: D

Topic: 2.6

Skill: Knowledge/Comprehension

24) A hydrogen atom has one electron. How many covalent bonds can hydrogen form?

- A) one covalent bond
- B) two covalent bonds
- C) four covalent bonds
- D) no covalent bonds

Answer: A

Topic: 2.6

Skill: Application/Analysis

25) Table salt is formed when

- A) chlorine gives an electron to sodium.
- B) a hydrogen bond forms between sodium and chlorine.
- C) sodium and chlorine share electrons to form a bond.
- D) sodium donates its single outer electron to chlorine.

Answer: D

Topic: 2.7

Skill: Knowledge/Comprehension

26) The body uses atoms in different ways to accomplish different tasks. For example, one portion of the body's calcium supply strengthens bones, whereas another portion combines with proteins to stimulate blood clotting after tissue injury. Which of the statements that follow provides the most logical chemical explanation of calcium's ability to perform such different functions?

- A) The bone contains calcium salts, which are less reactive than the calcium ions found in the blood.
- B) The calcium in blood is a more reactive form of the atom and therefore has fewer protons than the calcium in bone.
- C) There are many different isotopes of calcium, and the most reactive isotope is found in the bone.
- D) The calcium in blood has a lighter atomic mass than the calcium in bone and is in a more reactive form.

Answer: A

Topic: 2.7

Skill: Synthesis/Evaluation

27) Medicines are often administered in pill form. In many cases, the active ingredient of the pill (the drug) is joined to another substance by _____. This forms a(n) _____, which is stable in the dry environment of a pill bottle but dissociates under the wet conditions of the digestive system to release the drug to the body.

- A) ionic bonds; salt
- B) hydrogen bonds; base
- C) ionic bonds; acid
- D) covalent bonds; salt

Answer: A

Topic: 2.7

Skill: Application/Analysis

28) What is the fundamental difference between covalent and ionic bonding?

- A) In a covalent bond, the partners share a pair of electrons; in an ionic bond, one partner accepts electrons from the other.
- B) In covalent bonding, both partners end up with filled outer electron shells; in ionic bonding, one partner does and the other does not.
- C) Covalent bonding involves only the outermost electron shell; ionic bonding also involves the next electron shell inside the outermost shell.
- D) Covalent bonds form between atoms of the same element; ionic bonds form between atoms of different elements.

Answer: A

Topic: 2.6, 2.7

Skill: Knowledge/Comprehension

29) Which of the following statements regarding the oxygen atom of a water molecule is *true*?

- A) Oxygen is more positively charged than the hydrogen atoms.
- B) Oxygen attracts electrons less strongly than the hydrogen atoms.
- C) Oxygen is more electronegative than the hydrogen atoms.
- D) Oxygen is attracted to the negatively charged atoms of other molecules.

Answer: C

Topic: 2.8

Skill: Knowledge/Comprehension

30) In a water molecule, hydrogen and oxygen are held together by a _____ bond.

- A) double covalent
- B) nonpolar covalent
- C) hydrogen
- D) polar covalent

Answer: D

Topic: 2.8

Skill: Knowledge/Comprehension

31) A water molecule (H—O—H) is held together by

- A) a single covalent bond.
- B) a double covalent bond.
- C) two polar covalent bonds.
- D) hydrogen bonds.

Answer: C

Topic: 2.8

Skill: Knowledge/Comprehension

32) The hydrogen atoms of a water molecule are bonded to the oxygen atom by _____ bonds; whereas, neighbouring water molecules are held together by _____ bonds.

- A) hydrogen; polar covalent
- B) polar covalent; hydrogen
- C) ionic; covalent
- D) polar covalent; ionic

Answer: B

Topic: 2.8

Skill: Knowledge/Comprehension

33) _____ are weak bonds that are not strong enough to hold atoms together to form molecules but are strong enough to form bonds within and around large molecules.

- A) Ionic bonds
- B) Covalent bonds
- C) Polar covalent bonds
- D) Hydrogen bonds

Answer: D

Topic: 2.8

Skill: Knowledge/Comprehension

34) Water molecules stick to other water molecules because

- A) water molecules are neutral, and neutral molecules are attracted to each other.
- B) hydrogen bonds form between the hydrogen atoms of one water molecule and the oxygen atoms of other water molecules.
- C) covalent bonds form between the hydrogen atoms of one water molecule and the oxygen atoms of other water molecules.
- D) the oxygen atoms of adjacent water molecules are attracted to one another.

Answer: B

Topic: 2.8

Skill: Knowledge/Comprehension

35) Which of the following statements regarding chemical reactions is *false*?

- A) Chemical reactions involve the making and breaking of chemical bonds.
- B) Some chemical reactions create electrons; others destroy them.
- C) The reactants contain the same number of atoms as the products.
- D) Although the atoms of a reaction's reactants and products are identical to each other, their molecular formulae differ.

Answer: B

Topic: 2.9

Skill: Knowledge/Comprehension

36) In the equation $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$, the H_2 molecules are _____ and the H_2O molecules are _____.

- A) reactants; products
- B) products; reactants
- C) created; destroyed
- D) used; stored

Answer: A

Topic: 2.9

Skill: Knowledge/Comprehension

37) Photosynthesis requires many steps to make glucose. As a result of the synthesis process,

- A) all the carbons from the six carbon dioxide atoms are found in glucose.
- B) more atoms are present at the beginning than at the end.
- C) more carbon dioxide is released from the plant than is absorbed.
- D) water is synthesized by the plant from H_2 and O_2 .

Answer: A

Topic: 2.9

Skill: Knowledge/Comprehension

38) Chemical indicators that could potentially detect urine in a swimming pool

- A) are not used because they are carcinogenic.
- B) are used only in public pools.
- C) are not used because they do not exist.
- D) are not used because they are too expensive.

Answer: A

Topic: 2.10

Skill: Application/Analysis

39) The tendency of water molecules to stick together is referred to as

- A) adhesion.
- B) polarity.
- C) cohesion.
- D) transpiration.

Answer: C

Topic: 2.11

Skill: Knowledge/Comprehension

40) Water's surface tension and heat storage capacity is accounted for by its

- A) orbitals.
- B) hydrogen bonds.
- C) mass.
- D) size.

Answer: B

Topic: 2.10, 2.11

Skill: Knowledge/Comprehension

41) The temperature of evaporation is much higher for water than for alcohol. Without knowing more about the chemistry of alcohol, which of the following is the most logical chemical explanation for this phenomenon?

- A) Ionic bonds form between alcohol molecules. These are the weakest type of bond and are easier to break than the hydrogen bonds between water molecules.
- B) Alcohol has a higher surface tension than water. This means that alcohol molecules can easily break away from other alcohol molecules and evaporate at a lower temperature.
- C) Alcohol molecules are more cohesive than water molecules. This means that as alcohol molecules evaporate, they pull other alcohol molecules into the air along with them.
- D) Fewer hydrogen bonds form between alcohol molecules. As a result, less heat is needed for alcohol molecules to break away from solution and enter the air.

Answer: D

Topic: 2.11

Skill: Application/Analysis

42) As ice melts,

- A) hydrogen bonds are broken.
- B) water molecules become less tightly packed.
- C) the water becomes less dense.
- D) heat is released.

Answer: A

Topic: 2.12

Skill: Knowledge/Comprehension

43) Which of the following statements about water is *false*?

- A) Ice is more dense than liquid water.
- B) Water naturally exists in all three physical states on Earth.
- C) Floating ice on a pond insulates the liquid water below, slowing its rate of freezing.
- D) If ice sank, the oceans would eventually freeze solid.

Answer: A

Topic: 2.12

Skill: Knowledge/Comprehension

44) You've made a hot drink by dissolving a teaspoon of instant coffee and a teaspoon of sugar in a cup of hot water. Which of the following statements is *true*?

- A) You've just prepared an aqueous solution.
- B) The water is the solute portion of the drink.
- C) The instant coffee and sugar are solvents.
- D) The instant coffee and sugar dissolve because they have no charged regions to repel the partial positive and partial negative regions of the water molecules.

Answer: A

Topic: 2.13

Skill: Application/Analysis

45) Which of the following is dependent on the ability of water molecules to form hydrogen bonds with other molecules besides water?

- A) the evaporative cooling of skin surfaces
- B) the milder temperatures of coastal regions compared to inland areas
- C) the ability of certain insects to walk on the surface of water
- D) the universality of water as a solvent

Answer: D

Topic: 2.10, 2.11, 2.13

Skill: Application/Analysis

46) Clot formation in our blood can lead to a heart attack or stroke. What was altered in the proteins that made the clot?

- A) The proteins became more polar.
- B) The blood was saturated with proteins.
- C) The proteins were no longer soluble in the blood.
- D) The proteins became more soluble in the blood.

Answer: C

Topic: 2.13

Skill: Knowledge/Comprehension

47) A pharmaceutical company hires a chemist to analyze the purity of the water being used in its drug preparations. If the water is pure, the chemist would expect to find

- A) only molecules of H_2O .
- B) H_2O molecules and H^+ ions.
- C) H_2O molecules, H^+ ions, and OH^- ions.
- D) only H^+ ions and OH^- ions.

Answer: C

Topic: 2.14

Skill: Knowledge/Comprehension

48) A liquid consisting of a uniform mixture of two or more substances is a

- A) solute.
- B) solution.
- C) solvent.
- D) dissolvent.

Answer: B

Topic: 2.14

Skill: Knowledge/Comprehension

49) A solution with a pH of 7 is

- A) strongly acidic.
- B) weakly acidic.
- C) neutral.
- D) weakly basic.

Answer: C

Topic: 2.14

Skill: Knowledge/Comprehension

50) Compared to a solution of pH 3, a solution of pH 1 is

- A) 100 times more acidic.
- B) 10 times more acidic.
- C) 10 times more basic.
- D) 100 times more basic.

Answer: A

Topic: 2.14

Skill: Knowledge/Comprehension

51) Which of the following statements about pH is *true*?

- A) The pH scale is a measure of oxygen ion concentration.
- B) A single unit change on the pH scale is equivalent to a 1% change in hydrogen ion concentration.
- C) An increase in hydrogen ion concentration means a decrease in pH scale units.
- D) Basic pH levels are less than 7.

Answer: C

Topic: 2.14

Skill: Knowledge/Comprehension

52) Household ammonia has a pH of 12; household bleach has a pH of 13. Which of the following statements about them is *true*?

- A) Both of these substances are strong acids.
- B) The ammonia has 10 times as many OH⁻ ions as the bleach.
- C) The ammonia has 10 times as many H⁺ ions as the bleach.
- D) A solution that could buffer the bleach and ammonia would remove excess OH⁻ ions.

Answer: C

Topic: 2.14

Skill: Knowledge/Comprehension

53) A buffer

A) is an acid that is used to offset overly basic conditions in the body.

B) is a base that is used to offset overly acidic conditions in the body.

C) donates H^+ ions when conditions become too basic and accepts H^+ ions when conditions become too acidic.

D) donates OH^- ions when conditions become too basic and accepts OH^- ions when conditions become too acidic.

Answer: C

Topic: 2.14

Skill: Knowledge/Comprehension

54) A diabetic, who does not utilize insulin properly, will metabolize fats instead of glucose. A condition called diabetic ketoacidosis is a common result of excessive fat metabolism, causing blood pH values of 7.1 or less (normal range = 7.35-7.45). What has happened to the blood pH and why?

A) The pH is above normal (basic) because the ketones are too basic.

B) The pH is below normal (acidic) because the buffering capacity was exceeded.

C) The pH is not affected because the blood buffers can absorb the excess H^+ .

D) The pH is below normal because buffers can donate OH^+ .

Answer: B

Topic: 2.14

Skill: Application/Analysis

55) Which of the following statements about acid precipitation is *false*?

A) Acid precipitation is defined as having a pH below 5.6.

B) Acid precipitation damages natural wilderness areas.

C) Acid precipitation is primarily the result of burning fossil fuels.

D) Acid precipitation has little or no effect on soil chemistry.

Answer: D

Topic: 2.15

Skill: Knowledge/Comprehension

56) The emission of _____ and _____ are primarily responsible for acid precipitation.

A) carbon dioxide; methane

B) nitrogen oxides; sulfur oxides

C) halones; CFCs

D) carbon dioxide; ozone

Answer: B

Topic: 2.15

Skill: Knowledge/Comprehension

57) Which of the following would be considered an effective way to decrease the production of acid precipitation?

- A) drive more full-size SUVs
- B) build more coal-generated electricity power plants
- C) discourage the use of alternative energy resources such as solar, wind, and geothermal energy
- D) whenever possible, walk or ride a bicycle instead of driving a car

Answer: D

Topic: 2.15

Skill: Synthesis/Evaluation

58) Which of the following hypotheses would be supported if liquid water were found on Mars and contained evidence of bacteria-like organisms?

- A) Life must evolve in the presence of oxygen.
- B) The chemical evolution of life is possible.
- C) Life on Earth must have originated on Mars.
- D) Life is guided by intelligent design.

Answer: B

Topic: 2.16

Skill: Application/Analysis

59) What is the dissolving of CO₂ in seawater, which lowers the ocean's pH, called?

- A) ocean acidification
- B) acid precipitation
- C) CO₂ acidification
- D) salination

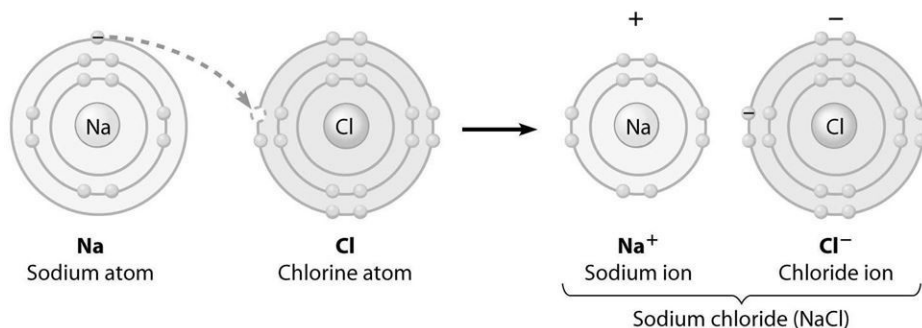
Answer: A

Topic: 2.16

Skill: Application/Analysis

2.2 Art Questions

1) What change is occurring in this figure?



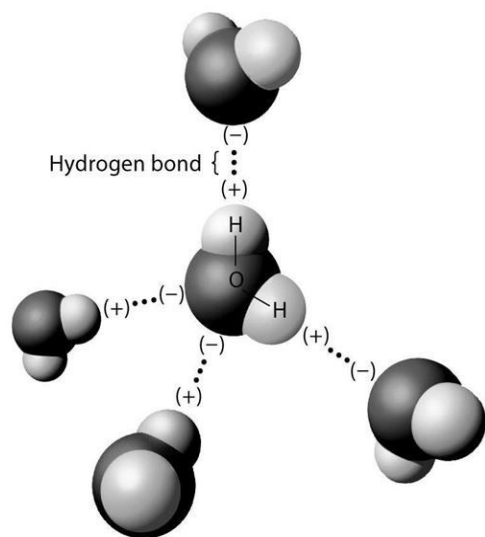
- A) Chlorine is losing an electron.
- B) Sodium is becoming negatively charged.
- C) Sodium is filling its third electron shell.
- D) Chlorine is filling its third electron shell.

Answer: D

Topic: 2.7

Skill: Knowledge/Comprehension

2) The hydrogen bonds shown in this figure are each



- A) between two hydrogen atoms.
- B) between an oxygen and a hydrogen atom of the same water molecule.
- C) between an oxygen and a hydrogen atom of different water molecules.
- D) between two atoms with the same charge.

Answer: C

Topic: 2.8

Skill: Application/Analysis

2.3 Scenario Questions

After reading the paragraph below, answer the question(s) that follow(s).

You've been experiencing acid indigestion lately, and you'd like a quick fix for the problem. You do a little research on the internet and discover that your problem is caused by excess stomach acid. In the pharmacy aisles, however, you're having a little trouble deciding what to purchase to address the problem. At the pharmacy counter, the clerk recommends that you purchase Pepcid-AC® or Alka-Seltzer® tablets.

- 1) If you could check the pH of the recommended tablets, you would expect it to be
- A) higher than 7.
 - B) lower than 7.
 - C) exactly 7.
 - D) pH neutral.

Answer: A

Topic: 2.14

Skill: Application/Analysis

- 2) If you were able to chemically analyze your stomach fluids 30 minutes after taking two tablets, you would find
- A) more hydrogen ions.
 - B) fewer hydrogen ions.
 - C) the same number of hydrogen ions.
 - D) that the pH in your stomach has decreased.

Answer: B

Topic: 2.14

Skill: Application/Analysis

After reading the paragraph below, answer the question that follows.

The ongoing search for extra-terrestrial life on distant planets focuses in part on searching for clues of water, ice, or patterns left in soil by water or ice that may have been present in the past. This approach is based on our understanding of the importance of water for life on Earth.

- 3) Which of the following statements regarding water and life is *not* correct?
- A) Most of the chemical reactions of metabolism take place in aqueous (water) solvents.
 - B) The earliest forms of life on Earth are thought to have evolved in water (oceans).
 - C) Water is an important form of energy storage in biological systems.
 - D) Water molecules are actually substrates or products of some chemical reactions in metabolism.

Answer: C

Topic: 2.17

Skill: Application/Analysis