Chapter 2
The Chemical Context of Life
Campbell/Reece 6e

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Which of the following best explains the distinction between biology and chemistry?
A) Biologists study living things, whereas chemists study nonliving things.
B) Biology has a hierarchy of structural levels, whereas chemistry does not.
C) Chemists study molecules, whereas biologists do not.
D) Chemical systems have emergent properties; biological systems do not.
E) There is no clear distinction because the two sciences are parts of the same whole.

2) Which four elements make up approximately 96% of living matter?
A) carbon, hydrogen, nitrogen, oxygen
B) carbon, sulfur, phosphorus, hydrogen
C) oxygen, hydrogen, calcium, sodium
D) carbon, sodium, chlorine, magnesium
E) carbon, oxygen, sulfur, calcium

3) Which of the following is a trace element that is essential to humans?
A) nitrogen B) calcium C) iodine D) carbon E) oxygen

4) Which of the following is a trace element that is essential to humans and other living organisms?
A) carbon B) nitrogen C) hydrogen D) iron E) oxygen

5) Each element is unique and different from other elements because of its
A) atomic weight.
B) atomic number.
C) mass number.
D) Only A and B are correct.
E) A, B, and C are correct.

6) The mass number of an element can be easily approximated by adding together the number of
A) protons and neutrons.
B) electron orbitals in each energy level.
C) protons and electrons.
D) neutrons and electrons.
E) isotopes of the atom.

7) Oxygen has an atomic number of 8. Therefore, it must have
A) 8 protons.
B) 8 electrons.
C) 16 neutrons.
D) Only A and B are correct.
E) A, B, and C are correct.

8) The atomic number of neon is 10. Therefore, it

A) has 8 electrons in the outer electron shell.

B) is inert.

C) has an atomic mass of 10.

D) Only A and B are correct.

E) A, B, and C are correct.

9) From its atomic number of 15, it is possible to predict that the phosphorus atom has

A) 15 neutrons.

B) 15 protons.

C) 15 electrons.

D) Only B and C are correct.

E) A, B, and C are correct.

10) How does one refer to an atomic form of an element containing the same number of protons but a different number of neutrons?

A) ion B) isotope C) polar atom D) isomer E) radioactive

11) How do isotopes differ from each other?

A) number of protons

B) number of electrons

C) number of neutrons

D) valence electron distribution

E) ability to form ions

12) Which of the following best describes the relationship between the atoms described below?

Atom 1	**Atom 2**
${}_{1}^{1}\mathrm{H}$	${}_{1}^{3}\mathrm{H}$

A) They are isomers.

B) They are polymers.

C) They are isotopes.

D) They are ions.

E) They are both radioactive.

13) Which of the following best describes the relationship between the atoms described below?

Atom 1	**Atom 2**
${}_{15}^{31}\mathrm{P}$	${}_{15}^{32}\mathrm{P}$

A) They are both radioactive.

B) They are both phosphorous cations.

C) They are both phosphorous anions.

D) They are both isotopes of phosphorous.

E) They contain 31 and 32 protons respectively.

14) One difference between carbon–12 $\left({}^{12}_{6}\mathrm{C}\right)$ and carbon–14 ($^{14}_{6}\mathrm{C}$) is that carbon–14 has

A) 2 more protons than carbon–12.

B) 2 more electrons than carbon–12.

C) 2 more neutrons than carbon–12.

D) Only A and C are correct.

E) A, B, and C are correct.

15) $^{3}\mathrm{H}$ is a radioactive isotope of hydrogen. One difference between hydrogen–1 ($^{1}_{1}\mathrm{H}$) and hydrogen–3 ($^{3}_{1}\mathrm{H}$) is that hydrogen–3 has

A) one more neutron and one more proton than hydrogen–1.

B) one more proton and one more electron than hydrogen–1.

C) one more electron and one more neutron than hydrogen–1.

D) two more neutrons than hydrogen–1.

E) two more protons than hydrogen–1.

16) The atomic number of carbon is 6. $^{14}\mathrm{C}$ is heavier than $^{12}\mathrm{C}$ because the atomic nucleus of $^{14}\mathrm{C}$ contains

A) six protons and six neutrons.

B) six protons and seven neutrons.

C) six protons and eight neutrons.

D) seven protons and seven neutrons.

E) eight protons and six neutrons.

17) Electrons exist only at fixed levels of potential energy. However, if an atom absorbs sufficient energy, a possible result is that

A) an electron may move to an electron shell farther out from the nucleus.

B) the atom may become a radioactive isotope.

C) an electron may move to an electron shell closer to the nucleus.

D) the atom would become a positively charged ion.

E) the atom would become a negatively charged ion.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

The following questions refer to Figure 2.1.

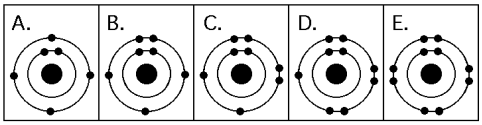


Figure 2.1

18) Which drawing depicts the electron configuration of neon ($^{20}_{10}\mathrm{Ne}$)?

19) Which drawing depicts the electron configuration of oxygen ($^{16}_{8}O$)?

20) Which drawing depicts the electron configuration of carbon ($^{12}_{6}C$)?

21) Which drawing is of an atom with the atomic number of 8?

22) Which drawing depicts an atom that is inert or chemically unreactive?

23) Which drawing depicts an atom with a valence of 3?

24) Which drawing depicts an atom with a valence of 2?

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

25) The reactive properties or chemical behavior of an atom depend on the number of
A) valence shells in the atom.
B) orbitals found in the atom.
C) electrons in each orbital in the atom.
D) electrons in the outer valence shell in the atom.
E) hybridized orbitals in the atom.

26) Atoms whose outer electron shells contain eight electrons tend to
A) form ionic bonds in aqueous solutions.
B) form covalent bonds in aqueous solutions.
C) be stable and nonreactive.
D) be unstable and very reactive.
E) be biologically important because they are present in organic molecules.

27) What are the chemical properties of atoms whose valence shells are filled with electrons?
A) They form ionic bonds in aqueous solutions.
B) They form covalent bonds in aqueous solutions.
C) They are stable and unreactive.
D) They exhibit similar chemical behaviors.
E) Both C and D are correct.

Use the information extracted from the periodic table in Figure 2.2 to answer the following questions.

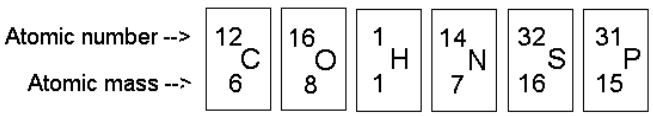


Figure 2.2

28) How many electrons does carbon have in its valence shell?
A) 4 B) 8 C) 7 D) 5 E) 2

29) How many electrons does sulfur have in its valence shell?

A) 1 B) 2 C) 4 D) 6 E) 8

30) How many neutrons does the nucleus of sulfur contain?

A) 16 B) 19 C) 32 D) 35 E) 51

31) How many neutrons does the nucleus of a nitrogen atom contain?

A) 2 B) 7 C) 8 D) 14 E) 21

32) Based on electron configuration, which of these elements would exhibit chemical behavior most like that of oxygen?

A) C B) H C) N D) S E) P

33) How many electrons would be expected in the outermost electron shell of an atom with atomic number 17?

A) 2 B) 5 C) 7 D) 8 E) 17

34) The atomic number of each atom is given to the left of each of the elements below. Which of the atoms has the same valence as carbon $(^{12}_{6}C)$?

A) 7_{nitrogen} B) 9_{fluorine} C) 10_{neon} D) $12_{\text{magnesium}}$ E) 14_{silicon}

35) What is the valence of an atom with seven electrons in its outer electron shell?

A) 1 B) 2 C) 3 D) 4 E) 5

36) How many additional electrons are needed to complete the valence shell of hydrogen?

A) 1 B) 2 C) 3 D) 4 E) 5

37) How many protons are in an atom with the atomic number of 5?

A) 1 B) 2 C) 3 D) 4 E) 5

38) What is the maximum number of electrons in the 1_s orbital?

A) 1 B) 2 C) 3 D) 4 E) 5

39) What are the maximum number of electrons in the 2_p orbital of an atom?

A) 1 B) 2 C) 3 D) 4 E) 5

40) A covalent chemical bond is one in which

A) electrons are removed from one atom and transferred to another atom so that the two atoms become oppositely charged.

B) protons or neutrons are shared by two atoms so as to satisfy the requirements of both.

C) outer–shell electrons are shared by two atoms so as to satisfactorily fill the outer electron shells of both.

D) outer–shell electrons of one atom are transferred to the inner electron shells of another atom.

E) the inner–shell electrons of one atom are transferred to the outer shell of another atom.

41) What do atoms form when they share electron pairs?

A) elements B) ions C) aggregates D) isotopes E) molecules

42) If atom ^{6}X(atomic number 6) were allowed to react with hydrogen, the molecule formed would be

A) X–H B) H–X–H C) H–X–H (H below X) D) H (H–X–H) H E) H=X=H

43) What are the maximum number of covalent bonds an element with atomic number 16 can make with hydrogen?

A) 1 B) 2 C) 3 D) 4 E) 5

44) What do the four elements most abundant in life—carbon, oxygen, hydrogen, and nitrogen—have in common?

A) They all have the same number of valence electrons.

B) Each element exists in only one isotopic form.

C) They are equal in electronegativity.

D) They are elements produced only by living cells.

E) They all have unpaired electrons in their valence shells.

45) When two atoms are equally electronegative, they will interact to form

A) equal numbers of isotopes.

B) ions.

C) polar covalent bonds.

D) nonpolar covalent bonds.

E) ionic bonds.

46) A covalent bond is likely to be polar when

A) one of the atoms sharing electrons is much more electronegative than the other atom.

B) the two atoms sharing electrons are equally electronegative.

C) the two atoms sharing electrons are of the same element.

D) it is between two atoms that are both very strong electron acceptors.

E) the two atoms sharing electrons are different elements.

47) Which of the following represents a polar covalent bond?

A) H–H B) C–C C) H–O D) C–H E) O–O

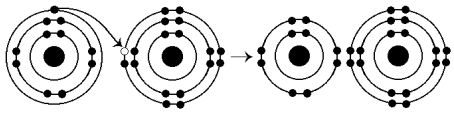


Figure 2.3

48) What results from the chemical reaction illustrated in Figure 2.3?
A) a cation with a net charge of +1
B) a cation with a net charge of –1
C) an anion with a net charge of +1
D) an anion with a net charge of –1
E) Both A and D are correct.

49) The ionic bond of sodium chloride is formed when
A) chlorine gains an electron from sodium.
B) sodium and chlorine share an electron pair.
C) sodium and chlorine both lose electrons from their outer valence shells.
D) sodium gains an electron from chlorine.
E) chlorine gains a proton from sodium.

50) What bond does NH_4 form with Cl to make ammonium chloride salt?
A) nonpolar covalent bond
B) polar covalent bond
C) ionic bond
D) hydrogen bond
E) covalent bond

51) What is the formula for ammonium chloride salt?
A) NHCl B) NH_4Cl C) NH_4Cl_2 D) $NHCl_2$ E) ClNH

52) Which atom is the cation in ammonium chloride salt?
A) NH_4 B) Cl C) H D) N E) NH_4Cl

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Use these choices to answer the following questions.

A. nonpolar covalent bond
B. polar covalent bond
C. ionic bond
D. hydrogen bond
E. hydrophobic interaction

53) Results from a transfer of electron(s) between atoms.

54) Results from an unequal sharing of electrons between atoms.

55) Explains most specifically the attraction of water molecules to one another.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

56) Nitrogen (N) is much more electronegative than hydrogen (H). Which of the following statements is *correct* about the atoms in ammonia (NH_3)?

A) Each hydrogen atom has a partial positive charge.
B) The nitrogen atom has a strong positive charge.
C) Each hydrogen atom has a slight negative charge.
D) The nitrogen atom has a partial positive charge.
E) There are covalent bonds between the hydrogen atoms.

57) Van der Waals interactions result when

A) hybrid orbitals overlap.
B) electrons are not symmetrically distributed in a molecule.
C) molecules held by ionic bonds react with water.
D) two polar covalent bonds react.
E) a hydrogen atom loses an electron.

58) Which of the following is *not* considered to be a weak molecular interaction?

A) covalent bond
B) van der Waals interactions
C) ionic bond in the presence of water
D) hydrogen bond
E) Both A and B are correct.

59) $3H_2 + N_2 \Leftrightarrow 2NH_3$
Which of the following is *true* for the above reaction?

A) The reaction is nonreversible.
B) Acid is being formed.
C) Concentrations of reactants are higher than those of products.
D) Ammonia is being formed and decomposed.
E) Hydrogen and nitrogen are being decomposed.

60) Which of the following best describes chemical equilibrium?

A) Reactions continue with no effect on the concentrations of reactants and products.
B) Concentrations of products are high.
C) Reactions have stopped.
D) Reactions stop only when all reactants have been converted to products.
E) There are equal concentrations of reactants and products.

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

A) 6 B) 8 C) +1 D) 12 E) 18

62) 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) 0 D) 5 E) 2

63) A hydrogen atom has 1 electron. How many bonds can hydrogen form?

A) 1 B) 4 C) 2 covalent bonds D) 2 ionic bonds

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

A) double covalent
B) ionic
C) nonpolar covalent
D) hydrogen
E) polar covalent

65) An element is to a(an) _____ as a tissue is to a(an) _____.

A) atom; organism
B) compound; organ
C) molecule; cell
D) atom; organ
E) compound; organelle

66) In the term *trace element,* the modifier *trace* means

A) the element is required in very small amounts.
B) the element can be used as a label to trace atoms through an organism's metabolism.
C) the element is very rare on Earth.
D) the element enhances health but is not essential for the organism's long–term survival.
E) the element passes rapidly through the organism.

67) Compared to ^{31}P, the radioactive isotope ^{32}P has

A) a different atomic number.
B) one more neutron.
C) one more proton.
D) one more electron.
E) a different charge.

68) Atoms can be represented by simply listing the number of protons, neutrons, and electrons—for example, $2p^+$; $2n^0$; $2e^-$ for helium. Which atom represents the ^{18}O isotope of oxygen?

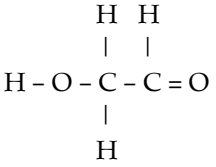
A) $6p^+$; $8n^0$; $6e^-$ B) $8p^+$; $10n^0$; $8e^-$ C) $9p^+$; $9n^0$; $9e^-$ D) $7p^+$; $2n^0$; $9e^-$ E) $10p^+$; $8n^0$; $10e^-$

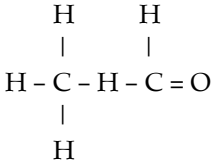
69) The atomic number of sulfur is 16. Sulfur combines with hydrogen by covalent bonding to form a compound, hydrogen sulfide. Based on the electron configuration of sulfur, we can predict that the molecular formula of the compound will be

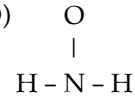
A) HS B) HS_2 C) H_2S D) H_3S_2 E) H_4S

70) Review the valences of carbon, oxygen, hydrogen, and then determine which of the following molecules is most likely to exist.

A) O = C–H

B)


C)


D)


71) The reactivity of an atom arises from

A) the average distance of the outermost electron shell from the nucleus.

B) the existence of unpaired electrons in the valence shell.

C) the sum of the potential energies of all the electron shells.

D) the potential energy of the valence shell.

E) the energy difference between the *s* and *p* orbitals.

72) Which of these statements is true of all anionic atoms?

A) The atom has more electrons than protons.

B) The atom has more protons than electrons.

C) The atom has fewer protons than does a neutral atom of the same element.

D) The atom has more neutrons than protons.

E) The net charge is minus 1.

73) What coefficients must be placed in the blanks to balance this chemical reaction?

$C_6H_{12}O_6 \rightarrow \_\_\_C_2H_6O + \_\_\_CO_2$

A) 1; 2 B) 2; 2 C) 1; 3 D) 1; 1 E) 3; 1

74) Which of the following statements correctly describes any chemical reaction that has reached equilibrium?

A) The concentration of products equals the concentration of reactants.

B) The rate of the forward reaction equals the rate of the reverse reaction.

C) Both forward and reverse reactions have halted.

D) The reaction is now irreversible.

E) No reactants remain.

Answer Key
Testname: UNTITLED3.TST

1) Answer: E
ID: bio6 2.1–1
Diff: 0
Topic:
Skill: Comprehension

2) Answer: A
ID: bio6 2.1–2
Diff: 0
Topic:
Skill: Knowledge

3) Answer: C
ID: bio6 2.1–3
Diff: 0
Topic:
Skill: Knowledge

4) Answer: D
ID: bio6 2.1–4
Diff: 0
Topic:
Skill: Knowledge

5) Answer: B
ID: bio6 2.1–5
Diff: 0
Topic:
Skill: Knowledge

6) Answer: A
ID: bio6 2.1–6
Diff: 0
Topic:
Skill: Knowledge

7) Answer: D
ID: bio6 2.1–7
Diff: 0
Topic:
Skill: Comprehension

8) Answer: D
ID: bio6 2.1–8
Diff: 0
Topic:
Skill: Comprehension

9) Answer: D
ID: bio6 2.1–9
Diff: 0
Topic:
Skill: Comprehension

10) Answer: B
ID: bio6 2.1–10
Diff: 0
Topic:
Skill: Knowledge

11) Answer: C
ID: bio6 2.1–11
Diff: 0
Topic:
Skill: Knowledge

12) Answer: C
ID: bio6 2.1–12
Diff: 0
Topic:
Skill: Comprehension

13) Answer: D
ID: bio6 2.1–13
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Topic:
Skill: Comprehension

14) Answer: C
ID: bio6 2.1–14
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Skill: Comprehension

15) Answer: D
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16) Answer: C
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Topic:
Skill: Comprehension

17) Answer: A
ID: bio6 2.1–17
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Topic:
Skill: Knowledge

18) Answer: E
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19) Answer: C
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Skill: Knowledge

20) Answer: A
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Topic:
Skill: Knowledge

21) Answer: C
ID: bio6 2.1–21
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Topic:
Skill: Comprehension

22) Answer: E
ID: bio6 2.1–22
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Topic:
Skill: Comprehension

23) Answer: B
ID: bio6 2.1–23
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Topic:
Skill: Knowledge

24) Answer: C
ID: bio6 2.1–24
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Topic:
Skill: Knowledge

25) Answer: D
ID: bio6 2.1–25
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Skill: Knowledge

26) Answer: C
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Skill: Knowledge

27) Answer: E
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28) Answer: A
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Skill: Comprehension

29) Answer: D
ID: bio6 2.1–29
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Skill: Comprehension

30) Answer: A
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Topic:
Skill: Comprehension

31) Answer: B
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Diff: 0
Topic:
Skill: Comprehension

32) Answer: D
ID: bio6 2.1–32
Diff: 0
Topic:
Skill: Application

33) Answer: C
ID: bio6 2.1–33
Diff: 0
Topic:
Skill: Comprehension

34) Answer: E
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Topic:
Skill: Application

35) Answer: A
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Topic:
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36) Answer: A
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Topic:
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37) Answer: E
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Topic:
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38) Answer: B
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Topic:
Skill: Knowledge

39) Answer: B
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Topic:
Skill: Knowledge

40) Answer: C
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Topic:
Skill: Knowledge

41) Answer: E
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Topic:
Skill: Knowledge

42) Answer: D
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Topic:
Skill: Application

43) Answer: B
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Topic:
Skill: Comprehension

44) Answer: E
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Topic:
Skill: Comprehension

45) Answer: D
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Topic:
Skill: Comprehension

46) Answer: A
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Skill: Comprehension

47) Answer: C
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Topic:
Skill: Comprehension

48) Answer: E
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Topic:
Skill: Knowledge

49) Answer: A
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Topic:
Skill: Knowledge

50) Answer: C
ID: bio6 2.1–50
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Topic:
Skill: Knowledge

51) Answer: B
ID: bio6 2.1–51
Diff: 0
Topic:
Skill: Comprehension

52) Answer: A
ID: bio6 2.1–52
Diff: 0
Topic:
Skill: Comprehension

53) Answer: C
ID: bio6 2.1–53
Diff: 0
Topic:
Skill: Knowledge

54) Answer: B
ID: bio6 2.1–54
Diff: 0
Topic:
Skill: Knowledge

55) Answer: D
ID: bio6 2.1–55
Diff: 0
Topic:
Skill: Knowledge

56) Answer: A
ID: bio6 2.1–56
Diff: 0
Topic:
Skill: Comprehension

57) Answer: B
ID: bio6 2.1–57
Diff: 0
Topic:
Skill: Knowledge

58) Answer: A
ID: bio6 2.1–58
Diff: 0
Topic:
Skill: Knowledge

59) Answer: D
ID: bio6 2.1–59
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Topic:
Skill: Comprehension

60) Answer: A
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Skill: Comprehension

61) Answer: D
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Skill:

62) Answer: D
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Topic: Web/CD Activity 2C
Skill:

63) Answer: A
ID: bio6 2.2–3
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Topic: Web/CD Activity 2E
Skill:

64) Answer: E
ID: bio6 2.2–4
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Topic: Web/CD Activity 2F
Skill:

65) Answer: B
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Diff: 0
Topic:
Skill:

66) Answer: A
ID: bio6 2.3–2
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Topic:
Skill:

67) Answer: B
ID: bio6 2.3–3
Diff: 0
Topic:
Skill:

68) Answer: B
ID: bio6 2.3–4
Diff: 0
Topic:
Skill:

69) Answer: C
ID: bio6 2.3–5
Diff: 0
Topic:
Skill:

70) Answer: B
ID: bio6 2.3–6
Diff: 0
Topic:
Skill:

71) Answer: B
ID: bio6 2.3–7
Diff: 0
Topic:
Skill:

72) Answer: A
ID: bio6 2.3–8
Diff: 0
Topic:
Skill:

73) Answer: B
ID: bio6 2.3–9
Diff: 0
Topic:
Skill:

74) Answer: B
ID: bio6 2.3–10
Diff: 0
Topic:
Skill: