

Ch. 2 The Chemical Context of Life

Questions for Chapter 2

- 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

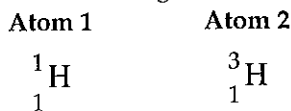
- 4) Which of the following is a trace element that is essential to humans and other living organisms?
 - A) carbon
 - B) nitrogen
 - C) hydrogen
 - D) iron
 - E) oxygen

- 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.

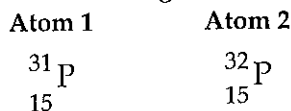
- 6) The mass number of an element can be easily approximated by adding together the number of
 - A) protons and neutrons.
 - B) electron orbitals in each energy level.
 - C) protons and electrons.
 - D) neutrons and electrons.
 - E) isotopes of the atom.

- 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?



- 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?



- 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 (${}^{12}_6\text{C}$) and carbon-14 (${}^{14}_6\text{C}$) is that carbon-14 has
- 2 more protons than carbon-12.
 - 2 more electrons than carbon-12.
 - 2 more neutrons than carbon-12.
 - Only A and C are correct.
 - A, B, and C are correct.
- 15) ${}^3_1\text{H}$ is a radioactive isotope of hydrogen. One difference between hydrogen-1 (${}^1_1\text{H}$) and hydrogen-3 (${}^3_1\text{H}$) is that hydrogen-3 has
- one more neutron and one more proton than hydrogen-1.
 - one more proton and one more electron than hydrogen-1.
 - one more electron and one more neutron than hydrogen-1.
 - two more neutrons than hydrogen-1.
 - two more protons than hydrogen-1.
- 16) The atomic number of carbon is 6. ${}^{14}\text{C}$ is heavier than ${}^{12}\text{C}$ because the atomic nucleus of ${}^{14}\text{C}$ contains
- six protons and six neutrons.
 - six protons and seven neutrons.
 - six protons and eight neutrons.
 - seven protons and seven neutrons.
 - 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
- an electron may move to an electron shell farther out from the nucleus.
 - the atom may become a radioactive isotope.
 - an electron may move to an electron shell closer to the nucleus.
 - the atom would become a positively charged ion.
 - the atom would become a negatively charged ion.

The following questions refer to Figure 2.1.

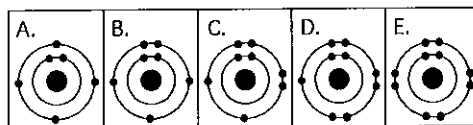


Figure 2.1

- 18) Which drawing depicts the electron configuration of neon (${}^{20}_{10}\text{Ne}$)?
- 19) Which drawing depicts the electron configuration of oxygen (${}^{16}_8\text{O}$)?

- 20) Which drawing depicts the electron configuration of carbon (^{12}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?
- 25) The reactive properties or chemical behavior of an atom depend on the number of
- valence shells in the atom.
 - orbitals found in the atom.
 - electrons in each orbital in the atom.
 - electrons in the outer valence shell in the atom.
 - hybridized orbitals in the atom.
- 26) Atoms whose outer electron shells contain eight electrons tend to
- form ionic bonds in aqueous solutions.
 - form covalent bonds in aqueous solutions.
 - be stable and nonreactive.
 - be unstable and very reactive.
 - 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?
- They form ionic bonds in aqueous solutions.
 - They form covalent bonds in aqueous solutions.
 - They are stable and unreactive.
 - They exhibit similar chemical behaviors.
 - Both C and D are correct.

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

Atomic number -->	12 C	16 O	1 H	14 N	32 S	31 P
Atomic mass -->	6	8	1	7	16	15

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 (${}^{12}_{6}\text{C}$)?
A) 7nitrogen
B) 9fluorine
C) 10neon
D) 12magnesium
E) 14silicon
- 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 $1s$ orbital?
A) 1 B) 2 C) 3 D) 4 E) 5
- 39) What are the maximum number of electrons in the $2p$ orbital of an atom?
A) 1 B) 2 C) 3 D) 4 E) 5

- 40) A covalent chemical bond is one in which
- electrons are removed from one atom and transferred to another atom so that the two atoms become oppositely charged.
 - protons or neutrons are shared by two atoms so as to satisfy the requirements of both.
 - outer-shell electrons are shared by two atoms so as to satisfactorily fill the outer electron shells of both.
 - outer-shell electrons of one atom are transferred to the inner electron shells of another atom.
 - 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?
- elements
 - ions
 - aggregates
 - isotopes
 - molecules
- 42) If atom ${}^6\text{X}$ (atomic number 6) were allowed to react with hydrogen, the molecule formed would be
- X-H
 - H-X-H
 - $$\begin{array}{c} \text{H-X-H} \\ | \\ \text{H} \end{array}$$
 - $$\begin{array}{c} \text{H} \\ | \\ \text{H-X-H} \\ | \\ \text{H} \end{array}$$
 - H=X=H
- 43) What are the maximum number of covalent bonds an element with atomic number 16 can make with hydrogen?
- 1
 - 2
 - 3
 - 4
 - 5
- 44) What do the four elements most abundant in life—carbon, oxygen, hydrogen, and nitrogen—have in common?
- They all have the same number of valence electrons.
 - Each element exists in only one isotopic form.
 - They are equal in electronegativity.
 - They are elements produced only by living cells.
 - They all have unpaired electrons in their valence shells.
- 45) When two atoms are equally electronegative, they will interact to form
- equal numbers of isotopes.
 - ions.
 - polar covalent bonds.
 - nonpolar covalent bonds.
 - ionic bonds.
- 46) A covalent bond is likely to be polar when
- one of the atoms sharing electrons is much more electronegative than the other atom.
 - the two atoms sharing electrons are equally electronegative.
 - the two atoms sharing electrons are of the same element.
 - it is between two atoms that are both very strong electron acceptors.
 - the two atoms sharing electrons are different elements.
- 47) Which of the following represents a polar covalent bond?
- H-H
 - C-C
 - H-O
 - C-H
 - O-O

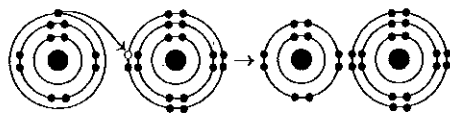


Figure 2.3

- 48) What results from the chemical reaction illustrated in Figure 2.3?
- a cation with a net charge of +1
 - a cation with a net charge of -1
 - an anion with a net charge of +1
 - an anion with a net charge of -1
 - Both A and D are correct.
- 49) The ionic bond of sodium chloride is formed when
- chlorine gains an electron from sodium.
 - sodium and chlorine share an electron pair.
 - sodium and chlorine both lose electrons from their outer valence shells.
 - sodium gains an electron from chlorine.
 - chlorine gains a proton from sodium.
- 50) What bond does NH_4 form with Cl to make ammonium chloride salt?
- nonpolar covalent bond
 - polar covalent bond
 - ionic bond
 - hydrogen bond
 - 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 |
|------------------|-------|------|------|---------------------------|

Use these choices to answer the following questions.

- nonpolar covalent bond
 - polar covalent bond
 - ionic bond
 - hydrogen bond
 - 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.

- 56) Nitrogen (N) is much more electronegative than hydrogen (H). Which of the following statements is *correct* about the atoms in ammonia (NH₃)?
- 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) $3\text{H}_2 + \text{N}_2 \rightleftharpoons 2\text{NH}_3$
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.