**Test questions for Chapter 3**

**Compounds and Molecules**

1. Below are two charged particles. What will they do when in close proximity to one another?

+ −

* 1. They will do nothing.
  2. The particle on the left will transfer its positive charge to the particle on the right.
  3. The particle on the right will transfer its negative charge to the particle on the left.
  4. They will attract one another.
  5. They will repel one another.

Ans: d Level of difficulty: easy Section: 3.1

1. In an ionic compound,
   1. nonmetals share electrons.
   2. nonmetals donate electrons to metals.
   3. metals are attracted to one another.
   4. metals share electrons.
   5. cations and anions are attracted to one another.

Ans: e Level of difficulty: easy Section: 3.1

1. Below are two ions (not drawn to scale). What will they do when in close proximity to one another?

Na+ Cl−

* 1. They will attract one another, forming an ionic compound.
  2. They will attract one another, forming a covalent bond.
  3. The sodium ion will transfer a proton to chloride.
  4. The chloride ion will transfer an electron to sodium.
  5. They will do nothing.

Ans: a Level of difficulty: easy Section: 3.1

1. Nonmetals typically \_\_\_\_\_\_ and metals typically \_\_\_\_\_\_.
   1. donate electrons; accept electrons
   2. accept electrons; donate electrons
   3. donate protons; accept protons
   4. accept protons; donate protons
   5. donate neutrons; accept neutrons

Ans: b Level of difficulty: medium Section: 3.1

1. Which of the following ions is a polyatomic ion?
   1. NH4+
   2. Mg2+
   3. O2-
   4. O2
   5. C2H6

Ans: a Level of difficulty: medium Section: 3.1

1. A polyatomic ion
   1. has many atoms, one of which has gained or lost electrons.
   2. is a molecule that has gained or lost electrons.
   3. has many atoms, one of which has gained or lost protons.
   4. is a molecule that has gained or lost protons.
   5. has many charges.

Ans: b Level of difficulty: easy Section: 3.1

1. What is the meaning of the symbol below?

[PO4]3-

1. The phosphorous has three more electrons than protons.
2. Three oxygens each have one more electron than protons.
3. Each of the four oxygens has three more electrons than protons.
4. The ion has three more electrons than protons.
5. The 3− means that the molecule has lost three electrons.

Ans: d Level of difficulty: hard Section: 3.1

1. An important part of writing a formula unit for an ionic compound is to make sure that
   1. the charges of the ions add up to zero.
   2. there is never more than one type of cation and one type of anion in the formula.
   3. the ionic compound actually exists in nature.
   4. the anion is written first, followed by the cation.
   5. the ratio of cation to anion is 1:1.

Ans: a Level of difficulty: easy Section: 3.1

1. What is the charge on iron in the ionic compound FeCl3?
   1. +3
   2. +1
   3. 0
   4. −1
   5. −3

Ans: a Level of difficulty: medium Section: 3.1

1. Calcium carbonate has the formula CaCO3. What is the charge on the polyatomic carbonate ion?
   1. +2
   2. +1
   3. 0
   4. −1
   5. −2

Ans: e Level of difficulty: medium Section: 3.1

1. Which of the following is not a valid ionic formula?
   1. NaF
   2. MgO
   3. KCl2
   4. CaF2
   5. Na2O

Ans: c Level of difficulty: hard Section: 3.1

1. People on a low salt diet use a potassium chloride substitute for sodium chloride. Which of the following is a valid ionic formula for potassium chloride?
   1. NaCl
   2. NaCl2
   3. KCl2
   4. KCl
   5. K2Cl

Ans: d Level of difficulty: medium Section: 3.1

1. Magnesium chloride is sometimes administered orally to suppress premature labor. Which of the following is a valid ionic formula for magnesium chloride?
   1. Mg2Cl2
   2. Mg2Cl
   3. MgCl
   4. MgCl2
   5. None of the above choices are magnesium chloride.

Ans: d Level of difficulty: medium Section: 3.1

1. The following ionic formula is not valid. Which of the following statements best describes what’s wrong with this formula?

AlCl2

* 1. It does not include both a nonmetal and a metal.
  2. The ratio of cations to anions is not 1:1.
  3. The anion is written first, followed by the cation.
  4. This compound does not exist in nature.
  5. The charges do not add up to zero.

Ans: e Level of difficulty: medium Section: 3.1

1. What ionic compound has the formula Na2O?
   1. disodium oxide
   2. sodium oxide
   3. sodium dioxide
   4. sodium oxygen
   5. disodium oxygen

Ans: b Level of difficulty: medium Section: 3.1

1. Which of the following is the formula for an ionic compound called calcium(II) chloride?
   1. C(II)Cl
   2. Ca(II)Cl
   3. Ca2Cl
   4. C2Cl
   5. CaCl2

Ans: e Level of difficulty: medium Section: 3.1

1. An intravenous therapy called Ringer’s solutions contains calcium and chloride along with other components.What is the charge on calcium in this ionic compound that forms from calcium and chlorine?

a. +1 b. −1 c. +2 d. −2 e. +3

Ans: c Level of difficulty: medium Section: 3.1

1. What is the charge on each chlorine in an ionic compound composed of calcium and chlorine?

a. +1 b. −1 c. +2 d. −2 e. +3

Ans: a Level of difficulty: medium Section: 3.1

1. What is the ionic formula for the ionic compound composed of calcium and chloride?
2. Ca­2Cl
3. CaCl
4. Ca­2Cl2
5. Ca2Cl3
6. CaCl2

Ans: e Level of difficulty: medium Section: 3.1

1. What is the name of the ionic compound that is composed of calcium and chlorine?
2. calcium dichloride
3. dicalcium trichloride
4. dicalcium chloride
5. calcium chloride
6. dicalcium dichloride

Ans: d Level of difficulty: medium Section: 3.1

1. A compound contains magnesium and phosphate. What is the formula unit of this compound?
2. Mg3P2
3. MgPO4
4. Mg3(PO4)2
5. Mg2(PO4)3
6. MgHPO4

Ans: c Level of difficulty: hard Section: 3.1

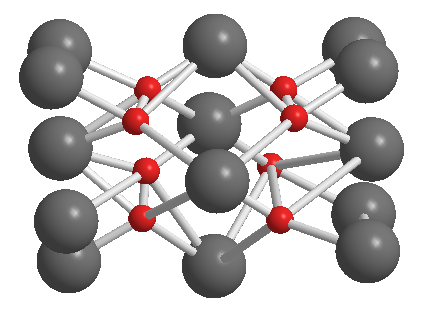
1. What is the name of Na2SO3, a preservative in many foods and drinks?
   1. sodium sulfite
   2. sodium sulfate
   3. disodium sulfur trioxide
   4. sodium sulfur trioxide
   5. disodium trisulfite

Ans: a Level of difficulty: medium Section: 3.1

1. What is the name of CaCO3, a common calcium supplement and antacid?
2. calcium carbon trioxide
3. calcium bicarbonate
4. calcium carbonate
5. calcium cyanide
6. calcium chlorite

Ans: c Level of difficulty: medium Section: 3.1

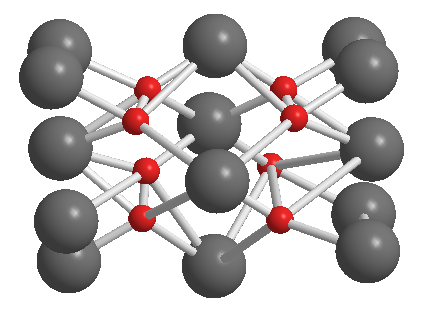
1. What is the ratio of ions in this lattice of lithium (the larger spheres) and oxygen (the smaller spheres) in *Li2O*?



* 1. 1 Li:1 O
  2. 2 Li:1 O
  3. 2 O:1 Li
  4. 4 O:5 Li
  5. 4 Li:5 O

Ans: b Level of difficulty: hard Section: 3.1

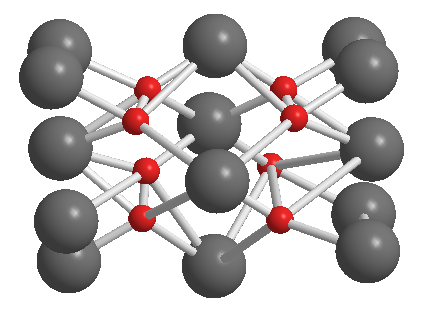
1. What are the charges on the ions that make up this lattice of lithium (the larger spheres) and oxygen (the smaller spheres) in *Li2O*?



1. Li has a −1 charge and O has a +1 charge.
2. Li has a +1 charge and O has a −1 charge.
3. Li has a −1 charge and O has a +2 charge.
4. Li has a +1 charge and O has a −2 charge.
5. Neither lithium nor oxygen is charged.

Ans: d Level of difficulty: medium Section: 3.1

1. Why does the lattice of Li2O below show more ions than the formula unit?



* 1. The formula unit is a ratio of cations and anions, not the absolute number of ions.
  2. There is an error in the formula unit.
  3. The formula unit is just a way to balance charge; it doesn’t mean anything physically.
  4. The formula was written before the true structure was determined.
  5. The lattice and the formula are unrelated.

Ans: a Level of difficulty: easy Section: 3.1

1. An ion that has more electrons than protons is a(n) \_\_\_\_\_\_\_\_.

a. cation

b. anion

c. ionic bond

d. covalent bond

e. salt

Ans: b Level of difficulty: easy Section: 3.1

1. Iron(II) is an example of a(n) \_\_\_\_\_\_\_\_.

a. cation

b. anion

c. ionic bond

d. covalent bond

e. salt

Ans: a Level of difficulty: easy Section: 3.1

1. Another name for an ionic compound is a(n) \_\_\_\_\_\_\_\_.

a. cation

b. anion

c. ionic bond

d. covalent bond

e. salt

Ans: e Level of difficulty: easy Section: 3.1

1. Electrons shared between two atoms is a(n) \_\_\_\_\_\_\_.

a. cation

b. anion

c. ionic bond

d. covalent bond

e. salt

Ans: d Level of difficulty: medium Section: 3.2

1. Below are four molecules and compounds. Choose the statement below that best describes these four.

CH2O Ti2O3 MgO H2O

**I II III IV**

a. All of these are ionic compounds.

b. I and II are covalent molecules, whereas III and IV are ionic.

c. II and III are ionic, whereas I and IV are covalent.

d. I, III, and IV and covalent, whereas II is ionic.

e. All of these are covalent molecules.

Ans: c Level of difficulty: medium Section: 3.2

1. In a covalent molecule,
   1. nonmetals share electrons.
   2. nonmetals donate electrons to metals.
   3. metals donate electrons to nonmetals.
   4. metals share electrons.
   5. cations and anions are attracted to one another.

Ans: a Level of difficulty: easy Section: 3.2

1. Vinegar (C2H4O2) and baking soda (NaHCO3) are combined together and the resulting mixture bubbles, releasing a gas. This gas is a(n)
2. ionic compound because ionic compounds can be gases at room temperature.
3. ionic compound because baking soda contains sodium.
4. covalent compound because covalent compounds can be gases at room temperature.
5. covalent compound because baking soda contains sodium.
6. It is neither a molecule nor an ionic compound.

Ans: c Level of difficulty: hard Section: 3.2

1. Which of the following is a diatomic molecule?
2. N2
3. NaCl
4. H2O
5. CO
6. Li2O

Ans: a Level of difficulty: easy Section: 3.2

1. Below is an illustration of an atom of fluorine. Which arrow points to the part of the atom involved in bonding?

A

B

C

7 e−

2 e−

a. A

b. B

c. C

d. Both B and C

e. None of the above are involved in bonding.

Ans: c Level of difficulty: easy Section: 3.2

1. Which of the following is the best name for the compound SF6, a potent greenhouse gas?
   1. sulfur fluorine
   2. sulfur fluoride
   3. sulfur hexafluoride
   4. sulfur pentafluoride
   5. monosulfur fluoride

Ans: c Level of difficulty: easy Section: 3.2

1. “Laughing gas” has the formula N2O. Which of the following is the best name for this compound?
2. nitrogen oxygen
3. nitrogen oxide
4. nitrogen dioxide
5. dinitrogen monoxide
6. nitrogen(II) oxide

Ans: d Level of difficulty: medium Section: 3.2

1. What is the name of CS2, an industrial solvent?
2. carbon sulfite
3. carbon sulfide
4. carbon disulfide
5. carbon sulfur
6. carbon disulfur

Ans: c Level of difficulty: easy Section: 3.2

1. Carbon tetrafluoride is a refrigerant and potent greenhouse gas. Which of the following is the molecular formula for this compound?
2. CF
3. C(IV)F
4. C4F4
5. C4F
6. CF4

Ans: e Level of difficulty: easy Section: 3.2

1. In this covalent molecule of methane,



methane

1. carbon is sharing its four electrons with the hydrogens.
2. carbon has donated four electrons to hydrogen, leaving it with a charge of +4.
3. hydrogen has eight electrons in its valence shell.
4. carbon is very unstable.
5. carbon does not have an octet of electrons.

Ans: a Level of difficulty: easy Section: 3.2

1. The arrow is pointing to a(n)



methane

1. triple bond.
2. double bond.
3. single bond.
4. electron.
5. valence shell.

Ans: c Level of difficulty: easy Section: 3.2

1. The total number of valence electrons in methane is



1. 2.
2. 4.
3. 8.
4. 16.
5. 40.

Ans: c Level of difficulty: medium Section: 3.2

1. Select the statement that best differentiates between bonding and nonbonding electrons.
   1. There are always more bonding electrons than lone pairs in a molecule.
   2. Nonbonding electrons are less chemically important than bonding electrons.
   3. Nonbonding electrons do not count toward an atom’s octet of electrons.
   4. Bonding electrons are shared and nonbonding electrons are not shared.
   5. The more nonbonding electrons that an atom has, the more unstable the atom.

Ans: d Level of difficulty: easy Section: 3.2

1. Which of these structures is a diatomic molecule?

 I II III IV V

1. I
2. II
3. III
4. IV
5. V

Ans: a Level of difficulty: easy Section: 3.2

1. Which of these structures has two nonbonding pairs of electrons?



I II III IV V

1. I and II
2. II only
3. III only
4. IV and V
5. III, IV, and V

Ans: e Level of difficulty: medium Section: 3.2

1. Which of the structures contains a double bond?



I II III IV V

1. I
2. II
3. III
4. IV
5. V

Ans: d Level of difficulty: easy Section: 3.2

1. Which of these structures represent ionic compounds?



I II III IV V

1. I and III
2. I and IV
3. IV and V
4. II and IV
5. I and V

Ans: e Level of difficulty: easy Section: 3.2

1. Which of the structures are covalent molecules?



I II III IV V

1. I and V
2. II, III, and IV
3. II and IV
4. V only
5. All of the choices are covalent molecules.

Ans: b Level of difficulty: easy Section: 3.2

1. In which of the structures are six electrons being shared between two atoms?



I II III IV V

1. I
2. II
3. III
4. IV
5. V

Ans: c Level of difficulty: medium Section: 3.2

1. Which of the following Lewis dot structures best represents the chlorine atom?



a. b. c. d. e.

Ans: b Level of difficulty: easy Section: 3.2

1. How many of chlorine’s electrons are unpaired?
   1. 0
   2. 1
   3. 2
   4. 3
   5. 4

Ans: b Level of difficulty: medium Section: 3.2

1. How many bonds is chlorine most likely to form?
   1. 0
   2. 1
   3. 2
   4. 3
   5. 4

Ans: b Level of difficulty: medium Section: 3.2

1. Lewis electron dot structures represent the
   1. number of unpaired electrons in an atom.
   2. total number of electrons in the atom.
   3. number of protons in the atom.
   4. number of valence electrons.
   5. number of nonbonding electrons.

Ans: d Level of difficulty: easy Section: 3.2

1. Which of the following statements best describes the behavior of period 2 elements in a covalent molecule?
   1. Period 2 elements lose electrons.
   2. Period 2 elements gain electrons.
   3. The nonmetals in period 2 form bonds so that they have a valence shell with eight electrons.
   4. The nonmetals in period 2 form bonds so that they have a valence shell with two electrons.
   5. Period 2 elements are not alike in any way.

Ans: c Level of difficulty: medium Section: 3.2

1. In general, how many bonds does a nonmetal in the second period 2 form?
   1. the same number as the number of nonbonding electrons in the atom
   2. the same number as the number of unpaired electrons in the atom
   3. the same number as the total number of electrons in the atom
   4. eight, in accordance with the octet rule
   5. It is impossible to predict the number.

Ans: b Level of difficulty: medium Section: 3.2

1. In general, how do elements in group 6A behave when they are a part of a covalent bond?
   1. These elements form two bonds to other nonmetals.
   2. These elements form one bond to another nonmetal.
   3. These elements donate two electrons to a metal.
   4. These elements accept two electrons from a metal.
   5. These elements do not interact with other elements.

Ans: a Level of difficulty: easy Section: 3.2

1. Which of the following is the best Lewis structure for a molecule with the formula HCN?



a. b. c. d. e.

Ans: e Level of difficulty: hard Section: 3.2

1. What is the most likely connectivity of the atoms in chloroethylene (*C2H3Cl*)?



a. b. c. d. e.

Ans: a Level of difficulty: medium Section: 3.2

1. What is the total number of valence electrons in the chloroethylene molecule (*C2H3Cl*)?
   1. 6
   2. 18
   3. 21
   4. 32
   5. 62

Ans: b Level of difficulty: medium Section: 3.2

1. How many nonbonding electrons are in the chloroethylene molecule (*C2H3Cl*)?
   1. None
   2. 6
   3. 8
   4. 10
   5. 18

Ans: b Level of difficulty: medium Section: 3.2

1. How many multiple bonds are in the chloroethylene molecule (*C2H3Cl*)?
   1. None
   2. 1 double bond
   3. 1 triple bond
   4. 2 double bonds
   5. 1 double and 1 triple bond

Ans: b Level of difficulty: medium Section: 3.2

1. Which of the following is the best Lewis structure for a molecule with the formula C2H3Cl?



a. b. c. d. e.

Ans: c Level of difficulty: medium Section: 3.2

1. Which of the following elements might have an expanded octet in a covalent molecule?
   1. No elements have an expanded octet.
   2. Atoms in period 2 might have an expanded octet.
   3. Atoms in period 3 might have an expanded octet.
   4. Any of the atoms in group two might have an expanded octet.
   5. Any of the atoms in group three might have an expanded octet.

Ans: c Level of difficulty: easy Section: extension 3-1

1. Which of the following statements best describes the meaning of an expanded octet?
   1. “Expanded octets” are molecules in which an element expands its valence shell to gain an octet of electrons.
   2. “Expanded octets” is a term that describes atoms that have more than eight electrons in their valence shells.
   3. “Expanded octets” refers to atoms that, when bonded, must be larger than normal.
   4. “Expanded octets” is used to describe elements that do not normally form an octet when bonded and would therefore have to expand to form the octet.
   5. “Expanded octets” is used to describe how atoms accept electrons to attain a full valence shell.

Ans: b Level of difficulty: medium Section: extension 3-1

1. Which of the molecules below contain an atom with an expanded octet?



**I II III IV**

1. I and II
2. III only
3. IV only
4. I, II, and III
5. All of these molecules have an expanded octet.

Ans: a Level of difficulty: medium Section: extension 3-1

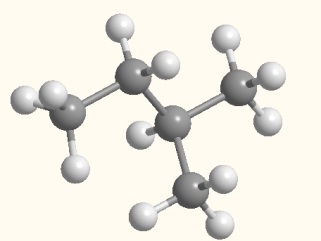
1. What feature of a molecule is illustrated by the ball-and-stick model of ethane on the left that is not illustrated by the Lewis dot structure on the right?



* 1. Nothing, these models illustrate the same thing.
  2. the bonds
  3. the types of atoms
  4. the three-dimensional shape of the molecule
  5. the core electrons

Ans: d Level of difficulty: easy Section: 3.3

1. Which Lewis dot structure is the same molecule as 2-methylbutane, shown below in its ball-and-stick model?



2-methylbutane



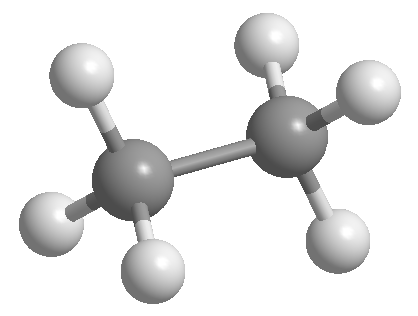
a. b. c. d. e.

Ans: a Level of difficulty: easy Section: 3.3

1. Why are there many different ways to model and draw molecules?
   1. There is no reason for this except to confuse students.
   2. Each type of model and way of drawing communicates different characteristics of an actual molecule.
   3. In different parts of the world, molecules are drawn differently.
   4. As our understanding of the atom changed over time, we developed more accurate ways of drawing atoms and molecules.
   5. Actually, there is currently only one correct way to draw or model a molecule.

Ans: b Level of difficulty: easy Section: 3.3

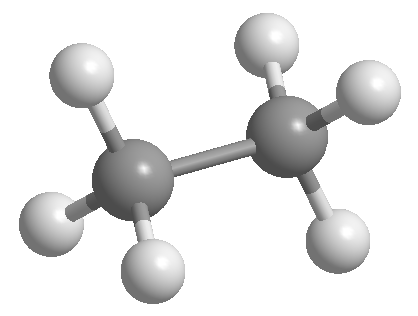
1. This is a \_\_\_\_\_\_\_ model of a molecule.



1. ball-and-stick
2. space-filling
3. Lewis
4. wire frame
5. tube

Ans: a Level of difficulty: easy Section: 3.3

1. In this model of ethane, the dark grey balls represent \_\_\_\_\_\_\_ and the white balls represent \_\_\_\_\_\_\_.



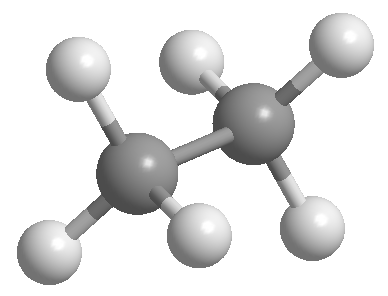
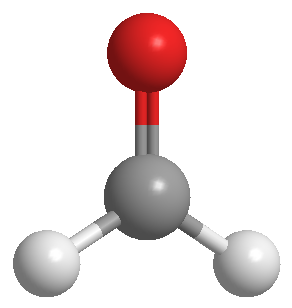
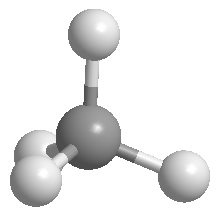
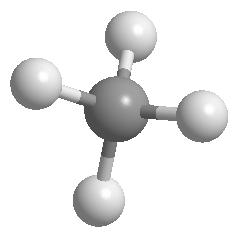
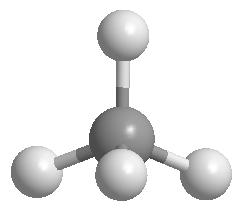
1. nitrogen; hydrogen
2. oxygen; hydrogen
3. hydrogen; oxygen
4. carbon; hydrogen
5. hydrogen; carbon

Ans: d Level of difficulty: easy Section: 3.3

1. What does a ball-and-stick model show clearly that a space-filling model does not?
2. relative atom size
3. relative bond length
4. relative bond strength
5. bond angle
6. atom identity

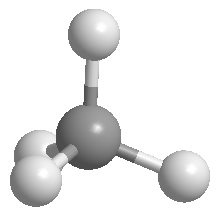
Ans: d Level of difficulty: medium Section: 3.3

1. Which of the following models does NOT contain a carbon with tetrahedral geometry? Assume that all atoms in all structures are visible.

a.  b.  c.  d. e. 

Ans: b Level of difficulty: easy Section: 3.3

1. Which of the following wedge-dash drawings best represents the ball-and-stick model of methane as it is drawn below?



Methane



a. b. c. d. e.

Ans: c Level of difficulty: easy Section: 3.3

1. What is the meaning of the “wedge bond” in the following structure?



1. This bond projects toward the viewer.
2. This bond projects away from the viewer.
3. This bond is in the plane of the paper.
4. These are nonbonding electrons.
5. It has no particular meaning.

Ans: a Level of difficulty: easy Section: 3.3

1. The structure below is the Lewis structure of methane. The Lewis structure tells us many things about methane that are useful. However, it also suggests one characteristic of methane that is, in fact, false. What is this one characteristic?



1. The Lewis structure suggests that carbon has a full valence shell, but it really doesn’t.
2. The Lewis structure suggests that carbon has four bonds, but it really doesn’t.
3. The Lewis structure suggests that carbon is bonded to four hydrogens, but it really isn’t.
4. The Lewis structure suggests that methane is flat, but it really isn’t.
5. The Lewis structure suggests that methane is stable, but it really isn’t.

Ans: d Level of difficulty: easy Section: 3.3

1. Which statement best describes the difference between electron geometry and molecular shape?
2. There is no real difference between these terms.
3. Electron geometry is two dimensional, whereas molecule shapes are three dimensional.
4. Electron geometry is theoretical, whereas molecular shape is real.
5. Electron geometry refers to the arrangement of electrons around a central atom, whereas molecular shape refers to the arrangement of atoms.
6. Answers b, c, and d are all true.

Ans: d Level of difficulty: easy Section: 3.3

1. What is the purpose of Valence Shell Electron Pair Repulsion (VSEPR) theory?
2. To predict which atom is the central atom in a Lewis structure.
3. To identify the lone pair and valence electrons in a molecule.
4. To determine the shape of a molecule from the Lewis structure.
5. To determine the shape of a molecule from a molecular model.
6. To determine the arrangement of valence electrons in an atom.

Ans: c Level of difficulty: medium Section: 3.3

1. Why do electrons around a central atom arrange themselves as far apart from one another as possible, while still remaining attached to the central atom?
2. Actually, electrons don’t do this, but atoms do.
3. The like charges of the electrons attract each other.
4. The protons direct the electrons to do this.
5. The like charges of the electrons repel each other.
6. There is no reason for this arrangement, it is just observed to be that way.

Ans: d Level of difficulty: easy Section: 3.3

1. When determining the shape of a molecule, it is necessary to count electron groups. Which of the following is NOT an electron group?
2. a single bond
3. a double bond
4. a triple bond
5. a core electron
6. a nonbonding pair of electrons.

Ans: d Level of difficulty: easy Section: 3.3

1. This table shows the relationship between the number of electron groups, the resulting electron geometries, and the corresponding angles between groups of electrons. Some of the blanks in the table have been filled in for you. The angle in the cell labeled A in the above table should be:

|  |  |  |
| --- | --- | --- |
| # of electron groups | Electron geometry | Angle between groups of electrons |
| *2* | *Linear* | A |
| *3* | B | *120º* |
| *4* | C | D |

1. 360º
2. 180º
3. 120º
4. 109.5º
5. 90º

Ans: b Level of difficulty: easy Section: 3.3

1. What is the angle between groups of electrons for an atom that has a trigonal planar electron geometry?
   1. 90°
   2. 120°
   3. 180°
   4. 105°
   5. 360°

Ans: b Level of difficulty: medium Section: 3.3

1. What is the electron geometry of the carbon in formaldehyde, shown below?



1. linear
2. bent
3. trigonal planar
4. trigonal pyramidal
5. tetrahedral

Ans: c Level of difficulty: medium Section: 3.3

1. What is the molecular shape of the carbon in formaldehyde, shown below?



1. linear
2. bent
3. trigonal planar
4. trigonal pyramidal
5. tetrahedral

Ans: c Level of difficulty: easy Section: 3.3

1. What is the electron geometry of the oxygen in methanol, shown below?



1. linear
2. bent
3. trigonal planar
4. trigonal pyramidal
5. tetrahedral

Ans: e Level of difficulty: medium Section: 3.3

1. What is the molecular shape of the oxygen in methanol, shown below?



1. linear
2. bent
3. trigonal planar
4. trigonal pyramidal
5. tetrahedral

Ans: b Level of difficulty: medium Section: 3.3

1. An atom, X, has a tetrahedral electron geometry but a trigonal pyramidal molecular shape. How many atoms is atom X bonded to?
2. 0
3. 1
4. 2
5. 3
6. 4

Ans: d Level of difficulty: hard Section: 3.3

1. An atom in a molecule has a trigonal planar molecular shape and a formula of MX3. What is the angle between the atoms in this molecule?
2. 360º
3. 180º
4. 120º
5. 109.5º
6. 90º

Ans: c Level of difficulty: medium Section: 3.3

1. Atom X in a molecule has tetrahedral electron geometry but a bent molecular shape. Which of the following describes the identity of atom X?
2. Atom X is the oxygen in a molecule of H2O.
3. Atom X is the nitrogen in a molecule of NH3.
4. Atom X is the hydrogen in a molecule of CH4.
5. Atom X is the carbon in a molecule of CH4.
6. Atom X could be any of these atoms.

Ans: a Level of difficulty: hard Section: 3.3

1. An atom in a molecule has two lone pairs and two atoms bonded to it. What is the molecular shape of this atom?
2. linear
3. bent
4. trigonal planar
5. trigonal pyramidal
6. tetrahedral

Ans: a Level of difficulty: hard Section: 3.3

1. Which of the following steps is done first to determine the molecular shape of dichloromethane (*CH2Cl2*)?
2. Calculate the molecular weight.
3. Look up the bond angle of a H-C-H bond.
4. Determine the electron geometry.
5. Construct the Lewis structure.
6. The molecular shape can be determined without doing any prior steps.

Ans: d Level of difficulty: easy Section: 3.3

1. How many lone pairs are on the carbon in dichloromethane (*CH2Cl2*)?
2. 0
3. 1
4. 2
5. 3
6. 4

Ans: a Level of difficulty: easy Section: 3.3

1. How many atoms are bonded to the carbon in dichloromethane (*CH2Cl2*)?
2. 0
3. 1
4. 2
5. 3
6. 4

Ans: e Level of difficulty: easy Section: 3.3

1. What is the electron geometry of dichloromethane (*CH2Cl2*)?
2. linear
3. bent
4. trigonal planar
5. trigonal pyramidal
6. tetrahedral

Ans: e Level of difficulty: easy Section: 3.3

1. What is the molecular shape of dichloromethane (*CH2Cl2*)?
2. linear
3. bent
4. trigonal planar
5. trigonal pyramidal
6. tetrahedral

Ans: e Level of difficulty: easy Section: 3.3

1. Ethylene is used as a starting material in making plastics. It has a molecular formula of C2H4.Which of the following structures is the correct Lewis dot structure for ethylene?



a. b. c. d. e.

Ans: a Level of difficulty: easy Section: 3.3

1. In addition to single bonds, which of the following electron groups do the carbons in ethylene (*C2H4*) have?
   1. a double bond
   2. a triple bond
   3. a single electron
   4. a lone pair of electrons
   5. None of the above

Ans: a Level of difficulty: easy Section: 3.3

1. How many electron groups do the carbons in ethylene (*C2H4*) have?
2. They both have 1.
3. They both have 2.
4. They both have 3.
5. They both have 4.
6. One has 2 and the other has 4.

Ans: c Level of difficulty: easy Section: 3.3

1. What is the electron geometry of each carbon in ethylene (*C2H4*)?
2. They are both linear.
3. They are both trigonal planar.
4. They are both tetrahedral.
5. One is linear and the other is trigonal planar.
6. One is linear and the other is tetrahedral.

Ans: b Level of difficulty: easy Section: 3.3

1. What is the molecular shape of each carbon in ethylene (*C2H4*)?
2. They are both linear.
3. They are both trigonal planar.
4. They are both bent.
5. One is bent and the other is trigonal planar.
6. One is bent and the other is tetrahedral.

Ans: b Level of difficulty: easy Section: 3.3

1. What is the H-C-H bond angle of each carbon in ethylene (*C2H4*)?
2. Both are 180º.
3. Both are 120º.
4. Both are 109.5º.
5. One is 180º and the other is 109.5º.
6. One is 120º and the other is 109.5º.

Ans: b Level of difficulty: medium Section: 3.3

1. Methylamine has a molecular formula of CH5N and an odor of rotten fish. Which of the following structures is the correct Lewis dot structure for methylamine?



a. b. c. d. e.

Ans: d Level of difficulty: easy Section: 3.3

1. In addition to single bonds, which of the following electron groups are on the nitrogen of methylamine (CH5N)?
   1. a double bond
   2. a triple bond
   3. a single electron
   4. a lone pair of electrons
   5. None of the above

Ans: d Level of difficulty: easy Section: 3.3

1. In addition to single bonds, which of the following electron groups are on the nitrogen of methylamine (CH5N)?
   1. a double bond
   2. a triple bond
   3. a single electron
   4. a lone pair of electrons
   5. None of the above

Ans: e Level of difficulty: easy Section: 3.3

1. How many electron groups are found on the carbon and the nitrogen methylamine (CH5N)?
2. They both have four.
3. Carbon has four and nitrogen has five.
4. Nitrogen has five and carbon has four.
5. Carbon has three and nitrogen has four.
6. Nitrogen has three and carbon has four.

Ans: a Level of difficulty: medium Section: 3.3

1. What is the electron geometry of the carbon and the nitrogen in methylamine (CH5N)?
2. Nitrogen is trigonal planar and carbon is tetrahedral.
3. Carbon is tetrahedral and nitrogen is bent.
4. Nitrogen is trigonal pyramidal and carbon is tetrahedral.
5. Carbon is linear and nitrogen is tetrahedral.
6. Both of them are tetrahedral.

Ans: e Level of difficulty: medium Section: 3.3

1. What is the molecular shape of carbon and nitrogen in methylamine (CH5N)?
2. Nitrogen is trigonal planar and carbon is tetrahedral.
3. Carbon is tetrahedral and nitrogen is bent.
4. Nitrogen is trigonal pyramidal and carbon is tetrahedral.
5. Carbon is linear and nitrogen is tetrahedral.
6. Both of them are tetrahedral.

Ans: c Level of difficulty: hard Section: 3.3

1. A polar molecule is one that has
2. one large atom and one small atom.
3. an even distribution of charge.
4. a positive or negative charge.
5. a more positive side and a more negative side.
6. only polar atoms.

Ans: d Level of difficulty: easy Section: 3.4

1. Electronegativity is a measure of an atom’s ability to
2. become an anion.
3. ionize.
4. draw electrons to itself in a covalent bond.
5. accept an electron from a metal.
6. donate an electron to a nonmetal.

Ans: c Level of difficulty: easy Section: 3.4

1. Which elements have the highest electronegativity and why?
2. The nonmetals, because they accept electrons in order to attain an octet
3. The metals, because they accept electrons in order to attain an octet
4. The nonmetals, because they donate electrons in order to attain an octet
5. The metals, because they donate electrons in order to attain an octet
6. The transition metals, because they can have different charges

Ans: a Level of difficulty: easy Section: 3.4

1. Which of the following elements is the least electronegative?
2. potassium
3. hydrogen
4. fluorine
5. carbon
6. oxygen

Ans: a Level of difficulty: easy Section: 3.4

1. Which of the following elements is the most electronegative?
2. fluorine
3. bromine
4. chlorine
5. iodine
6. boron

Ans: a Level of difficulty: easy Section: 3.4

1. Which of the following elements is the most electronegative?
2. nitrogen
3. carbon
4. oxygen
5. sulfur
6. selenium

Ans: c Level of difficulty: easy Section: 3.4

1. Which of the following bonds is nonpolar?
2. C-O
3. O-F
4. C-F
5. C-H
6. H-F

Ans: d Level of difficulty: easy Section: 3.4

1. Which of the following covalent bonds is polar?
2. C-C
3. C-H
4. O-Cl
5. Cl-Cl
6. Mg-Cl

Ans: c Level of difficulty: easy Section: 3.4

1. The electronegativity difference between C and O is \_\_\_\_ and therefore the C-O bond is a(n)\_\_\_\_ bond.
2. 1.0; nonpolar covalent
3. 6.0; polar covalent
4. −1.0; ionic
5. 6.0; nonpolar covalent
6. 1.0; polar covalent

Ans: e Level of difficulty: medium Section: 3.4

1. The electronegativity difference between C and H is \_\_\_\_ and therefore the C-H bond is a(n)\_\_\_\_ bond.
2. 0.4; nonpolar covalent
3. 0.4; polar covalent
4. 4.6; ionic
5. −0.4; nonpolar covalent
6. 4.6; polar covalent

Ans: a Level of difficulty: easy Section: 3.4

1. The electronegativity difference between Mg and Cl is \_\_\_\_ and therefore the Mg-Cl bond is a(n)\_\_\_\_ bond.
2. 1.8; polar covalent
3. −1.8; nonpolar covalent
4. 4.2; ionic
5. −4.2; nonpolar covalent
6. 1.8; ionic

Ans: e Level of difficulty: easy Section: 3.4

1. What is meant by the following symbols?



1. This means that the hydrogen has donated an electron to the oxygen.
2. This means that the oxygen has donated an electron to the hydrogen.
3. This means that the oxygen is pulling electrons toward itself and is partially negative.
4. This means that the hydrogen is pulling electrons toward itself and is partially positive.
5. These are not symbols used in chemistry.

Ans: c Level of difficulty: medium Section: 3.4

1. Which bond is correctly labeled with a dipole arrow?

C-H O-H N-H C-Cl C-C

a. b. c. d. e.

Ans: c Level of difficulty: medium Section: 3.4

1. Match the atomic and ion symbols with the correct terms.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mg2+ | Cl− | Cδ+ | Fδ− |
| a. | cation | anion | cation | anion |
| b. | cation | anion | partially positive carbon | partially negative fluorine |
| c. | anion | cation | anion | cation |
| d. | cation | anion | partially negative carbon | partially positive fluorine |
| e. | anion | cation | partially negative carbon | partially positive fluorine |

Ans: b Level of difficulty: medium Section: 3.4

1. Which of the following molecules contains polar bonds but is nonpolar overall?
2. Cl2
3. CF4
4. H2O
5. N2
6. NH3

Ans: b Level of difficulty: hard Section: 3.4

1. Which of the following covalent molecules is polar?



a. b. c. d. e.

Ans: a Level of difficulty: hard Section: 3.4

1. Chloroform (CHCl3) is an anesthetic and is also used in the synthesis of ozone damaging refrigerants called CFCs. Which of the following is the Lewis structure for chloroform?

 a. b. c. d. e.

Ans: a Level of difficulty: easy Section: 3.4

1. What is the electron geometry of chloroform (CHCl3)?
2. linear
3. bent
4. trigonal planar
5. trigonal pyramidal
6. tetrahedral

Ans: e Level of difficulty: easy Section: 3.4

1. What is the molecular shape of chloroform (CHCl3)?
2. linear
3. bent
4. trigonal planar
5. trigonal pyramidal
6. tetrahedral

Ans: e Level of difficulty: easy Section: 3.4

1. Does chloroform (CHCl3) contain polar bonds?
2. Yes, all of the bonds in chloroform are polar.
3. Yes, the C-Cl bond in chloroform is polar.
4. Yes, the C-H bond in chloroform is polar.
5. Yes, all atoms in chloroform are highly electronegative.
6. No, all bonds in chloroform are nonpolar.

Ans: b Level of difficulty: medium Section: 3.4

1. Is chloroform (CHCl3) a polar molecule?
2. No, all polarities cancel out.
3. Yes, all molecules with polar bonds are polar.
4. No, the bonds in chloroform are not polar.
5. Yes, the polarities do not cancel out.
6. No, carbon compounds cannot be polar.

Ans: d Level of difficulty: medium Section: 3.4

1. Which of the bonds in the following molecule are polar covalent?



* 1. C-H and O-H only
  2. C-O and O-H only
  3. C-O only
  4. C-C and C-O
  5. O-H only

Ans: b Level of difficulty: medium Section: 3.4

1. Which of the bonds in the following molecule are polar covalent?



1. C-H only
2. C-N only
3. C=O only
4. C-N and C=O
5. C-N, C=O, and N-H

Ans: e Level of difficulty: medium Section: 3.4

1. According to this diagram showing the boiling of liquid water, what happens to liquid water when it boils?



1. The water turns into hydrogen and oxygen gas.
2. Covalent bonds in water are broken.
3. Hydrogen bonding forces are broken.
4. Covalent bonds in water are formed.
5. Hydrogen bonding forces are formed.

Ans: c Level of difficulty: medium Section: 3.5

1. In this diagram showing the boiling of liquid water, Arrow A points to



1. a covalent bond.
2. a hydrogen bonding force.
3. a dispersion force.
4. a molecule.
5. heat.

Ans: b Level of difficulty: medium Section: 3.5

1. In this diagram showing the boiling of liquid water, Arrow B points to



1. a covalent bond.
2. a hydrogen bonding force.
3. a dispersion force.
4. a molecule.
5. heat.

Ans: a Level of difficulty: medium Section: 3.5

1. Which of the following interactions is the strongest?
2. dipole-dipole forces
3. hydrogen bonding forces
4. dispersion forces
5. covalent bond
6. All of the above interactions have the same strength.

Ans: d Level of difficulty: medium Section: 3.5

1. Water (H2O) has a higher boiling point than methane (CH4) because water has \_\_\_\_\_\_\_ between molecules.

a. ionic bonding

b. covalent bonding

c. dispersion forces

d. dipole-dipole forces

e. hydrogen bonding forces

Ans: e Level of difficulty: easy Section: 3.5

1. The only interactions between two or more molecules of a nonpolar material such as methane (CH4) are \_\_\_\_\_\_\_ because these molecules do not have permanent dipoles.

a. ionic bonding

b. covalent bonding

c. dispersion forces

d. dipole-dipole forces

e. hydrogen bonding forces

Ans: c Level of difficulty: easy Section: 3.5

1. \_\_\_\_\_\_ is the sharing of electrons between two atoms and is much stronger than intermolecular forces.

a. ionic bonding

b. covalent bonding

c. dispersion forces

d. dipole-dipole forces

e. hydrogen bonding forces

Ans: b Level of difficulty: easy Section: 3.5

1. Electrostatic interactions between positive and negative ions are called \_\_\_\_\_\_\_.

a. ionic bonding

b. covalent bonding

c. dispersion forces

d. dipole-dipole forces

e. hydrogen bonding forces

Ans: a Level of difficulty: easy Section: 3.5

1. In molecules with permanent dipoles, \_\_\_\_\_\_\_ are the attraction of the positive end of a dipole on one molecule with the negative end of the dipole on another molecule.

a. ionic bonding

b. covalent bonding

c. dispersion forces

d. dipole-dipole forces

e. hydrogen bonding forces

Ans: d Level of difficulty: easy Section: 3.5

1. Formaldehyde is used as a preservative and in disinfection. It has the structure shown below. What is the strongest type of intermolecular interaction attracting molecules of formaldehyde together?



1. ionic bonding
2. covalent bonding
3. dispersion forces
4. dipole-dipole forces
5. hydrogen bonding forces

Ans: d Level of difficulty: medium Section: 3.5

1. Does formaldehyde have a permanent dipole?



1. Yes, the carbon is partially negative and the oxygen is partially positive.
2. Yes, the carbon is partially negative and the hydrogen is partially positive.
3. Yes, the carbon is partially positive and the oxygen is partially negative.
4. Yes, the carbon is partially positive and the hydrogen is partially negative.
5. No, formaldehyde only has a temporary dipole.

Ans: c Level of difficulty: medium Section: 3.5

1. Which of the following figures best illustrates how two molecules of formaldehyde (CH2O) interact?





a. b. c. d. e.

Ans: e Level of difficulty: hard Section: 3.5

1. Propane is a fuel commonly used in barbeques and to heat homes. It has the structure shown below. Does propane have a permanent dipole?



1. Yes, the carbon is partially negative and the hydrogen is partially positive.
2. Yes, the carbon is partially positive and the hydrogen is partially negative.
3. Yes, one side of the molecule is always partially positive and the other side is partially negative.
4. No, propane has a temporary dipole.
5. No, propane never displays any dipole at all.

Ans: d Level of difficulty: medium Section: 3.5

1. What is the strongest type of intermolecular interaction attracting molecules of propane together?



1. ionic bonding
2. covalent bonding
3. dispersion forces
4. dipole-dipole forces
5. hydrogen bonding forces

Ans: c Level of difficulty: medium Section: 3.5

1. Does propane or octane (C8H18) exhibit stronger dispersion forces?



1. Propane, because the smaller molecules can get closer to one another
2. Propane, because propane has a larger permanent dipole
3. Octane, because octane has a larger permanent dipole
4. Octane, because octane has more surface area
5. They both have the same amount of forces

Ans: d Level of difficulty: hard Section: 3.5

1. Ethanol is an alcohol found in wine and beer and it is also used as a fuel. It has the structure shown below. What is the strongest type of intermolecular interaction attracting molecules of ethanol together?



1. ionic bonding
2. covalent bonding
3. dispersion forces
4. dipole-dipole forces
5. hydrogen bonding forces

Ans: e Level of difficulty: medium Section: 3.5

1. Which of the following best describes your reasoning in answering the previous question?



1. Ethanol is nonpolar.
2. Ethanol has polar bonds.
3. Ethanol contains an O-H bond.
4. Ethanol forms ions in solutions.
5. Ethanol does not contain any metals.

Ans: c Level of difficulty: medium Section: 3.5

1. Does ethanol have a permanent dipole?



1. Yes, the carbon is partially negative and the oxygen is partially positive.
2. Yes, the carbon is partially negative and the hydrogen is partially positive.
3. Yes, the hydrogen is partially positive and the oxygen is partially negative.
4. Yes, the oxygen is partially positive and the hydrogen is partially negative.
5. No, ethanol only has a temporary dipole.

Ans: c Level of difficulty: medium Section: 3.5

1. Which of the following figures best illustrates how two molecules of ethanol interact?



a. b. c. d. e.

Ans: a Level of difficulty: hard Section: 3.5

1. Which of the following molecules exhibits the strongest intermolecular forces of attraction?

 a. b. c. d. e.

Ans: d Level of difficulty: hard Section: 3.5

1. Which of the molecules do not have a permanent dipole?



A B C D E

Ans: d Level of difficulty: medium Section: 3.5

1. Which of the molecules exhibits the strongest intermolecular forces of attraction?

 A B C D E

Ans: a Level of difficulty: medium Section: 3.5

1. Which of the molecules below exhibits hydrogen-bonding forces between like molecules?

 A B C D E

1. A only
2. A and B
3. A, B, and C
4. A, B, C, and D
5. E only

Ans: a Level of difficulty: medium Section: 3.5

1. Which of these molecules exhibits dipole-dipole forces but cannot hydrogen bond with like molecules?

 A B C D E

1. B only
2. A, B, and C
3. B, C, and E
4. A, B, C, and E
5. D only

Ans: c Level of difficulty: medium Section: 3.5

1. What is the molecular shape of the carbon indicated with arrow I in this structure of caffeine?



* 1. bent
  2. trigonal planar
  3. trigonal pyramidal
  4. tetrahedral
  5. linear

Ans: b Level of difficulty: medium Section: opener/3.5

1. What is the electronic geometry of the nitrogen indicated with arrow II?



1. bent
2. trigonal planar
3. trigonal pyramidal
4. tetrahedral
5. linear

Ans: b Level of difficulty: hard Section: opener/3.5

1. What is the molecular shape of the nitrogen indicated with arrow II?



1. bent
2. trigonal planar
3. trigonal pyramidal
4. tetrahedral
5. linear

Ans: a Level of difficulty: hard Section: opener/3.5

1. Which bonds in caffeine are polar covalent bonds?



1. All of them
2. the C-N bonds only
3. the C=C, C-C and C-H bonds
4. the C-N, C=O, and C=N bonds
5. the O-H bonds

Ans: d Level of difficulty: medium Section: opener/3.5

1. What is the strongest type of intermolecular force that a caffeine molecule could form with other caffeine molecules?



1. dispersion forces
2. nonpolar covalent bonds
3. hydrogen bonds
4. covalent bonds
5. dipole-dipole interactions

Ans: e Level of difficulty: hard Section: opener/3.5

1. What is the strongest type of intermolecular force that a caffeine molecule could form with water?



1. dispersion forces
2. nonpolar covalent bonds
3. hydrogen bonds
4. covalent bonds
5. dipole-dipole interactions

Ans: c Level of difficulty: hard Section: opener/3.5

1. How does estradiol stimulate the growth of breast cancer cells?
2. Estradiol is a toxin and all toxins stimulate the growth and spread of cancer.
3. Estradiol is a damaged estrogen that stimulates the growth of damaged cell.
4. Estradiol binds to breast cancer cell receptors as well as receptors found in other parts of the body.
5. Once a woman reaches adulthood, estradiol has no purpose in the body and so it causes breast cancer.
6. All of the above statements are true.

Ans: c Level of difficulty: medium Section: 3.5

1. How is estradiol recognized by the estrogen receptor?
2. The molecular weight is recognized.
3. The atom types in the ligands are recognized by the receptors.
4. Single bonds, double bonds, and triple bonds are recognized by receptors.
5. Receptors recognize ligands by shape only.
6. Ligands are recognized by shape and intermolecular forces.

Ans: e Level of difficulty: medium Section: 3.5

1. Which of the following is a challenge in developing drugs for the treatment of breast cancer?
2. There are no challenges. Several drugs have been developed for this purpose.
3. The structure of estradiol is unknown.
4. The structure of the estrogen receptor is unknown.
5. The estrogen receptor on the breast cancer cell must be blocked but not the receptors in other parts of the body.
6. For some reason, most breast cancer cells are resistant to treatment with current drugs.

Ans: d Level of difficulty: medium Section: 3.5

1. Tamoxifen has some key similarities to estradiol. Which of the following statements describes one of the similarities?
2. Tamoxifen has the same structure as estradiol.
3. Tamoxifen has the same number of atoms as estradiol.
4. Tamoxifen performs the same function in the cell as estradiol.
5. Tamoxifen binds to the same receptor as estradiol.
6. Tamoxifen deforms the shape of the estrogen receptor in the same way as estradiol.

Ans: d Level of difficulty: medium Section: 3.5

1. Antiestrogens are one type of molecule that can be used to treat breast cancer. Which of the following characteristics should be included in the design of a novel antiestrogen?
   1. The molecule should bind to the estrogen receptor on breast cancer cells.
   2. The molecule should not interfere with the normal role of estrogen.
   3. The molecule should prevent the activation of genes in breast cancer cells.
   4. The molecule should not have negative side effects.
   5. All of the above are design considerations.

Ans: e Level of difficulty: easy Section: 3.5