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7 IONIC AND METALLIC BONDING

SECTION 7.1 IONS (pages 187–193)

This section explains how to use the periodic table to infer the number of valence electrons in an atom and draw its electron dot structure. It also describes the formation of cations from metals and anions from nonmetals.

▶ Valence Electrons (pages 187–188)

1. What are valence electrons? _____

_____

2. The valence electrons largely determine the _____ of an element and are usually the only electrons used in _____ .

3. Is the following sentence true or false? The group number of an element in the periodic table is related to the number of valence electrons it has. _____

4. What is an electron dot structure? _____

_____

5. Draw the electron dot structure of each of the following atoms.

a. argon _____

b. calcium _____

c. iodine _____

▶ The Octet Rule (page 188)

6. What is the octet rule? _____

_____

_____

7. Metallic atoms tend to lose their valence electrons to produce a(n) _____, or a positively charged ion. Most nonmetallic atoms achieve a complete octet by gaining or _____ electrons.

▶ Formation of Cations (pages 188–190)

8. Write the electron configurations for these metals and circle the electrons lost when each metal forms a cation.

a. Mg _____

b. Al _____

c. K _____

Match the noble gas with its electron configuration.

_____ **9.** argon **a.** $1s^2$

_____ **10.** helium **b.** $1s^2 2s^2 2p^6$

_____ **11.** neon **c.** $1s^2 2s^2 2p^6 3s^2 3p^6$

_____ **12.** krypton **d.** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

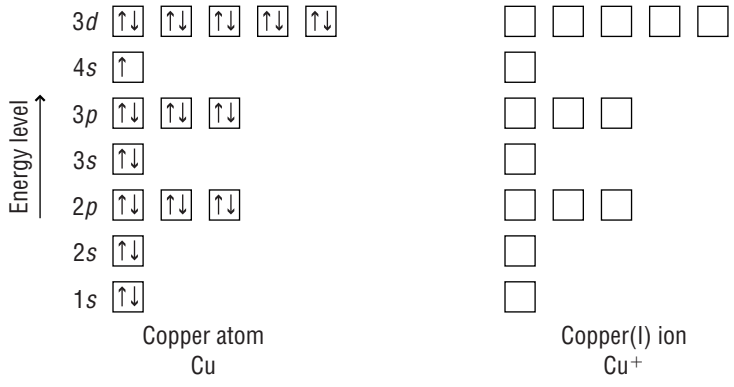
13. What is the electron configuration called that has 18 electrons in the outer energy level and all of the orbitals filled?

_____

14. Write the electron configuration for zinc.

_____

15. Fill in the electron configuration diagram for the copper(I) ion.



▶ Formation of Anions (pages 191–192)

16. Atoms of most nonmetallic elements achieve noble-gas electron configurations by gaining electrons to become _____, or negatively charged ions.

17. What property of nonmetallic elements makes them more likely to gain electrons than lose electrons?

_____

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18. Is the following sentence true or false? Elements of the halogen family lose one electron to become halide ions. _____

19. How many electrons will each element gain in forming an ion?

a. nitrogen _____

b. oxygen _____

c. sulfur _____

d. bromine _____

20. Write the symbol and electron configuration for each ion from Question 19, and name the noble gas with the same configuration.

a. nitride _____

b. oxide _____

c. sulfide _____

d. bromide _____

SECTION 7.2 IONIC BONDS AND IONIC COMPOUNDS (pages 194–199)

This section lists the characteristics of an ionic bond. It also describes the use of these characteristics to explain the electrical conductivity of ionic compounds when melted and when in aqueous solutions.

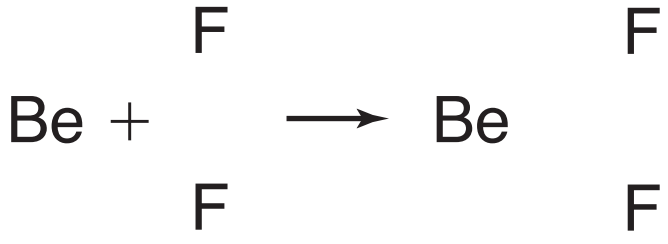
▶ Formation of Ionic Compounds (pages 194–195)

1. What is an ionic bond? _____

_____

2. In an ionic compound, the charges of the _____ and _____ must balance to produce an electrically _____ substance.

3. Complete the electron dot structures below to show how beryllium fluoride (BeF_2) is formed. Use figure on page 194 as a model.



4. Why do beryllium and fluorine combine in a 1 : 2 ratio?

_____

_____

_____

5. A chemical formula shows the types and _____ of atoms in the smallest representative unit of a substance.

6. List the numbers and types of atoms represented by these chemical formulas.

a. Fe_2O_3 _____

b. $KMnO_4$ _____

c. CH_3 _____

d. NH_4NO_3 _____

7. What is a formula unit?

_____

8. Explain why the ratio of magnesium ions to chloride ions in $MgCl_2$ is 1 : 2.

_____

_____

9. Describe the structure of ionic compounds.

_____

_____

▶ Properties of Ionic Compounds (pages 196–198)

10. Most ionic compounds are _____ at room temperature.

11. Is the following sentence true or false? Ionic compounds generally have low melting points. _____

12. What does a coordination number tell you?

_____

_____

13. What is the coordination number of the ions in a crystal of NaCl? _____

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14. Circle the letter of each statement that is true about ionic compounds.

a. When dissolved in water, ionic compounds can conduct electricity.

b. When melted, ionic compounds do not conduct electricity.

c. Ionic compounds have very unstable structures.

d. Ionic compounds are electrically neutral.

Reading Skill Practice

By looking carefully at photographs and drawings in textbooks, you can better understand what you have read. Look carefully at Figure 7.9 on page 197. What important idea does this drawing communicate? Do your work on a separate sheet of paper.

SECTION 7.3 BONDING IN METALS (pages 201–203)

This section uses the theory of metallic bonds to explain the physical properties of metals. It also describes the arrangements of atoms in some common metallic crystal structures.

▶ Metallic Bonds and Metallic Properties (pages 201–202)

1. Is the following sentence true or false? Metals are made up of cations, not neutral atoms. _____

2. What are metallic bonds? _____

_____

_____

3. Name three properties of metals that can be explained by metallic bonding.

a. _____

b. _____

c. _____

4. What happens to an ionic crystal when a force is applied to it?

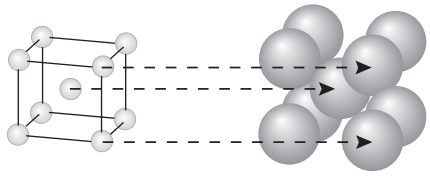
_____

_____

▶ Crystalline Structure of Metals (page 202)

5. Metal atoms in crystals are arranged into very _____ and orderly patterns.

6. Label each of the following arrangements of atoms with the correct name.



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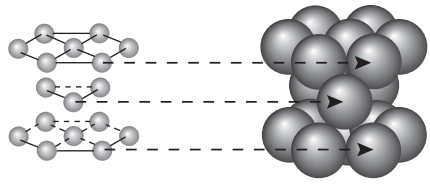

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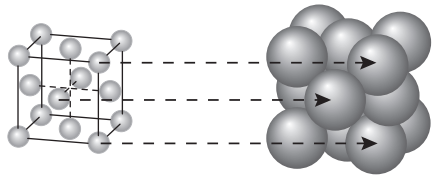

_____

7. Circle the letter of each metal whose atoms form a face-centered cubic pattern.

a. magnesium **c.** sodium

b. copper **d.** aluminum

Match the arrangement with the number of neighbors each atom in the arrangement has.

_____ **8.** body-centered cubic **a.** 12

_____ **9.** face-centered cubic **b.** 8

_____ **10.** hexagonal close-packed

▶ Alloys (page 203)

11. A mixture of two or more elements, at least one of which is a metal, is called a(n) _____ .

12. Is the following sentence true or false? Pure metals are usually harder and more durable than alloys. _____

13. The most common use of nonferrous alloys is in _____ .

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14. What four properties make steel an important alloy?

a. _____

b. _____

c. _____

d. _____

15. What are the component elements for the following alloys?

a. sterling silver _____

b. brass _____

c. surgical steel _____

d. cast iron _____

16. _____ alloys have smaller atoms that fit into the spaces between larger atoms. _____ alloys have component atoms that are roughly equal in size.

GUIDED PRACTICE PROBLEM

GUIDED PRACTICE PROBLEM 12 (page 196)

12. Use electron dot structures to determine formulas of the ionic compounds formed when
a. potassium reacts with iodine.
b. aluminum reacts with oxygen.

a. potassium reacts with iodine.

Analyze

Step 1. Is one of the elements a metal? If so, which one? _____

Step 2. Metal atoms _____ their valence electrons when forming ionic compounds.

Nonmetal atoms _____ electrons when forming ionic compounds.

Solve

Step 3. Write the electron dot structures for the two atoms

potassium _____ iodine _____

Step 4. The metal atom, _____ , must lose _____ electron(s) in order to achieve an octet in the next-lowest energy level. The nonmetal atom, _____ , must gain _____ electron(s) in order to achieve a complete octet.

Step 5. Using electron dot structures, write an equation that shows the formation of the ionic compound from the two elements. Make sure that the electrons lost equals the electrons gained.

Step 6. The chemical formula for the ionic compound formed is _____ .

b. aluminum reacts with oxygen.

Analyze

Step 1. Is one of the elements a metal? If so, which one? _____

Step 2. Metal atoms _____ their valence electrons when forming ionic compounds. Nonmetal atoms _____ electrons when forming ionic compounds.

Solve

Step 3. Write the electron dot structures for the two atoms

aluminum _____ oxygen _____

Step 4. The metal atom, _____ , must lose _____ electron(s) in order to achieve an octet in the next-lowest energy level. The nonmetal atom, _____ , must gain _____ electron(s) in order to achieve a complete octet.

Step 5. Using electron dot structures, write an equation that shows the formation of the ionic compound from the two elements. Make sure that the electrons lost equals the electrons gained.

Step 6. The chemical formula for the ionic compound formed is _____ .