Name Date

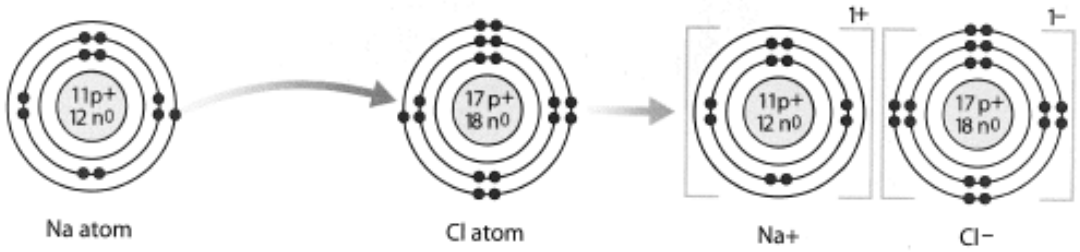
Topic 2.4 Highlights

How do elements combine to form compounds?

Use with textbook pages 136–151.

Ionic Compounds

An **ionic compound** consists of a positively charged ion and a negatively charged ion, held together by strong **ionic bonds**. A *binary ionic compound* is made up of two elements: a metal transfers its electron(s) to a non-metal, so that full valence shells can be achieved. The diagram below shows how a sodium atom transfers its electron to the chlorine atom to form stable ions in the ionic compound, sodium chloride.



The ions in ionic compounds form repeating patterns called lattices. Ionic compounds tend to have high melting points, are hard and brittle, conduct thermal energy, and conduct electric current when in liquid form or dissolved in a liquid such as water.

Covalent Compounds

A **covalent compound** consists of two or more non-metals held together by strong **covalent bonds**. These bonds are created when the elements share their valence electrons. Glucose, $C_6H_{12}O_6$, is an example of a covalent compound. A **molecule** is formed when two or more atoms are bonded together by covalent bonds. Water, H_2O, is an example of a molecule where hydrogen is bonded to oxygen by covalent bonds. Refer to Figure 2.29 on page 145 of the textbook to see three different models used to represent covalent compounds. The non-metals in covalent compounds can achieve stability of full valence shells by sharing their electrons. Analyze Table 2.4 on page 146. How can metals and non-metals achieve full valence shells?

In contrast to ionic compounds, covalent compounds have low melting points, are soft, and are poor conductors of electric current and thermal energy.

Diatomic Molecules

There are seven elements on the periodic table that exist as **diatomic molecules** in nature: H_2, O_2, F_2, Br_2, I_2, N_2, Cl_2. Note that they consist of two atoms that share electrons. Figure 2.33 on page 148 in the textbook shows how single bonds, double bonds, and triple bonds can form in diatomic molecules.

© 2017, originally acquired by McGraw-Hill Ryerson Limited

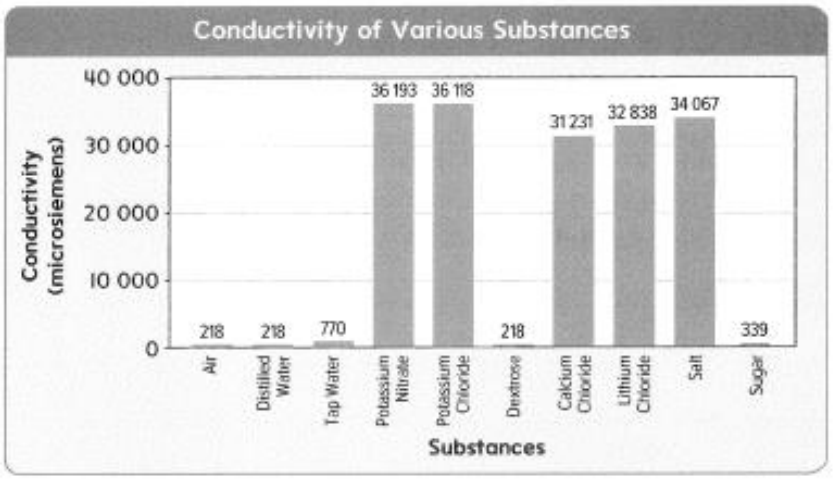
Electrical Conductivity of Ionic and Covalent Compounds

Use with textbook pages 140–147.

Use the following experimental set ups and conductivity graph to answer questions 1 to 15.

An experiment is carried out to test the conductivity of different solutions. The following table outlines the procedures carried out in the experiment.

Set Up #1 Distilled Water (H_2O)	Set Up #2 Sugar ($C_{12}H_{22}O_{11}$)	Set Up #3 Salt (NaCl)
		
Procedure: 1. Place 250 mL of distilled water in a beaker. 2. Connect two metal electrodes to a light bulb and put in the beaker with the water.	Procedure: 1. Place 10 g of sugar in a beaker with 250 mL of distilled water. Dissolve the sugar in the water. 2. Connect two metal electrodes to a light bulb and put in the beaker with the sugar solution.	Procedure: 1. Place 10 g of salt in a beaker with 250 mL of distilled water. Dissolve the salt in the water. 2. Connect two metal electrodes to a light bulb and put in the beaker with the salt solution.



© 2017, originally acquired by McGraw-Hill Ryerson Limited

1. Define conductivity.

2. What type of compound is salt (NaCl)? What bond holds the atoms in this compound together?

3. What type of compound is sugar ($C_{12}H_{22}O_{11}$)? What bond holds the atoms together in this compound?

4. What is the purpose of having a beaker of distilled water in this experiment?

5. What happened to the salt when it dissolved in water?

6. Which beaker(s) would you expect to have positively and negatively charged ions that are able to move freely?

7. Which beaker(s) have uncharged particles in the solution?

8. At the atomic level, what do you think the salt (NaCl) compounds and sugar ($C_{12}H_{22}O_{11}$) compounds look like before and after they are placed and dissolved in water? Draw some diagrams in the boxes below to show this.

Salt	Sugar
Salt **Before** It Dissolved in Water	Sugar **Before** It Dissolved in Water
Salt **After** It Dissolved in Water	Sugar **After** It Dissolved in Water

© 2017, originally acquired by McGraw-Hill Ryerson Limited

9. What do you think allows water to conduct electricity?

10. According to the graph, which set up(s) will not conduct electricity and not light up the light bulb? Explain.

11. According to the graph, which set up(s) will conduct electricity and light up the light bulb? Explain.

12. Analyze the conductivity graph. What do all the compounds that are good conductors of electric current have in common?

13. Based on its conductivity shown in the graph, predict whether dextrose is an ionic compound or a covalent compound. Explain your answer.

14. Predict what would happen to the brightness of the light bulb if you added more salt to the solution in set up #3. Explain your reasoning.

15. a) Reflect on your experiences with conductivity. What new questions do you have about conductivity? Come up with two questions about conductivity. State them in the form of testable questions.

b) Now state a hypothesis and a prediction based on your testable questions so that they can be answered through scientific investigations.

© 2017, originally acquired by McGraw-Hill Ryerson Limited

Properties of Ionic and Covalent Compounds

Use with textbook pages 140–147.

Use the following information to answer questions 1 to 10.

Compound	Formula	Melting Point (°C)	Boiling Point (°C)
sodium iodide	NaI	660	1304
calcium chloride	$CaCl_2$	782	1600
lithium bromide	LiBr	845	1676
magnesium oxide	MgO	2852	3600
water	H_2O	0	100
ethanol	C_2H_5OH	−114	78.3
ammonia	NH_3	−78	−33.3
nitrogen	N_2	−210	−196
carbon tetrachloride	CCl_4	−23	77

1. Create a bar graph for the melting point data shown above.

2. What type of compounds are NaI, $CaCl_2$, LiBr, and MgO?

© 2017, originally acquired by McGraw-Hill Ryerson Limited

3. What type of compounds are C_2H_5OH, NH_3, N_2, and CCl_4?

4. How do the melting and boiling points of ionic compounds compare to those of covalent compounds? Note two things that you notice about the temperatures.

5. Why do you think there is such a huge difference in the melting points of ionic and covalent compounds?

6. What is the relationship between the melting point and the strength of the bonds that hold the atoms together?

7. Which compound, magnesium oxide or sodium iodide, requires more energy to overcome the electrostatic forces holding the ions together in the lattice structure? Explain your choice.

8. Based on their melting points, what can you infer about the state of ionic compounds at room temperature?

9. Analyze the data given. In what state are covalent compounds at room temperature?

10. Methane, CH_4, has a melting point of –182 °C and a boiling point of –164 °C. Predict whether methane is a covalent or an ionic compound.

© 2017, originally acquired by McGraw-Hill Ryerson Limited

Covalent Bonding

Use with textbook pages 148–149.

1. Base Word, Suffixes, and Word Parts

To understand an unfamiliar word, try breaking it down into smaller parts. Then, determine what each part means. If the word is made up of a prefix, a base, and a suffix, break the word down to identify these three components. Refer to the words *diatomic molecule* on page 148 in the textbook.

a) In the word *diatomic*, what is the prefix? _____

b) What do you think this prefix means? _____

c) In the word *diatomic*, what is the base word? _____

d) What do you think the suffix is? _____

e) What does this suffix mean? _____

f) Put together your answers to parts a) to e) to explain what *diatomic molecule* means.

_____

2. Visualizing

Visualizing means forming an image in your mind based on the text that you are reading. The following table shows the steps for visualizing the concepts while reading the paragraph about diatomic molecules and covalent bonds on page 148 in the textbook. Complete the table.

Steps	How I Form a Picture in My Mind
1. Start with a part of the text that is familiar.	
2. Look for specifics in the text to make your picture more accurate.	
3. Once you have created a picture in your mind, sketch it.	

3. Check for Understanding

Create a mnemonic to help you remember the seven elements that exist as diatomic molecules. An example of a mnemonic is: "**H**ere **i**n **B**ritish **C**olumbia, **N**ear **O**ur **F**riends."

_____

© 2017, originally acquired by McGraw-Hill Ryerson Limited

2.4 Assessment

Match each term on the left with the best description on the right. Each descriptor may be used only once.

Term	Description
1. ____ molecule	A. bond that forms when atoms share electrons
2. ____ ionic bond	B. a compound that consists of a metallic ion and a non-metallic ion
3. ____ covalent bond	C. a particle that has two or more atoms held together by covalent bonds
4. ____ ionic compound	D. bond that forms between a positively charged ion and a negatively charged ion
5. ____ covalent compound	E. a compound that consists of two or more elements that are covalently bonded together

Circle the letter of the best answer for questions 6 to 16.

6. Which of the following represents a diatomic molecule?

A. H^+

B. F_2

C. KI

D. H_2O

7. Which of the following correctly shows an example of an ionic compound and a covalent compound?

	Ionic Compound	Covalent Compound
A.	H_2	CO_2
B.	$SrCl_2$	CH_4
C.	$C_6H_{12}O_6$	NaOH
D.	$KMnO_4$	RbCl

8. Which of following will have ionic bonds holding the compound together?

A. ozone, O_3

B. ethanol, C_2H_6O

C. sucrose, $C_{12}H_{22}O_{11}$

D. beryllium sulfide, BeS

9. Which of the following correctly describes what happens when a magnesium atom and an oxygen atom form a compound?

A. A magnesium atom transfers its valence electrons to an oxygen atom.

B. An oxygen atom transfers its valence electrons to a magnesium atom.

C. A magnesium atom shares its valence electrons with an oxygen atom.

D. A magnesium atom and an oxygen atom both switch valence electrons with each other.

© 2017, originally acquired by McGraw-Hill Ryerson Limited

10. Which of the following compounds has a lattice structure?

A. CO

B. CCl_4

C. ZnS

D. H_2O

11. Calcium fluoride is a crystalline solid at room temperature. What accounts for this compound being hard and brittle?

A. the low melting point of the compound

B. the sharing of the electrons between calcium and fluorine

C. the repulsive force between the calcium and fluoride ions

D. the strength of the ionic bond that holds the calcium and fluoride ions together

12. Which of the following correctly compares the melting points of ionic compounds to covalent compounds?

	Ionic Compound	Covalent Compound
A.	Has low melting point	Has low melting point
B.	Has high melting point	Has high melting point
C.	Has low melting point	Has high melting point
D.	Has high melting point	Has low melting point

13. Which of the following explains why potassium bromide (KBr) has a high melting point of 734 °C?

A. It requires high temperatures to form the lattices.

B. It requires a lot of energy to break the ionic bonds.

C. It requires high temperatures to maintain the strong electrostatic forces.

D. It requires a lot of energy to produce forces of repulsion to break the crystals.

14. Which of the following will allow an electric current to flow through it?

A. a beaker of distilled water, H_2O

B. a beaker of solid lithium chloride, LiCl

C. a beaker of methanol solution, CH_3OH

D. a beaker of lithium chloride solution, LiCl

© 2017, originally acquired by McGraw-Hill Ryerson Limited

15. Which of the following describes ways that atoms can become stable?

I	an iodine atom loses one electron
II	a calcium atom loses two electrons
III	two bromine atoms share electrons

A. I and II only

B. I and III only

C. II and III only

D. I, II, and III

16. Which of the following is a property of both ionic and covalent compounds?

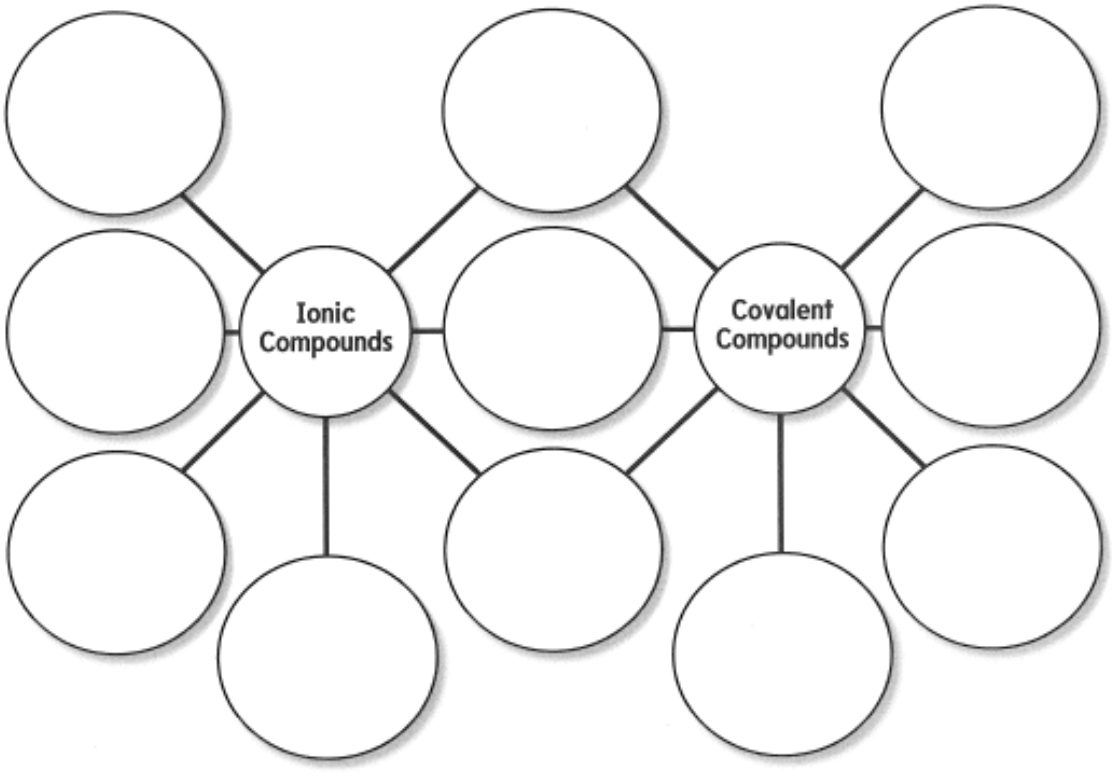
A. low boiling points

B. full valence shells

C. sharing of electrons

D. transferring of electrons

17. Complete the mind map for ionic and covalent compounds.



© 2017, originally acquired by McGraw-Hill Ryerson Limited