Elements and Chemical Bonds

How do elements join together to form chemical compounds?

Before You Read

Before you read the chapter, think about what you know about elements and chemical bonds. Record your thoughts in the first column. Pair with a partner, and discuss his or her thoughts. Write those thoughts in the second column. Then record what you both would like to share with the class in the third column.

<table>
<thead>
<tr>
<th>Think</th>
<th>Pair</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chapter Vocabulary

<table>
<thead>
<tr>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW chemical bond</td>
<td>NEW chemical formula</td>
<td>NEW ion</td>
</tr>
<tr>
<td>valence electron</td>
<td>covalent bond</td>
<td>ionic bond</td>
</tr>
<tr>
<td>electron dot diagram</td>
<td>molecule</td>
<td>metallic bond</td>
</tr>
<tr>
<td>REVIEW compound</td>
<td>polar molecule</td>
<td>ACADEMIC conduct</td>
</tr>
</tbody>
</table>

A Lesson Content Vocabulary page for each lesson is provided in the Chapter Resources Files.
Lesson 1  Electrons and Energy Levels

Scan Lesson 1. Record three questions you have about electrons and energy levels in your Science Journal. Try to answer your questions as you read.

--- Main Idea ---

I found this on page 381.

The Periodic Table

Describe characteristics of the periodic table.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic number</td>
<td>the number of protons in an atom of the element</td>
</tr>
<tr>
<td>Atomic mass</td>
<td>the average mass of all of the different isotopes of the element</td>
</tr>
<tr>
<td>Period</td>
<td>a row of elements</td>
</tr>
<tr>
<td>Group</td>
<td>a column of elements</td>
</tr>
<tr>
<td>Metals</td>
<td>the elements arranged on the left side of the periodic table, except H</td>
</tr>
<tr>
<td>Metalloids</td>
<td>the elements arranged in a stair-step pattern between metals and nonmetals</td>
</tr>
<tr>
<td>Nonmetals</td>
<td>the elements on the right side of the periodic table, plus hydrogen</td>
</tr>
</tbody>
</table>

I found this on page 382.

Atoms Bond

I found this on page 382.

Describe compounds.

Compounds are composed of atoms of two or more elements held together by chemical bonds.

I found this on page 383.

Summarize the relationship between an electron’s energy level and its location in an atom. Circle the word that makes each statement true.

The closer to the nucleus, the lower / higher an electron’s energy level. The farther from the nucleus, the lower / higher an electron’s energy level.
Model the structure of an atom. Use the labels listed below to indicate the location of protons, neutrons, and electrons. Draw lines from the labels to indicate the position of the nucleus, the lowest energy level, and the highest energy level.

- 6 protons (label “+”)
- 6 neutrons (label “n”)
- 6 electrons (label “–”)
- nucleus
- lowest energy level
- highest energy level

Analyze details about valence electrons.

Sequence the steps in constructing and interpreting an electron dot diagram.

1. Identify the element’s ________ group number ________.
2. Identify the number of ________ valence electrons ________, which is the same as the ________ ones digit ________ of the ________ group number ________.
3. Place ________ one ________ dot at a time on each ________ side ________ of the ________ element symbol ________. Pair up the dots until all are used.
4. Identify an atom as ________ stable ________ if all ________ dots ________ are ________ paired ________.
5. Count the ________ unpaired dots ________ to determine how many ________ bonds ________ an unstable atom can form.
Explain why noble gases are stable.
All noble gases (except helium) have eight valence electrons, so all of their valence electrons are paired.

Complete the flowchart about the behavior of atoms with unpaired valence electrons.

An atom has unpaired valence electrons.

The atom is chemically unstable.

The atom must gain, lose, or share unpaired electrons.

The atom forms bonds with other atom(s).

When an atom’s unpaired valence electrons become paired, the atom becomes stable.

Analyze It Use what you have learned in Lesson 1 to explain why elements are rarely found in their pure forms.

Accept all reasonable responses. Sample answer: Atoms of most elements are unstable because they have unpaired valence electrons. Therefore, they have a strong tendency to bond with other atoms and form compounds with completed electron pairs.
Lesson 2  Compounds, Chemical Formulas, and Covalent Bonds

Predict three facts that will be discussed in Lesson 2 after reading the headings. Record your predictions in your Science Journal.

Main Idea

From Elements to Compounds

I found this on page 390.

Recall information about elements and compounds. Read each statement. If it is true, write T in the center column. If it is false, write F in the center column and rewrite the underlined words to make the statement true.

<table>
<thead>
<tr>
<th>Statement</th>
<th>T or F</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compounds are chemical combinations of elements.</td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>Compounds usually have the same properties as the bonds they are made from.</td>
<td>F</td>
<td>seldom, elements</td>
</tr>
<tr>
<td>Atoms form bonds by sharing physical properties.</td>
<td>F</td>
<td>valence electrons</td>
</tr>
</tbody>
</table>

Define covalent bond.

A chemical bond formed when two nonmetal atoms share one or more pairs of valence electrons

Describe types of covalent bonds.

<table>
<thead>
<tr>
<th>Covalent Bond</th>
<th>Description of Valence Electron Sharing</th>
<th>Comment on the Strength of the Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>2 atoms share 1 pair of valence electrons</td>
<td>weakest type of covalent bond</td>
</tr>
<tr>
<td>Double</td>
<td>2 atoms share 2 pairs of valence electrons</td>
<td>stronger than single covalent bonds</td>
</tr>
<tr>
<td>Triple</td>
<td>2 atoms share 3 pairs of valence electrons</td>
<td>stronger than double covalent bonds</td>
</tr>
</tbody>
</table>
Lesson 2 | Compounds, Chemical Formulas, and Covalent Bonds (continued)

Main Idea

Covalent Compounds
I found this on page 392.

Details

Identify 4 common properties of covalent compounds.

1. low melting point
2. low boiling point
3. poor conductor of electricity or thermal energy
4. usually gas or liquid at room temperature

Complete the analogy.

Atom is to element as molecule is to compound.

I found this on page 392.

Summarize the structure of polar molecules.

unequal sharing of electrons results in a partial positive end and a partial negative end polar molecule

I found this on page 393.

Explain why water is a polar molecule.

Water molecules are polar because the negative electrons are more strongly attracted to the oxygen atom, leaving a slightly positive charge near the hydrogen atoms.

I found this on page 393.

Differentiate polar and nonpolar molecules with regard to shared electrons.

<table>
<thead>
<tr>
<th>Polar Molecules</th>
<th>Nonpolar Molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrons are shared unequally.</td>
<td>Electrons are shared equally.</td>
</tr>
</tbody>
</table>

I found this on page 393.

Relate the saying “like dissolves like” to the ability of compounds to dissolve one another.

Sample answer: Polar compounds can dissolve in other polar compounds, and nonpolar compounds can dissolve in other nonpolar compounds, but polar and nonpolar compounds do not dissolve in each other.
Lesson 2 | Compounds, Chemical Formulas, and Covalent Bonds (continued)

Main Idea
I found this on page 394.

Details

I found this on page 394.

Define chemical formula.

A chemical formula is a group of symbols and numbers that represent the elements and the number of atoms of each element that compose a compound.

Explain the chemical formula for a molecule of water. Describe what each symbol represents.

Explain why there are many more covalent compounds than there are pure elements.

Accept all reasonable responses. Sample answer: There are several combinations of possible ways that valence electrons can be shared, and unstable atoms have a tendency to bond in order to become more stable.
Lesson 3  Ionic and Metallic Bonds

Scan Lesson 3. Read the lesson titles and bold words. Look at the pictures. Identify three facts you discovered about ionic and metallic bonds. Record your facts in your Science Journal.

Main Idea

Understanding Ions
I found this on page 398.

Organize information about ions.

| An atom gains an electron | Overall charge becomes negative |
| An atom loses an electron | Overall charge becomes positive |

I found this on page 399.

Analyze what happens to sodium and chlorine atoms in the formation of the compound sodium chloride.

<table>
<thead>
<tr>
<th>Na (sodium)</th>
<th>Cl (chlorine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of element</td>
<td>metal</td>
</tr>
<tr>
<td>Atomic number</td>
<td>11</td>
</tr>
<tr>
<td>Number of valence electrons</td>
<td>1</td>
</tr>
<tr>
<td>Stable or unstable?</td>
<td>unstable</td>
</tr>
<tr>
<td>Electron transfer</td>
<td>1 lost</td>
</tr>
<tr>
<td>Description after transfer</td>
<td>stable, 10 electrons like neon</td>
</tr>
<tr>
<td>Type of ion</td>
<td>positive (+)</td>
</tr>
</tbody>
</table>

Ionic Bonds—Electron Transferring
I found this on page 400.

Complete the diagram of an ionic bond.

positive ion → + −← negative ion

Ionic Bond

Explanation: The oppositely charged ions attract one another and form an ionic compound.
Lesson 3 | Ionic and Metallic Bonds (continued)

**Main Idea**

**Ionic Compounds**

I found this on page 400.

Ions strongly attracted to each other

Good conductors of electricity when in water

Usually solid at room temperature

High melting point

High boiling point

**Metallic Bonds—Electron Pooling**

I found this on page 401.

A metallic bond forms when many metal atoms share their pooled valence electrons.

**Details**

Identify five common properties of ionic compounds.

1. Ions strongly attracted to each other
2. Good conductors of electricity when in water
3. Usually solid at room temperature
4. High melting point
5. High boiling point

Explain how a metallic bond forms.

A metallic bond forms when many metal atoms share their pooled valence electrons.

Describe three properties of metallic compounds.

- High melting and boiling points
- Good conductors of thermal energy and electricity
- Can be hammered into sheets or pulled into wires

Contrast 3 ways atoms can bond and become stable.

<table>
<thead>
<tr>
<th>Process</th>
<th>Electron Pooling</th>
<th>Electron Transfer</th>
<th>Electron Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of chemical bond</td>
<td>metallic</td>
<td>ionic</td>
<td>covalent</td>
</tr>
<tr>
<td>Valence electrons of metal atoms are not bonded to any one atom.</td>
<td>Valence electrons are transferred from nonmetal to metal atoms.</td>
<td>Valence electrons are shared by nonmetal atoms.</td>
<td></td>
</tr>
</tbody>
</table>

Analyze It Explain the difference between a neutral atom and a stable atom.

An atom is stable if its highest energy level contains the maximum number of paired electrons. An atom is electrically neutral if it has the same number of protons and electrons, the positive and negative charges of which balance.
Chapter Wrap-Up

Now that you have read the chapter, think about what you have learned.

Use this checklist to help you study.

☐ Complete your Foldables® Chapter Project.
☐ Study your Science Notebook on this chapter.
☐ Study the definitions of vocabulary words.
☐ Reread the chapter, and review the charts, graphs, and illustrations.
☐ Review the Understanding Key Concepts at the end of each lesson.
☐ Look over the Chapter Review at the end of the chapter.

Summarize It  Reread the chapter Big Idea and the lesson Key Concepts. Use what you have learned to describe why it is important in the modern world to understand the types of chemical bonds and the properties of types of compounds. Give at least one example.

Accept all reasonable responses. Sample answer: All the technologies we rely on in modern society are made of matter that behaves in certain ways. The way matter behaves determines what it can be used for; for example, our electrical circuits are made of metal because metal can be pulled into wire and is a good conductor of electricity. The pooling of electrons in metallic bonding allows the metal to be flexible. Because valence electrons can move easily from atom to atom, they can carry an electric charge.

Challenge  Research the uses of noble gases in technological devices. Why do the properties of the gases make them useful? Summarize your discoveries in your Science Journal.