Glencoe Science

Chapter Resources

Atomic Structure and Chemical Bonds

Includes:

Reproducible Student Pages

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- ✔ Teacher Guide and Answers

Glencoe

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Reproducible Student Pages

Reproducible Student Pages

■ Hands-On Activities

■ Meeting Individual Needs

Extension and Intervention

■ Assessment

■ Transparency Activities

Hands-On Activities

Mini LAB

Drawing Electron Dot Diagrams

Procedure

1. Draw a periodic table that includes the first 18 elements—the elements from hydrogen through argon. Make each block a 3-cm square.
2. Fill in each block with the electron dot diagram of the element.

Analysis

1. What do you observe about the electron dot diagrams of the elements in the same group?

2. Describe any changes you observe in the electron dot diagrams across a period.

TRY AT HOME Mini LAB

Constructing a Model of Methane

Procedure

1. Using **circles of colored paper** to represent protons, neutrons, and electrons, build paper models of one carbon atom and four hydrogen atoms.
2. Use your models of atoms to construct a molecule of methane by forming covalent bonds. The methane molecule has four hydrogen atoms chemically bonded to one carbon atom.

Analysis

1. In the methane molecule, do the carbon and hydrogen atoms have the same arrangement of electrons as two noble gas elements? Explain your answer.

_____

_____

_____

2. Does the methane molecule have a charge?

_____

Ionic Compounds

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. Why do you use the tacks in this lab?

2. How many electrons does a sulfur atom have in its outer energy level?

Metals in Groups 1 and 2 often lose electrons and form positive ions. Nonmetals in Groups 16 and 17 often gain electrons and become negative ions. How can compounds form between these four groups of elements?

Real-World Question

How do different atoms combine with each other to form compounds?

Materials

paper (8 different colors)
scissors
corrugated cardboard
tacks (2 different colors)

Goals

- **Construct** models of electron gain and loss.
- **Determine** formulas for the ions and compounds that form when electrons are gained or lost.

Safety Precautions

Procedure

1. Cut colored-paper disks 7 cm in diameter to represent the elements Li, S, Mg, O, Ca, Cl, Na, and I. Label each disk with one symbol.
2. Lay circles representing the atoms Li and S side by side on cardboard.
3. Choose colored thumbtacks to represent the outer electrons of each atom. Place the tacks evenly around the disks to represent the outer electron levels of the elements.
4. Move electrons from the metal atom to the nonmetal atom so that both elements achieve noble gas arrangements of eight outer electrons. If needed, cut additional paper disks to add more atoms of one element.
5. In the Data and Observations section, write the formula for each ion and the compound formed when you shift electrons.
6. Repeat steps 2 through 6 to combine Mg and O, Ca and Cl, and Na and I.

LAB (continued)

Data and Observations

Atoms	Formulas for Ions and Compounds Formed
1. Li, S	
2. Mg, O	
3. Ca, Cl	
4. Na, I	

Conclude and Apply

1. Draw electron dot diagrams for all of the ions produced.

2. Identify the noble gas elements having the same electron arrangements as the ions you made in this lab.

3. Analyze Results Why did you have to use more than one atom in some cases? Why couldn't you take more electrons from one metal atom or add extra ones to a nonmetal atom?

Communicating Your Data

Compare your compounds and dot diagrams with those of other students in your class. **For more help, refer to the Science Skill Handbook.**

Model and Invent

Atomic Structure

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. Where are electrons located relative to the nucleus?

2. Where are neutrons and protons located? How do they relate to an element's atomic number?

As more information has become known about the structure of the atom, scientists have developed new models. Making your own model and studying the models of others will help you learn how protons, neutrons, and electrons are arranged in an atom. Can an element be identified based on a model that shows the arrangement of the protons, neutrons, and electrons of an atom?

Real-World Question

How will your group construct a model of an element that others will be able to identify?

Possible Materials

magnetic board
rubber magnetic strips
candy-coated chocolates
scissors
paper
marker
coins

Goals

- **Design** a model of a chosen element.
- **Observe** the models made by others in the class and identify the elements they represent.

Safety Precautions

WARNING: *Never eat any food in the laboratory. Wash hands thoroughly.*

Plan the Model

1. Choose an element from periods 2 or 3 of the periodic table. How can you determine the number of protons, neutrons, and electrons in an atom given the atom's mass number?
2. How can you show the difference between protons and neutrons? What materials will you use to represent the electrons of the atom? How will you represent the nucleus?
3. How will you model the arrangement of electrons in the atom? Will the atom have a charge? Is it possible to identify an atom by the number of protons it has?
4. Make sure your teacher approves your plan before you proceed.

Make the Model

1. **Construct** your model. Then record your observations on a separate sheet of paper and include a sketch.
2. **Construct** another model of a different element.
3. **Observe** the models made by your classmates. Identify the elements they represent.

LAB (continued)

Analyze Your Data

1. State what elements you identified using your classmates' models.

2. **Identify** which particles always are present in equal numbers in a neutral atom.

3. **Predict** what would happen to the charge of an atom if one of the electrons were removed.

4. **Describe** what happens to the charge of an atom if two electrons are added. What happens to the charge of an atom if one proton and one electron are removed?

5. **Compare and contrast** your model with the electron cloud model of the atom. How is your model similar? How is it different?

Conclude and Apply

1. **Define** the minimum amount of information that you need to know in order to identify an atom of an element.

2. **Explain** If you made models of the isotopes boron-10 and boron-11, how would these models be different?

Communicating Your Data

Compare your models with those of other students. Discuss any differences you find among the models.

LAB 1 Laboratory Activity

Chemical Bonds

An ion is an atom that is no longer neutral because it has gained or lost electrons. One important property of ions is the ability to conduct electricity in solution.

Ions can form in solution in several ways. Ionic compounds, which are often compounds created from metals of Groups 1 and 2 and nonmetals in Groups 16 and 17, dissolve in water to form ions. Acids and bases also form ions in solution. Although acids and bases contain covalent bonds (bonds in which electrons are shared), acids form the hydronium ion (H_3O^+), while bases form the hydroxide ion (OH^-) in water.

Other covalent compounds form solutions, too. These solutions, however, do not conduct an electric current because they do not form ions in solution. A measure of how well a solution can carry an electric current is called conductivity.

Strategy

You will determine the conductivity of several solutions.

You will classify the compounds that were dissolved in the solutions as ionic compounds or covalent compounds.

Materials

9-V battery and battery clip
tape
cardboard sheet, 10 cm × 10 cm
alligator clips (4)
LED (light-emitting diode)
resistor, 1,000-Ω
copper wire, insulated, 20-cm lengths (2)
microplate, 24-well
pipettes, plastic (7)
sulfuric acid solution, 0.1*M* H_2SO_4
sodium chloride solution, 0.1*M* NaCl
sodium hydroxide solution, 0.1*M* NaOH
sucrose solution, 0.1*M* sucrose
glucose solution, 0.1*M* glucose
sugar cubes (sucrose)
sodium chloride (rock, crystalline)
water, distilled
paper towels

WARNING: *Sulfuric acid and sodium hydroxide can cause burns. Avoid contacting them with your skin or clothing. Do not taste, eat, or drink any materials used in the lab.*

Procedure

Part A—Constructing a Conductivity Tester

1. After putting your apron and goggles on, attach the 9-V battery clip to the 9-V battery. Use tape to attach the battery securely to the cardboard sheet, as shown in Figure 1.
2. Attach an alligator clip to one of the lead wires of the 1,000-Ω resistor. Connect the alligator clip to the *red* lead wire of the battery clip. Tape the resistor and alligator clip to the cardboard sheet as shown in Figure 2. **WARNING:** *Use care when handling sharp objects.*
3. Attach an alligator clip to the *long* lead wire of the LED. Connect this alligator clip to the second wire of the 1,000-Ω resistor. Tape the alligator clip to the cardboard sheet.
4. Attach an alligator clip to the *short* lead wire of the LED. Connect this clip to one end of one of the insulated copper wires. Tape the clip to the cardboard sheet as shown in Figure 3.
5. Attach the last alligator clip to one end of the second insulated copper wire. Connect the alligator clip to the *black* lead wire of the battery clip. Tape the alligator clip to the cardboard sheet as shown in Figure 4.
6. Check to be certain that the alligator clips, resistor, and battery are securely taped to the cardboard sheet and that the clips are not touching one another.

Laboratory Activity 1 (continued)

7. Have your teacher check your conductivity tester.

8. Touch the two ends of the two insulated wires and observe that the LED glows.

Figure 1

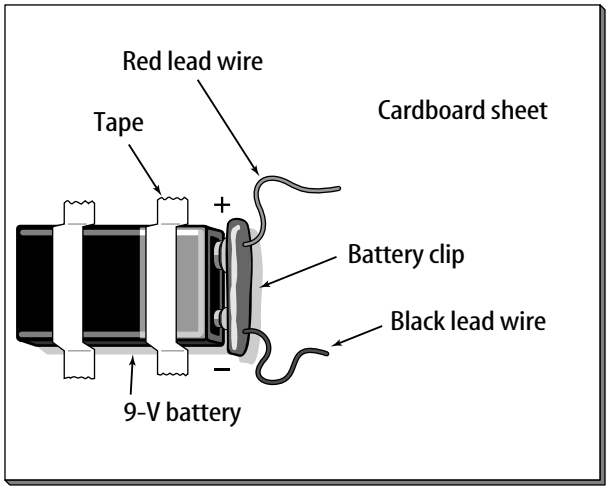


Figure 2

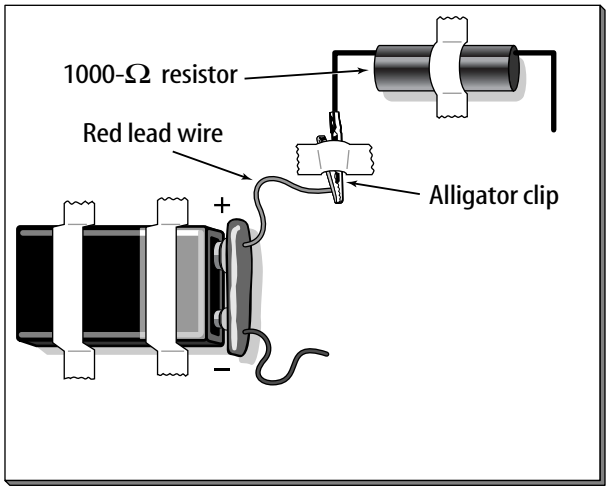


Figure 3

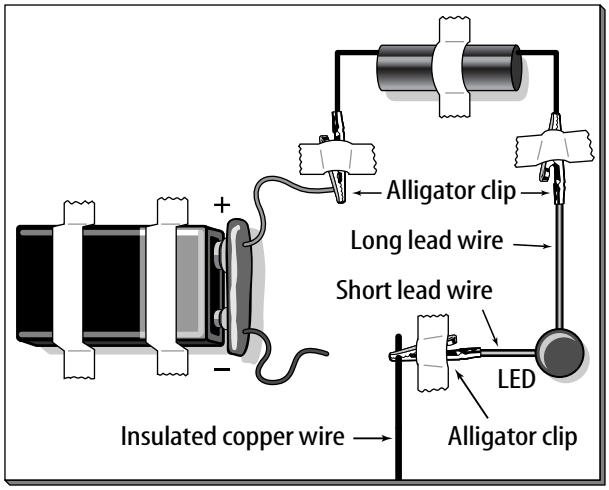
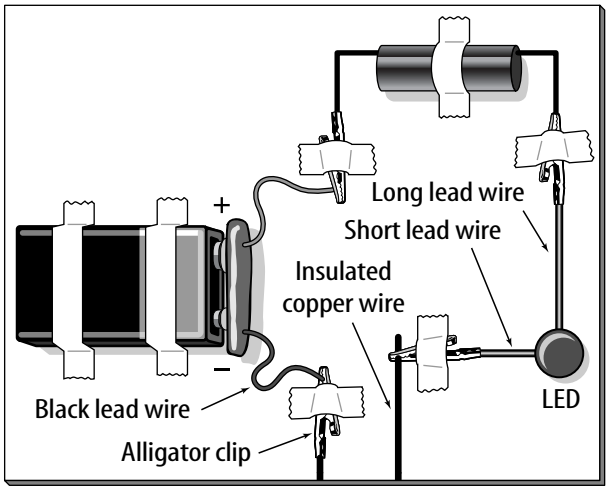
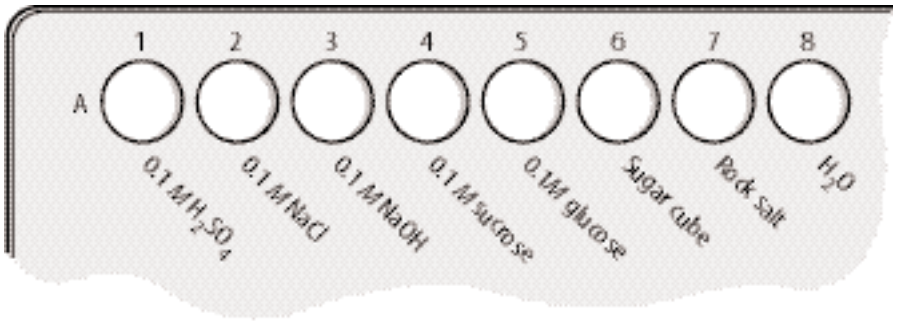


Figure 4



Laboratory Activity 1 (continued)

Figure 5

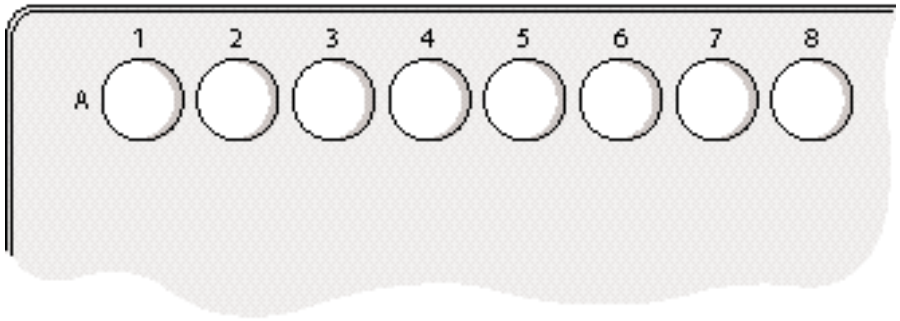


Part B—Testing the Conductivity of a Solution

1. Place the microplate on a flat surface. Have the numbered columns of the microplate at the top and the lettered rows at the left. **WARNING:** *Wash hands immediately after coming in contact with any of the prepared solutions. Inform your teacher if you come in contact with any chemicals.*
2. Using a clean pipette, add a pipette of the sulfuric acid solution to well A1.
3. Using another clean pipette, add a pipette of the sodium chloride solution to well A2.
4. Repeat step 3 for each remaining solution. Use a clean pipette for each solution. Add the sodium hydroxide solution to well A3, the sucrose solution to well A4, the glucose solution to well A5, a sugar cube to well A6, and a piece of rock salt to well A7.
5. Using a clean pipette, add a pipette of distilled water to well A8. For steps 1–5 see Figure 5.
6. Place the exposed ends of the two insulated copper wires into the solution in well A1, positioning the wires so they are at opposite sides of the well. Be sure that the exposed ends of the wire are completely submerged.
7. Observe the LED. Use the brightness of the LED as an indication of the conductivity of the solution. Rate the conductivity of the solution using the following symbols: + (good conductivity); – (fair conductivity); or 0 (no conductivity). Record your rating in the corresponding well of the microplate shown in Figure 6.
8. Remove the wires and dry the ends of the wires with a paper towel.
9. Repeat steps 6, 7, and 8 for each remaining well in the microplate.

Data and Observations

Figure 6



Laboratory Activity 1 (continued)

Questions and Conclusions

1. What is the conductivity of distilled water?

2. Why was the conductivity of the distilled water measured?

3. After studying your results, infer which solutions contained ions. Which solutions did not contain ions?

4. Which solutions contained covalent compounds? Did any of these solutions conduct an electric current?

5. Did the crystal of table salt or the sugar cube conduct electricity?

6. How did the conductivities of the crystal of table salt and the 0.1*M* NaCl solution compare?

7. From your results, describe one property of ions in solution.

Strategy Check

_____ Can you test the conductivity of a solution?

_____ Can you distinguish between a solution that contains ions and one that does not?

LAB 2 Laboratory Activity

Chemical Activity

The atoms of most chemical elements either gain or lose electrons during reactions. Elements whose atoms lose electrons during reactions are classified as metals. Metals are found on the left side of the periodic table of elements. The tendency of an element to react chemically is called activity. The activity of a metal is a measure of how easily the metal's atoms lose electrons.

Strategy

You will observe chemical reactions between metals and solutions containing ions of metals.
You will compare the activities of different metals.
You will rank the metals in order of their activities.

Materials

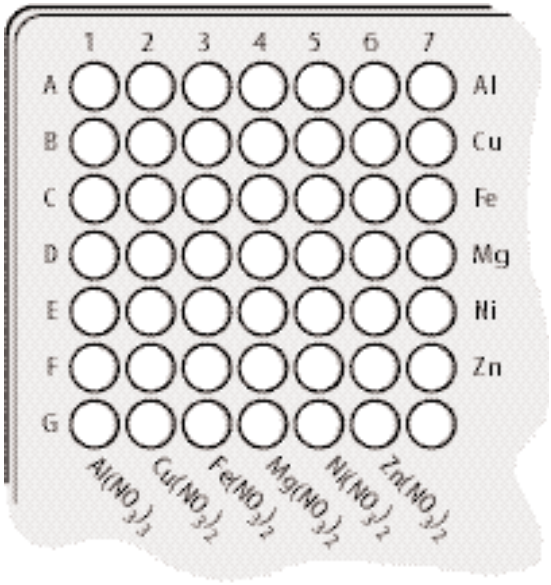
microplate, 96-well
paper, white
pipette, plastic microtip
aluminum nitrate solution, 0.1*M* $Al(NO_3)_3$
water, distilled
copper nitrate solution, 0.1*M* $Cu(NO_3)_2$
iron nitrate solution, 0.1*M* $Fe(NO_3)_2$
magnesium nitrate solution, 0.1*M* $Mg(NO_3)_2$
nickel nitrate solution, 0.1*M* $Ni(NO_3)_2$
zinc nitrate, 0.1*M* $Zn(NO_3)_2$
paper towels
metal strips (8 1-mm × 10-mm strips of each: aluminum, Al; copper, Cu; iron, Fe; magnesium, Mg; nickel, Ni; and zinc, Zn)
hand lens or magnifier

WARNING: *Many of these solutions are poisonous. Avoid inhaling any vapors from the solutions. These solutions can cause stains. Do not allow them to contact your skin or clothing.*

Procedure

1. Wear an apron and goggles during this experiment.
2. Place the microplate on a piece of white paper on a flat surface. Have the numbered columns of the microplate at the top and lettered rows at the left.
3. Using the microtip pipette, place 15 drops of the aluminum nitrate solution in each of wells A1–G1. Rinse the pipette with distilled water.
4. Place 15 drops of copper nitrate solution in each of wells A2–G2 using the pipette. Rinse the pipette with distilled water.

Figure 1



Laboratory Activity 2 (continued)

5. Repeat step 4 for each of the remaining solutions. Add the iron nitrate solution to wells A3–G3, the magnesium nitrate solution to wells A4–G4, the nickel nitrate solution to wells A5–G5, the zinc nitrate solution to wells A6–G6. Leave the wells in column 7 empty.
6. Carefully clean each metal strip with a paper towel.
7. Place one strip of aluminum in each of wells A1–A7.
8. Place one strip of copper in each of wells B1–B8.
9. Repeat step 8 for the remaining metals. Add the iron strips to wells C1–C7, the magnesium strips to wells D1–D7, the nickel strips to wells E1–E7, and the zinc strips to wells F1–F7. Do not put strips in the wells in row G.
10. Figure 1 shows the metals and the solutions that are in each of wells A1–G7.
11. Wait 10 min.
12. Use a hand lens or magnifier to observe the contents of each well. Look for a change in the color of the solution in each well by comparing it with the color of the solution in well G at the bottom of the column. Look for a change in the texture or color of the metal strip in each well by comparing it with the piece of metal in well 7 at the end of that row. Look for the appearance of deposited materials in the bottom of the well. Each change or appearance of deposits is an indication that a chemical reaction is taking place.
13. If you see an indication of a reaction, draw a positive sign (+) in the corresponding well of the microplate shown in Figure 2 in the Data and Observations section. If you see no indication of a reaction, draw a negative sign (–) in the corresponding well of Figure 2.
14. Count the number of positive signs in each row of wells in Figure 2. Record the value under the corresponding metal in Table 1.

Data and Observations

Figure 2

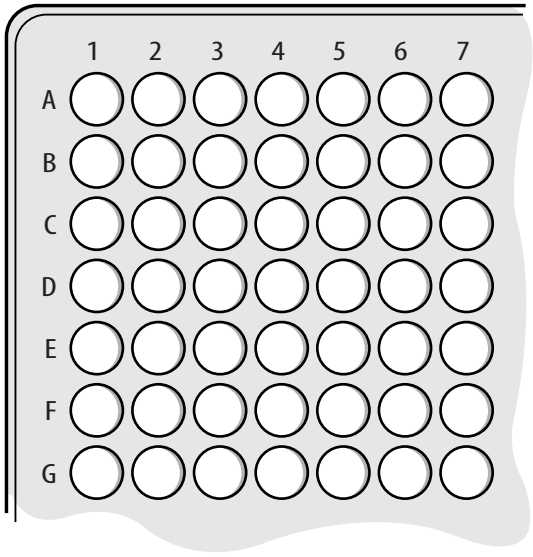


Table 1

Metal	Al	Cu	Fe	Mg	Ni	Zn
Number of reactions	1.	2.	3.	4.	5.	6.

Laboratory Activity 2 (continued)

Questions and Conclusions

1. Why were solutions but not strips of metal placed in wells G1–G6?

2. Why were strips of metal but no solutions added to wells A7–F7?

3. Why did you clean the metal strips with the paper towel?

4. Using the number of reactions for each metal in Table 1, rank the metals from the most active to the least active.

5. Solutions of dissolved metal compounds contain metal ions. An ion is an atom that has gained or lost electrons. Ions of metals are positively charged because the metals lose electrons when they react. The activity of the ion of a metal is a measure of how easily an ion gains electrons. Use the results of this experiment to rank the activities of ions of metals in solutions.

6. How does the activity of an ion of a metal compare with the activity of the metal?

Strategy Check

_____ Can you identify evidence that a chemical reaction has occurred between a metal and a solution containing metal ions?

_____ Can you interpret evidence of chemical reactions between metals and solutions of metal ions and arrange the metals in order according to their activities?

Chemical Bonds

Directions: *Use this page to label your Foldable at the beginning of the chapter.*

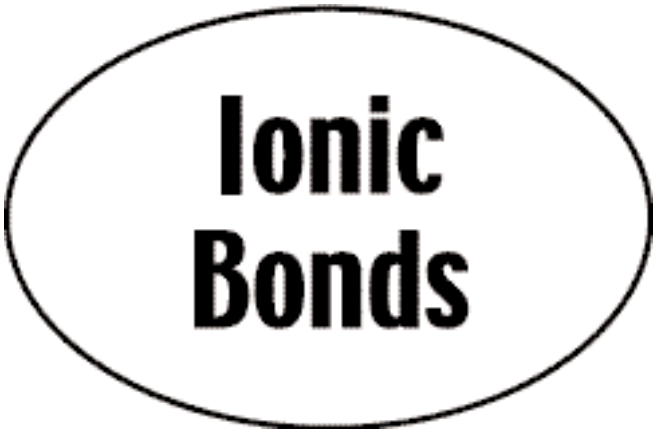
The neutral particle that forms when atoms share electrons is called a molecule.

These bonds form a compound, or pure substance containing two or more chemically bonded elements.

These bonds form when a metal atom loses one or more electrons and a nonmetal atom gains one or more electrons.

These bonds form when two or more nonmetal atoms share electrons.

When the electrons in these bonds spend more time nearer one atom than the other, they are called polar bonds.



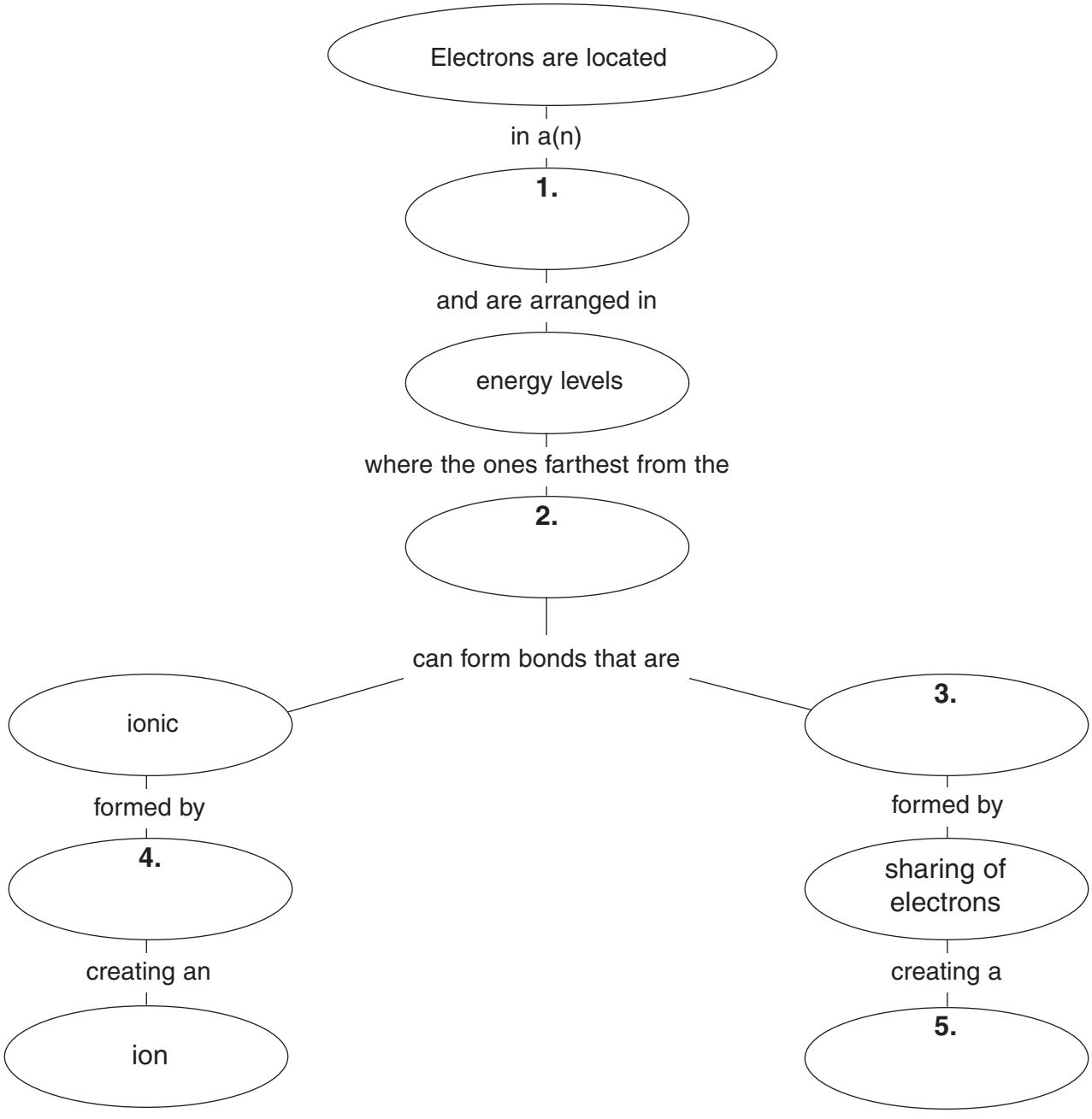
Meeting Individual Needs

Directed Reading for Content Mastery

Overview
Atomic Structure and Chemical Bonds

Directions: *Complete the concept map using the terms listed below.*

covalent **molecule** **nucleus**
electron cloud **gain or loss of electrons**



Name Date Class

Directed Reading for Content Mastery

Section 1 ▪ Why do atoms combine?

Directions: *Use the periodic table to complete the electron dot diagrams below.*

1. H

2. Cl

3. P

4. Ne

Directions: *Answer the following questions about elements and the periodic table.*

5. Does neon combine easily with other elements? Explain your answer.

6. Nitrogen has the same number of electrons in its outer energy level as which element above?

7. What name is given to the family of elements that includes chlorine?

8. Which elements have properties similar to calcium?

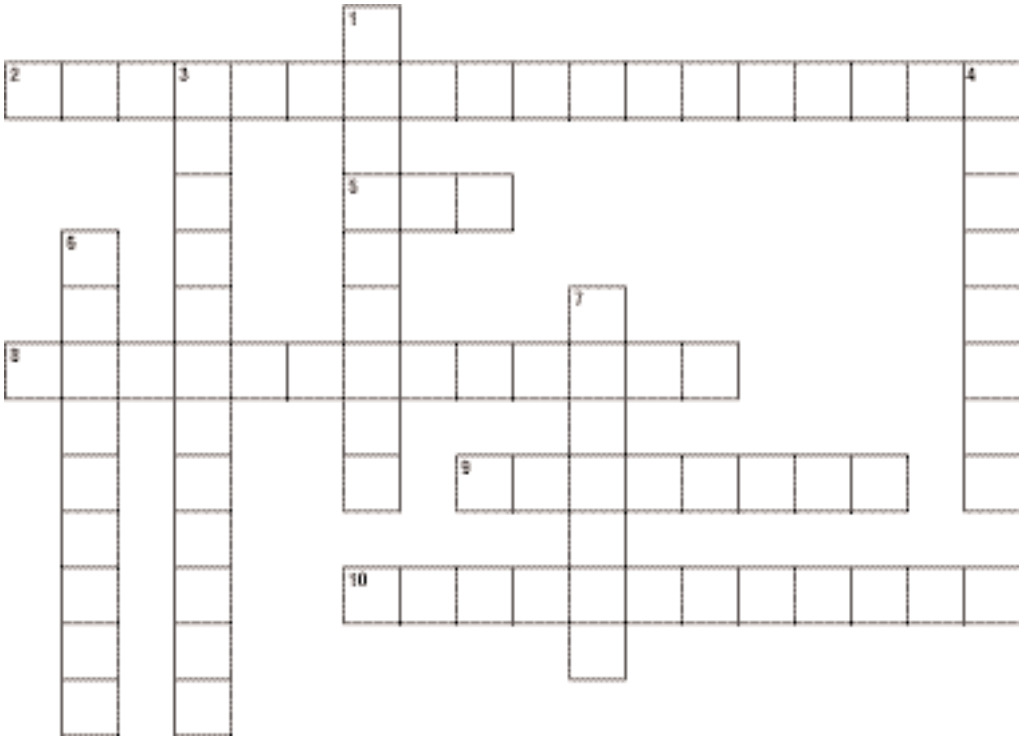
Meeting Individual Needs

Directed Reading for Content Mastery

Section 2 ▪ How Elements Bond

Directions: *Use the following terms to complete the crossword puzzle.*

chemical bond **compound** **covalent bond**
electron cloud **electron dot diagram** **formula**
ion **ionic bond** **molecule** **polar bond**



Across

2. Shows the number of electrons in the outer energy level

5. An atom that has gained or lost an electron

8. All electrons in an atom are in the _____.

9. A pure substance that contains two or more elements

10. Bond formed when atoms share electrons

Down

1. An attraction that holds ions close together

3. A force that holds two atoms together

4. Neutral particle formed when atoms share electrons

6. Type of bond in which electrons are shared unequally

7. A combination of chemical symbols

Name Date Class

Directed Reading for Content Mastery

Key Terms
Atomic Structure and Chemical Bonds

Directions: *Use the following terms to complete the sentences below.*

polar bond **compound** **chemical bond** **ion**
ionic bond **covalent bond** **polar molecule** **electron cloud**
molecule **formula** **electron dot diagram** **metallic bond**

1. Ions are held close together by a(n) _____.
2. A charged atom particle is called a(n) _____.
3. A force that holds two atoms together is a(n) _____.
4. A pure substance that contains two or more elements is a(n) _____.
5. A(n) _____ forms between atoms when they share electrons.
6. A(n) _____ is formed when atoms form covalent bonds.
7. NaCl is an example of a chemical _____.
8. A(n) _____ is a way to represent atoms and electrons in their outer energy levels.
9. Electrons are shared unequally in a(n) _____.
10. A(n) _____ has a slight positive charge on one end and a slight negative charge on the other end.
11. The area of space around the nucleus in which an atom's electrons travel is called the _____.
12. When metal atoms share their pooled electrons, a _____ is formed.

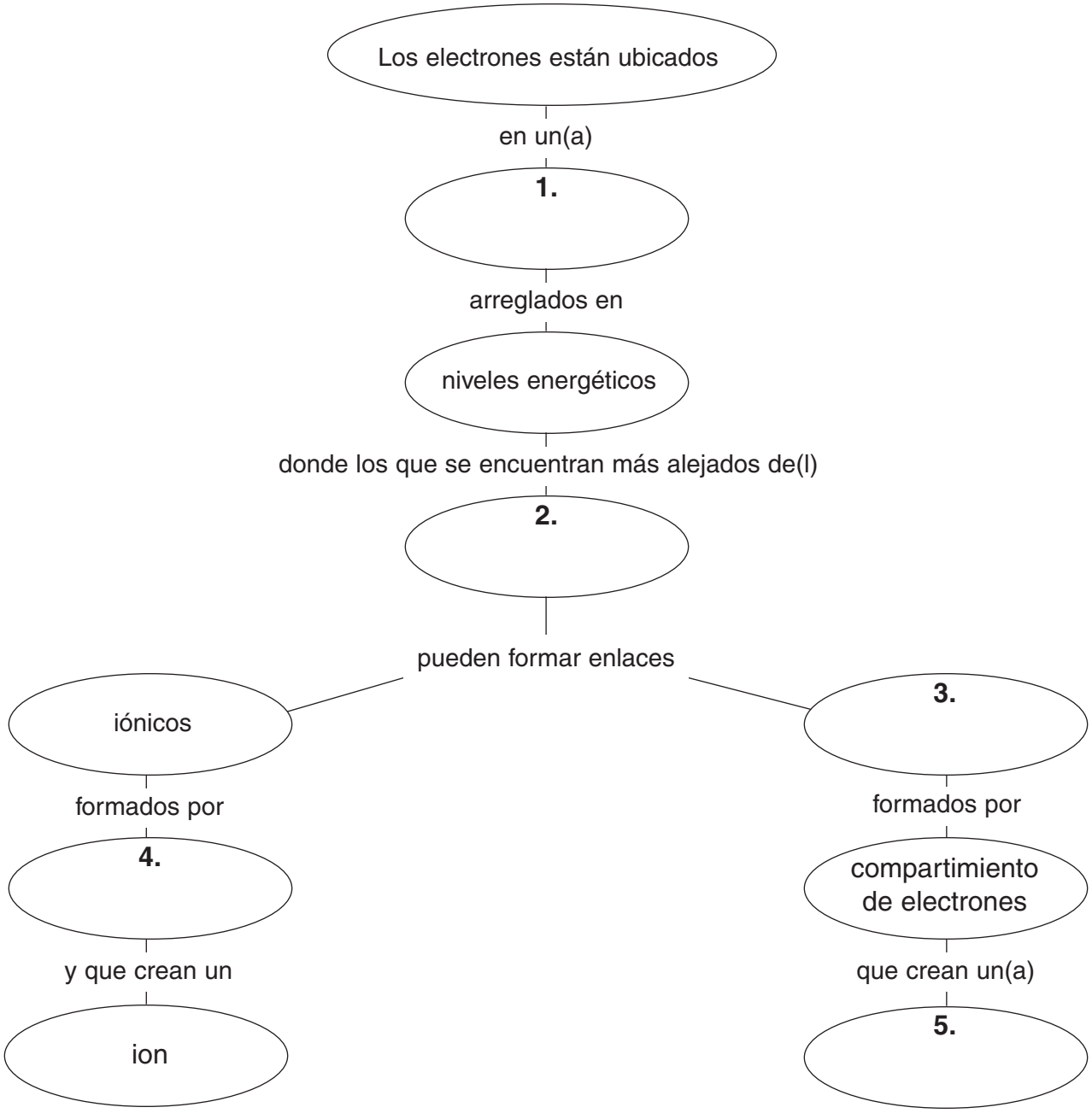
Meeting Individual Needs

Lectura dirigida para
Dominio del contenido

Sinopsis
Estructura del átomo y enlaces químicos

Instrucciones: *Completa el mapa conceptual usando los siguientes términos.*

covalentes **molécula** **núcleo**
nube electrónica **ganancia o pérdida de electrones**



Lectura dirigida para Dominio del contenido

Sección 1 ▪ ¿Por qué se combinan los átomos?

Instrucciones: *Usa la tabla periódica para completar los siguientes diagramas de puntos.*

1. H

2. Cl

3. P

4. Ne

Instrucciones: *Contesta estas preguntas sobre los elementos de la parte anterior.*

5. ¿Se combina el neón fácilmente con otros elementos? Explica.

6. ¿Cuál de estos elementos tiene el mismo número de electrones en su nivel de energía externo que el nitrógeno?

7. ¿Qué nombre se le da a la familia de elementos que incluye el cloro?

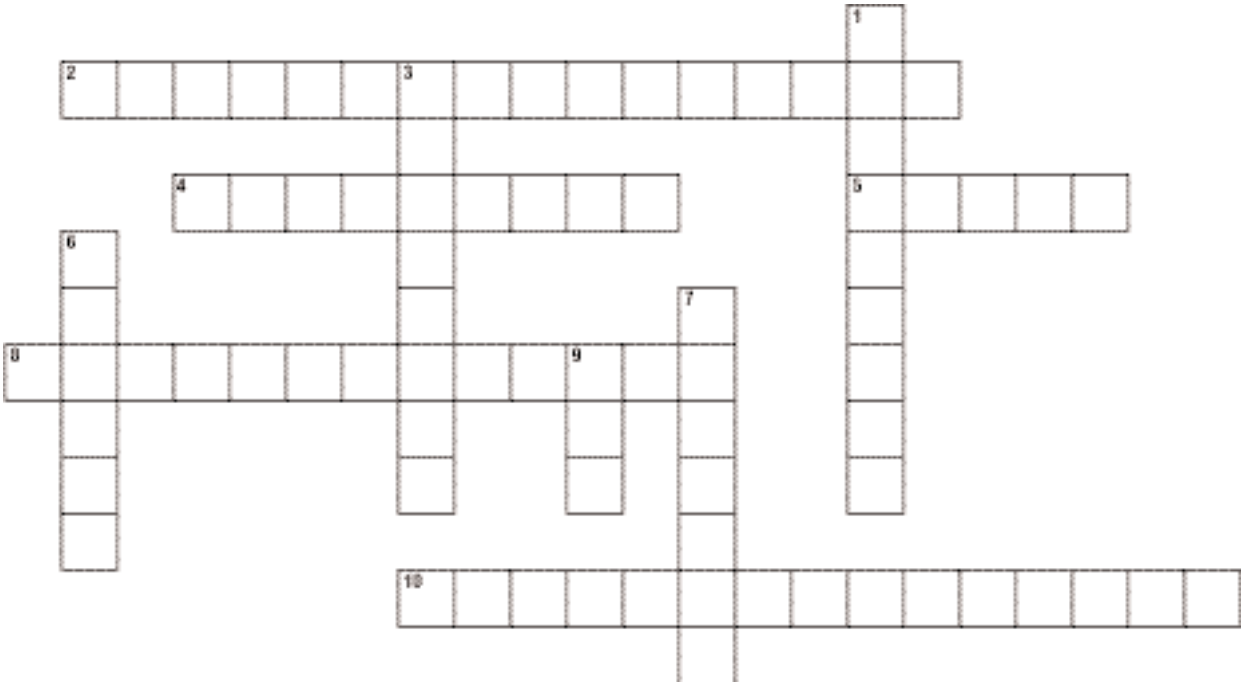
8. ¿Cuáles elementos tienen propiedades similares a las del calcio?

Lectura dirigida para Dominio del contenido

Sección 2 ▪ Cómo se unen los elementos

Instrucciones: *Usa los siguientes términos para completar el crucigrama.*

enlace químico **compuesto** **covalente**
nube electrónica **diagramas de puntos** **fórmula**
ion **enlace iónico** **molécula** **enlace polar**



Horizontales

2. Muestra el número de electrones en el nivel más externo

4. Enlace que se forma cuando los átomos comparten electrones

5. Tipo de enlace en el cual los electrones se comparten en forma desigual.

8. Fuerza que mantiene unidos a los átomos

10. Todos los electrones de un átomo están en su _____.

Verticales

1. Sustancia pura que contiene dos o más elementos

3. Partícula neutra que se forma cuando los átomos comparten electrones

6. Tipo de enlace que mantiene unidos los iones

7. Combinación de símbolos químicos

9. Átomo que ha ganado o perdido un electrón

Lectura dirigida para Dominio del contenido

Términos claves
Estructura del átomo y enlaces químicos

Instrucciones: *Usa los siguientes términos para completar las oraciones.*

enlace polar **compuesto** **enlace químico** **enlace metálico**
enlace iónico **enlace covalente** **molécula polar** **nube electrónica**
molécula **fórmula** **diagrama de puntos de electrones** **ion**

1. Los iones se mantienen unidos por medio de un(a) _____.
2. Una partícula atómica con carga se llama un(a) _____.
3. La fuerza que mantiene a dos átomos unidos es un(a) _____.
4. Una sustancia pura que contiene uno o más elementos es un(a) _____.
5. Cuando los átomos comparten electrones se forma un(a) _____ entre ellos.
6. Cuando los átomos forman enlaces covalentes se forma un(a) _____.
7. El NaCl es un ejemplo de un(a) _____ químico(a).
8. Un(a) _____ es una forma de representar los átomos y electrones en los niveles de energía externos.
9. En un(a) _____ los electrones se comparten de manera desigual.
10. Un(a) _____ tiene una pequeña carga positiva en un extremo y una pequeña carga negativa en el otro extremo.
11. El espacio alrededor del núcleo en el cual viajan los electrones del átomo se llama _____.
12. Cuando los átomos de los metales comparten sus electrones combinados, se forma un(a) _____.

Satisface las necesidades individuales

Name Date Class

SECTION 1 Reinforcement

Why do atoms combine?

Directions: *Complete the sentences below using the following terms. Some of the terms may not be used.*

atomic structure	**electron dot diagram**	**outer energy level**
electron	**element families**	**proton**
electron cloud	**nucleus**	**period**

1. An element is stable with eight electrons in its _____.
2. The closer a(n) _____ is to the nucleus, the stronger the attractive force.
3. An atom's _____ contains its protons and neutrons.
4. A(n) _____ model with dark bands representing energy levels shows where an atom's electrons are most likely to be.
5. The chemical symbol for an element surrounded by as many dots as there are electrons in its outer energy level is called a(n) _____.
6. Columns in the periodic table are known as _____.
7. The number of electrons in a neutral atom increases by one as you go from left to right across a _____ in the periodic table.
8. Each element has a different number of protons and electrons, so each has a different _____.

Directions: *Answer the following questions.*

9. Explain how the arrangement of electrons in an atom is related to the periodic table.

_____

_____

_____

_____

_____

10. Use the periodic table to construct electron dot diagrams for the following elements: aluminum, magnesium, sulfur, and bromine.

Meeting Individual Needs

Name Date Class

SECTION 2 Reinforcement

How Elements Bond

Directions: *Correctly complete the following paragraphs using terms from the list below. Some terms may not be used, and some terms may be used more than once.*

electrons	**losing**	**positive**	**covalent**
molecules	**protons**	**gaining**	**negative**
random	**gains**	**neutral**	**regular**	**ionic**
nonpolar	**ions**	**loses**	**polar**	**sharing**

Elements in Group 1 become more stable by **1.** _____ an electron. These elements form **2.** _____ ions because they have more **3.** _____ than **4.** _____. Chlorine readily **5.** _____ an electron, forming a **6.** _____ ion. The attraction between sodium ions and chlorine ions forms **7.** _____ bonds. In sodium chloride, the ions are lined up in a **8.** _____ pattern.

Unlike sodium and chlorine, some atoms become more stable by sharing **9.** _____, forming **10.** _____ rather than charged **11.** _____. The bonds in a molecule of oxygen are **12.** _____ **13.** _____ bonds, while the bonds in a molecule of water are **14.** _____ **15.** _____ bonds.

Directions: *Next to each formula, write the number of atoms of each element found in one unit of the compound.*

16. potassium iodide, KI _____

17. sodium sulfide, Na_2S _____

18. silicon dioxide, SiO_2 _____

19. carbonic acid, H_2CO_3 _____

Directions: *Complete the following activity.*

20. Hydrogen combines with sulfur much like hydrogen combines with oxygen. Draw an electron dot diagram showing hydrogen combined with sulfur and write the chemical formula below.

Meeting Individual Needs

Name Date Class

SECTION 1 Enrichment

Tiny Matter

Neutrinos are subatomic particles. Trillions of them cross the Earth—and move through you—every second. They weigh less than a fraction of the mass of an electron and they are neutral. There are three types of neutrinos: electron-neutrinos, muon-neutrinos, and tau-neutrinos. Physicists have been studying neutrinos since the 1930s. The most important discoveries are listed below.

1930 Based on observations of radioactive decay, Wolfgang Pauli hypothesizes that neutrinos exist.

1956 Clyde Cowan and Fred Reines discover neutrinos by using a nuclear reactor.

1956–57 Bruno Pontecorvo, Shoichi Sakata, and other physicists suggest that neutrinos oscillate or change form.

1964 John Bahcall and Ray Davis propose measuring neutrinos from the Sun.

1965 The first neutrinos are observed by Fred Reines and other physicists in a gold mine in South Africa.

1976 Scientists design new neutrino detectors in Hawaii.

1980s First massive underground instrument for neutrino detection is built 600 meters underground in a salt mine near Cleveland, Ohio. An experiment begins in Kamioka, Japan, in a zinc mine.

1986 The Kamioka group observes solar neutrinos.

1996 A U.S.-Japan team uses Super-Kamiokande, the largest detector ever built, to search for neutrino interactions.

1998 The Super-Kamiokande team reports oscillations or changes in form.

1999 The Super-Kamiokande team detects a neutrino that had been produced artificially.

Meeting Individual Needs

Directions: *Use the encyclopedia and other library resources to answer the following questions.*

1. How would you describe the first 25 years of neutrino studies?

2. Based on the types of neutrinos, what kinds of changes do you think the scientists observed in 1998?

3. What properties of neutrinos make them especially difficult to study?

4. Will the study of neutrinos change scientists' understanding of the atom?

Name Date Class

SECTION 2 Enrichment

Ionic and Covalent Bonds

Many of the foods we eat include some kind of additive. Sometimes additives are used to improve the appearance of the food, as is quite often the case with fruits. For example, antioxidants are added to cut fruits so that they won't turn brown as quickly as they would otherwise. In addition, desserts and soft drinks often have artificial sweeteners added to keep the over all caloric count low without adversely affecting the taste.

A Common Cure

People have been using food additives for centuries. Before refrigeration, people used to pickle or cure their foods to keep the food from spoiling. While pickling and curing still take place, the refrigerator and freezer have made these methods less of a necessity than they once were.

A common ionic substance, curing salt, is used to help preserve ham, bacon, sausage, and most other cured meats. At first, this was thought to be a wonderful way to reduce the risks of botulism, which is extremely dangerous. As time went on, however, scientists discovered that the very ionic properties that prevent the growth of bacteria also cause cancer.

Trouble with Nitrites

The ion nitrate used in curing is converted to nitrite by enzymes or bacteria. The nitrite then prevents the bacteria from growing. Both nitrate and nitrite help in producing the pinkish coloring in some meat. Unfortunately, nitrite also interacts with a substance called amine. Amine is found in all meats. When nitrite and amine react at high temperatures they produce a group of chemicals called nitrosamines. Nitrosamines have been found to cause cancer in every species of animals they have been tested on. In order for the chemical reaction that produces nitrosamines to take place, the meat must be cooked at very high temperatures. Any meat that is fried is at a greater risk of having nitrosamines produced.

1. Why are food additives used?

2. How was most food preserved in the past and what inventions changed that?

3. Why are nitrates used to help preserve food?

4. Is it accurate to say that curing salts are both beneficial and harmful? Why or why not?

Meeting Individual Needs

Name Date Class

Note-taking Worksheet

Atomic Structure and Chemical Bonds

Section 1 Why do atoms combine?

A. The _____, containing protons and neutrons, is at the center of an atom and is surrounded by the _____, an area of space around the _____ where _____ travel.

1. _____ have a negative charge and do not travel in well defined orbits.

2. Each element has a different _____ consisting of a particular number of protons, neutrons, and electrons.

B. The _____ and _____ of electrons in the electron cloud determines the physical and chemical properties of the element.

1. Electrons are arranged in different _____ at different distances from the nucleus.

2. The _____ an energy level is from the nucleus, the more electrons it can hold.

3. Electrons in the level closest to the nucleus have the _____ amount of energy; electrons farthest from the nucleus have the _____ amount of energy.

C. Data from the _____ _____ can be used to understand energy levels.

1. The _____ is the same as the number of protons (or electrons) in an electrically neutral atom.

2. The number of electrons in an element's outermost energy level _____ from left to right across a period.

a. The first energy level is complete with two electrons, and the _____ has two elements.

b. The last element in each of the other_____ has _____ electrons in its outer energy level.

3. Each column in the periodic table contains one element family or group with _____ chemical properties.

a. The _____ in Group 8 do not combine easily with other elements because their energy levels are stable.

Meeting Individual Needs

Note-taking Worksheet (continued)

b. The _____ have 7 electrons in their outer energy levels; reactivity of the halogens decreases down the group.

c. The _____ in Group 1 have one electron in their outer energy level; reactivity of the alkali metals increases down the group.

D. An _____ is the symbol for the element surrounded by as many dots as there are electrons in its outer energy level.

1. Dots are written on four sides of the element symbol.

a. _____ dot represents a single electron.

b. Paired electrons are represented by _____ dots.

2. A _____ is the force that holds two atoms together.

a. Electron _____ diagrams can be used to show how _____ bond with each other.

b. Atoms bond with other atoms so that each atom has a _____ energy level.

Section 2 How Elements Bond

A. Atoms form _____ by losing electrons, by gaining electrons, by pooling electrons, or by sharing electrons.

1. An atom that is no longer neutral because it has lost or gained an electron is called an _____.

2. An _____ forms when positive and negative ions attract each other.

a. Sodium chloride is formed from _____ ions and chloride _____.

b Two or more elements that are chemically bonded form a _____.

3. Some atoms can gain or lose _____ than one electron when they form ions.

B. _____ form when metal atoms share their pooled electrons.

C. A _____ forms between atoms that share electrons.

1. Atoms sharing electrons form a neutral particle called a _____.

a. Covalently bonded compounds are called _____.

b. No electrons are gained or _____.

2. Two pairs of electrons are involved in a _____ bond.

Note-taking Worksheet (continued)

D. A _____ occurs when electrons are unevenly shared.

1. _____ molecules such as water have two opposite ends, or poles, like a magnet.

2. _____ bonds form between atoms of the same element.

E. Symbols are used to _____ atoms and compounds.

1. _____ are represented by a one-, two-, or three-letter symbol.

2. _____ are described using element symbols and numbers.

3. In the formula H_2, the small 2 after the H is called a _____, and indicates the number of _____ of hydrogen that are in the molecule.

4. A _____ is a combination of chemical symbols and numbers.

a. It tells which _____ are present and how many _____ of each element are present.

b. No subscript means that _____ atom of that element is present.

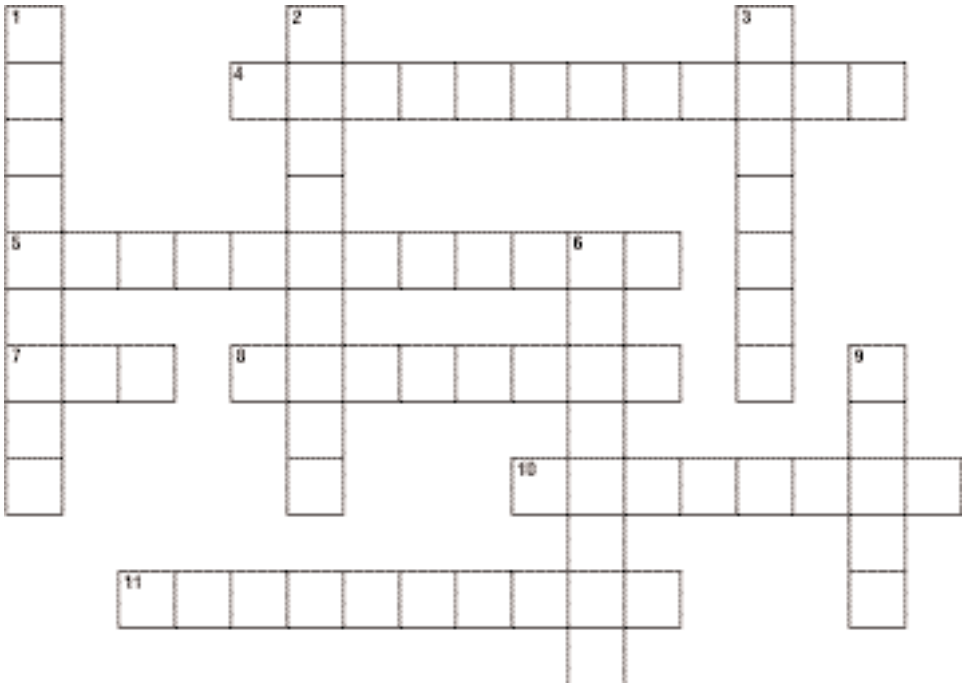
Assessment

Chapter Review

Atomic Structure and Chemical Bonds

Part A. Vocabulary Review

Directions: *Complete the crossword puzzle using the clues below.*



Across

4. The bond that forms between atoms when they share electrons

5. Force that holds two atoms together

7 An atom that is no longer neutral because it has gained or lost an electron

8. A pure substance that contains two or more elements

10. A neutral particle formed when atoms share electrons

11. An electron _____ is the chemical symbol for the element surrounded by as many dots as there are electrons in its outer energy level.

Down

1. Number to the lower right on an element symbol indicating number of atoms of that element

2. The attraction that holds positive and negative ions together

3. A combination of chemical symbols and numbers that shows what a molecule is made of

6. Molecule that does not have two opposite ends or poles

9. Molecule that has two opposite ends or poles

Part B. Concept Review

Directions: *Fill in the blanks with the correct terms.*

1. Sodium chloride is an example of a(n) _____ because it contains two or more elements.

2. An ionic compound, salt is a hard, crystalline substance in which the _____ and _____ ions are lined up in a regular pattern.

Chapter Review (continued)

3. At the center of an atom is a(n) _____ that contains one or more positively charged _____ and neutral _____.
4. Electrons that are closest to the atom's nucleus are in the _____ energy level.
5. When two atoms share an electron unevenly and one of the atoms has a slight negative charge as a result, their bond is referred to as a(n) _____.
6. If there is a balanced sharing of electrons and neither atom has a slight negative or positive charge, their bond is referred to as a(n) _____.
7. The chemical formula CO_2 represents a molecule that contains one atom of _____ and _____ atoms of oxygen.

Directions: *Answer the following using complete sentences. Include chemical symbols where appropriate.*

8. Describe how electron dot diagrams can be used and why they are helpful.

9. Describe how elements form ions that have a stable atomic structure like that found in a noble gas. Give at least two examples.

10. Describe what would happen if a positively charged sodium ion and a negatively charged chlorine ion came into contact.

11. Explain why a stairway is a good model for the energy levels in an atom.

12. How does a polar bond differ from a nonpolar bond?

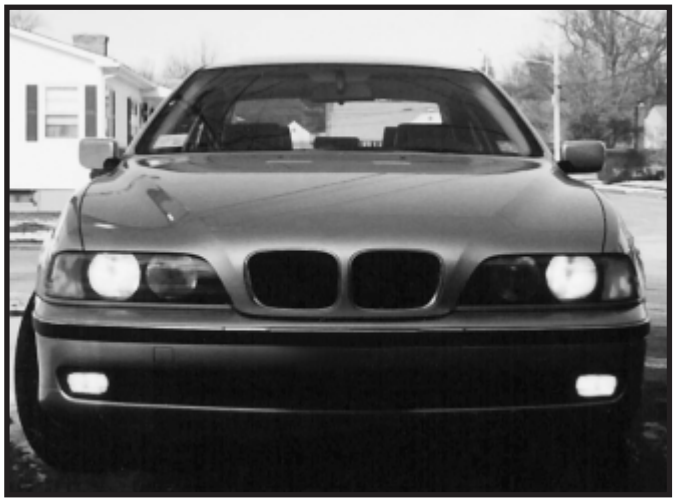
Transparency Activities

Name Date Class

SECTION 1 Section Focus Transparency Activity

Lighting the Way

You may have noticed that some new cars have headlights with a different, bluish glow. These headlights use xenon gas to light up the night. The photos below compare the two types of headlights; the upper image shows traditional lights, while the lower one shows xenon lights.



1. **Describe the headlights in this picture.**
2. **What is a compound?**
3. **Name another gas that is used to make lights. Does the gas you named have anything in common with xenon?**

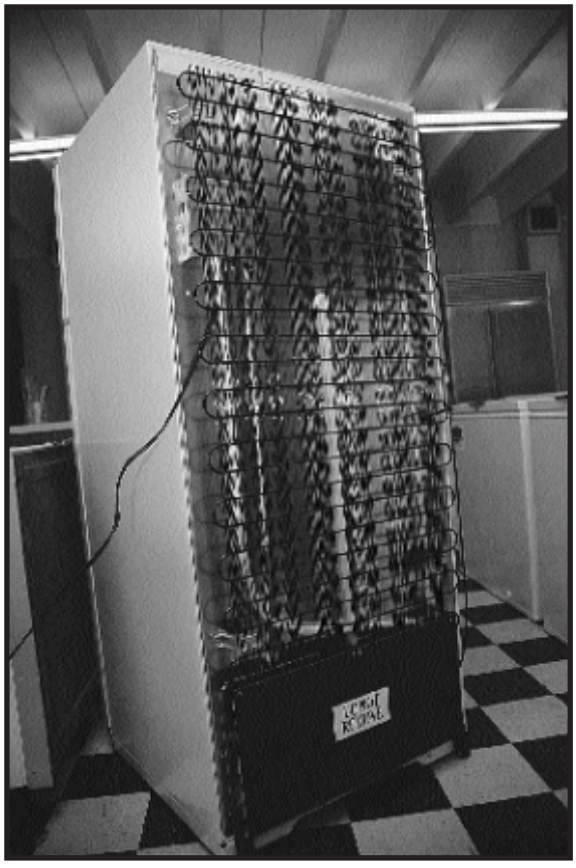
Transparency Activities

Name Date Class

SECTION 2 Section Focus Transparency Activity

Reactive, but Cool

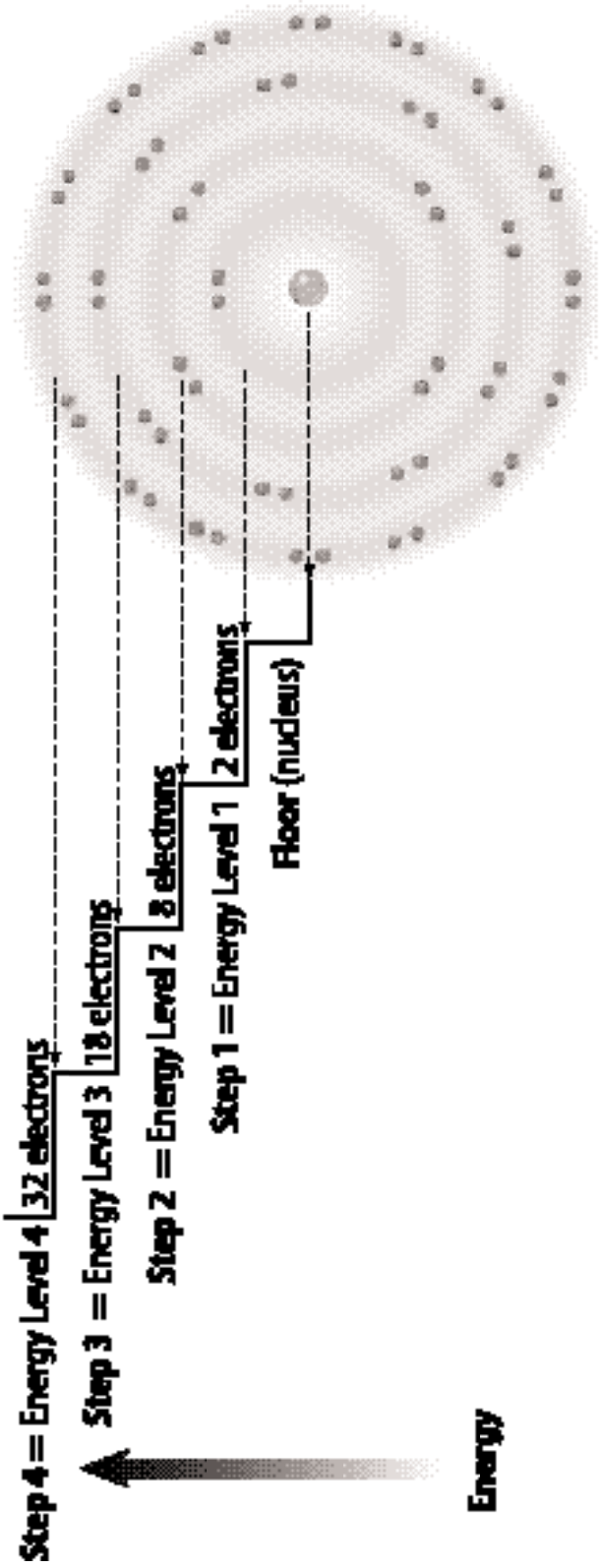
One of the elements in refrigerator coolants is fluorine, the most reactive element in the halogen group. It's so reactive that it is very difficult to separate from its compounds. While elemental fluorine is very dangerous, the fluorine in coolants is combined with other atoms, making it appropriate for use in refrigerators.



1. **When forming bonds, why does fluorine gain rather than lose an electron?**
2. **Sodium and chlorine form a compound (table salt). Do you think potassium and chlorine also combine? Why or why not?**
3. **After atoms combine, does the new substance resemble the elements of which it is composed? Illustrate your answer with an example.**

SECTION 1 Teaching Transparency Activity

Energy Levels



Teaching Transparency Activity (continued)

1. Count the number of electrons. If this is a neutral atom, which element is represented?

2. On the transparency, which electrons have the lowest energy? Which have the highest?

3. Which electrons have the strongest attraction to the nucleus? Which have the weakest?

4. How many electrons are there in level three of the atom on the transparency?

5. How many levels of electrons does sulfur (atomic number 16) have?

6. What do the outer energy levels of elements in a family have in common? Which family contains the elements with the most stable energy levels?

Name Date Class

Assessment Transparency Activity

Atomic Structure and Chemical Bonds

Directions: *Carefully review the table and answer the following questions.*

Dot Diagrams for Some Atoms

Element	Periodic Group	Dot Diagram
Lithium	Group 1	Li·
Aluminum	Group 13	·Al·
Carbon	Group 14	·C·
Chlorine	Group 17	:Cl·

1. Most elements strive to become stable having eight electrons in their outer energy level. According to this information, how many more electrons would chlorine need to become stable?

A 7 **C** 3

B 5 **D** 1

2. Elements in the same group have a similar dot diagram. Given that potassium is a Group 1 element, its dot diagram most likely ___.

F has three electron dots **H** has one electron dot

G has seven electron dots **J** has four electron dots

3. According to the table, which element has the greatest number of electrons in its dot diagram?

A Lithium **C** Aluminum

B Chlorine **D** Carbon