

# Bonding

## Teacher's Guide Middle School

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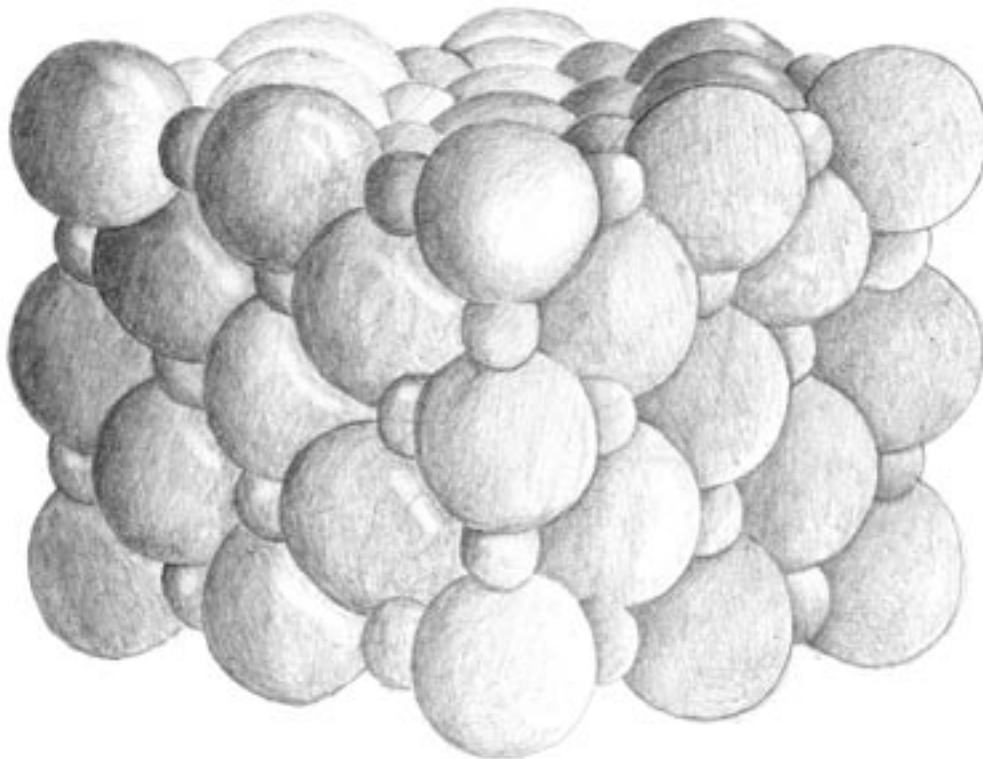
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# **A Message from our Company...**

Dear Educator:

Thank you for your interest in the educational videos produced by the Visual Learning Company. We are a Vermont-based, family owned and operated business specializing in the production of quality educational science videos and materials.

We have a long family tradition of education. Our grandmothers graduated from normal school in the 1920's to become teachers. Brian's mother was an elementary teacher and guidance counselor, and his father was a high school teacher and superintendent. This family tradition inspired Brian to become a science teacher, and to earn a Ph.D. in education, and led Stephanie to work on science educational programs at NASA.

In developing this video, accompanying teacher's guide, and student activities, our goal is to provide educators with the highest quality materials, thus enabling students to be successful. In this era of more demanding standards and assessment requirements, supplementary materials need to be curricular and standards based - this is what we do!

Our videos and accompanying materials focus on the key concepts and vocabulary required by national and state standards and goals. It is our mission to help students meet these goals and standards, while experiencing the joy and thrill of science.

Sincerely,

Brian and Stephanie Jerome



# National Standards Correlations

## National Science Education Standards

(Content standards: 5-8, National Academy of Sciences, c. 1996)

Physical Science

Content Standard B:

Properties and Changes of Properties in Matter

As a result of their activities in grades 5-8, all students should develop an understanding of:

- Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals are an example of such a group.
- Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.

## Benchmarks for Science Literacy

(Project 2061 – AAAS, c. 1993)

4D Structure of Matter

By the end of the 8th grade, students should know that:

- All matter is made up of atoms, which are far too small to see directly through a microscope. The atoms of any element are alike but are different from atoms of other elements. Atoms may stick together in well-defined molecules or may be packed together in large arrays. Different arrangements of atoms into groups compose all substances.



# Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students will be able to do the following:

- Describe an element as the simplest type of a pure substance that cannot be made any simpler by chemical means.
- Define an atom as the simplest part of an element that still has all the properties of that element.
- Understand that different elements are made up of different kinds of atoms.
- Create a simple diagram of an atom featuring protons, neutrons, and electrons.
- Explain that a chemical compound is made up of two or more elements that are chemically combined or bonded together.
- Understand that the arrangement of electrons affects how atoms bond with other atoms.
- Explain that valence electrons play a critical role in determining how atoms bond, and that atoms bond in ways that tend to make their outermost energy levels complete with electrons.
- Explain that ions are atoms that have lost or gained electrons. Ions are charged atoms.
- Describe an ionic bond in which one atom gains electrons and the other atom loses electrons.
- Provide an example of a substance that is formed as a result of an ionic bond.
- Create a simple diagram of a crystal lattice.
- Describe a covalent bond as a bond in which electrons are shared between different atoms.
- Provide an example of a substance that is created as a result of a covalent bond such as sugar or water.
- Explain that a metallic bond consists of positively charged ions surrounded by a “sea of electrons” which are attracted to multiple nuclei at the same time.



# Assessment

## **Preliminary Assessment:**

The Preliminary Assessment, provided in the Student Masters section, is an assessment tool designed to gain an understanding of students' pre-existing knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

## **Video Review:**

The Video Review, provided in the Student Masters section, can be used as an assessment tool or as a student activity. There are two main parts. The first part contains questions that can be answered during the video. The second series of ten questions consists of a video quiz to be answered at the conclusion of the video.

## **Post Assessment:**

The Post Assessment, provided in the Student Masters section, can be utilized as an assessment tool following completion of the video and student activities. The results of the Post Assessment can be compared against the results of the Preliminary Assessment to evaluate student progress.



## Introducing the Video

Before viewing the video, show the following substances to your students: salt, water, and paper clips. Ask students how these substances look similar and different from each other. Write the name of the three substances on the black board. Ask students to describe the characteristics of each substance. Write their descriptions under each substance on the board.

After writing the characteristics of each substance, ask students this difficult question: Why are these substances different from each other? Write their ideas on the black board. Next give them a hint explaining that each of these substances is made up of a combination of two or more different kinds of atoms. Ask students to define the word “compound”.

Next, tell students that the atoms in these compounds are held together or bonded together in different ways. Write the following types of bonds on the board: ionic bond, covalent bond, and metallic bond. Tell students to pay close attention to the video to see what type of bond each of these different substances possesses.

## Video Viewing Suggestions

The student Master “Video Review” is provided for distribution to students. You may choose to have your students complete this Master while viewing the program or to do so upon its conclusion.

The program is approximately twenty minutes in length and includes a ten question video quiz. Answers are not provided to the Video Quiz on the video, but are included in this teacher’s guide. You may choose to grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.



## Video Script: Bonding

1. Have you ever wondered what makes materials such as the steel in this bridge so strong?...
2. Or have you ever thought about what makes materials like plastic melt when exposed to heat?
3. ...or glass shatter when something hits it?
4. Perhaps you have observed that materials like wood and paper burn easily.
5. Whereas, other materials such as this steel poker do not burn.
6. What makes these materials behave the way they do?
7. The answer lies in their chemical composition.
8. More specifically, in the way their atoms are arranged and held together.
9. During the next few minutes we are going to explore some of the properties of atoms.
10. And we are also going to discuss how atoms combine with each other in the process of chemical bonding.
11. **Graphic Transition – Elements and Atoms**
12. **You Compare!** What makes the copper found in this wire...
13. ...different from the helium gas used to fill balloons?
14. Copper is a metal that readily conducts electricity. It tends to be orange in color. . .
15. ...and is found in the wiring of your home and school.
16. Helium gas is not a metal and does not conduct electricity easily.
17. So, as you can see, these two substances have properties that are quite different from each other.
18. These two substances are two different elements. An element is the simplest type of a pure substance that cannot be made any simpler by chemical means.
19. In other words, it is a chemically pure substance.
20. Gold and silver are other elements with which you may be familiar.
21. There are over 100 different kinds of elements.
22. Elements are made up of a single kind of tiny particle called an atom.
23. Aluminum found in this flashing, for example, is made up of aluminum atoms.
24. An atom is the smallest part of an element that still has all the properties of that element.
25. Each different kind of element is made up of a different kind of atom.
26. Let us take a closer look inside atoms.
27. **Graphic Transition – Inside Atoms**
28. Our bodies are made up of millions of microscopic cells.
29. Cells are the building blocks of life.



## Script (cont.)

30. **You Decide!** What are the building blocks of cells?
31. Atoms are the building blocks of cells.
32. In fact, atoms are the building blocks of matter.
33. All living things are made of atoms,...
34. ...as are nonliving things such as rocks...
35. ...as well as objects we use every day.
36. There are billions of atoms in this single drop of water.
37. Believe it or not, atoms are made up of even smaller particles called subatomic particles.
38. There are three different types of subatomic particles: protons, neutrons, and electrons.
39. In the center of the atom is the nucleus which is made up of protons and neutrons.
40. This is a model of an atom of carbon. It has six protons which have a plus sign and six neutrons.
41. Protons are subatomic particles that have a positive charge.
42. Neutrons have a neutral charge. Over 99% of an atom's mass is located in the nucleus.
43. Swirling around the nucleus are electrons, the third type of subatomic particle.
44. Electrons have a negative charge and orbit the nucleus at extremely high speeds.
45. **You Decide!** What makes atoms in the element gold different from those in lead?
46. The atoms in these two elements have different numbers of protons, neutrons, and electrons.
47. Gold has 79 protons, 118 neutrons, and 79 electrons.
48. Whereas, lead has 82 protons, 125 neutrons and 82 electrons.
49. Due to these differences in chemical structure, these substances are very different from each other.
50. **Graphic Transition – Chemical Bonding**
51. We already discussed some types of elements such as silver, gold, copper, and lead.
52. And we mentioned that there are over 100 known elements.
53. But, think about all the different substances found on earth – there are thousands.
54. Common examples include water,...



## Script (cont.)

55. ...salt that we sprinkle on food...
56. ...sugar that we cook with...
57. ...and vinegar that we put on salad.
58. These are all examples of chemical compounds.
59. A chemical compound is made up of two or more elements that are chemically combined or bonded together.
60. The combining of atoms to form a new substance is called chemical bonding.
61. The way atoms bond together is determined by certain characteristics of their chemical makeup.
62. Let us take a look at some of these characteristics.
63. **Graphic Transition – Electrons and Bonding**
64. We already know that different kinds of atoms have different numbers of protons, neutrons, and electrons.
65. Protons and neutrons are found in the nucleus. But, how are the electrons arranged?
66. The arrangement of electrons outside the nucleus effects how atoms bond with other atoms.
67. Electrons are arranged in energy levels. Energy levels are kind of like paths around which electrons move. Each energy level can hold a certain number of electrons.
68. The first energy level can hold only two electrons.
69. The second energy level can hold up to eight electrons.
70. The third energy level can hold up to 18 electrons.
71. Larger atoms have more than three energy levels.
72. The electrons in the outermost energy level of an atom are called valence electrons.
73. These valence electrons play a critical role in determining how atoms bond.
74. Atoms tend to bond in ways that make their outermost energy levels complete with electrons.
75. When this occurs, atoms achieve stability, which is their general tendency.
76. **Graphic Transition – Ionic Bonds**
77. When an atom has an equal number of positively charged protons and negatively charged electrons, it has a neutral charge.
78. For example, iron such as that found in these railroad cars has 26 protons and 26 electrons, giving it an overall charge of zero.



## Script (cont.)

79. **You Compute!** What is the overall charge of iron when it loses an electron?
80. When iron loses a negatively charged electron, its overall charge becomes +1.
81. When an atom gains an electron its overall charge becomes  $-1$ .
82. An ion is an atom that has lost or gained electrons. Ions are charged atoms.
83. Ionic bonding involves the transfer of electrons between atoms.
84. In ionic bonding an atom gains electrons and the other atom loses electrons.
85. These positively charged pieces of paper are attracted to this negatively charged comb. This is due to the fact that oppositely charged particles are attracted to each other.
86. Similarly, oppositely charged ions are attracted to each other in an ionic bond.
87. This sodium atom has one electron in its outermost energy level.
88. And chlorine has seven electrons in its outermost energy level.
89. When sodium and chlorine bond together the sodium atom donates its electrons to the chlorine atom making its outermost energy level full...
90. ...forming common table salt which is called sodium chloride.
91. Sodium is a positively charged ion having lost an electron, and chlorine is a negatively charged ion having gained an electron.
92. The attraction between these oppositely charged ions is the basis for the ionic bond.
93. Many ionic compounds form a regular repeating pattern called a crystal lattice.
94. Salt crystals are made of a crystal lattice that forms a cubic shape.
95. **Graphic Transition – Covalent Bond**
96. If you have a sweet tooth, you probably like foods such as ice cream...
97. ...cookies and cake. These foods are sweetened with...
98. ...a chemical compound called sugar. Sugar is held together with another type of bond called a covalent bond.
99. In a covalent bond, electrons are shared between different atoms.
100. Atoms in covalent bonds are held together by an attractive force between the positively charged nucleus and the shared electrons.
101. The bonding of two hydrogen atoms is an example of a simple covalent bond.
102. Each hydrogen atom has a single electron.
103. When they bond, they share the electrons; and fill their only outer energy level with two electrons.
104. Hydrogen can also form a covalent bond with chlorine, which has seven electrons in its outermost energy level.



## Script (cont.)

105. When they bond, both of their outermost energy levels become complete.
106. Water, one of the most common substances on earth consists...
107. ...of a covalent bond formed between two hydrogen atoms and one oxygen atom.
108. **Graphic Transition – Metallic Bonds**
109. **You Compare!** What do this steel, the filament in this light bulb, and this can have in common?
110. That is right, they are all made of metal!
111. Metals are extremely important, used in building materials...
112. ...and in common everyday objects such as paperclips and staples.
113. Most metals, such as copper, consist of atoms held together by metallic bonds.
114. In metallic bonds, positively charged ions are surrounded by a “sea of electrons”, which are attracted to multiple nuclei at the same time.
115. In a metallic bond, the outer electrons of metal atoms tend to be quite mobile.
116. This ability of electrons to flow freely makes electrons good conductors of electricity,
117. ...allows metals to be malleable,
118. ...permits many metals to be drawn into wires,
119. ...and accounts for the high melting points of many metals.
120. **Graphic Transition – Summing Up**
121. During the past few minutes we have explored some of the fascinating ways atoms combine in the process of bonding.
122. We discussed how the structure of atoms affect how they bond with other atoms.
123. More specifically, we explored how electrons in atoms, particularly those in the outermost energy level, determine how atoms bond.
124. We explored the nature of ions and ionic bonding which involves the transfer of electrons between atoms.
125. We also investigated some of the characteristics of covalent bonding in which electrons are shared between bonded atoms.
126. Finally, we discussed metallic bonds and some of the common characteristics of metals.
127. So, the next time you use a fork...
128. ...measure out a spoonful of sugar...
129. ...or sprinkle some salt on your food, think about the ways atoms are bonded in different substances...
130. ...You might just look at the matter in your world a little differently.



## Script (cont.)

### 131. Graphic Transition – Video Assessment

Fill in the correct word to complete the sentence. Good luck and let us get started.

1. An \_\_\_\_\_ is the simplest type of a pure substance.
2. The smallest part of an element is an \_\_\_\_\_.
3. The combining of atoms to form new substances is called chemical \_\_\_\_\_.
4. Electrons in the outermost energy level are called \_\_\_\_\_ electrons.
5. An \_\_\_\_\_ is an atom that has lost or gained electrons.
6. \_\_\_\_\_ bonds involve the transfer of electrons between atoms.
7. Table salt consists of a \_\_\_\_\_ lattice.
8. In a \_\_\_\_\_ bond electrons are shared between atoms.
9. In metallic bonds, the outermost electrons are quite \_\_\_\_\_.
10. Metals tend to be good \_\_\_\_\_ of electricity.



# Student Assessments and Activities

## Assessment Masters:

- Preliminary Assessment
- Video Review
- Post Assessment

## Student Activity Masters:

- Covalent and Ionic Compounds
- Diagramming Covalent Bonds
- Vocabulary of *Bonding*



# Answers to Student Assessments

## Preliminary Assessment (pgs. 20-21)

1. element
2. atom
3. bonding
4. electrons
5. valence
6. complete
7. ion
8. transfer
9. covalent
10. mobile
11. false
12. false
13. true
14. false
15. true
16. true
17. true
18. false
19. false
20. true

## Video Review (pg. 22)

1. Copper is a metal which readily conducts electricity. It tends to be orange in color. Helium is not a metal and does not readily conduct electricity.
2. Atoms are the building blocks of cells.
3. The atoms in the element gold have 79 protons, 118 neutrons, and 79 electrons. The atoms in the element lead have 82 protons, 125 neutrons, and 82 electrons.
4. The overall charge of iron when it loses an electron is +1.

5. This steel, the filament in this light bulb, and this can are all made of metal. Most metals consist of atoms held together by metallic bonds.

## Video Quiz (p. 22)

1. element
2. atom
3. bonding
4. valence
5. ion
6. ionic
7. crystal
8. covalent
9. mobile
10. conductors

## Post Assessment (pgs. 23-24)

1. mobile
2. electrons
3. element
4. complete
5. ion
6. bonding
7. covalent
8. valence
9. atom
10. transfer
11. false
12. true
13. true
14. false
15. false
16. false
17. true
18. true
19. false
20. true

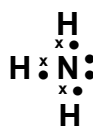
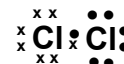


# Answers to Student Activities

## Covalent and Ionic Compounds (pgs. 25-27)

1. A covalent bond is formed when atoms are held together by an attractive force between the positively charged nucleus and the electrons that are shared between atoms.
2. An ionic bond is formed when oppositely charged ions are attracted to each other. These ions are formed when they donate or accept electrons from one another.
3. Sugar does not conduct electricity well and has a relatively low melting point. It is held together via covalent bonds.
4. Salt does conduct electricity well and has a higher melting point than the sugar. It is held together via ionic bonds.
5. Substances with ionic bonds often have crystal lattice shapes. Solid substances held together via ionic bonds tend to have high melting points and tend to be good conductors. Ionic compounds with a crystal lattice shape tend to be very stable. Covalently bonded solids tend to have lower melting points, although there are exceptions because of the large molecules that some covalently bonded substances are made up of. Covalently bonded substances tend to be poor conductors.

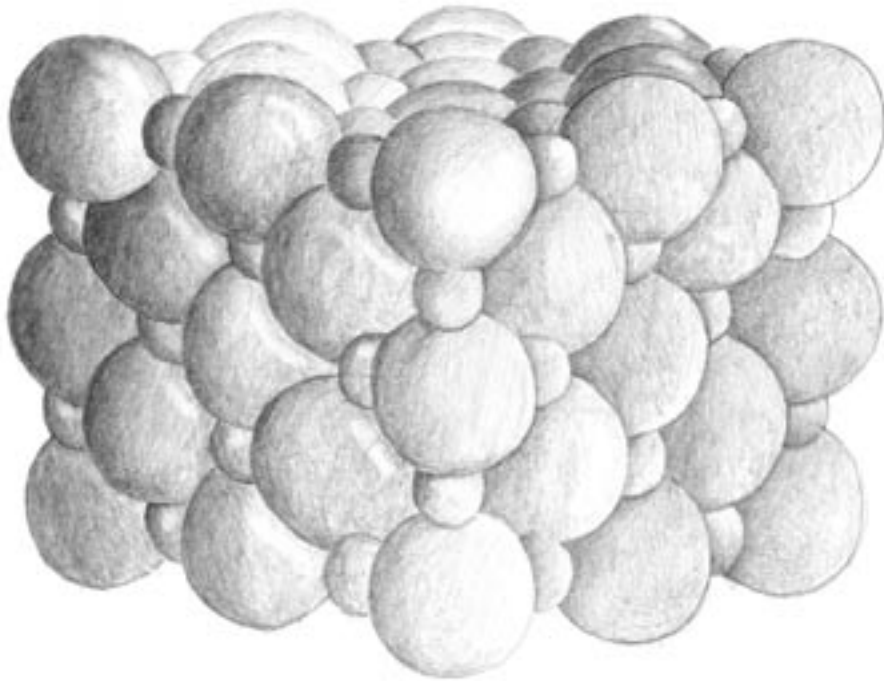
## Diagramming Covalent Bonds (pgs. 28-29)



## Vocabulary of Bonding (p. 30)

1. j - electrons
2. a - chemical bonding
3. b - chemical compound
4. c - atom
5. i - ionic
6. h - valence electrons
7. g - covalent
8. f - ion
9. e - metallic
10. d - energy levels

# **Assessment and Student Activity Masters**





# Preliminary Assessment

**Directions:** Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

1. An \_\_\_\_\_ is the simplest type of a pure substance.
2. The smallest part of an element is an \_\_\_\_\_.
3. Chemical \_\_\_\_\_ is the process of atoms combining to form a new substance.
4. The arrangement of \_\_\_\_\_ largely determines how atoms bond with other atoms.
5. Electrons in the outermost energy level of an atom are called \_\_\_\_\_ electrons.
6. Atoms tend to bond in ways that make their outermost energy levels \_\_\_\_\_.
7. An \_\_\_\_\_ is an atom that has lost or gained electrons.
8. Ionic bonding involves the \_\_\_\_\_ of electrons.
9. \_\_\_\_\_ bonding involves the sharing of electrons.
10. In a metallic bond the outer electrons tend to be quite \_\_\_\_\_.

atom  
bonding  
complete  
covalent  
electrons

element  
ion  
mobile  
transfer  
valence



# Preliminary Assessment

**Directions:** Decide whether the statement is true (T) or false (F).

- |   |   |   |
|---|---|---|
| 11. Different elements are made up of the same kinds of atoms.                                  | T | F |
| 12. Protons and electrons are located in the nucleus of an atom.                                | T | F |
| 13. The combining of atoms to form a new substance is called chemical bonding.                  | T | F |
| 14. Each energy level around an atom holds the same number of electrons.                        | T | F |
| 15. Valence electrons play a critical role in determining how atoms bond.                       | T | F |
| 16. Atoms tend to bond in ways that make their outermost energy levels complete with electrons. | T | F |
| 17. Many ionic compounds form a regular repeating pattern called a crystal lattice.             | T | F |
| 18. In a covalent bond electrons are transferred between atoms.                                 | T | F |
| 19. Water is a substance consisting of an ionic bond between atoms.                             | T | F |
| 20. Copper, tin, and aluminum are substances which are held together via metallic bonds.        | T | F |



# Video Review

**Directions:** During the course of the program, answer the questions as they are presented in the video. At the end of the video, answer the Video Quiz questions.

## You Compare!

1. What makes the copper found in this wire different from the helium gas used to fill balloons?

## You Decide!

2. What are the building blocks of cells?

## You Decide!

3. What makes atoms in the element gold different from those in lead?

## You Compute!

4. What is the overall charge of iron when it loses an electron?

## You Compare!

5. What do this steel, the filament in this light bulb, and this can have in common?

## Video Quiz:

1. An \_\_\_\_\_ is the simplest type of a pure substance.
2. The smallest part of an element is an \_\_\_\_\_.
3. The combining of atoms to form new substances is called chemical \_\_\_\_\_.
4. Electrons in the outermost energy level are called \_\_\_\_\_ electrons.
5. An \_\_\_\_\_ is an atom that has lost or gained electrons.
6. \_\_\_\_\_ bonds involve the transfer of electrons between atoms.
7. Table salt consists of a \_\_\_\_\_ lattice.
8. In a \_\_\_\_\_ bond electrons are shared between atoms.
9. In metallic bonds, the outermost electrons are quite \_\_\_\_\_.
10. Metals tend to be good \_\_\_\_\_ of electricity.



# Post Assessment

**Directions:** Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

1. In a metallic bond the outer electrons tend to be quite \_\_\_\_\_.
2. The arrangement of \_\_\_\_\_ largely determines how atoms bond with other atoms.
3. An \_\_\_\_\_ is the simplest type of a pure substance.
4. Atoms tend to bond in ways that make their outermost energy levels \_\_\_\_\_.
5. An \_\_\_\_\_ is an atom that has lost or gained electrons.
6. Chemical \_\_\_\_\_ is the process of atoms combining to form a new substance.
7. \_\_\_\_\_ bonding involves the sharing of electrons.
8. Electrons in the outermost energy level of an atom are called \_\_\_\_\_ electrons.
9. The smallest part of an element is an \_\_\_\_\_.
10. Ionic bonding involves the \_\_\_\_\_ of electrons.

atom  
bonding  
complete  
covalent  
electrons

element  
ion  
mobile  
transfer  
valence



# Post Assessment

**Directions:** Decide whether the statement is true (T) or false (F).

- |   |   |   |
|---|---|---|
| 11. Each energy level around an atom holds the same number of electrons.                        | T | F |
| 12. Copper, tin, and aluminum are substances which are held together via metallic bonds         | T | F |
| 13. Many ionic compounds form a regular repeating pattern called a crystal lattice.             | T | F |
| 14. Protons and electrons are located in the nucleus of an atom.                                | T | F |
| 15. Different elements are made up of the same kinds of atoms.                                  | T | F |
| 16. In a covalent bond electrons are transferred between atoms.                                 | T | F |
| 17. The combining of atoms to form a new substance is called chemical bonding.                  | T | F |
| 18. Atoms tend to bond in ways that make their outermost energy levels complete with electrons. | T | F |
| 19. Water is a substance consisting of an ionic bond between atoms.                             | T | F |
| 20. Valence electrons play a critical role in determining how atoms bond.                       | T | F |



# Covalent and Ionic Compounds

## Background:

There are over 100 different elements. Elements combine in many different ways to form millions of different compounds. We are quite familiar with many of the compounds because we eat, drink, and wear them. Even though you may be quite familiar with many different types of compounds, you may not be as familiar with how the atoms in elements join together, or bond, to form compounds.

Bonding is the process by which atoms combine to form a new substance. There are three main ways atoms come together to form bonds. In this activity we will take a look at two of these types of bonds: covalent bonds, and ionic bonds.

In a covalent bond, electrons are shared between different atoms. The bonding of two hydrogen atoms is an example of a simple covalent bond. Each hydrogen atom has a single electron. When the two atoms of hydrogen bond they share electrons and fill their outer (and only) energy level with two electrons, making it complete. Water is also an example of a compound that is held together via covalent bonds.

Ionic bonding involves the transfer of electrons between atoms. In ionic bonding one atom gains electrons and the other atom loses electrons. Compounds held together by ionic bonds tend to be good conductors of electricity.

## Materials:

Battery, three wire leads, light bulb, two copper strips, beaker, Epsom salts, sugar, styrofoam cups, test tube, test tube holder, protective eye glasses or goggles, candle flame, magnifying glass, water, beaker, stirring rod.

## Directions:

1. Scientists can often identify the types of bonds in a given substance by examining some of its properties. In this activity we will examine salt as well as sugar to try to determine what type of bonds hold their atoms together. The first step is to build a device to measure conductivity. Conductivity is the ability of a substance to conduct, or transfer electricity.
2. Obtain a battery, 3 wire leads, light bulb, two copper strips, and a beaker. Attach one lead between a battery terminal and a copper strip. Attach another lead between the other battery terminal and the light bulb. Attach the third lead between the light bulb and the other copper strip.



## Covalent and Ionic Compounds (cont.)

- To test the circuit, touch the two pieces of copper together. If the light bulb lights, then the circuit is working properly. If it is working, proceed to the next step.
- Obtain a sample of Epsom salts ( $\text{MgSO}_4$ ), as well as a sample of sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ).
- Place approximately 10 grams of each substance in its own cup. Label cups "Epsom salts" and "sugar".
- Obtain a 100 ml beaker and place approximately 40 ml of water in the beaker.
- Place the metal strips attached to the wires into the water but do not let them touch each other. Does the light bulb light up? Dry off the piece of metal and record your observations.
- Next, place the sample of Epsom salts on a piece of paper. Use a magnifying glass to closely examine the shape of the crystals. Record your observations in the data table.
- Next put the salt between the ends of the pieces of metal on the leads. Does the salt conduct electricity? Record your observations.
- Add about 10 grams of Epsom salts to the 40 ml of water in the beaker. Stir thoroughly for one to two minutes.
- Place the metal strips attached to the leads in the liquid without touching the metal strips together. Does the bulb light up? Record your observations.
- Repeat the same steps as above but with a sample of sugar. Remember to record your observations in the data table.
- The next part of this activity will be demonstrated by your teacher. Make careful observations of what occurs and record your findings in the data table.
- Your teacher will place approximately 5 grams of Epsom salts in a test tube.
- While wearing protective eye glasses your teacher will use a test tube holder to hold the sample in a candle flame for about two minutes. Be careful to keep the open end of the test tube pointed away from people.
- As soon as the substances begin to melt stop timing and remove from flame. Record the time.
- Complete the same process with a sample of sugar, and record your observations.
- Clean up and put away materials as directed by your teacher.
- Answer the questions on the following page.



# Covalent and Ionic Compounds (cont.)

	Epsom salts	Sugar
Structure of crystals		
Conductivity of solid		
Conductivity of solid in solution		
Observations when heated (time to melt in seconds)		
Type of bond		

**Questions:**

1. Describe the process of formation of a covalent bond.
2. Describe the process of formation of an ionic bond.
3. What did you discover about the conductivity and melting point of sugar? Is sugar held together via covalent bonds or ionic bonds?
4. What did you discover about the conductivity and melting point of salt? Is salt held together via covalent bonds or ionic bonds?
5. What generalizations can you make about the characteristics of substances with ionic bonds and those substances with covalent bonds?



# Diagramming Covalent Bonds

## Background:

As you know, there are three major types of bonds: covalent bonds, ionic bonds, and metallic bonds. In the process of bonding, atoms tend to fill or complete their outermost energy level, thus making it more stable. The valence electrons, or electrons in the outermost energy level of an atom, play a critical role in determining how an atom will bond with another atom. We will create diagrams of covalent bonds in this activity.

To help visualize the nature of bonds, scientists sometimes create diagrams which illustrate the general concept of a bond between two or more atoms. While these diagrams do not accurately represent what a covalently bonded compound looks like, they do help us symbolize what is going on.

The types of diagrams we will create are called electron-dot diagrams. In this type of diagram the chemical symbol for an element represents the nucleus, as well as all the inner energy levels of the atom. The electrons in the outermost energy level, the valence electrons, are symbolized by dots surrounding the nucleus. Hydrogen, for example, has just one valence electron. Therefore an electron-dot diagram representing hydrogen looks like this: H•

In this activity, you will create several diagrams of compounds which are bonded via covalent bonds.

## Materials:

Paper, colored pencils.

## Directions:

1. Draw electron-dot diagrams for the atoms on the following page.
2. When you have finished this, make some electron-dot diagrams on your own.
3. Look up the element that you are going to make a dot-diagram of on the periodic table.
4. Write down the chemical symbol for an element and then distribute valence electrons around it by drawing a dot to represent each electron.
5. To bond atoms in electron-dot diagrams, place the atoms side by side so that they share electrons. You may want to use different colored pencils so that each different atom has a different color for its electrons.



# Diagramming Covalent Bonds

H H

Cl Cl

H Cl

H F

H

H N

H

H O

H



# Vocabulary of Bonding

**Directions:** Unscramble the vocabulary words in the first column. Match the words to the definitions in the second column.

- |  |  |
|--|--|
| ____ 1. lernestoc _____                  | a. the combining of atoms to form a new substance  |
| ____ 2. hccielma gonnibd _____<br>_____  | b. two or more elements that are chemically combined or bonded together  |
| ____ 3. hccielma ooucndmp _____<br>_____ | c. the smallest part of an element that still has the properties of that element   |
| ____ 4. mato _____                       | d. kind of like paths around which electrons move  |
| ____ 5. ocnii _____                      | e. a type of bond in which positively charged ions are surrounded by a "sea of electrons", which are attracted to multiple nuclei at the same time |
| ____ 6. acevnle sleotenrc _____<br>_____ | f. an atom that has lost or gained electrons   |
| ____ 7. tolvance _____                   | g. a type of bond in which electrons are shared between two atoms  |
| ____ 8. nio _____                        | h. the electrons in the outermost energy level of an atom  |
| ____ 9. mcaeltli _____                   | i. a type of bond in which one atom gains electrons and one atom loses electrons   |
| ____ 10. egnrye llsvee _____<br>_____    | j. negatively charged subatomic particles  |