Forming Bonds

Teacher's Guide

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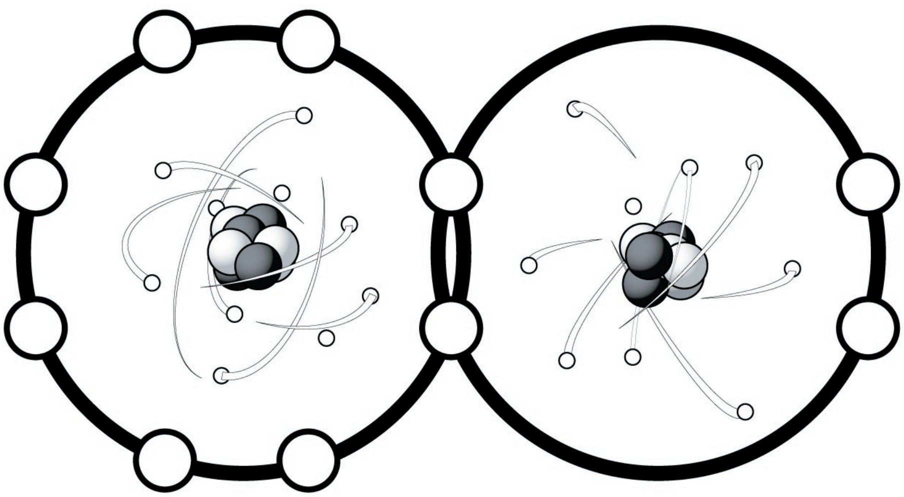

Elementary Science

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Table of Contents

National Standards Correlations

Benchmarks for Science Literacy
(Project 2061 - AAAS) **Grades 3-5**

The Physical Setting - The Structure of Matter (4D)

By the end of the 5th grade, students should know that:

- Materials may be composed of parts that are too small to be seen without magnification.

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.

National Science Education Standards
(Content Standards: K-4, National Academy of Sciences)

Physical Science - Content Standard B

As a result of their activities in grades K-4, all students should develop an understanding of:

- Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

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 is an example of such a group.

Student Learning Objectives

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

- Understand that matter is made up of tiny particles called atoms.
- Explain that atoms consist of many different types of subatomic particles including protons, neutrons, and electrons.
- Describe protons as subatomic particles possessing a positive charge and are located in the nucleus of the atom.
- Explain that neutrons are neutrally charged particles found in the nucleus of the atom.
- Understand that electrons are negatively charged particles orbiting the nucleus at extremely high speeds.
- Create a simple diagram of an atom labeling the following structures: nucleus, protons, neutrons, and electrons.
- Describe how electrons travel in energy levels around the nucleus of the atom. Electrons in the outermost energy levels are called valence electrons. Valence electrons play a key role in forming bonds with other atoms.
- Explain that when atoms bond with other atoms, valence electrons move between them.
- Understand that atoms have the tendency to fill their outermost energy level.
- Define an ionic bond as a bond that involves the transfer of electrons from one atom to another.
- Describe an ion as a charged atom that has lost or gained electrons.
- Cite some of the characteristics of ionic compounds.
- Explain that covalent bonds form when atoms share electrons. By sharing electrons, each atom fills up its outermost energy level, making atoms more stable.
- Understand that in metallic bonds, positively charged ions are surrounded by a “sea of electrons”, which are attracted to multiple nuclei at the same time.
- Explain that the ability of electrons to flow freely make metals good conductors of electricity, allow metals to be bent, and accounts for the high melting points of many metals.

Assessment

Preliminary Test (p. 14–15):

The Preliminary Test is an assessment tool designed to gain an understanding of students' preexisting knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

Post-Test (p. 16–17):

The Post-Test can be utilized as an assessment tool following student completion of the program and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.

Video Review (p. 18):

The Video Review can be used as an assessment tool or as a student activity. There are two sections. The first part contains questions displayed during the program. The second part consists of a five-question video quiz to be answered at the end of the video.

Introducing the Program

Before showing students the video, review the basic parts of the atom. You may want to make a simple diagram on the board illustrating some of the basic structures of the atom: protons, neutrons, nucleus and electrons. Explain to students that electrons travel at extremely high speeds in paths referred to as energy levels. Valence electrons are located in the outermost energy level of an atom. Explain to students that valence electrons play a very important role in forming bonds with other atoms.

Next, explain to students that atoms bond in different ways. The types of bonds atoms form have a big effect on the properties of chemical compounds. Hold up the following substances in front of the class: salt, a glass of water, and an aluminum can or other object containing metal. Explain that these three substances contain atoms that are bonded in three different ways. Tell students to pay close attention to the video to learn about the different ways the atoms in these substances are bonded together. Following the video ask students to explain how these substances form bonds. Also ask them to describe some of the properties of these substances.

Program Viewing Suggestions

The student master “Video Review” (p.18) is provided for distribution to students. You may choose to have your students complete this master while viewing the program or do so upon its conclusion.

The program is approximately 14 minutes in length and includes a five-question video quiz. Answers are not provided to the Video Quiz in the video, but are included in this guide on page 12. 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

1. Water – it's one of the most important chemical compounds on the planet, and it is essential to life.
2. We drink water everyday, we use it to clean things, and we eat foods that need water to survive.
3. Water is a chemical compound consisting of two elements - hydrogen and oxygen.
4. These elements are joined together by a chemical bond.
5. Chemical bonds hold many familiar compounds together, like salt and sugar.
6. But, what are chemical bonds?
7. How do chemical bonds work?
8. And, what are some of the different types of chemical bonds?
9. During the next few minutes we are going to answer these questions and others...
10. ...as we investigate the fascinating process of forming bonds.
11. **Graphic Transition – Atoms and Bonding**
12. As you know, all matter, from the objects around you, to the air we breathe, is made up of atoms.
13. Atoms are so tiny they can't be seen with the naked eye.
14. Even smaller than atoms are the subatomic particles they contain.
15. While there are many different types of subatomic particles the three main ones are protons, neutrons, and electrons.
16. Let's quickly review the characteristics of each. Protons and neutrons are located in the nucleus of the atom and make up over 99% of the atom's mass.
17. Protons have a positive charge. Neutrons have no charge, or what is called a neutral charge.
18. Atoms are often described by something called an atomic number. The atomic number is the number of protons in an atom.
19. **You Observe!** What is the atomic number of this carbon atom?
20. There are six protons in carbon. Therefore it has an atomic number of six. Each different type of atom has a unique atomic number.
21. In addition to protons and neutrons atoms also contain electrons.
22. Electrons are negatively charged and they whirl around the nucleus of an atom at incredibly high speeds in paths called energy levels.
23. That's important because the key to understanding chemical bonding lies in the arrangement of these electrons in an atom.
24. Generally speaking, atoms tend to have equal numbers of positively charged protons and negatively charged electrons, giving the atom an overall neutral charge.
25. This is a model of a chlorine atom.
26. The small dots orbiting the nucleus are electrons. The electrons are traveling in three energy levels.
27. Energy levels can only hold so many electrons.
28. In the case of chlorine, the first energy level has two electrons, which is the most it can hold. The second energy level has eight electrons, the most it can hold. The third energy level contains seven electrons, but it could hold eight.

Video Script

29. These seven electrons in the outermost energy level are called valence electrons.
30. Valence electrons play a key role in forming bonds with other atoms.
31. **Graphic Transition – How Atoms Bond**
32. We know that electrons in the outermost energy level of an atom, called the valence electrons, are important in forming bonds with other atoms.
33. But, how does it happen?
34. First, it is important to note that not all atoms bond in the same way, and in fact some atoms rarely bond at all.
35. But, when atoms do form bonds with other atoms, valence electrons move between them.
36. Valence electrons are either transferred, or they are shared between atoms.
37. The reason this occurs is because atoms have the tendency to fill their outermost energy level.
38. Let's look at an example. This yellow substance contains the element sulfur.
39. Sulfur has six valence electrons in its outermost energy level, but it is capable of holding eight.
40. This metal is magnesium.
41. **You Observe!** How many valence electrons does magnesium have?
42. That's right, it has two valence electrons.
43. When sulfur and magnesium form a bond, sulfur gains two electrons, and magnesium loses two electrons
44. When this occurs the outermost energy level of sulfur becomes completely filled with a total of eight electrons. Magnesium eliminates its outermost energy level when it loses two electrons. That leaves its next energy level filled.
45. **Graphic Transition – Ionic Bonds**
46. If you have ever sprinkled salt on your food,...
47. ...you have used a compound whose atoms are joined together with a type of bond called an ionic bond.
48. What is an ionic bond?
49. An ionic bond involves the transfer of electrons from one atom to another.
50. Ionic bonding gets its name from the word ion.
51. An ion is a charged atom.
52. Remember that atoms are generally neutral due to the fact that they have an equal number of positively charged protons and negatively charged electrons.
53. But, if electrons are gained or lost, a neutral atom becomes a charged atom referred to as an ion. If an atom gains electrons, it becomes a negative ion, and if it loses electrons, it becomes a positive ion.
54. Let's look at an example of the ionic bond of sodium chloride; also know as salt.
55. Sodium has one valence electron,...
56. ... and chlorine has seven valence electrons.
57. When they bond, one electron is transferred from the sodium atom to the chlorine atom giving sodium an overall positive charge.

Video Script

58. You Decide! What type of ion is sodium?
59. That's right, it is a positive ion because it lost a negatively charged electron.
60. In turn chlorine gained a negatively charged electron making it a negative ion.
61. Ions with opposite charges attract each other. This attractive force is what holds atoms together in an ionic bond.
62. Ionic compounds tend to have some common properties including the fact that they are hard and brittle, have high melting points,...
63. ...and possess a crystal lattice.
64. In a crystal lattice, the atoms form a regular, repeating three-dimensional pattern as seen in this model of a salt crystal.
65. There are many different crystal shapes, some of which are seen in these beautiful minerals.
66. Graphic Transition – Exploring Covalent Bonds
67. Every time you eat foods containing sugar you are consuming a compound held together with a type of bond called a covalent bond.
68. Covalent bonds form when atoms share electrons.
69. By sharing electrons, each atom fills up its outermost energy level, making atoms more stable.
70. Let's take a look at the covalent bond between an atom of hydrogen and an atom of chlorine.
71. Hydrogen has one valence electron and chlorine has seven valence electrons.
72. By sharing valence electrons, each atom fills its outermost energy levels.
73. In the case of water, two atoms of hydrogen, each having one valence electron, bond with oxygen that has six valence electrons.
74. In this bond all three atoms share electrons filling their outermost energy levels.
75. Atoms joined together in covalent bonds form molecules.
76. A molecule is a group of atoms held together by covalent bonds.
77. A water molecule, for example, has all the properties of water found in a glass of water and even a lake full of water.
78. Graphic Transition – Investigating Metallic Bonds
79. You Compare! What do this paperclip, the filament in this light bulb, and this can have in common?
80. That is right, they are all made of metal!
81. Metals are extremely important. They are used in cars...
82. ...and in common everyday objects such as pans and appliances.
83. Most metals, such as copper, consist of atoms held together by metallic bonds.
84. In metallic bonds, positively charged ions are surrounded by a "sea of electrons", which are attracted to multiple nuclei at the same time.
85. In a metallic bond, the outer electrons of metal atoms tend to be quite mobile.
86. This ability of electrons to flow freely, makes electrons good conductors of electricity,
87. ...and accounts for the high melting points of many metals.

Video Script

88. Graphic Transition – Summing Up

89. During the past few minutes we have explored some of the fascinating ways atoms join together to form bonds.
90. We began by reviewing the basic characteristics of the three major types of sub-atomic particles – protons, neutrons, and electrons.
91. And, we discussed how electrons in the outermost energy level, called valence electrons, play an important role in bond formation.
92. More specifically, we discussed the process by which ionic bonds form when electrons are transferred between atoms,...
93. ...and how covalent bonds occur when atoms share electrons.
94. Last, we discussed the nature of metallic bonds.
95. So, the next time you think about what holds substances such as sugar,...
96. ...salt,...
97. ...water,...
98. ...or metal together, think about some of the things we've discussed during the past few minutes.
99. You just might think about the way bonds form a little differently.

100. Graphic Transition – Video Assessment

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

1. When atoms join together a _____ is formed.
2. _____ electrons are located in the outermost energy level.
3. Atoms tend to ________ their outermost energy level.
4. An ____ bond involves the transfer of electrons.
5. Covalent bonds form when atoms ____ electrons.

Answer Key to Student Assessments

Pre-Test (p. 14-15)

1. a - subatomic particles
2. c - atomic number
3. d - electrons
4. a - energy levels
5. c - valance electrons
6. b - bond
7. d - ion
8. c - ionic
9. a - shared
10. d - copper and aluminum
11. false
12. true
13. true
14. false
15. true
16. Protons, electrons, and neutrons are subatomic particles found in most atoms.
17. Protons and neutrons are located in the nucleus of most atoms.
18. A chemical bond is formed when two or more atoms join together. It consists of an attractive force.
19. Electrons orbit the nucleus at very high speeds.
20. Valence electrons move between atoms to form bonds.

Post-Test (p. 16-17)

1. c - valence electrons
2. a - shared
3. d - ion
4. a - subatomic particles
5. d - copper and aluminum
6. c - ionic
7. d - electrons
8. b - bond
9. a - energy levels
10. c - atomic number
11. true
12. false
13. false
14. true
15. true
16. Protons and neutrons are located in the nucleus of most atoms.
17. Electrons orbit the nucleus at very high speeds.
18. Protons, electrons, and neutrons are subatomic particles found in most atoms.
19. Valence electrons move between atoms to form bonds.
20. A chemical bond is formed when two or more atoms join together. it consists of an attractive force.

Video Review (p. 18)

1. The atomic number for the carbon atom is six because there are six protons in carbon.
2. Magnesium has two valence electrons.
3. Sodium is a positive ion because it lost a negatively charged electron.
4. The paperclip, the filament in the light bulb, and the can are all made of metal.

1. When atoms join together a ***bond*** is formed.
2. ***Valence*** electrons are located in the outermost energy level.
3. Atoms tend to ***fill*** or ***complete*** their outermost energy level.
4. An ***ionic*** bond involves the transfer of electrons.
5. Covalent bonds form when atoms ***share*** electrons.

Vocabulary (p. 19)

1. subatomic particles
2. atomic number
3. nucleus
4. valence electrons
5. chemical bond
6. ion
7. ionic bond
8. ionic compounds
9. covalent bonds
10. metallic bonds

Answer Key to Student Activities

Writing Activity (p. 20)

As you know, all ***matter***, from the objects around you to the air we breathe is made up of ***atoms***. In many cases atoms join other atoms in a process called ***chemical bonding***. When atoms form bonds with other atoms, ***valence electrons***, found in outermost ***energy levels*** move between them. There are three major types of chemical bonds. An ***ionic bond*** involves the ***transfer*** of electrons from one atom to another. Ionic bonding gets it name from the word **ion** which is a charged atom that has gained or lost electrons. Another type of bond called a ***covalent bond*** is formed when atoms share electrons. The third type of bond called a ***metallic bond*** occurs when positively charged ions are surrounded by a "sea of electrons" that are attracted to multiple nuclei at the same time.

In Your Own Words (p. 20)

1. Chemical bonds enable atoms to join together to form new and different substances.
2. In an ionic bond electrons are transferred between atoms. Whereas in a covalent bond, electrons are shared between atoms.
3. In forming bonds, valence electrons are either transferred or shared between atoms.

Bonds Everywhere (p. 21–22)

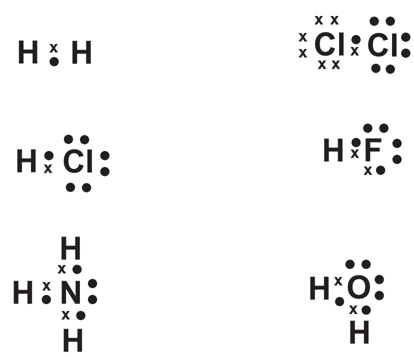
Substance	Type of bonds it contains	Elements	Properties
sugar	covalent	carbon, hydrogen, oxygen	White, has crystals
salt	ionic	sodium, chlorine	white, has crystals
paperclip	metallic	iron and other metals	metallic, shiny, can be bent
piece of copper	metallic	copper	metal, shiny, orangish color
water	covalent	hydrogen, oxygen	clear liquid
baking soda	ionic	sodium, hydrogen, carbon, oxygen	white powder
aluminum can	ionic	aluminum	metallic, can be bent
piece of sulfur	covalent	sulfur	yellow, smells like rotten eggs

1. A chemical bond is an attractive force that holds two or more atoms together.
2. The three main types of bonds are covalent, ionic, and metallic.
3. Sugar, water, and sulfur had covalent bonds.
4. The paperclip, piece of copper, and aluminum can had metallic bonds.
5. Substances held together by metallic bonds tend to be good conductors of heat and electricity. They also can be bent and have high melting points.

Making a Molecule (p. 23)

1. A molecule is the smallest complete piece of a compound consisting of two or more atoms that are bonded together.
2. The white marshmallows represented oxygen atoms and the colored marshmallow represented a carbon atom. The gumdrops represented hydrogen atoms.
3. The toothpick represented the covalent bond between the different atoms.

Creating Covalent Bonds (p. 24–25)



Pre-Test

Name ______________________________

Circle the best answer for each of the following questions.

1. Atoms are made up of smaller:

   a. subatomic particles ***b. molecules*** ***c. atoms*** ***d. gases***

2. The number of protons in an atom is referred to as the:

   a. atomic mass ***b. nuclear weight*** ***c. atomic number*** ***d. proton mass***

3. Which of the following subatomic particles has a negative charge?

   a. protons ***b. neutrons*** ***c. orbitals*** ***d. electrons***

4. Electrons travel at incredibly high speeds in paths called:

   a. energy levels ***b. nuclear rings*** ***c. pulsars*** ***d. belts***

5. The following play(s) a key role in forming bonds with other atoms:

   a. fusion levels ***b. atomic mass*** ***c. valence electrons*** ***d. neutron number***

6. When atoms join together they are held together by an attractive force called a:

   a. code ***b. bond*** ***c. power*** ***d. fusion***

7. If an atom gains or loses electrons it becomes a charged atom referred to as a(n):

   a. light particle ***b. lively electron*** ***c. energized atom*** ***d. ion***

8. This type of bond involves the transfer of electrons from one atom to another:

   a. covalent ***b. metallic*** ***c. ionic*** ***d. neutral***

9. Covalent bonds form when electrons between atoms are:

   a. shared ***b. stolen*** ***c. separated*** ***d. destroyed***

10. Metallic bonds occur in the following substances:

    a. sugar and salt ***b. water and oxygen*** ***c. sodium and chloride*** ***d. copper and aluminum***

Pre-Test

Name ______________________________

Write true or false next to each statement.

11. ____________________ All atoms are the same.

12. ____________________ Electrons orbit the nucleus at very high speeds.

13. ____________________ Atoms have the tendency to fill their outermost energy level with electrons when they bond.

14. ____________________ Valence electrons do not play an important role in forming bonds.

15. ____________________ Most metals possess metallic bonds.

Write a short answer for each of the following.

16. List two subatomic particles found in atoms.

____

____

17. Where are protons and neutrons located in atoms?

____

____

18. What is a chemical bond?

____

____

19. Where are electrons located in atoms?

____

____

20. What role do valence electrons play in forming bonds?

____

____

Post–Test

Name ______________________________

Circle the best answer for each of the following questions.

1. The following play(s) a key role in forming bonds with other atoms:

   a. fusion levels ***b. atomic mass*** ***c. valence electrons*** ***d. neutron number***

2. Covalent bonds form when electrons between atoms are:

   a. shared ***b. stolen*** ***c. separated*** ***d. destroyed***

3. If an atom gains or loses electrons it becomes a charged atom referred to as a(n):

   a. light particle ***b. lively electron*** ***c. energized atom*** ***d. ion***

4. Atoms are made up of smaller:

   a. subatomic particles ***b. molecules*** ***c. atoms*** ***d. gases***

5. Metallic bonds occur in the following substances:

   a. sugar and salt ***b. water and oxygen*** ***c. sodium and chloride*** ***d. copper and aluminum***

6. This type of bond involves the transfer of electrons from one atom to another:

   a. covalent ***b. metallic*** ***c. ionic*** ***d. neutral***

7. Which of the following subatomic particles has a negative charge?

   a. protons ***b. neutrons*** ***c. orbitals*** ***d. electrons***

8. When atoms join together they are held together by an attractive force called a:

   a. code ***b. bond*** ***c. power*** ***d. fusion***

9. Electrons travel at incredibly high speeds in paths called:

   a. energy levels ***b. nuclear rings*** ***c. pulsars*** ***d. belts***

10. The number of protons in an atom is referred to as the:

    a. atomic mass ***b. nuclear weight*** ***c. atomic number*** ***d. proton mass***

Post–Test

Name ______________________________

Write true or false next to each statement.

11. ____________________ Electrons orbit the nucleus at very high speeds.

12. ____________________ Valence electrons do not play an important role in forming bonds.

13. ____________________ All atoms are the same.

14. ____________________ Most metals possess metallic bonds.

15. ____________________ Atoms have the tendency to fill their outermost energy level with electrons when they bond.

Write a short answer for each of the following.

16. Where are protons and neutrons located in atoms?

____

____

17. Where are electrons located in atoms?

____

____

18. List two subatomic particles found in atoms.

____

____

19. What role do valence electrons play in forming bonds?

____

____

20. What is a chemical bond?

____

____

Video Review

Name ______________________________

While you watch the video, answer these questions:

You Observe!

1. What is the atomic number of this carbon atom?

____
____
____

You Observe!

2. How many valence electrons does magnesium have?

____
____
____

You Decide!

3. What type of ion is sodium?

____
____
____

You Compare!

4. What do this paperclip, the filament in this light bulb, and this can have in common?

____
____
____

After you watch the video, test your knowledge with these questions.

1. When atoms join together a ________________ is formed.
2. ________________ electrons are located in the outermost energy level.
3. Atoms tend to ________________ their outermost energy level.
4. An ________________ bond involves the transfer of electrons.
5. Covalent bonds form when atoms ________________ electrons.

Vocabulary

Name ______________________________

Use these words to fill in the blanks next to the sentences below.

Words				
nucleus	valence electrons	covalent bonds	atomic number	ionic bond
subatomic particles	ionic compounds	chemical bond	metallic bonds	ion

1. ____________________ Smaller pieces of matter that make up an atom; examples include electrons, protons, and neutrons.

2. ____________________ The number of protons in an atom.

3. ____________________ The core, or center of an atom; contains protons and neutrons.

4. ____________________ Electrons located in the outermost energy level of an atom.

5. ____________________ The joining of two or more atoms.

6. ____________________ A charged atom that has lost or gained electrons.

7. ____________________ A bond that involves the transfer of electrons between atoms.

8. ____________________ Substances that tend to have high melting points, and form crystal lattices; salt is an example.

9. ____________________ Bonds that form when atoms share electrons.

10. ____________________ Bonds that form when electrons flow freely and are quite mobile; found in copper and aluminum.

Writing Activity

Name ________________________________

Words				
valence electrons	ion	atoms	transfer	chemical bonding
covalent bond	ionic bond	metallic bond	energy levels	matter

Use the correct word from above to complete the sentences in the following paragraph.

As you know, all _______________, from the objects around you to the air we breathe is made up of _____________. In many cases atoms join other atoms in a process called ____________ ___________________. When atoms form bonds with other atoms, _____________ __________, found in outermost _____________ _____________ move between them. There are three major types of chemical bonds. An ___________ ___________ involves the _______________ of electrons from one atom to another. Ionic bonding gets it name from the word ___________ which is a charged atom that has gained or lost electrons. Another type of bond called a ________________ ________________ is formed when atoms share electrons. The third type of bond called a ________________ ________________ occurs when positively charged ions are surrounded by a "sea of electrons" that are attracted to multiple nuclei at the same time.

In Your Own Words

1. What do chemical bonds enable atoms to do?

____

____

____

2. What is the difference between an ionic bond and a covalent bond?

____

____

____

3. What role do valence electrons play in forming bonds?

____

____

____

Bonds Everywhere

Name ____________________________________

Background: As you know, all matter, from the things around you, to the air we breathe, is made up of atoms. There are many, many, different kinds of atoms. An atom is the smallest complete part of a chemically pure substance called an element. There are over 100 known elements, each made up of a different type of atom. Examples of elements include carbon, oxygen, and aluminum to name just a few. In many cases atoms remain solitary, meaning they do not join with other atoms. But, on some occasions atoms do join, or form bonds, with other atoms. A chemical bond is the attractive force that holds two or more atoms together. 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. In the process of bonding, atoms tend to fill or complete their outermost energy level, thus making the atoms involved more stable.

There are three main ways that atoms form bonds. The three major types of bonds are: covalent bonds, ionic bonds, and metallic bonds. In covalent bonds atoms share electrons. By sharing electrons, each atom fills up its outermost energy level, making the atoms more stable. In the case of water, two atoms of hydrogen, each having one valence electron, bond with oxygen that has six valence electrons. In this bond all three atoms share electrons thus filling their outermost energy levels.

An ionic bond involves the transfer of electrons from one atom to another. Let's look at an example of an ionic bond. Sodium chloride, also known as salt is held together with ionic bonds. Sodium has one valence electron, and chlorine has seven valence electrons. When they bond, one electron is transferred from the sodium atom to the chlorine atom giving sodium an overall positive charge. In turn, chlorine gains a negatively charged electron making it a negative ion. Ions with opposite charges attract each other. This attractive force is what holds atoms together in an ionic bond. Compounds with ionic bonds tend to have high melting points, a crystal lattice, and are often hard and brittle.

Most metals such as copper, consist of atoms held together by metallic bonds. In metallic bonds, positively charged ions are surrounded by a "sea of electrons", which are attracted to multiple nuclei at the same time. In a metallic bond, the outer electrons of metal atoms tend to be quite mobile. The ability of electrons to flow freely makes objects containing metallic bonds good conductors of heat and electricity. They also can be bent and have high melting points.

Materials: paperclip, sugar, piece of copper, salt, water, baking soda, aluminum can, sulfur

Directions:

1. Obtain the items listed in the materials and bring them to your desk.
2. Arrange the items in the order they appear in the chart on the following page.
3. Each of these substances is held together by a different type of bond. Your job is to figure out the type of bonds in the object.
4. Fill in the information in the chart for each material. You may need to use textbooks, encyclopedias, or other resources to obtain answers.

Bonds Everywhere

Name ______________________________

Substance	Type of bonds it contains	Elements	Properties
sugar			
salt			
paperclip			
piece of copper			
water			
baking soda			
aluminum can			
piece of sulfur			

Questions:

1. What is a chemical bond?

2. List the three major types of chemical bonds.

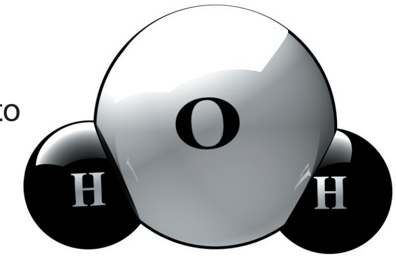
3. Among the substances you studied, which ones had covalent bonds?

4. What substances are held together in a metallic bond?

5. What are some of the properties of substances held together by metallic bonds?

Making a Molecule

Name ________________________________



Background: Everyday you drink water or drink something made from water. We also wash with water, use it to cook our food, and even swim in water. All life either directly or indirectly needs water to survive. Have you ever thought about what water is actually made up of? If you were to break water down to the smallest complete piece of water, it would consist of something called a molecule of water. A molecule consists of two or more atoms that are bonded together. Atoms in molecules are held together by specific types of bonds called covalent bonds. A molecule is the smallest particle of a covalently bonded substance that has all the properties of that substance. In the case of a molecule of water, two hydrogen atoms are covalently bonded to an atom of oxygen. In this activity you will create models of molecules.

Materials: marshmallows, gum drops, toothpicks

Directions:

1. On the top part of this page is a diagram of a water molecule. Take a minute to study it.
2. Obtain a marshmallow and two gumdrops that are the same color, and two toothpicks.
3. Create a model of a water molecule using these materials.
4. We breathe in a gas called oxygen and breathe out a gas called carbon dioxide. You will make models of both of these compounds.
5. Oxygen we breathe in consists of two oxygen atoms bonded together (O_2). Obtain two marshmallows and a toothpick. Create a model of O_2.
6. Carbon dioxide has the chemical formula of CO_2. Obtain three marshmallows and two toothpicks. Color one of the marshmallows to represent a carbon atom. Create a model of a molecule of carbon dioxide.
7. Answer the questions below.

Questions:

1. What is a molecule?

2. What did the marshmallow and gumdrops represents?

3. What did the toothpicks represent?

Creating Covalent Bonds

Name ______________________________

Background: Many of the substances around us are made up of two or more elements joined together via chemical bonds. In the process of bonding, atoms tend to fill or complete their outermost energy level, thus making the atoms 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. In this activity you will create diagrams of covalent bonds.

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 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 many want to use different colored pencils so that each different atom has a different color for its electrons.

Creating Covalent Bonds

Name ______________________________

H H

Cl Cl

H Cl

H F

H
H N
H

H O
H