Get Ready

What do you think?

Before you begin, decide if you agree or disagree with each of these statements.

As you view this presentation, see if you change your mind about any of the statements.

Get Ready

Do you agree or disagree?

- Elements rarely exist in pure form. Instead, combinations of elements make up most of the matter around you.
- Chemical bonds that form between atoms involve electrons.

Key Concepts/Essential Questions

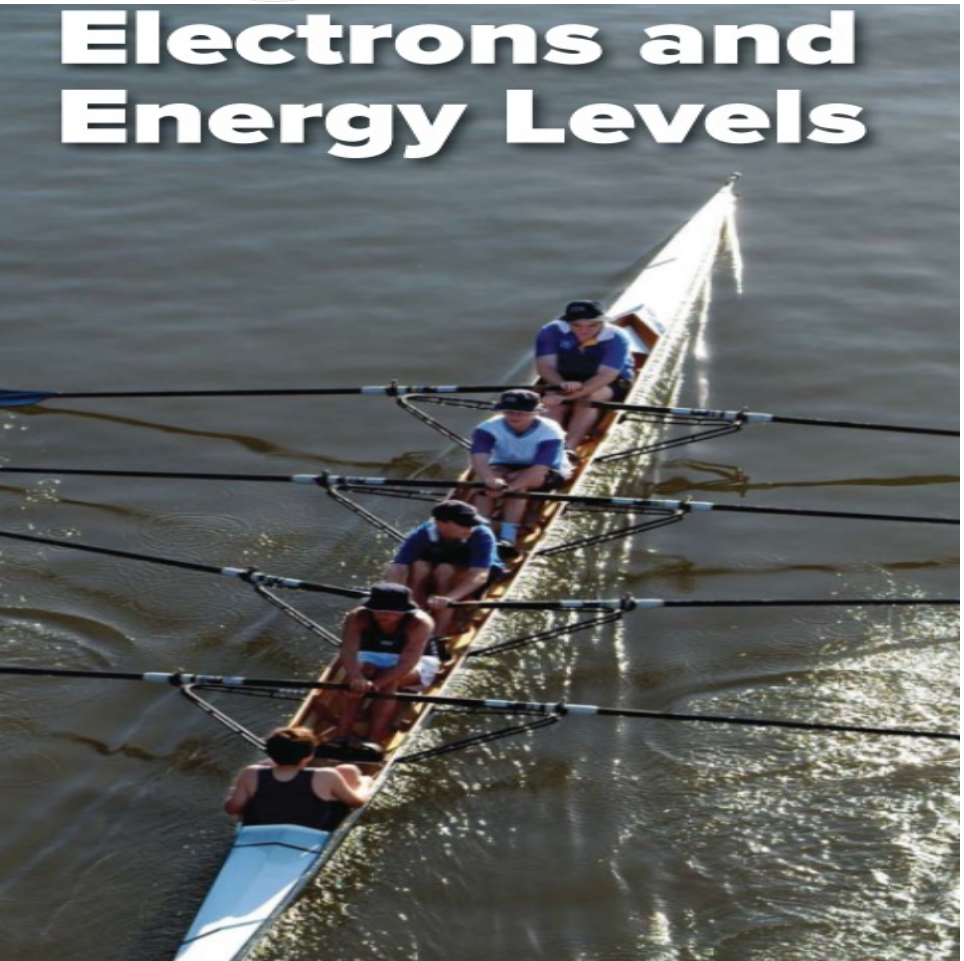
- How is an electron's energy related to its distance from the nucleus?
- Why do atoms gain, lose, or share electrons?

Vocabulary

Watch out for these words!

- chemical bond
- valence electron
- electron dot diagram

Inquiry Are pairs more stable?



Look at the photo at the beginning of the lesson. Rowing can be hard work, especially if you are part of a racing team. The job is made easier because the rowers each pull on the water with a pair of oars. How do pairs make the boat more stable?

LESSON 1

Electrons and Energy Levels – Periodic Table

The periodic table presents information about the elements in an organized way and has more than 100 blocks. Each known element is a block and describes basic properties of one element, such as its state of matter at room temperature, its atomic number, and its atomic mass. The atomic number is the number of protons in each atom of the element. The atomic mass is the average mass of all the different isotopes of an element.

LESSON 1

Electrons and Energy Levels – Periodic Table

Periods and Groups

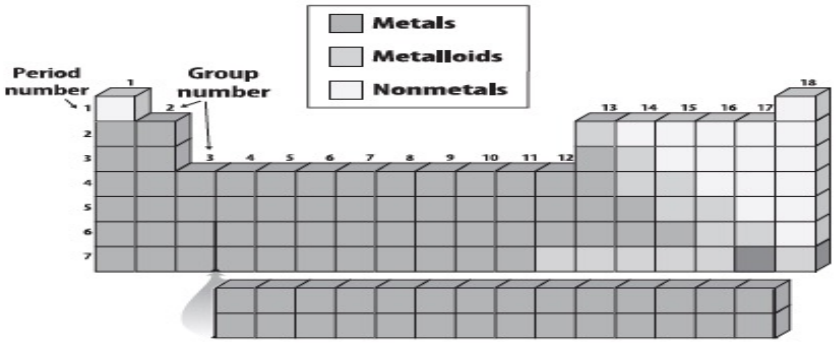
Elements are organized in periods (rows) and groups (columns). The table lists elements in order of atomic number. The number increases from left to right as you move across a period. Elements in each group have similar chemical properties and react with other elements in similar ways.

Metals, Nonmetals, and Metalloids

There are three main regions of elements on the periodic table. The regions classify elements as metals, nonmetals, or metalloids.

LESSON 1

Electrons and Energy Levels – Periodic Table



Metals, Nonmetals, and Metalloids

The table above shows the three regions. Except for hydrogen, elements on the left side are metals, which are good conductors of electricity and thermal energy. Can easily be hammered into sheets. Metalloids form a narrow stair-step pattern between the metals and nonmetals. Metalloids have properties in common with both, used as semiconductors in electronic devices. Nonmetals are on the right side of the table, they don't conduct electricity or thermal energy well. Most are gases at room temperature, solids tend to be brittle.

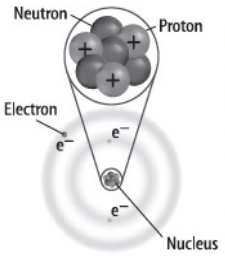
LESSON 1

Electrons and Energy Levels – Atoms Bonds

Elements rarely exist in pure form in nature. Instead, atoms of different elements chemically combine and form compounds. Compounds make up most of the matter around you, including living and nonliving things.

Elements combine and form millions of compounds. Chemical bonds hold the compounds together. A **chemical bond** *is a force that holds two or more atoms together in a compound.*

Electron Number and Arrangement



Atoms contain protons, neutrons, and electrons. We already know a proton has positive charge, neutron has no charge, and electron has a negative charge. The element's atomic number is the same as protons in each atom of the element. Neutral (uncharged) atoms have equal protons and electrons.

LESSON 1

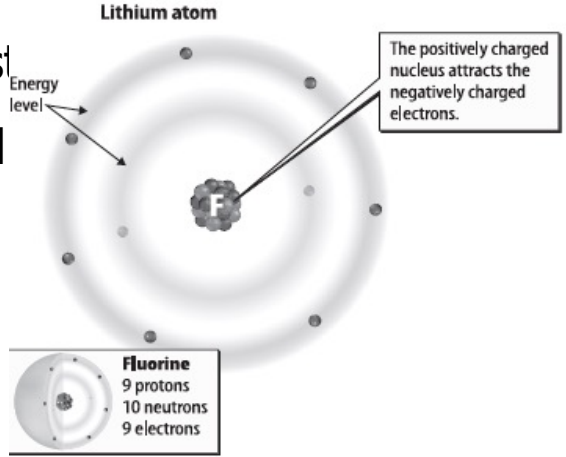
Electrons and Energy Levels – Atoms Bonds

Position of Electrons

The exact position cannot be determined because they constantly move around the nucleus. Some are close to the nucleus and some are farther away.

Electrons and Energy

They have different amounts of energy. The areas around the nucleus are called **energy levels**. The amount of energy an electron has is related to its distance from the nucleus. Closest to the nucleus have the lowest energy level and leas
Those farthest from have the highest energy level
and most energy.



LESSON 1

Electrons and Energy Levels – Atoms Bonds

Electrons and Bonding

Imagine two magnets. The closer they are to each other, the stronger the attraction of their opposite ends. This is the same for negatively charged electrons and the positively charged nucleus.

The nuclei of other atoms can easily attract outer electrons. This attraction between the positive nucleus of one atom and the negative electrons of another atom creates a chemical bond.

Electrons and Energy Levels – Atoms Bonds

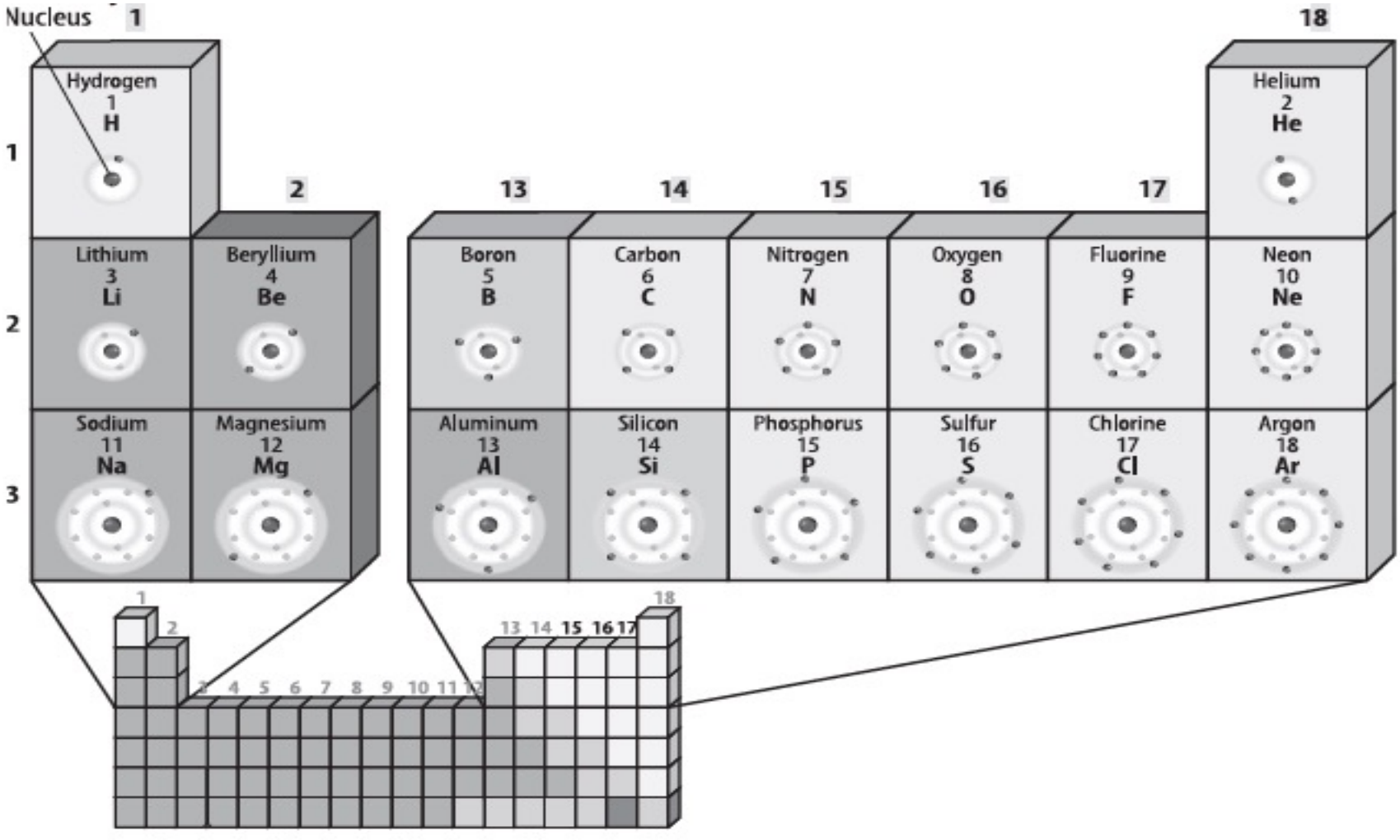
Valence Electrons

Electrons farthest from their nucleus are easily attracted to the nuclei of nearby atoms. These outermost electrons are the only electrons that form chemical bonds. A **valence electron** *is an outermost electron of an atom that participates in chemical bonding*. Valence electrons have the most energy of all the electrons in an atom. The number helps determine the type & number of bonds the atom can form. The table can tell you the number of valence each atoms has, except helium. The number of valence electrons in an atom equals the ones digit of the group number at the top of the column. Each of these digits is highlighted in the figure below. Helium is an exception. An atom of helium has two valence electrons.

LESSON 1

Electrons and Energy Levels – Atoms Bonds

Valence Electrons



Electrons and Energy Levels – Atoms Bonds

Electron Dot Diagram

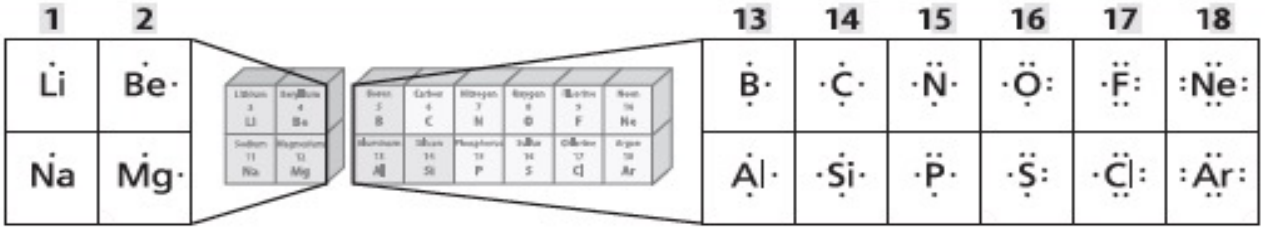
Is a model that represents valence electrons in an atom as dots around the element's chemical symbol. They predict how an atom will bond with other atoms. Dots, representing valence electrons, are placed one-by-one on each side of an element's symbol, then are paired up until all the dots are used. The number of unpaired dots represents the number of bonds an atom can form.

LESSON 1

Electrons and Energy Levels – Atoms Bonds

Electron Dot Diagram

Steps for writing a dot diagram	Beryllium	Carbon	Nitrogen	Neon
1 Identify the element's group number on the periodic table.	2	14	15	18
2 Identify the number of valence electrons. • This equals the ones digit of the group number.	2	4	5	8
3 Draw the electron dot diagram. • Place one dot at a time on each side of the symbol (top, right, bottom, left). Pair up the dots until all are used.	Be·	·C·	·N·	:Ne:
4 Determine if the atom is stable. • An atom is stable if all dots on the electron dot diagram are paired.	Unstable	Unstable	Unstable	Stable
5 Determine how many bonds this atom can form. • Count the dots that are unpaired.	2	4	3	0



Electrons and Energy Levels – Atoms Bonds

Noble Gases

These elements are in Group 18 on the table with the exception of helium, noble gases have 8 valence electrons and chemically stable. Stable atoms do not easily react, or form bonds, with other atoms.

Stable and Unstable Atoms

Atoms with unpaired dots in their electron dot diagrams are reactive, or chemically unstable. Unstable atoms become more stable by forming chemical bonds with other atoms. Forming a bond gains, loses, or shares valence electrons with other atoms and become more chemically stable. Atoms are most stable with eight valence electrons. Atoms with less than eight valence electrons form bonds and become stable.

Lesson Review

What do you think NOW?

Do you agree or disagree?

Elements rarely exist in pure form. Instead, combinations of elements make up most of the matter around you.

Agree. Most of the materials around you are substances that have been made from a combination of two or more elements.

Lesson Review

What do you think NOW?

Do you agree or disagree?

Chemical bonds that form between atoms involve electrons.

Agree. Chemical bonds that form between atoms only involve electrons.

Key Concept/Essential Question Review

How is an electron's energy related to its distance from the nucleus?

Electrons with more energy are farther from the atom's nucleus and are in a higher energy level.

Key Concept/Essential Question Review

Why do atoms gain, lose, or share electrons?

Atoms with fewer than eight valence electrons gain, lose, or share valence electrons and form stable compounds. Atoms in stable compounds have the same electron arrangement as a noble gas.

Get Ready

What do you think?

Before you begin, decide if you agree or disagree with each of these statements.

As you view this presentation, see if you change your mind about any of the statements.

Compounds, Chemical Formulas, and Covalent Bonds

Get Ready

Do you agree or disagree?

- The atoms in a water molecule are more chemically stable than they would be as individual atoms.
- Many substances dissolve easily in water because opposite ends of a water molecule have opposite charges.

Compounds, Chemical Formulas, and Covalent Bonds

Key Concepts/Essential Questions

- How do elements differ from the compounds they form?
- What are some common properties of a covalent compound?
- Why is water a polar compound?

Vocabulary

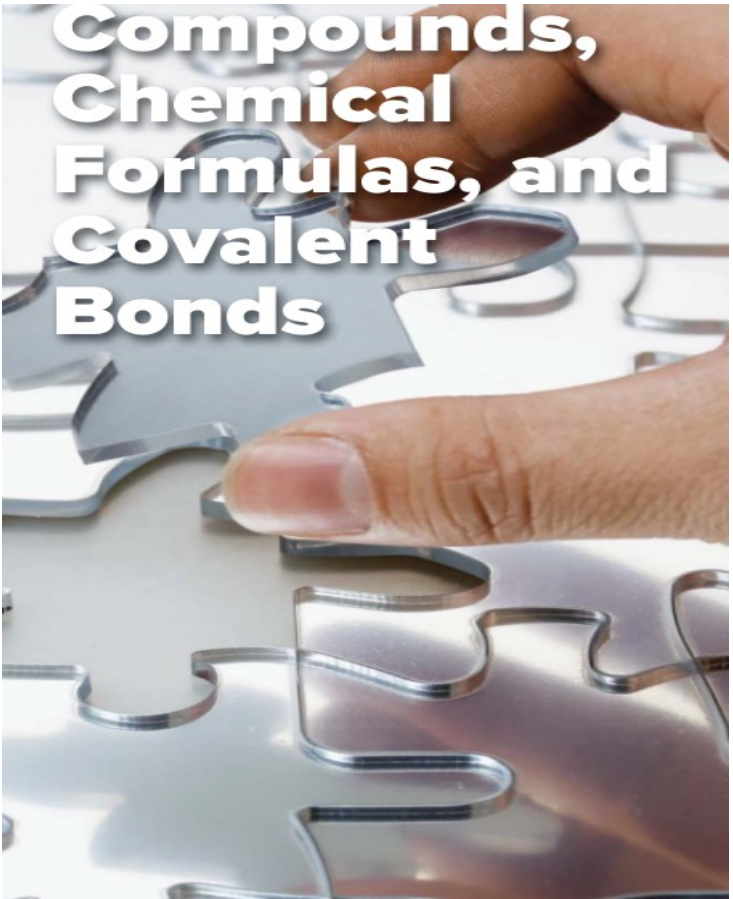
Watch out for these words!

- covalent bond
- molecule
- polar molecule
- chemical formula

Compounds, Chemical Formulas, and Covalent Bonds

Inquiry

How do they combine?



Look at the photo at the beginning of the lesson. A jigsaw puzzle has pieces that connect in a certain way. The pieces fit together by sharing tabs with other pieces. All of the pieces combine and form a complete puzzle. Like pieces of a puzzle, atoms can join together and form a compound by sharing electrons.

LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (From Elements to Compounds)

A compound is a substance made up of two or more different elements. Compounds are different from their elements. An element is made of one type of atom. Compounds are chemical combinations of different types of atoms. Compounds and the elements that make them up often have different properties and chemical bonds join atoms together.

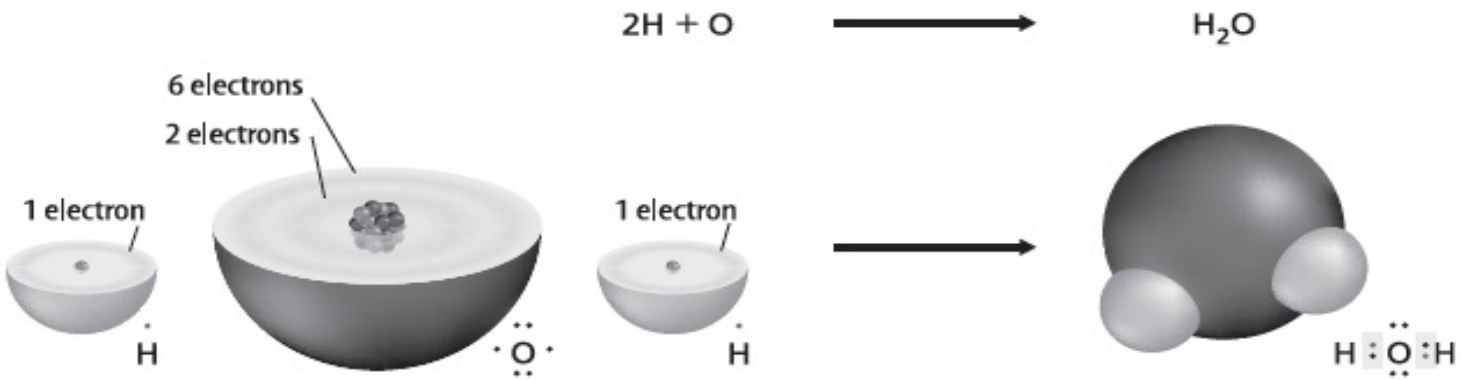
LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Bonds- Electron Sharing)

A **covalent bond** *is a chemical bond formed when two atoms share one or more pairs of valence electrons.* The atoms then form a stable covalent compound.

A Noble Gas Electron Arrangement

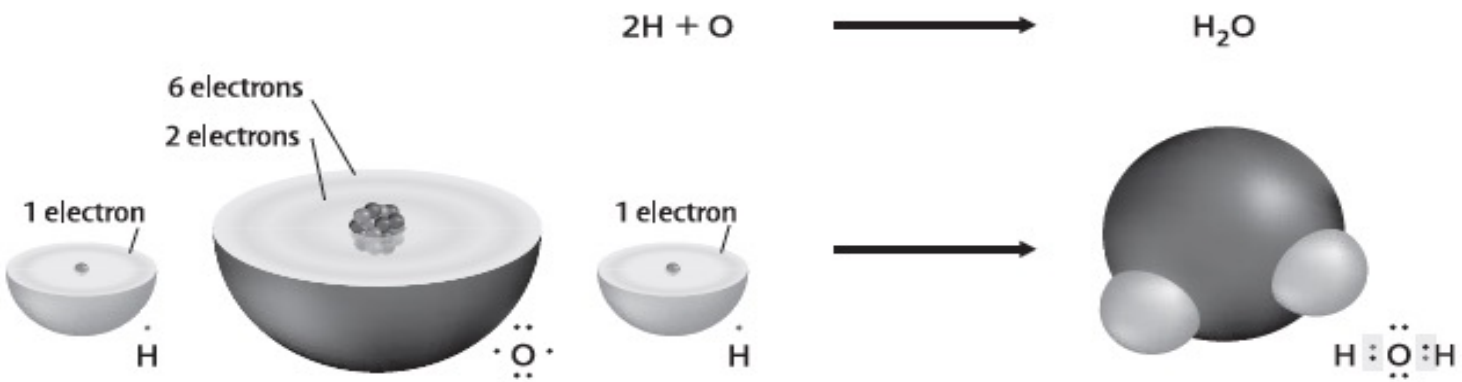
Hydrogen and oxygen can react to form water (H2O). Before the reaction, they are chemically unstable. Each hydrogen atom is unstable with one valence electron. The oxygen atom is unstable with six valence electrons.



LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Bonds- Electron Sharing)

To become chemically stable with eight valence electrons are needed. This is the same arrangement as a noble gas. An atom with less than eight valence electrons becomes stable by forming chemical bonds until it has eight valence electrons. An oxygen atom forms two bonds to become stable. A hydrogen atom is stable with two valence electrons. It forms one bond to become stable.

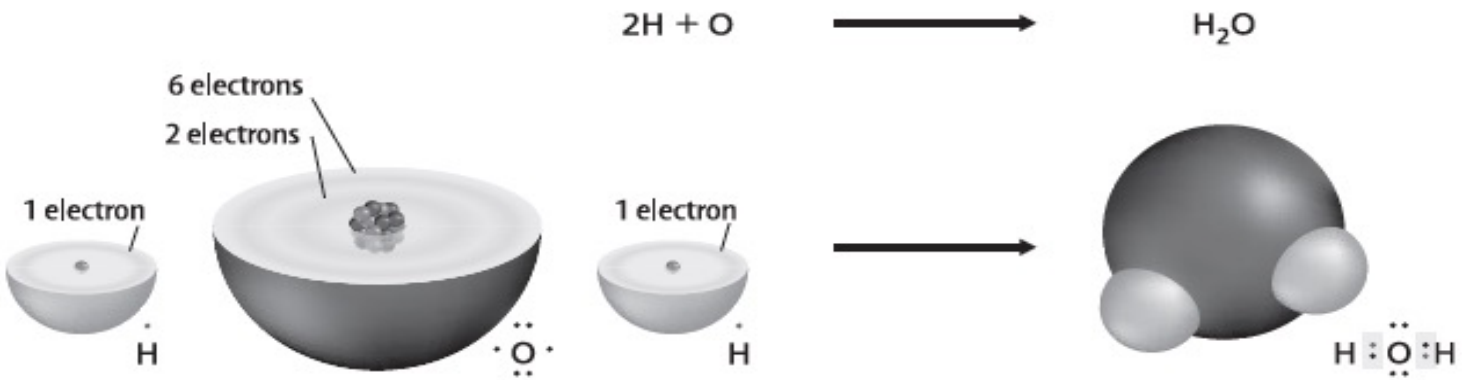


Compounds, Chemical Formulas, and Covalent Bonds (Covalent Bonds- Electron Sharing)

Shared Electrons

How did the oxygen atom and the hydrogen atoms become chemically stable? By sharing the unpaired valence electrons, a stable covalent compound is formed.

The dot diagram for water shows that hydrogen now has two valence electrons. Oxygen bonded with two hydrogen atoms, resulted in oxygen having 8 valence electrons. The compound is stable.



LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Bonds- Electron Sharing)

Each hydrogen atom is chemically unstable with 1 unpaired valence electron.

Single Covalent Bond

In a hydrogen molecule, each hydrogen atom shares its valence electron with the other, forming a single covalent bond.

Each oxygen atom is chemically unstable with 2 unpaired valence electrons. A carbon atom is unstable with 4 unpaired valence electrons.

Double Covalent Bond

In a carbon dioxide molecule, the carbon atom shares 2 pairs of electrons with each oxygen atom, forming a double covalent bond.

Each nitrogen atom is chemically unstable with 3 unpaired valence electrons.

Triple Covalent Bond

In a nitrogen molecule, each nitrogen atom shares 3 valence electrons with the other, forming a triple covalent bond.

LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Compounds)

When two or more atoms share valence electrons, they form a stable **covalent compound**. The covalent compound's carbon dioxide and water are different, but they share similar properties. They usually have low melting points and oiling points. Usually gases or liquids at room temperature, but can be solids. Covalent compounds are poor conductors of thermal energy and electricity.

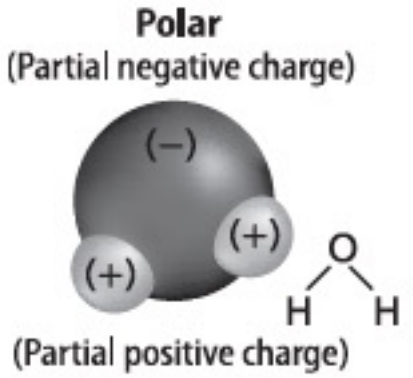
Molecules

The chemically stable unit of a covalent compound is a molecule. A **molecule** *is a group of atoms held together by covalent bonding that acts as an independent unit*. Table sugar is a covalent compound. $\mathbf{C_{12}H_{22}O_{11}}$

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Compounds)

Water and Other Polar Molecules

In a covalent bond, one atom can attract the shared electrons more strongly than the another. In a water molecule, the oxygen atom attracts the electrons more strongly than each hydrogen atom does. Resulting in shared electrons being pulled closer to the oxygen atom. Since electrons have a negative charge, oxygen atom has a partial negative charge and the hydrogen atoms have a partial positive charge, making the molecule polar.



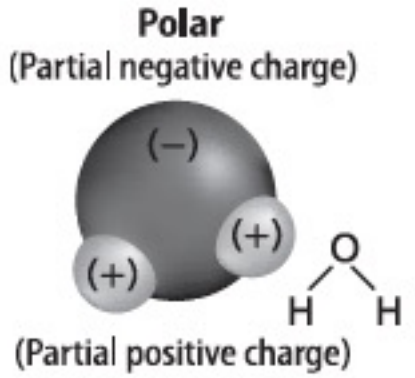
LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Compounds)

A Polar Molecule *is a molecule that has a partial positive end and a partial negative end because of unequal sharing of electrons.*

The charges on the ends affect its properties.

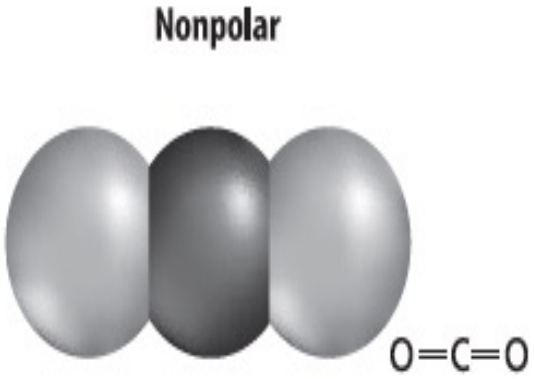
Sugar dissolves easily in water because both sugar and water are polar. The negative end of a water molecule pulls on the positive end of a sugar molecule. Also, the positive end of a water molecule pulls on the negative end of a sugar molecule. This causes the sugar molecules to separate from one another and mix with the water molecules



Compounds, Chemical Formulas, and Covalent Bonds (Covalent Compounds)

Nonpolar Molecule

A molecule is nonpolar if its atoms pull equally on the shared valence electrons. A hydrogen molecule, H2, is a nonpolar molecule. Because the two hydrogen atoms are identical, their attraction for shared electrons is equal. A carbon dioxide molecule, CO2, below is also nonpolar because the carbon atom and the oxygen atoms pull equally on the shared electrons. A nonpolar compound can will not easily dissolve in a polar compound. Oil and water don't mix.

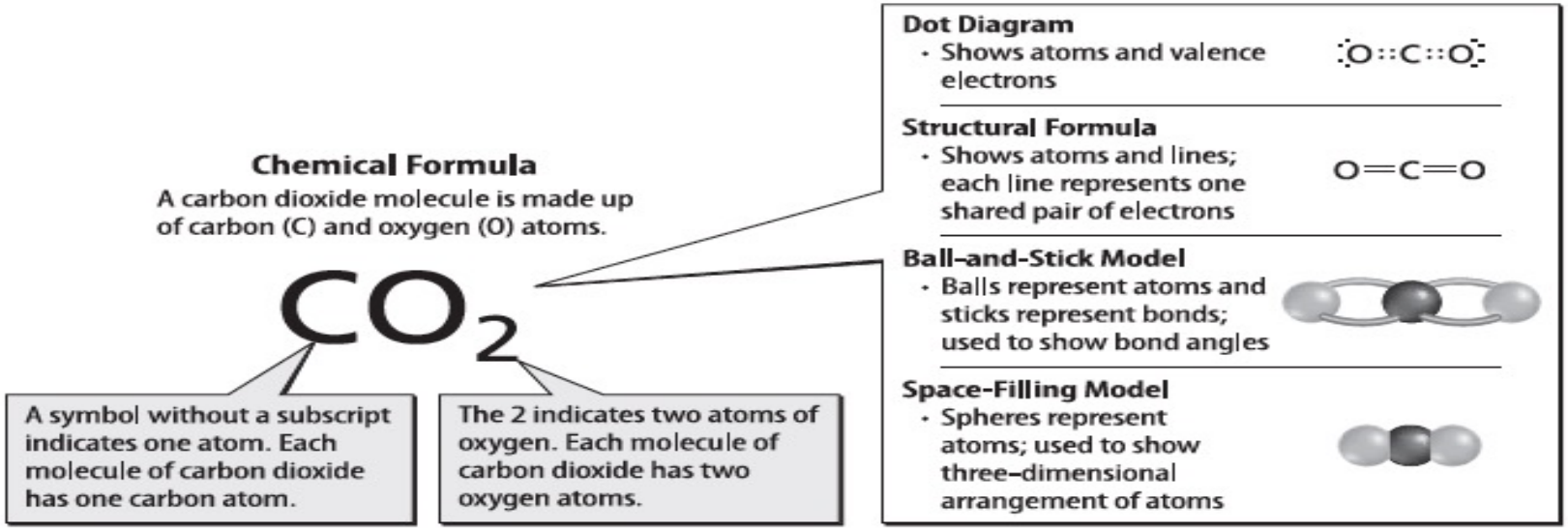


LESSON 2

Compounds, Chemical Formulas, and Covalent Bonds (Covalent Compounds)

Chemical Formulas and Molecular Models

How do you know which elements make up a compound? A **chemical formula** *is a group of chemical symbols and numbers that represent the elements and the number of atoms of each element that make up a compound*. Just as a recipe lists the ingredients, a chemical formula lists the elements in a compound.



Lesson Review

What do you think NOW?

Do you agree or disagree?

The atoms in a water molecule are more chemically stable than they would be as individual atoms.

Agree. A hydrogen atom has only one valence electron and an oxygen atom has six valence electrons. The makes them unstable. When two hydrogen atoms and an oxygen atom combine, they share two pairs of valence electrons. This gives them the electron arrangement of a noble gas and makes them stable.

Lesson Review

What do you think NOW?

Do you agree or disagree?

Many substances dissolve easily in water because opposite ends of a water molecule have opposite charges.

Disagree. Only other polar compounds dissolve easily in water because opposite ends of a water molecule have opposite charges.

Key Concept/Essential Question Review

How do elements differ from the compounds they form?

A compound and the elements it is made from have different chemical and physical properties

Key Concept/Essential Question Review

What are some common properties of a covalent compound?

A covalent bond forms when two nonmetal atoms share valence electrons. Common properties of covalent compounds include low melting points and low boiling points. They are usually gas or liquid at room temperature and poor conductors of electricity.

Key Concept/Essential Question Review

Why is water a polar compound?

Water is a polar compound because the oxygen atom pulls more strongly on the shared valence electrons than the hydrogen atoms do.

Get Ready

What do you think?

Before you begin, decide if you agree or disagree with each of these statements.

As you view this presentation, see if you change your mind about any of the statements.

Get Ready

Do you agree or disagree?

- Losing valence electrons can make some atoms more chemically stable.
- Metals are good electrical conductors because they tend to hold onto their valence electrons very tightly.

Key Concepts/Essential Questions

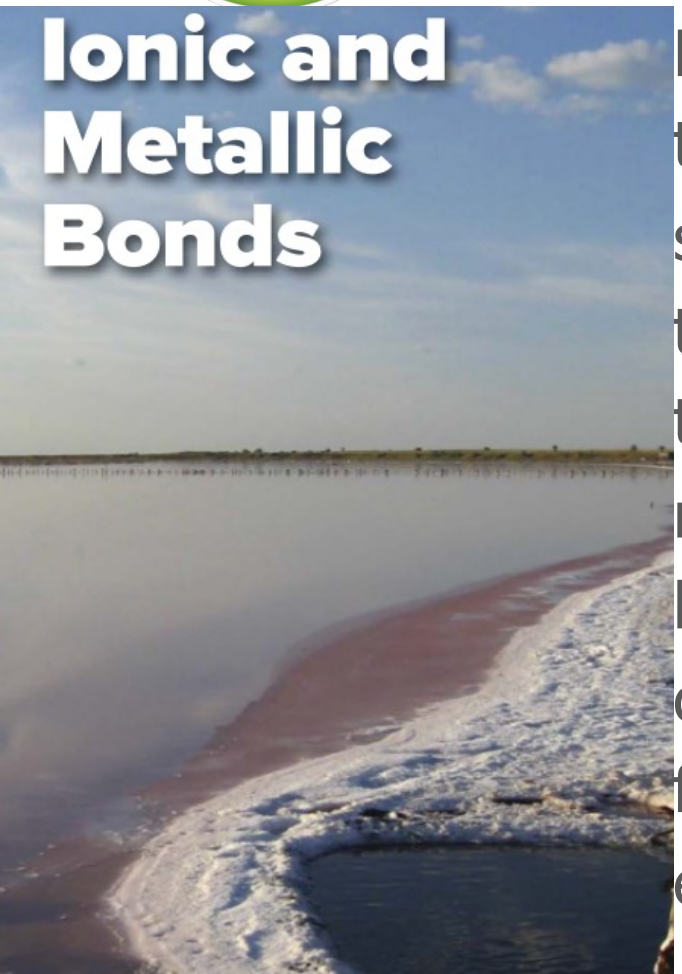
- What is an ionic compound?
- How do metallic bonds differ from covalent and ionic bonds?

Vocabulary

Watch out for these words!

- ion
- ionic bond
- metallic bond

Inquiry **What is this?**



Look at the photo at the beginning of the lesson. This scene might look like snow along a shoreline, but it is actually thick deposits of salt on a lake. Over time, tiny amounts of salt dissolved in river water that flowed into this lake and built up as water evaporated. Salt is a compound that forms when elements form bonds by gaining or losing valence electrons, not sharing them.

LESSON 3

Ionic and Metallic Bonds – Understanding Ions

When an atom loses or gains a valence electron, it becomes an ion. An **ion** *is an atom that is no longer electrically neutral because it has lost or gained valence electrons.* Because electrons have a negative charge, gaining or losing an electron changes the overall charge of the atom. An atom that loses valence electrons becomes an ion with a positive charge. This is because after an atom loses an electron, the atom has more protons than electrons. The atom is now an ion with a positive charge. An atom that gains valence electrons becomes an ion with a negative charge. This is because the number of protons is now less than the number of Electrons.

Ionic and Metallic Bonds – Understanding Ions

Losing Valence Electrons

Sodium (Na) is a metal. Its atomic number is 11. (11 P & E) Sodium is in group 1 on the table and has one valence electron making it unstable.

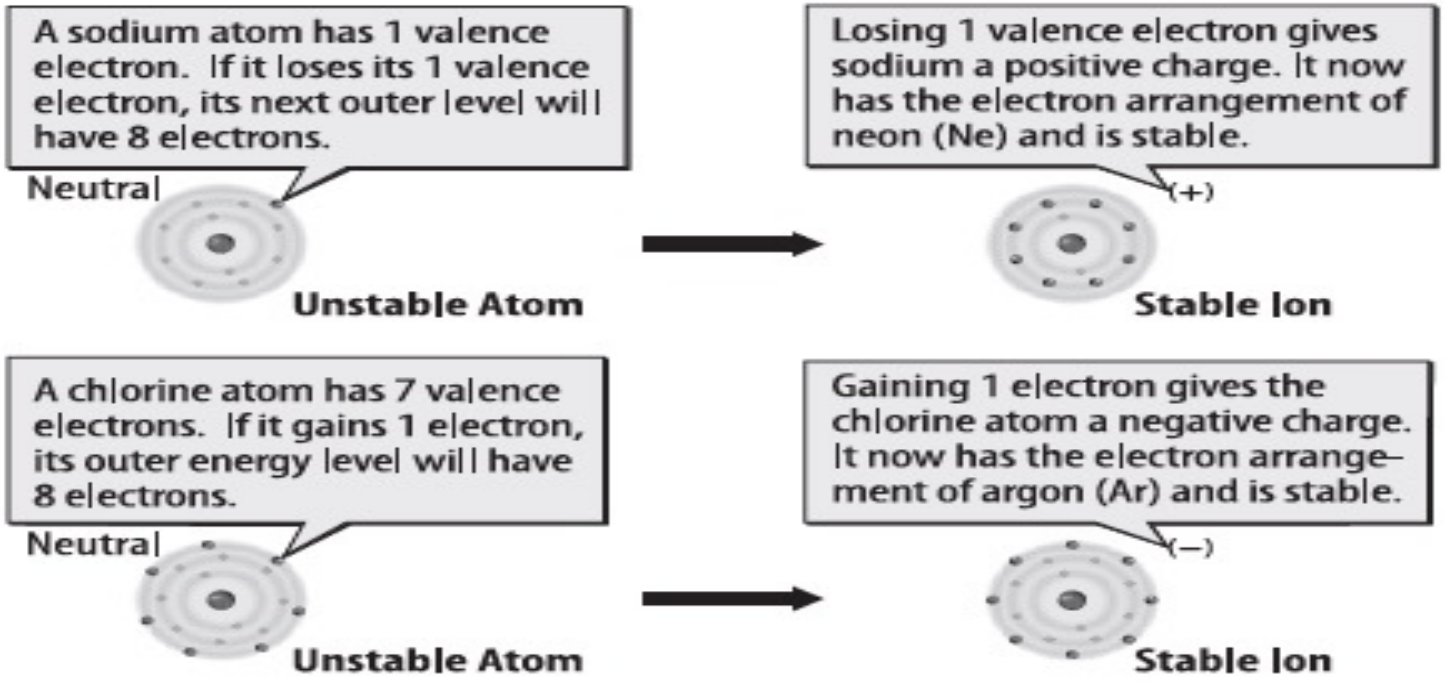
Metal atoms, such as sodium, become more stable when they lose valence electrons and form a chemical bond with a nonmetal

Gaining Valence Electrons

Nonmetal atoms can also gain valence electrons from metal atoms to achieve the electron arrangement of a noble gas. The nonmetal chlorine (Cl) has an atomic number of 17. Chlorine atoms have seven valence electrons. If a chlorine gains one valence electron, it will have eight valence electrons and be the same as the stable noble gas argon (Ar).

Gaining Valence Electrons

When a sodium atom loses a valence electron, it becomes a positively charged ion. This is shown by a plus (+) sign. When a chlorine atom gains a valence electron, it becomes a negatively charged ion. This is shown by a negative (-) sign



Determining an Ion's Charge

Atoms are electrically neutral because they have the same number of protons (+) and electrons (-). Once an atom gains or loses electrons, it becomes a charged ion.

For example, the atomic number for nitrogen (N) is 7. This means that each N atom has 7 protons and 7 electrons. It is electrically neutral. When forming an ionic bond, N atoms gain 3 electrons. The N ion then has 10 electrons. To determine the charge of the ion, subtract the number of electrons in the ion from the number of protons.

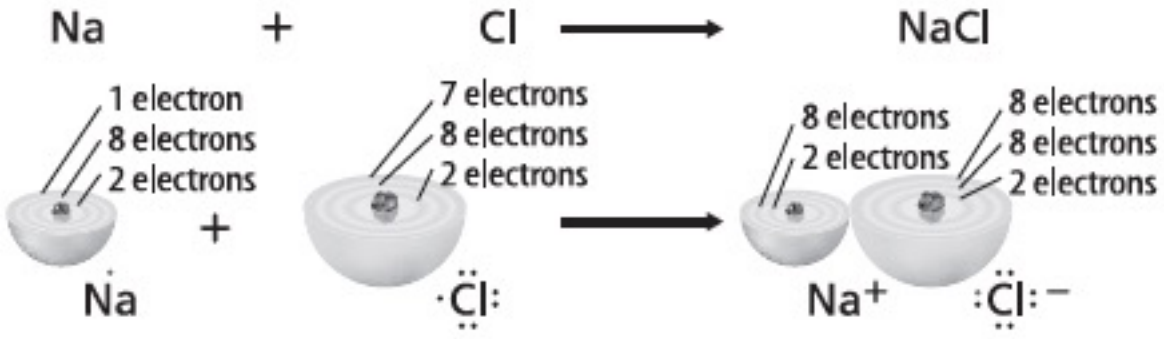
7 protons - 10 electrons = -3 charge

A nitrogen ion has a -3 charge. This is written as N^{3-}.

LESSON 3

Ionic and Metallic Bonds – Ionic Bonds – Electron Transferring

Metal atoms lose valence electrons and nonmetal atoms gain valence electrons. When forming a chemical bond, the nonmetal atoms gain the electrons lost by the metal atoms. Table salt (NaCl), a sodium atom loses one valence that is transferred to chlorine. Sodium is now a positively charged ion and chlorine atom is a negatively charged ion. These ions attract each other and form a stable ionic compound. *The attraction between positively and negatively charged ions in an ionic compound is an* **ionic bond.**



LESSON 3

Ionic and Metallic Bonds – Ionic Bonds – Electron Transferring

Ionic Compounds

The ions are strongly attracted to each other and are usually solid and brittle at room temperature. Relatively high melting and boiling points. Water with dissolved ionic compounds is a good conductor of electricity.

Comparing Ionic and Covalent Compounds

Covalent bond is two or more nonmetal atoms share electrons and form a unit, or molecule. Covalent compounds are made up of many molecules. When nonmetal ions bond to metal ions in an ionic compound, there are no molecules. Instead, there is a large collection of ions with opposite charges. The ions are all attracted to each other and are held together by ionic bonds.

Ionic and Metallic Bonds – Metallic Bonds – Electron Pooling

Metallic Bonds—Electron Pooling

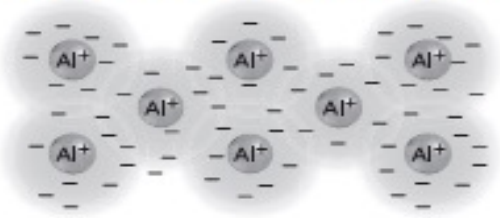
Metal atoms typically lose valence electrons when forming compounds. Metal atoms form compounds with one another by combining, or pooling, their valence electrons. A **metallic bond** *is a bond formed when many metal atoms share their pooled valence electrons*.

Properties of Metallic Compounds

Metals are good conductors of thermal energy and electricity. When hammered into a sheet or drawn into a wire, it does not break. The ions can slide past one another in the electron sea and move to new positions. Shiny because the valence electrons at the surface interact with light.

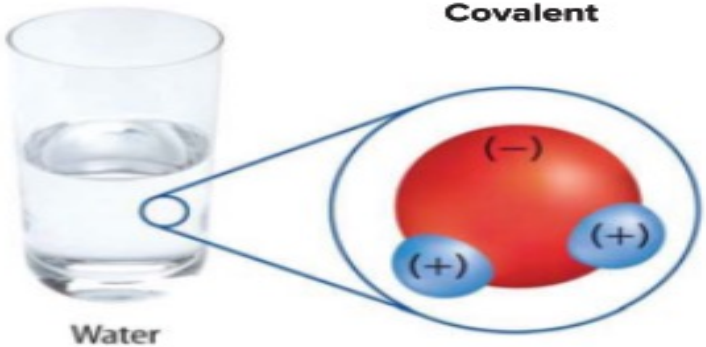
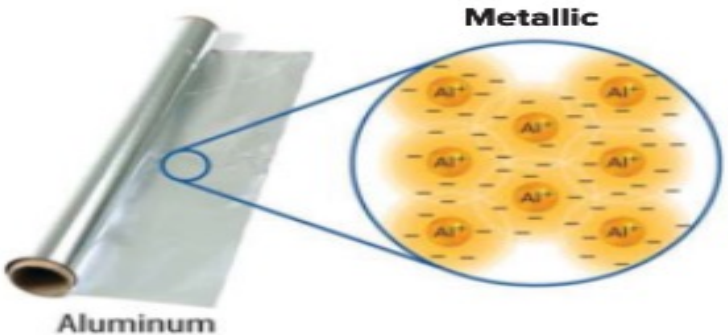
LESSON 3

Ionic and Metallic Bonds – Metallic Bonds – Electron Pooling

Type of Bond	What is bonding?	Properties of Compounds
Covalent—share valence electrons  Water	nonmetal atoms; nonmetal atoms	• gas, liquid, or solid • low melting and boiling points • often not able to dissolve in water • poor conductors of thermal energy and electricity • dull appearance
Ionic—transfer valence electrons  Salt	nonmetal ions; metal ions	• solid crystals • high melting and boiling points • dissolves in water • solids are poor conductors of thermal energy and electricity • ionic compounds in water solutions conduct electricity
Metallic—pool valence electrons  Aluminum	metal ions; metal ions	• usually solid at room temperature • high melting and boiling points • do not dissolve in water • good conductors of thermal energy and electricity • shiny surface • can be hammered into sheets and pulled into wires

LESSON 3

Ionic and Metallic Bonds – Metallic Bonds – Electron Pooling

Type of Bond	What is bonding?	Properties of Compounds
Covalent  Water	nonmetal atoms; nonmetal atoms	• gas, liquid, or solid • low melting and boiling points • dissolves in water if covalent bonds are polar • do not dissolve in water if covalent bonds are nonpolar • poor conductors of thermal energy and electricity • dull appearance
Ionic  Salt	nonmetal ions; metal ions	• solid crystals • high melting and boiling points • dissolves in water • solids are poor conductors of thermal energy and electricity • ionic compounds in water solutions conduct electricity
Metallic  Aluminum	metal ions; metal ions	• usually solid at room temperature • high melting and boiling points • do not dissolve in water • good conductors of thermal energy and electricity • shiny surface • can be hammered into sheets and pulled into wires

Lesson Review

What do you think NOW?

Do you agree or disagree?

Losing valence electrons can make some atoms more chemically stable.

Agree. If an atom only has one valence electron, losing it gives the atom the electron arrangement of a noble gas, which makes it stable.

Lesson Review

What do you think NOW?

Do you agree or disagree?

Metals are good electrical conductors because they tend to hold onto their valence electrons very tightly.

Disagree. Metals are good electrical conductors because their valence electrons can easily move from atom to atom.

Key Concept/Essential Question Review

What is an ionic compound?

An ionic compound is held together by ionic bonds, which are attractions between positively and negatively charged ions.

Key Concept/Essential Question Review

How do metallic bonds differ from covalent and ionic bonds?

A metallic bond forms when valence electrons are pooled among many metal atoms.