Edgenuity

Warm-Up | Ionic Bonding

Lesson Objectives

By the end of this lesson, you should be able to:

- Explain how ionic bonds form.
- Explain that ionic compounds form [crystal] lattices.
- Describe how [polyatomic] ions form ionic bonds with other ions.
- Explain how ionic bonds affect the properties of ionic compounds.

Science Practice: Explain the process by which ionic bonds form.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

ionic bond	a bond resulting from the [attraction] between oppositely charged ions
cations	positively charged particles (typically [metals])
anions	[negatively] charged particles (typically nonmetals)
crystal	a solid in which the particles are arranged in a [regular], repeating pattern
crystal lattice	a three-dimensional [structure] of points that represents the alternating patterns of atoms or ions in a crystal

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W2K

Words to Know

formula unit	an electrically neutral group of ions joined by ionic bonds; the smallest unit of an ionic compound
polyatomic ion	an ion that is made up of two or more atoms bonded together, acts as a single unit, and has an overall electric charge
lattice energy	the energy released when gas-phase ions combine to form crystals; the change in enthalpy that occurs when gaseous ions condense to form one mole of an ionic solid

Instruction | Ionic Bonding

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Lesson Question

How do ionic bonds form between atoms?

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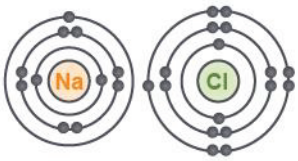
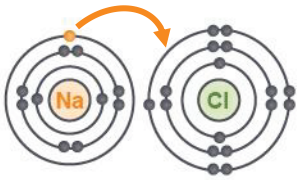
Ionic Bonds

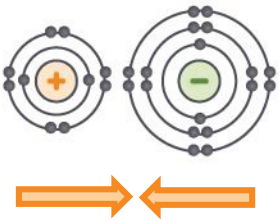
An **ionic bond** is an attraction that holds two [oppositely] charged ions together.



Metal and nonmetal atoms



Transfer of electrons to form **cations** (positively charged) and [anions] (negatively charged)



Electrostatic attraction between [ions]

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Crystals and Crystal Lattices

Ionic compounds form **crystals**.

- **Crystal**: a solid in which the particles are arranged in a regular, repeating [pattern]
- **Crystal lattice**: a three-dimensional structure of points that represent the alternating patterns of [atoms] or ions in a crystal

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Formula Units

The chemical formula for an ionic compound is called a **formula unit**.

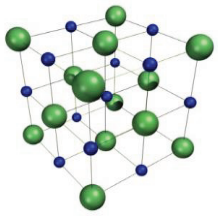
- Smallest repeating unit of an ionic compound
- Simplest ratio of ions in the crystal lattice

Ionic compounds do not form molecules.

NaCl: 1 Na^+, 1 Cl^-

$CaCl_2$: 1 Ca^{2+}, 2 Cl^-

Al_2O_3: 2 Al^{3+}, 3 O^{2-}



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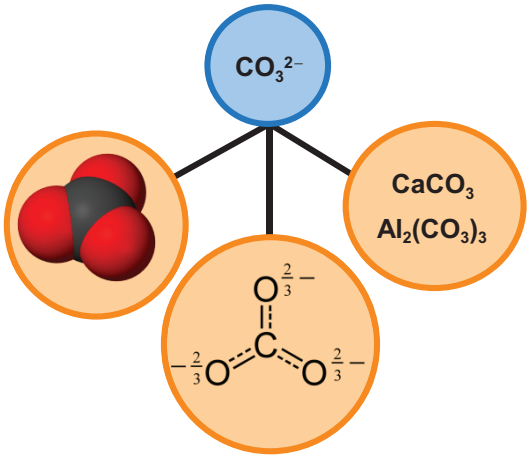
Compounds with Polyatomic Ions

A **polyatomic ion**:

- is a single unit.
- is made of atoms that are bonded together covalently.
- has a charge that is distributed over the entire unit.
- forms ionic bonds with other ions.



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Common Polyatomic Ions

- Most polyatomic ions are anions, meaning that they're [negative].
- Many polyatomic ions differ only in the number of hydrogen or oxygen [atoms]. This affects how they are named.
  - Sulfite and sulfate differ in the number of oxygen atoms.
  - Nitrite and nitrate differ in the number of oxygen atoms.
  - Carbonate and bicarbonate or hydrogen carbonate differ in their hydrogens.

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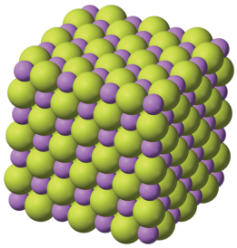
Forming Crystal Lattices

Lattice energy is the [energy] released when [gas-phase] ions combine to form crystals. Lattice energy is a measure of the [bond] strength. The energy of a crystal lattice is actually lower than the individual discrete molecule, making it more stable. It's the result of the attraction between negative and positive ions.



Lithium [fluoride]

Nitryl fluoride

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Lattice Energies

Lattice energy is:

- greater for [smaller] ions.
- greater for ions with larger [charges].
- a measure of the bond energy/strength.

Compound	Lattice Energy (kJ/mol)
LiF	–1,036
LiCl	–853
NaF	–923
NaCl	–786
KF	–821
KCl	–715
$CaCl_2$	–2,258

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Ionic Bonding Affects Properties

Lattice [energy] affects the properties of ionic compounds.

- High melting and [boiling] points
- Hard
- Varying solubility
- Low conductivity as [solids]; high conductivity as liquids or in [solution]

Summary | Ionic Bonding

Lesson Question

How do ionic bonds form between atoms?

Answer

(Sample answer) The formation of an ionic bond is a result of the large electronegativity difference between atoms. Due to this, electrons are transferred from metals to nonmetals. The energy that is released due to formation of ionic bonds is known as lattice energy.

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How Ionic Compounds Form

- Ionic bonds form by the transfer of electrons from atoms.
- Metals lose electrons to become cations; nonmetals gain electrons to become anions.
- The resulting cations and anions form the ionic bond as a result of electrostatic attraction, with an electronegativity difference greater than 1.7.
- The formula unit of an ionic compound represents the simplest ratio of ions in the crystal lattice, not in a molecule.
- The atoms in a polyatomic ion are bonded together covalently and the charge is distributed over the entire ion, which acts as *one* ionic unit.

Summary | Ionic Bonding

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Properties of Ionic Compounds

- Lattice energy is the energy released when gas-phase ions combine to form crystals.
- Lattice energy is a measure of bond strength.
- Lattice energy depends on the size and charge of the ions.
- The nature of ionic bonding affects the properties of ionic compounds.
- Ionic compounds tend to be hard, have high boiling and melting points, and a range of solubility.
- Ionic compounds can conduct electricity as liquids or when ions are in water solution.

Use this space to write any questions or thoughts about this lesson.