

Qualitative Analysis and Chemical Bonding

AP[®] Chemistry Big Idea 2, Investigation 6

An Advanced Inquiry Lab

Introduction

Looking for patterns in the properties of solids can help us understand how and why atoms join together to form compounds. What kinds of forces hold atoms together? How do these forces influence the properties of materials? Use your knowledge of the relationship between chemical bonding type and the properties of substances to determine the identity of mystery solids.

Concepts

- Chemical bonds
- Covalent bonding
- Ionic bonding
- Metallic bonding
- Physical and chemical properties
- Electronegativity

Background

Groups of atoms are held together by attractive forces that we call *chemical bonds*. The origin of chemical bonds is reflected in the relationship between force and energy in the physical world. Think about the force of gravity—in order to overcome the force of attraction between an object and the Earth, we have to supply energy. Whether we climb a mountain or throw a ball high into the air, we have to supply energy. Similarly, in order to break a bond between two atoms, energy must be added to the system, usually in the form of heat, light or electricity. The opposite is also true; whenever a bond is formed, energy is released.

The term *ionic bonding* describes attractive forces between oppositely charged ions in an ionic compound. An ionic compound is formed when a metal reacts with a nonmetal to form positively charged cations and negatively charged anions, respectively. The oppositely charged ions are arranged in a tightly packed, extended three-dimensional structure called a crystal lattice (see Figure 1). The net attractive forces between oppositely charged ions in the crystal structure are called ionic bonds.

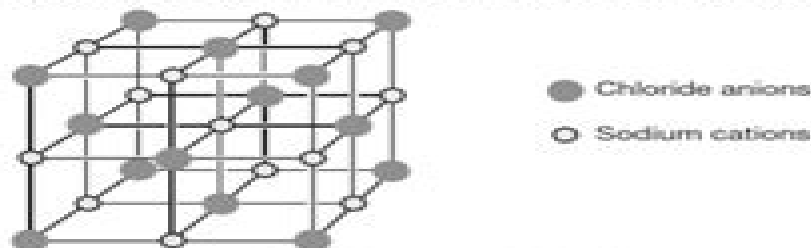


Figure 1. Crystal Structure of Sodium Chloride.

Covalent bonding represents another type of attractive force between atoms. Covalent bonds are defined as the net attractive forces resulting from pairs of electrons that are shared between atoms (the shared electrons are attracted to the nuclei of both atoms in the bond). A group of atoms held together by covalent bonds is called a molecule. Atoms may share one, two or three pairs of electrons between them to form single, double and triple bonds, respectively.

Substances held together by covalent bonds are usually divided into two groups based on whether individual (distinct) molecules exist or not. In a *molecular solid*, individual molecules in the solid state are attracted to each other by relatively weak intermolecular forces between the molecules. *Covalent-network solids*, on the other hand, consist of atoms forming covalent bonds with each other in all directions. The result is an almost infinite network of strong covalent bonds—there are no individual molecules.

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**William L. Masterton, Emil J.
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