

## Solutions and Molecules

A **solvent** is a substance that is capable of dissolving another substance (called a **solute**) into a uniform mixture known as a **solution**. In order for a solvent to be able to accomplish this task it must overcome the forces that bind the solute (the substance being dissolved) together.



Have you ever made bouillon soup? When you make bouillon soup you are dissolving a solute (the bouillon cube) with a solvent (water) to make a solution (bouillon soup).

## Molecular Forces

Molecules are held together by electrostatic attractions called van der Waals forces. However the forces causing molecules to stick together are much weaker than chemical bonds. Chemical bonds are the forces that bind the atoms of a molecule together. Although van der Waals forces are weak they affect the properties of solvents. As you will discover in this lesson, only solvents with van der Waals forces similar to those of the solute will be able to pull the molecules of the solute apart so that it will dissolve.

## Understanding Solvents Affects Human Health



Understanding the properties of solvents is important. Some organic solvents are highly toxic and harmful to human health. In this lesson we will learn how to make decisions about these solvents to help protect human health.

## Solvent Properties:

Solvents have many properties which should all be considered before deciding which solvent to use for a given task, namely:

*Dissolving power*

*Viscosity*

*Evaporation rates*

*Color*

*Odor*

*Toxicity*

*Flammability*

*Environmental Impact*



For purposes of simplicity, this lesson will focus on understanding how to predict the dissolving power of a solvent given the properties of the material to be dissolved (the solute).

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## Factors Affecting Dissolving Power

As mentioned earlier, a solvent's ability to dissolve a solute is dependent upon how similar its electrostatic forces are to those of the solute. There are three component forces that make up these van der Waals forces. These component forces are *dispersion forces*, *polar forces* and *hydrogen bonding forces*.

### Dispersion Forces

Dispersion forces are caused by the temporary attractions generated by the dynamic nature of electron orbits. Because electrons vary their paths as they circle the nucleus, pockets of electrostatic force are created on the surface of a molecule whenever a nucleus is temporarily exposed by the dispersed electrons. **Dispersion forces are size dependent; the larger the molecule, the stronger the bond between molecules.**

### Polar Forces

**Polar forces are dependent upon molecular characteristics such as atomic composition, geometric shape and size.** Some molecules have areas of their surface with a permanent electrostatic force which causes them to attract other molecules. Molecules that display these constant electrostatic attractions are called polar molecules. Polar molecules vary in the strength of their electrostatic forces because molecules vary in the characteristics that generate these forces.

## Hydrogen Bonding Forces

Hydrogen bonding force is a specialized electrostatic force that is usually created by the electrical attraction between the hydrogen of one molecule with the oxygen of another. When the single electron orbiting a hydrogen atom is pulled away by another atom in a molecule, a strong electromagnetic attraction is created by the exposed hydrogen proton. **The hydrogen bonding force of a solvent increases as the number of exposed hydrogen atoms in a molecule increases.**

## Determining Dissolving Power

The properties of solvents vary because the strength and the nature of the component forces binding them together vary. In order to predict whether a solvent will be able to dissolve a solute it is necessary to determine the cumulative effect of the component forces that make up the van der Waals force for that solvent.

