

## What the heck is an intermolecular force, anyway?

There are two main types of forces that can occur in a compound, **intramolecular** forces and **intermolecular** forces:

**Intramolecular** forces are the forces that keep the atoms in a compound stuck to each other - in other words, they're just chemical bonds. For example, if you're looking at a water molecule, the force that holds the hydrogen atoms to the oxygen are intramolecular forces (covalent bonds). Same deal with sodium chloride - the forces that hold the sodium ions to the chloride ions are intramolecular forces (covalent bonds).

**Intermolecular** forces, on the other hand, are the forces that hold two covalent molecules to one another. For example, if we talk about water, the forces that attract one water molecule to another nearby water molecule are intermolecular forces. These aren't chemical bonds like you've talked about before - instead, they're all based on magnetic attractions between different molecules. This attraction is caused by polarity.

### An aside: What's polarity?

Polarity is when a molecule acts like a little magnet. This is because one side of the molecule has more electrons than the other side. An example would be HF: The fluorine is very electronegative, so the electrons that would normally be shared equally between the hydrogen and the fluorine tend to spend more time near the fluorine atom, causing the fluorine atom to have a partial negative charge and the hydrogen atom to have a partial positive charge. Because these partial charges are present in the molecule, it behaves like a little magnet.

## What the heck is each type of intermolecular force and how do they work, anyway?

There are three main types of intermolecular forces. I'll discuss each of them below, starting with the easiest one:

### **1) Dipole-dipole forces:**

In the "aside" above, we discussed polarity. Dipole-dipole forces are simply when two molecules that both behave like little magnets stick to each other. The strength of the dipole-dipole force depends on how polar the molecule is, because the more polar each molecule is, the stronger the magnetic force present. The molecules of every polar compound are stuck to each other by these dipole-dipole forces.

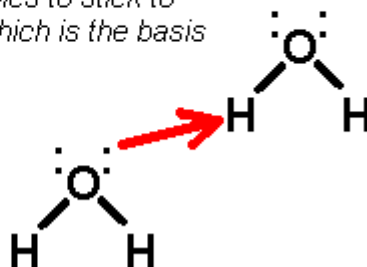
### **2) Hydrogen bonds:**

Hydrogen bonds also take place in polar molecules. However, the molecules that undergo hydrogen bonding all contain a hydrogen atom that's bonded to a nitrogen atom, oxygen atom, or fluorine atom. If there are no H-N, H-O, or H-F bonds, there's no hydrogen bonding.

The big question, of course, is why are hydrogen bonds different than regular dipole-dipole forces? After all, wouldn't a molecule with hydrogen bonding be polar?

Of course it would! In the hydrogen-oxygen bond (or H-N or H-F bonds), the hydrogen is less electronegative than the other atom, causing the electrons in the bond to be pulled away from it. However, in a hydrogen bond, you'll notice that the atoms that hydrogen is bonded to each have lone pairs. Because the oxygen, fluorine, and nitrogen atoms all have these lone pairs, the lone pairs tend to be attracted toward the partial-positively charged hydrogen atoms on nearby molecules. Check out the diagram below:

*The lone pairs on the electronegative oxygen are attracted to the partially-positive hydrogen atom on a different water molecule. This attraction causes the two molecules to stick to each other a little bit, which is the basis for hydrogen bonding.*



Hydrogen bonds are generally much stronger than dipole-dipole forces, because the interaction of the lone pairs with the hydrogen atoms on another molecule are very strong.

### **3) Van der Waals forces:**

Van der Waals forces are when nonpolar molecules stick together due to magnetic attractions.