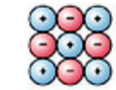
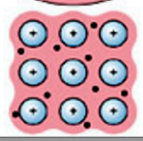
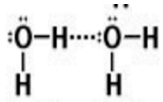
What types of attractive forces hold particles together?

Bonding Forces

Force	Model	Basis of Attraction	Energy (kJ/mol)	Example
Ionic		Cation–anion	400–4000	NaCl
Covalent		Nuclei–shared e⁻ pair	150–1100	H—H
Metallic		Cations–delocalized electrons	75–1000	Fe

Nonbonding (Intermolecular) Forces

Force	Model	Basis of Attraction	Energy (kJ/mol)	Example
Dispersion (London)		Polarizable e⁻ clouds	0.05–40	F–F····F–F
Dipole-dipole		Dipole charges	5–25	I–Cl····I–Cl
H bond		Polar bond to H–dipole charge (high EN of N, O, F)	10–40	

The strength of intermolecular forces for a substance depends on the size, polarity and hydrogen bonding potential of a molecule.

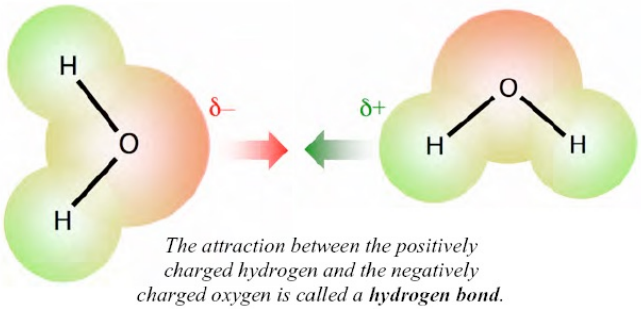
Molecular size: the larger the molecule, the stronger the dispersion forces. The attractive forces that depend on the size of the molecule are referred to as "London dispersion forces". This is the *weakest* attraction between molecules. (The origin of this attractive force can be considered to be momentary instantaneous dipole attractions.)

Molecular polarity: the more polar a molecule, the stronger the dipole-dipole attraction Think about the molecule I-Cl. Due to the difference in electronegativity between I and Cl, the molecule is polar. This molecule will be attracted to neighboring I-Cl molecules.

I—Cl ---→ ←--- **I—Cl**

$\delta+$ $\delta-$ $\delta+$ $\delta-$

Hydrogen-bonding: polar molecules attract one another unusually strongly whenever the positive atom is *hydrogen* and the negative atom is *oxygen or nitrogen*. This attraction is called hydrogen bonding. *Molecules containing O—H and N—H bonds form "hydrogen bonds".* This is the strongest attraction between molecules.



The attraction between the positively charged hydrogen and the negatively charged oxygen is called a ***hydrogen bond.***