

Liquids and Solids

10.1 Intermolecular Forces

Considering the condensed state of matter and the forces among molecules, intermolecular forces.

During phase changes, molecules remain intact. Compare heat of vaporization of water, 40.7 kJ/mol to the O – H bond energy, 934 kJ/mol.

Dipole – Dipole Forces:

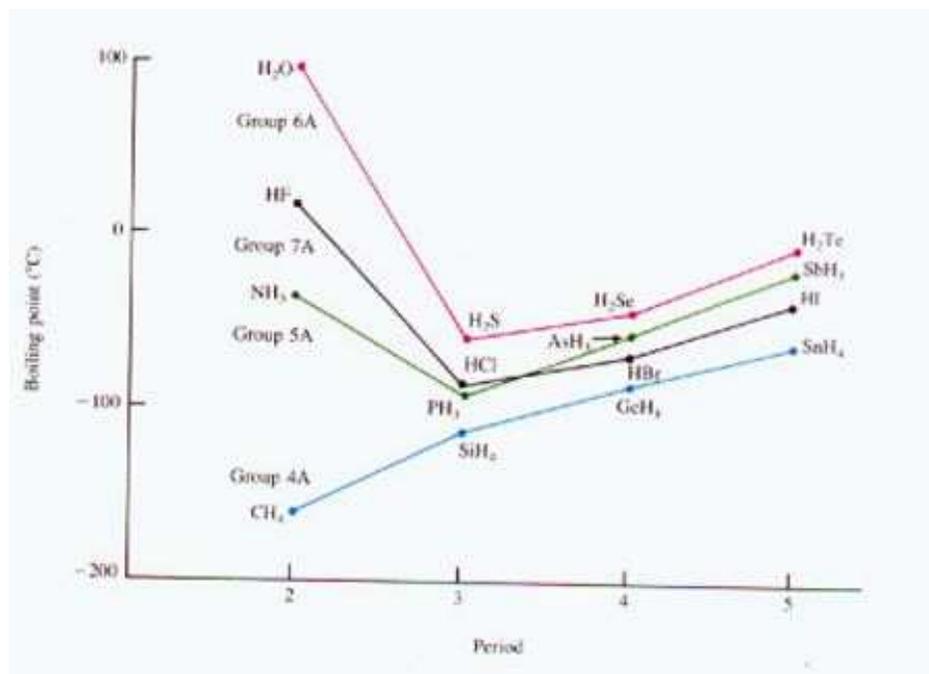
Molecules that behave as if they have a center of positivity and a center of negativity in a magnetic field. Forces are only 1% as strong as a covalent bond and rapidly become weaker as distance increases.

Hydrogen Bonding: Molecules in which H is bonded to a highly electronegative atom such as F, N, or O.

These bonds are highly polar and the H atom is very small. Small size gives close attractions.

These dipole – dipole attractions are extremely strong. See graph below:

Note the increase in boiling point of the compounds with H-bonding



London Dispersion Forces:

What accounts for the interactions of substances that are not polar? Ex. noble gases.

A temporary dipole in one molecule can induce a dipole in another molecule. This non-symmetrical distribution of electrons produces a temporary dipole moment. This instantaneous dipole that accidentally occurs in a molecule can induce a similar dipole on a neighboring atom. These interactions are weak and short lived, but are more significant **for larger atoms** with *more electrons* (greater increased chance of momentary dipole interactions.. More pronounced affects at **lower temperatures**.

Applies to molecules such as: H₂, CO₂, CH₄, etc.

10.2 The Liquid State

Surface Tension: The resistance of a liquid to an increase in its surface area.

Liquids with high intermolecular forces have relatively high surface tensions. Molecules at the surface have an uneven attraction. This tends to pull them into the body of the liquid, and assume the shape of a sphere, minimum surface area.

Capillary Action; polar liquids spontaneously rise in a narrow tube. Cohesive (intermolecular forces) and adhesive (liquid and the container. The container is made of polar bonds). The concave shape of the meniscus is evidence that the adhesive property is stronger than the cohesive properties for water. Hence, Hg shows a convex meniscus.

Viscosity; a measure of the liquid's resistance to flow. Liquids with large intermolecular forces have a high viscosity. Additionally, molecular complexity adds to viscosity due to the nature of molecules to become entangled.

Model: Contains strong intermolecular attractions, yet has significant motion.

10.3-6 Structure and Bonding in Solids (metals and molecules)

Solids can be crystalline (having regular arrangement) or amorphous (considerable disorder, frozen liquids)

10.7 Ionic Solids

Stable, high melting, substances held together by strong electrostatic attractions.

Read Chemical Impact, P.443

Practice P. 475 #10, 12, 29, 30, 31, 32, 33, 34, 35, 36, 37, 40, 110