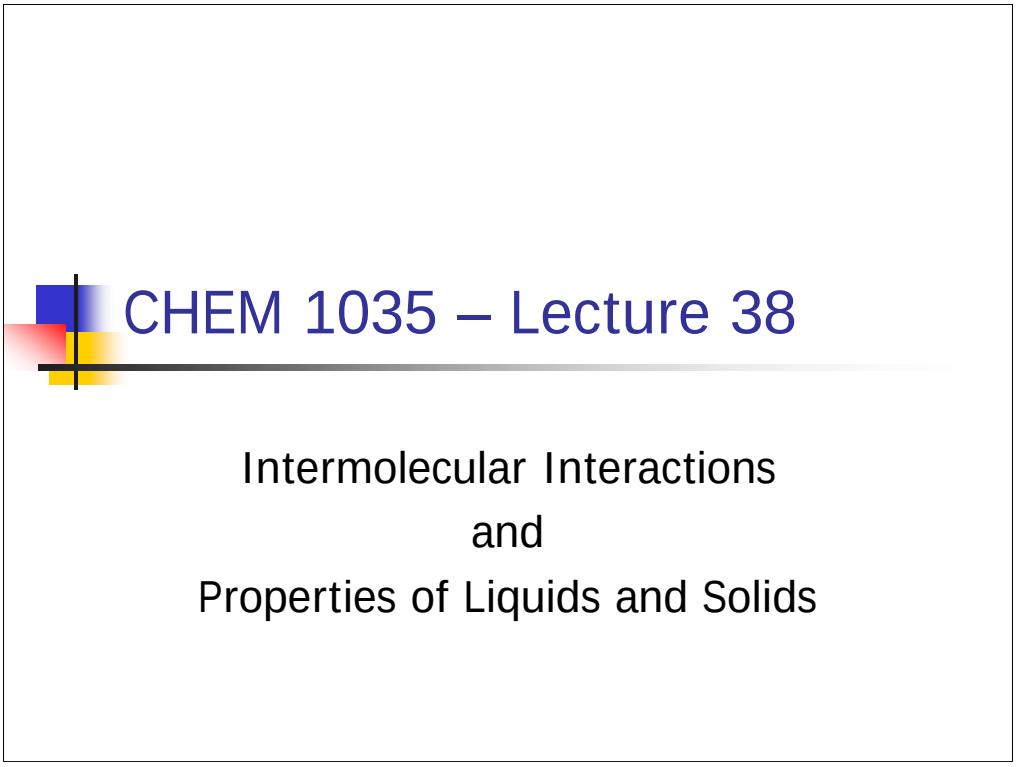


The physical properties of liquids and solids can be explained in part by considering the type and strength of the intermolecular interactions that exist between the molecules.

Dispersion Forces

Although nonpolar covalent bonds share the electrons equally between the atoms, at any one instance in time, the electrons in a covalent bond may induce momentary polarity in the bond by being associated with one atom. When this happens, it can “induce” polarity in bonds of neighboring molecules.

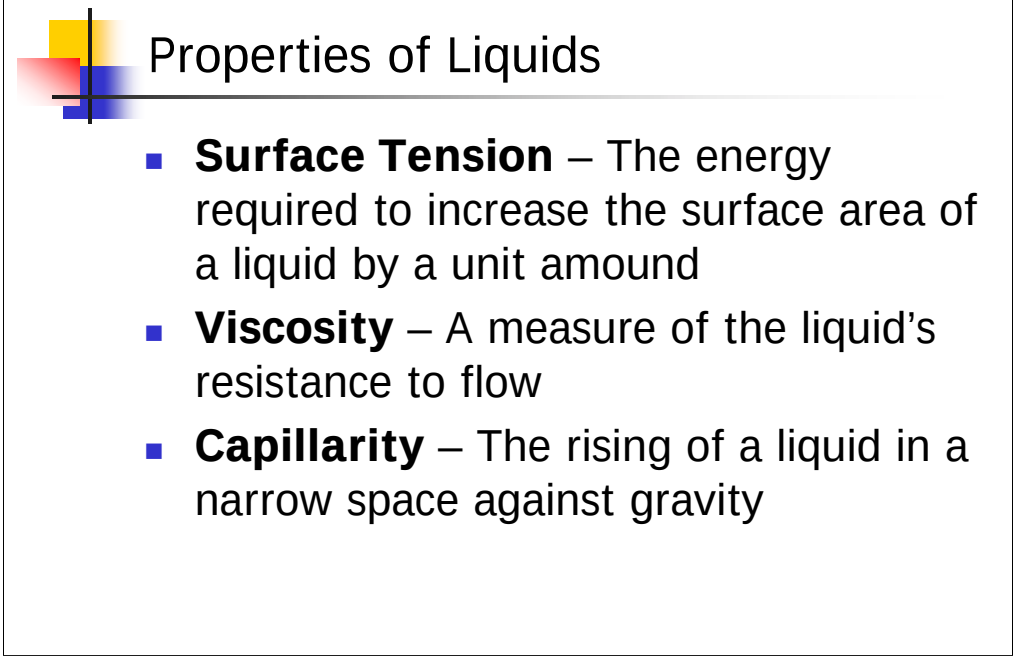
Draw Graphic on board.

All molecules have dispersion forces. Individually these are very weak; however, collectively throughout the entire molecule, they can be reasonably strong.

Strength of Dispersion forces relative to the molecular shape.

Relative Strength of Intermolecular Interactions

- Weakest — Dispersion
  - Dipole-Induced Dipole
  - Ion – Induced Dipole
  - Dipole – Dipole
  - Hydrogen Bond – Dipole
- Strongest — Ion Dipole



The type and strength of the intermolecular between molecules leads to the observed physical properties of the material.

For a liquid:

Surface Tension – the force that acts on molecules that draws the molecules at the surface of a liquid into the bulk. This is the reason that most liquids form spheres when isolated in space. The molecules try to maximize their association with the bulk and mimimize their association with the the adjacent phase

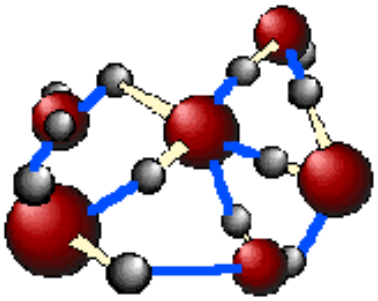
Viscosity – the resistance of a liquid to flow, e.g. the ability of molecules in the liquid phase to "slip" past each other. The stronger the intermolecular interactions between molecules of a liquid, the larger the viscosity. Consider maple syrup – it has a high viscosity. When heated, what happens to its viscosity? Why?

Capillarity – The rising of a liquid through a narrow space against the pull of gravity. This occurs with the walls of the narrow space have favorable intermolecular interactions with the molecules of the liquid.

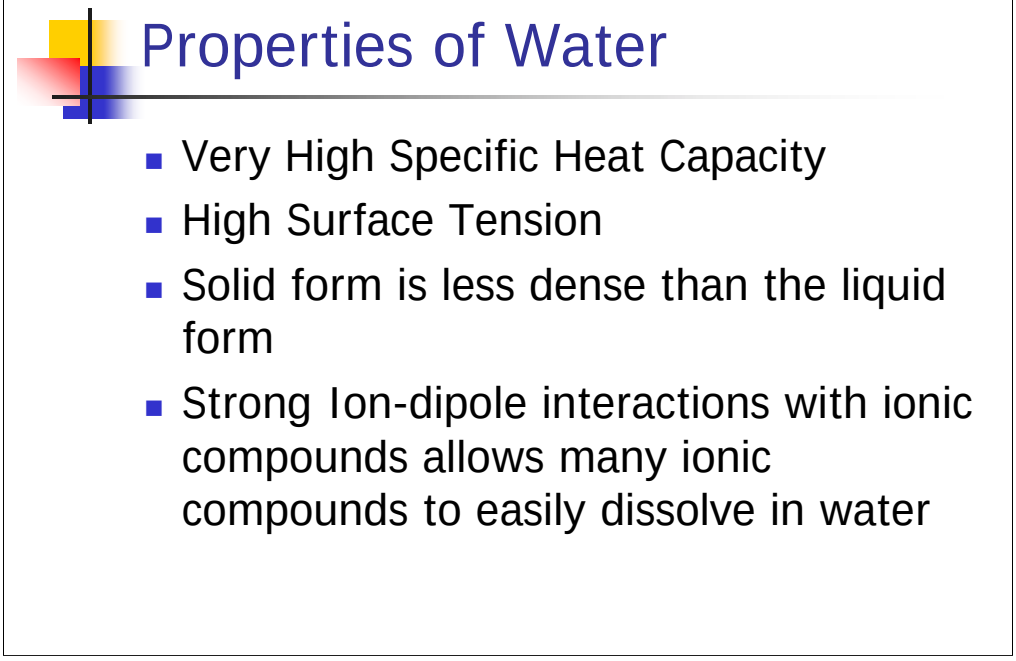
Each of these properties of all liquids are functions of the intermolecular forces that exist between the molecules of compounds in the liquid phase.

Water

Water is a very unique compound that has interesting chemical and physical properties.



Look at the Lewis structure of Water. What is the VSEPR structure? What type of intermolecular interactions does it have? Hydrogen bonding. Interestingly, each molecule of water has the ability to have 2 donor hydrogen bonds, and 2 acceptor hydrogen bonds. This affords the opportunity to form an extended “lattice” of water.



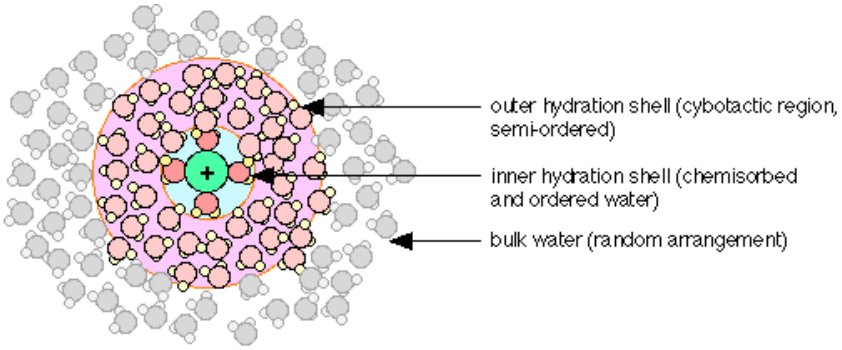
Specific heat capacity – the ability to absorb heat. Water can absorb a lot of heat.

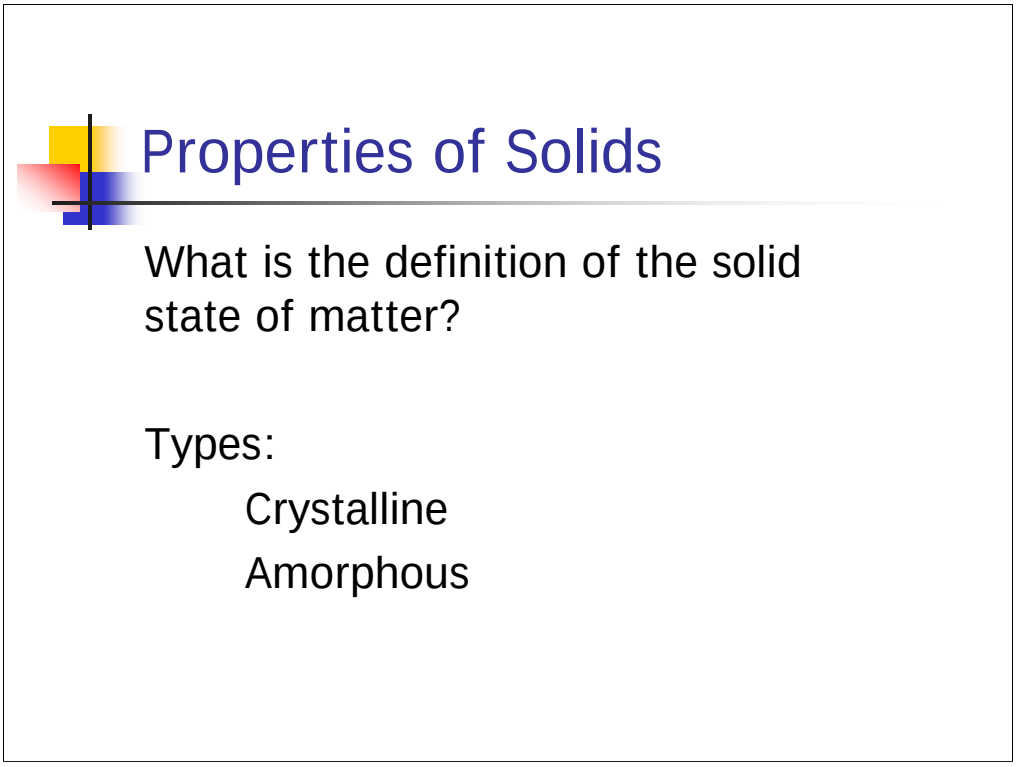
High surface tension – why? Strong intermolecular interactions (4 H-bonds per molecule)

Experiment, Place ice cubes into beaker of water. They float, why?

Solid is less dense than the liquid.

Ion-Solvation by water





Solids are substances that have fixed shape and do not assume the shape of their container.

What are some solids that we have considered previously? Ionic compounds and metals. In the case of these solids, as well as covalent solids, there are strong attraction between the entities that make up the solid. In the case of covalent solids, the attraction between molecules are the intermolecular interactions.

If solids have fixed shape, that suggests that individual molecules of the solid have a shape relation to each other. We consider 2 types of covalent solids, defined by how the particles of the solid arrange/pack in the solid: Crystalline and amorphous

Crystalline – solids which have a defined spatial arrangement of the molecules with respect to each other.

Amorphous – solids which have no spatial relationship between the molecules that make the solid.

Crystalline solids

- Simple Cubic : solids in which the molecules are at the corners of a cube.
- Body-centered cubic : simple cubic with a particle in the center of the unit cell
- Face-centered cubic : simple cubic with a particle in the face (side) of each cube.

Definitions:

Crystal Lattice – the regular arrangement of the molecules in the solid

Unit cell – smallest unit that, if repeated in all directions, results in the crystal

Coordination number – the number of nearest neighbors to any member of the crystal lattice

Simple cube – coordination number=6

BCC – coordination number=8

FCC – coordination number=12