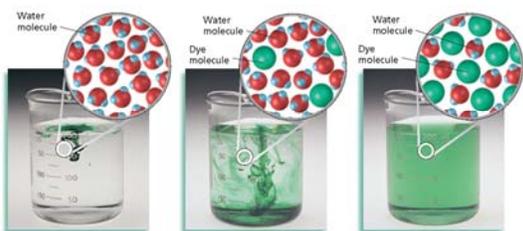


Properties of Liquids

- The attraction between liquid particles is caused by the intermolecular forces:
 - ✓ London dispersion forces
 - ✓ dipole-dipole forces
 - ✓ hydrogen bonding
- The particles are not bound in fixed positions; they move about constantly
- **Relatively High Density**
- **Relative Incompressibility**

Ability to Diffuse



Like gases, the two liquids in this beaker diffuse over time. The green liquid food coloring from the drop will eventually form a uniform solution with the water.

Surface Tension

- A force that pulls adjacent parts of a liquid's surface together, decreasing surface area to the smallest possible size.
- The higher the force of attraction between the particles of a liquid, the higher the surface tension

Capillary Action

- Attraction of the surface of a liquid to the surface of a solid
- This attraction tends to pull the liquid molecules upward along the surface and against the pull of gravity.
- Responsible for the concave liquid surface, called a **meniscus**, that forms in a test tube or graduated cylinder.

Properties of a Solid

- Attractive forces tend to hold the particles of a solid in relatively fixed positions.

There are two types of solids:

1. **Crystalline solids**- particles are arranged in an orderly, geometric, repeating pattern.
2. **Amorphous solids** - particles are arranged randomly; have no definite melting point
Sometimes called **supercooled liquids** (retain certain liquid properties even at temperatures at which they appear to be solid)

Solids

- Definite Shape and Volume
- High Density and Incompressibility
- Low Rate of Diffusion

Binding Forces in Crystals

1. *Ionic crystals*: + and - ions arranged in a regular pattern.
2. *Covalent network crystals*: covalently bonded atoms
3. *Metallic crystals*: metal cations surrounded by a sea of electrons.
4. *Covalent molecular crystals*: covalently bonded molecules held together by intermolecular forces.

Phase Changes (change of state)

- A **phase** has uniform composition and properties
- **Equilibrium** is a condition in which two opposing changes occur at equal rates in a closed system; a balance
- **LeChatelier's Principle**: When a system at equilibrium is disturbed, it will shift to minimize the stress applied and form a new equilibrium position

Six Possible Phase Changes

- solid → liquid = melting
- liquid → solid = freezing
- liquid → gas = vaporization
- gas → liquid = condensation
- solid → gas = sublimation
- gas → solid = deposition

Phase changes need either the absorption of energy or release of energy to occur.

Heat is the transfer of energy from an object at a higher temperature to an object at lower temperature.

Endothermic process: absorbs energy
(vaporization, melting, sublimation)

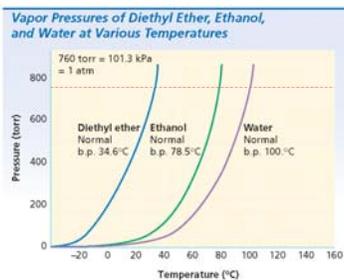
Exothermic process: release of energy
(condensation, freezing, deposition)

Vaporization

- **Evaporation** only occurs at the surface of a liquid.
- **Volatile liquids** are liquids that evaporate readily.
- **Boiling** is the conversion of a liquid to a vapor *within* the liquid as well as at its surface.
- **Boiling point:** the temperature at which the vapor pressure of the liquid equals the atmospheric pressure.

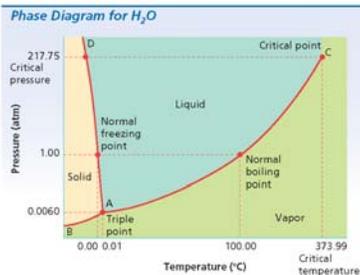
The *normal* boiling point of a liquid is the boiling point at normal atmospheric pressure (1 atm, 760 torr, or 101.3 kPa).

For example: The *normal* boiling point of water is exactly 100°C.



Phase Diagrams

- A graph of pressure versus temperature that shows the conditions under which the phases of a substance exist.



- **triple point:** the temperature and pressure at which all three phases can coexist at equilibrium.
- **critical point:** the critical temperature and critical pressure above which a substance cannot exist as a liquid.
- Above the **critical temperature** water cannot be liquefied, no matter how much pressure is applied.

