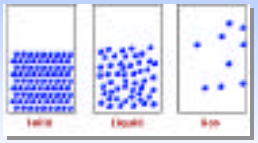
1

Liquids

Section 13.3



In a liquid

- molecules are in constant motion
- there are appreciable intermolec. forces
- molecules close together
- Liquids are almost incompressible
- Liquids do not fill the container

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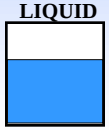
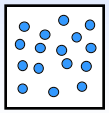
Liquids

Section 13.3

The two key properties we need to describe are **EVAPORATION** and its opposite—**CONDENSATION**

evaporation--->

LIQUID  VAPOR 

Add energy
break IM bonds

make IM bonds
Remove energy

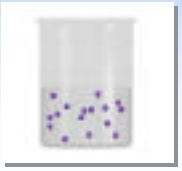
<---condensation

3

Liquids

Section 13.3

To evaporate, molecules must have sufficient energy to break IM forces.



Breaking IM forces requires energy. The process of evaporation is **endothermic**.

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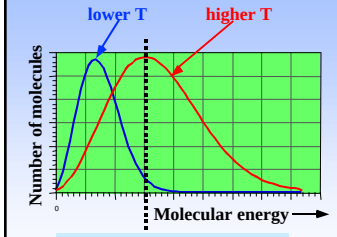
Liquids



Minimum energy req'd to break IM forces and evaporate

Distribution of molecular energies in a liquid.

KE is proportional to T.

See Figure 13.17

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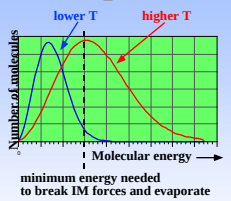
Liquids



At higher T a much larger number of molecules has high enough energy to break IM forces and move from liquid to vapor state.

High E molecules carry away E. You cool down when sweating or after swimming.

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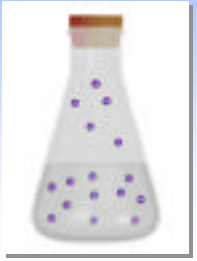
When molecules of liquid are in the vapor state, they exert a **VAPOR PRESSURE**

EQUILIBRIUM VAPOR PRESSURE is the pressure exerted by a vapor over a liquid in a closed container when the rate of evaporation = the rate of condensation.

See Fig. 13.18

Liquids

Section 13.3



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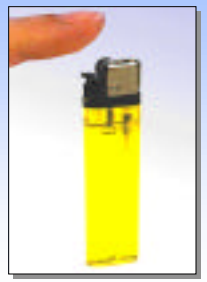
Vapor Pressure

CD, Screen 13.9



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Liquids

FIGURE 13.19 shows VP as a function of T.

1. The curves show all conditions of P and T where LIQ and VAP are in EQUILIBRIUM
2. The VP rises with T.
3. When VP = external P, the liquid boils.

This means that BP's of liquids change with altitude.

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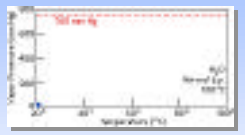
Boiling Liquids



Liquid boils when its vapor pressure equals atmospheric pressure.

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Boiling Point at Lower Pressure

When pressure is lowered, the vapor pressure can equal the external pressure at a lower temperature.

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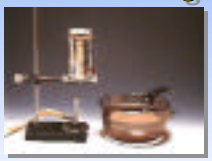
Consequences of Vapor Pressure Changes



When can cools, vp of water drops. Pressure in the can is less than that of atmosphere, so can is crushed.

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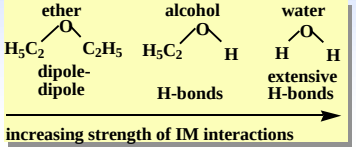
Liquids

Section 13.3

FIGURE 13.19 shows VP as a function of T.

4. If external P = 760 mm Hg, T of boiling is the NORMAL BOILING POINT
5. VP of a given molecule at a given T depends on IM forces. Here the VP's are in the order



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Liquids

Section 13.3

HEAT OF VAPORIZATION is the heat req'd (at constant P) to vaporize the liquid.

LIQ + heat ---> VAP

Compd.	ΔH_{vap} (kJ/mol)	IM Force
H_2O	40.7 (100 °C)	H-bonds
SO_2	26.8 (-47 °C)	dipole
Xe	12.6 (-107 °C)	induced dipole

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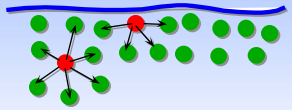
Liquids

Section 13.3

Molecules at surface behave differently than those in the interior.



Molecules at surface experience net INWARD force of attraction.
This leads to **SURFACE TENSION** — the energy req'd to break the surface.

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Surface Tension

Section 13.3

SURFACE TENSION also leads to spherical liquid droplets.

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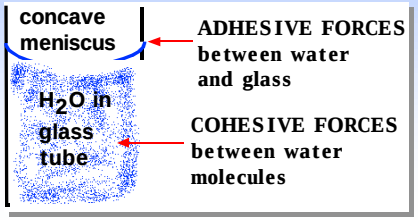
Liquids

Section 13.3

Intermolec. forces also lead to **CAPILLARY** action and to the existence of a concave meniscus for a water column.



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Capillary Action

Movement of water up a piece of paper depends on H-bonds between H_2O and the OH groups of the cellulose in the paper.