STATES OF MATTER

Lecture 2
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Physical pharmacy
The liquid state

Liquefaction of gases

- When gas is cooled, it loses some of its kinetic energy in the form of heat, and the velocity of the molecules decreases.
- If pressure is applied to the gas, the molecules are brought within the sphere of the van der Waals interaction forces and pass into the liquid state.
- The transition from gas to a liquid and from a liquid to a solid depend not only on the temperature but also on the pressure.
If the temperature is elevated sufficiently, a value is reached above which it is impossible to liquefy a gas irrespective of the pressure applied. This temperature, above which a liquid no longer exist, is known as the critical temperature.

The pressure required to liquefy a gas at its critical temperature is the critical pressure.

The further the gas is cooled below its critical pressure, the less pressure is required to liquefy it.

The critical temperature of water is 374°C or 647K, and its critical pressure is 218 atm whereas for helium are 5.2 K and 2.26 atm.
The critical temperature serves as a rough measure of the attractive forces between molecules because at temperature above the critical value, the molecules possess sufficient kinetic energy so no amount of pressure can bring them within the range of attractive forces that cause the atoms or molecules to stick together.

The high critical value of water results from the strong dipolar forces between molecule and particularly the hydrogen bonding that exist, conversely only London forces attracts helium molecules.
Aerosols

Gases can be liquefied under high pressures in a closed chamber as long as the chamber is maintained below the critical temperature. When the pressure is reduced, the molecules expand and the liquid reverts to a gas.

This reversible change of state is the basic principle involved in the preparation of pharmaceutical aerosols.
In such products, a drug is dissolved or suspended in a propellant, a material that is liquid under the pressure conditions existing inside the container but that forms a gas under normal atmospheric conditions. The container is so designed that, by depressing a valve, some of the drug–propellant mixture is expelled owing to the excess pressure inside the container. If the drug is nonvolatile, it forms a fine spray as it leaves the valve orifice; at the same time, the liquid propellant vaporizes off.
VAPOR PRESSURE OF LIQUIDS

- Evaporation is the name of the process by which a liquid becomes a gas.
- Evaporation takes place from the surface of the liquid.
- If we place a liquid in a sealed container with some empty space above the liquid initially there will be no vapor or gas above that liquid.
- The molecules on the surface of the liquid with sufficient energy will leave the liquid and enter the gas phase (forming a vapor above the liquid)
This vapor exert a pressure on the surface of the liquid, i.e., the vapor pressure.

And some molecules will return to the liquid state or condense.

When the rate of condensation equal the rate of evaporization we say the system at equilibrium.

The equilibrium vapor pressure is the vapor pressure measured when a dynamic equilibrium between condensation and evaporation.