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 vander 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 2.26atm.

- 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.