SCH 3U

KINETIC MOLECULAR THEORY

PROPERTIES of SOLIDS, LIQUIDS & GASES

PROPERTY	SOLIDS	LIQUIDS	GASES
compression	no	no	yes
shape	definite shape - crystal lattice	bottom of container; particles slip past others (ie. flow)	fills container; little attraction between particles
particle motion	vibrational	vibrational & rotational	vibrational; rotational & translational

FORCES between PARTICLES

- Strength of solids >>> gases

Strength depends on...

① **TEMPERATURE (kinetic energy or motion)**

② **TYPES OF FORCES:**

(a) ***IONIC***

- Electrostatic attraction between oppositely charged ions
- Very strong, high mp and high bp
- Eg. NaCl
- Usually solids

(b) POLAR COVALENT MOLECULES

- Intermolecular force (dipole-dipole attractions)
- Weaker attractions; therefore, lower mp and bp
- Eg. H_2O
- Eg. CH_3CH_2OH & CH_3COOH
- Usually liquids & solids

(c) NON-POLAR COVALENT MOLECULES

- Temporary dipoles (dispersion forces)
- Very weak attractions
- Gases for small molecules; Eg. CO_2, O_2
- As size increases, bp increases; therefore, larger molecules are liquid at 20°C
- Eg. C_8H_{18} (octane in fuel)
- Larger molecules form more temporary dipoles.

KINETIC MOLECULAR THEORY (KMT) -- assumptions of an IDEAL GAS

① Gases consist of an extremely large number of very tiny particles moving in constant and random motion.

② Gases have a very small volume.
- The contribution of a gas to the total volume can be ignored.

③ Gases have no electrostatic attractions (neither attract nor repel) between molecules.
- They move in straight line paths and collide in perfectly elastic collisions with themselves and with the walls of the container.

REAL GASES – "the truth"

① Have volume.

② Experience electrostatic attractions.

Pressure is the sum of all the forces of all the gas molecules colliding with a surface. Therefore, the more collisions, the higher the pressure.

GAS PROPERTIES – EXPLAINED BY KMT

① **LOW DENSITY –** molecules are moving at high speed and not held back by electrostatic attractions, so they spread out. And because gases have small volume as well as being spread out, they have low density.

② **COMPRESSIBILITY** – molecules have space between them, thus can be compressed unlike liquids and solids where there is little space between the molecules.

③ **EXPANSION** – molecules moving at high speed will spread out if given opportunity.

④ **DIFFUSION** – molecules are moving at a high rate of speed, they will spread out.
EG. perfume diffusing through air

⑤ **EFFUSION** – molecules moving at a high speed will eventually "collide" with a hole and escape EG. air escaping through a hole in balloon.

APPLICATIONS

① OXYGEN

Compressed Oxygen

- Hyperbaric oxygen chambers used to treat cerebral palsy, etc.
- High [O_2] cause blood vessels to constrict and lowers swelling
- At 3X normal level, forces pure oxygen into the lungs
- Increased dissolved O_2 in blood reaches injured tissue 15X faster
- Inflates alveoli of premature babies and increases chances of survival

At High Altitudes

- Commercial jets flying up to 9 km carry pressurized oxygen
- Mountain climbers in altitudes of 8 km above sea level

Combustion

- The more oxygen available, the hotter a fire will burn
- Pressurized oxygen used in manufacture of steel
- Fuel cells burn hydrogen and oxygen gas leaving water as a by-product

② NITROGEN

Uses

- Coffee is packaged in a nitrogen-enhanced container (oxidized coffee is bitter)
- Quick-freezing (b.p. 77 K) used to preserve food, resulting in less cell damage, decrease in weight and size
- Cryosurgery uses $N_{2(l)}$ as a preliminary procedure in removing warts, tumours etc.

At Low Depths

- Nitrogen narcosis may develop in scuba divers at 40-60 m
- Each 10 m of depth adds an additional pressure of 1 atmosphere (101.3 kPa)
- Diver must inhale air at the same pressure as the surroundings
- As depth increases the volume of gases inhaled increases
- Increased nitrogen leads to giddiness, disorientation and even panic
- If diver rises to the surface too quickly, gases come out of blood solution, form bubbles and block vessels → "the bends"