Force and Pressure

7.1 Pressure

Pressure is the force per unit area.

$$\text{Pressure}=\frac{Force(N)}{Area\ (\ \ m^{\ 2})}$$

S.I unit for pressure is N/m^2 or Nm^{-2}
A pascal is the pressure developed when a force of 1N acts on an area of $1m^2$.
The smaller the area, the bigger the pressure.
For example: If you poke your skin with a pen tip, it will hurt more than if you try to poke it with a bottle cap. This is because the pen tip has less area than the bottle cap.

Pressure in liquids

Pressure= Density x Depth x Acceleration due to gravity
P= hρg

Whereby:
P is the pressure
h is the depth
$\rho(rho)$ is the density
g is the acceleration due to gravity

- The more the depth, the more the pressure.
- The more the density, the more the pressure.
- The pressure is more vertical because it has more depth than horizontal.

The S.I. unit to use for pressure in liquids is *Pascals (Pa)*.

7.2 Atmospheric Pressure

Atmospheric pressure is the pressure exerted by the Earth's atmosphere at any given point.

Variation with altitude:

- Atmospheric pressure decreases as the altitude increases. The higher you go in the atmosphere, the lesser the air you get above. The atmospheric pressure is low at higher altitudes.

Atmospheric pressure is measured using a device called a **Barometer.** The reading on a barometer is often referred to as *barometric pressure*.

7.3 Buoyancy

Buoyancy is the upward force exerted by a fluid on an object placed in it.
The buoyant force is equal to the weight of the fluid displaced by the submerged object.

- If the weight of the object is less than the buoyant force, the object will float, if the weight of the object is greater, the object will sink.
- If an object has a greater density than the density of the fluid, the object will sink. If the object's density is lesser than the density of the fluid, the object will float.

For example: Hot air balloons utilize the principle of buoyancy to rise. The air inside the balloon is heated, making it less dense than the surrounding air, causing the balloon to float.

- Even if two objects have the same mass, the one with greater volume will generally be more buoyant.

7.4 Gas Laws

There are three gas laws:
1. Boyle's Law
2. Charle's Law
3. Pressure Law

Boyle's Law

Boyle's Law states that
The volume of a fixed mass of a gas is inversely proportional to the pressure at a constant temperature.

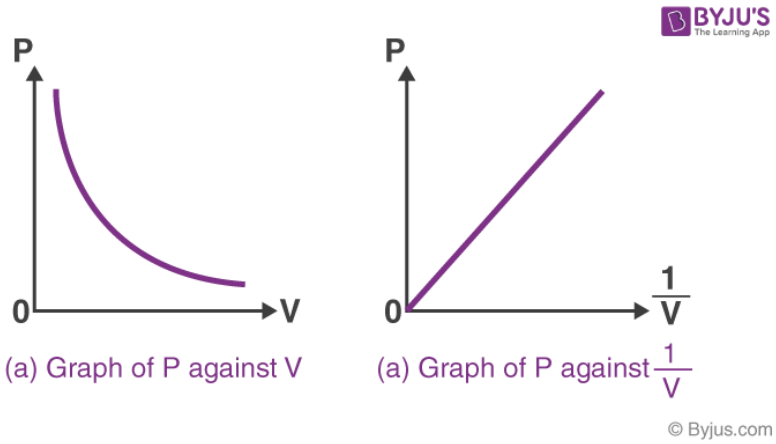
$$P \propto 1/V$$

$$P_1V_1 = P_2V_2$$

Kinetic Theory

- When molecules are placed in a container and since they always move in a random motion, they collide with the wall of the container and also between themselves and every time they exert force, pressure is generated.
- When the volume of the container is reduced, the rate at which the molecules hit the walls of the container increases and so the pressure increases. When the volume of the container is increased, the rate at which the molecules hit the walls of the container reduces and so the pressure decreases.

Variation of Pressure and Volume



Charle's Law

Charle's Law states that
The volume of a fixed mass of a gas at constant pressure is directly proportional to its absolute temperature.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

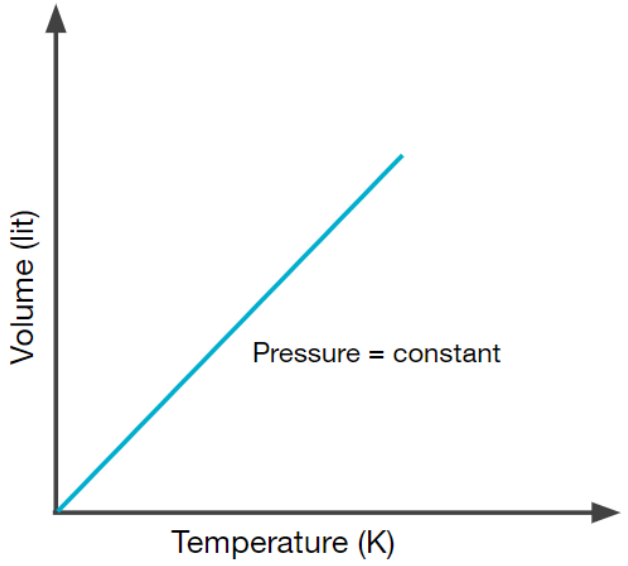
$$T \propto V$$

Note: Temperature must be expressed in Kelvin (K)

Kinetic Theory

- When temperature increases, the kinetic energy of the molecules move far from one another occupying a bigger space hence increasing the volume.

Variation of Pressure and Volume



Credit: Byjus.com

Pressure Law

Pressure Law states that
The pressure of a fixed mass of a gas at constant volume is directly proportional to its absolute temperature.

$$P \propto T$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Kinetic theory:

- As the temperature increases, the kinetic energy of the gas molecules increases, causing them to move rapidly causing them to collide with the walls of the container exerting force on the walls of the container causing an increase in pressure.