SAFALTA CLASS™

An Initiative by अमर उजाला

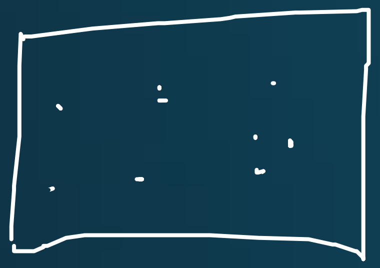
- Touching a stove and being burned → Conduction
- Ice cooling down your hand → conduction
- Boiling water by thrusting a red-hot piece of iron into it
  ↳ conduction
- Hot air rising, cooling, and falling (convection currents)
- An old-fashioned radiator (creates a convection cell in a room by emitting warm air at the top and drawing in cool air at the bottom). ⇒ Convection

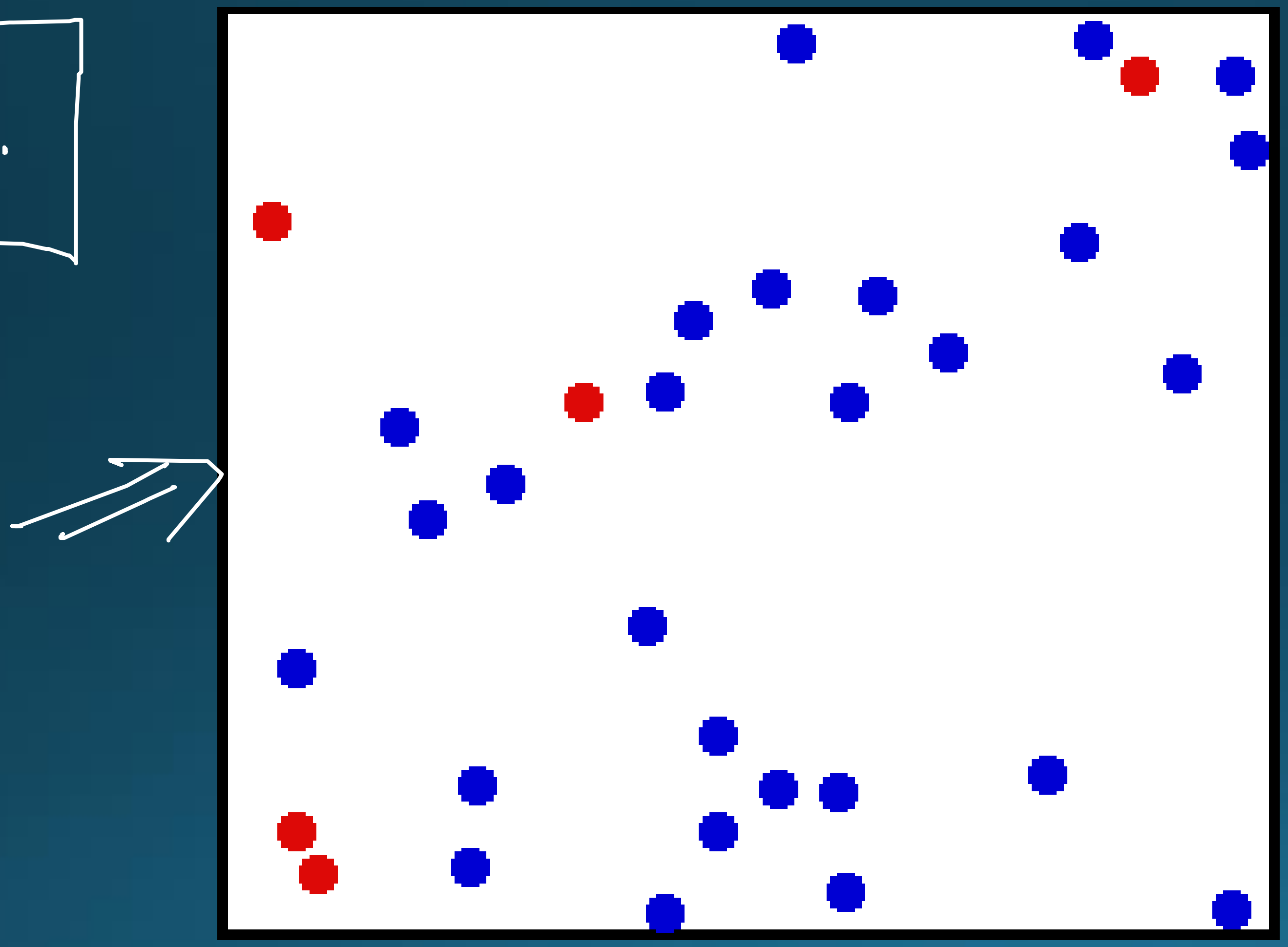
- Heat from the sun warming your face → Radiation
- Heat from a lightbulb → Radiation
- Heat from a fire
- Heat from anything else which is warmer than its surroundings.

Radiation

K. T. G.

⇒ Kinetic Theory of Gases





Imagination IDEAL GAS (आदर्श गैस) →

⇒ No Gas in universe is ideal.

⇒ Real Gases :- O_2, N_2, He . . . .

⇒ The Gas is called ideal which Follows
- Boyle's Law
- Charles Law
- Avogadro Law | hypothesis.

* Ideal Gas Equation:- आदर्श गैस समीकरण :-

$$PV = nRT$$

$P \rightarrow$ Pressure

$V \Rightarrow$ Volume

$n \Rightarrow$ no. of moles

$R \Rightarrow$ Universal Gas Constant

$T \Rightarrow$ Temp.

$$R = \frac{1}{12} \simeq 0.082 \ \frac{\text{atm-lit}}{\text{mol-Kelvin}}$$

$$R = 2 \ \text{cal/mol-K}$$

$$R = 8.3 \ \text{J/mol-K}$$

BOYLE'S LAW

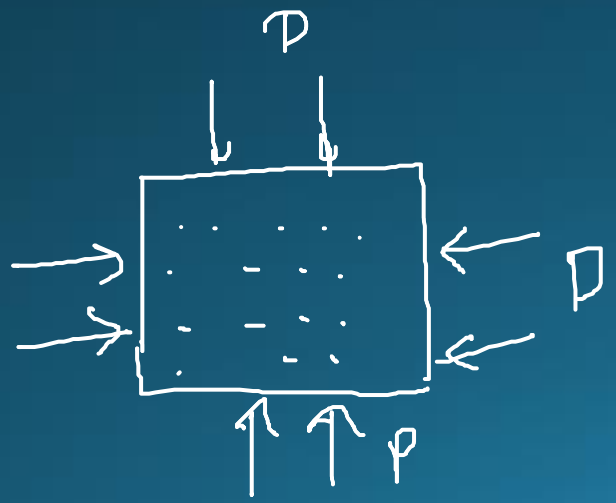
* At constant Temp:- Pressure $\propto \frac{1}{\text{Volume}}$ of ideal Gas.

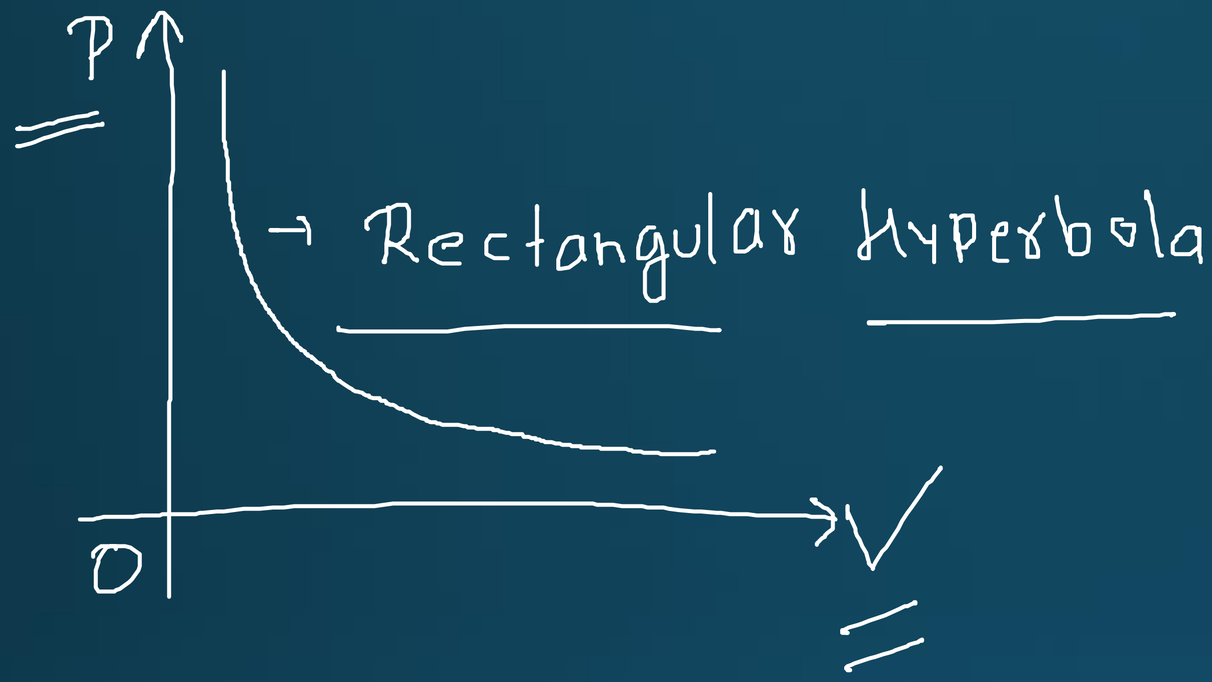
⇒ $PV = nRT$

$PV = \text{constant}$ ⇒ $P_1 V_1 = P_2 V_2 = P_3 V_3$

$= \text{Constant}$

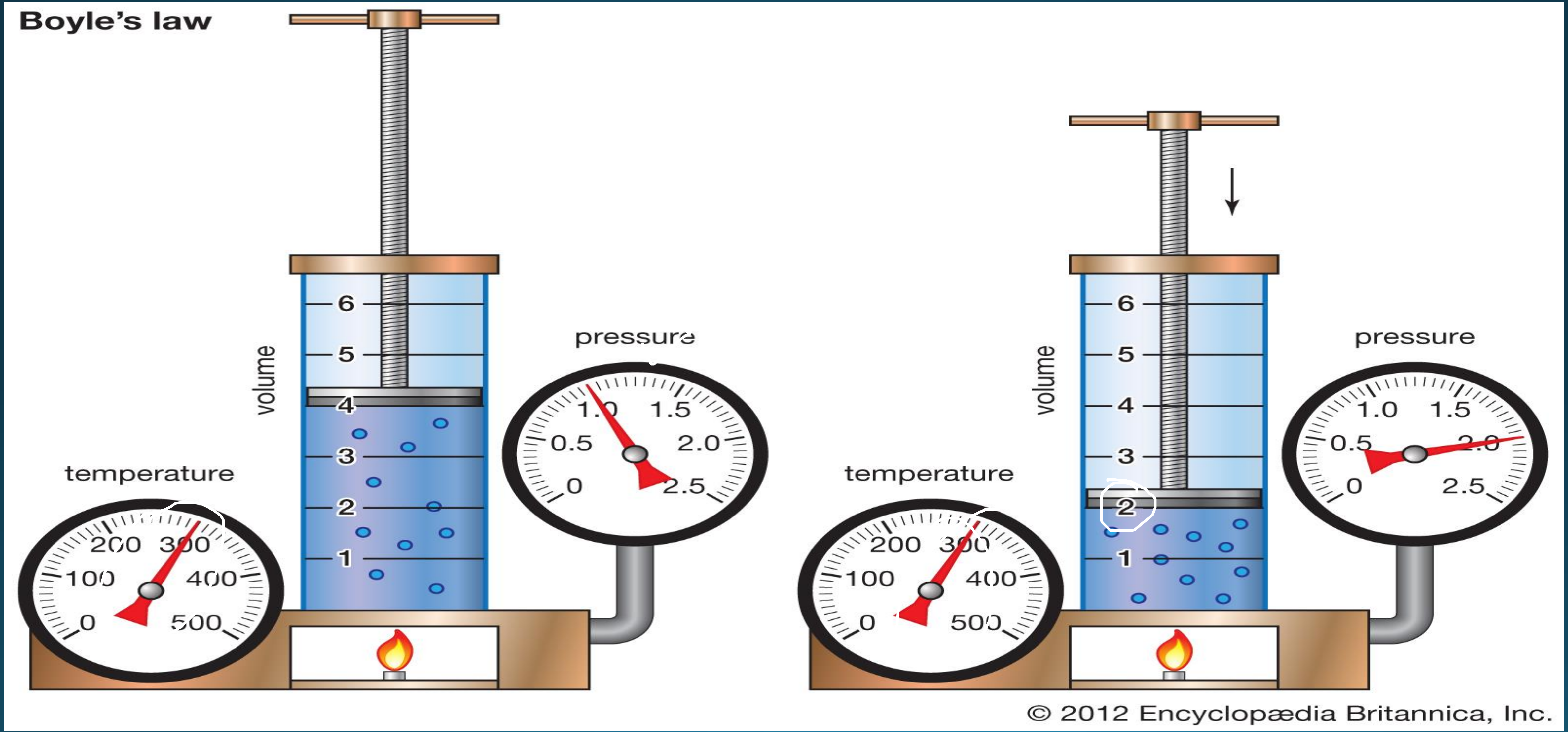
$$P \propto \frac{1}{V}$$



⇒ 

Graph

Relation b/w P & V at Constant Temp.


Boyle's law
volume
6
5
4
3
2
1
pressure
0
0.5
1.0
1.5
2.0
2.5
temperature
0
100
200
300
400
500
© 2012 Encyclopædia Britannica, Inc.

CHARLE'S LAW

⇒ At constant Pressure:- $V \propto T$

Volume & Temp.

⇒ $PV = nRT$

$V = \frac{nRT}{P}$ ⇒ $V \propto T$ ⇒ $V_1 \propto T_1$

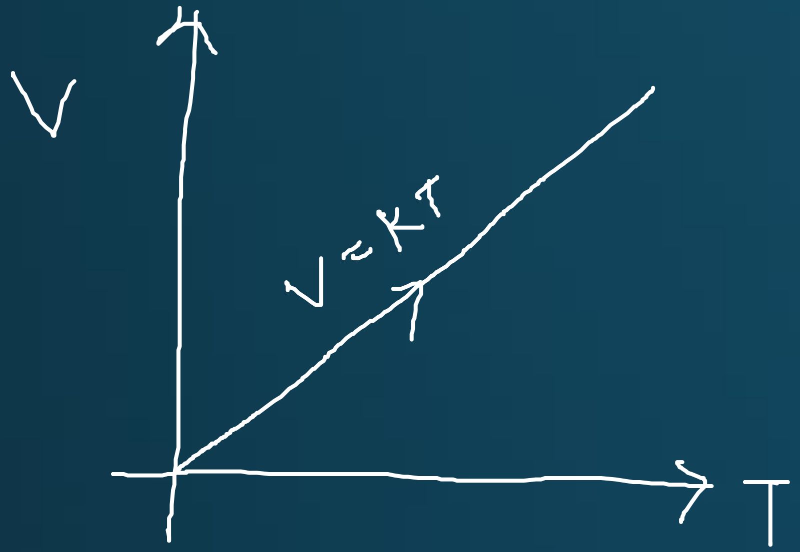
$V_2 \propto T_2$

⇒ $\frac{V_1 = kT_1}{V_2 = kT_2}$ ⇒ $\frac{V_1}{V_2} = \frac{T_1}{T_2}$ or

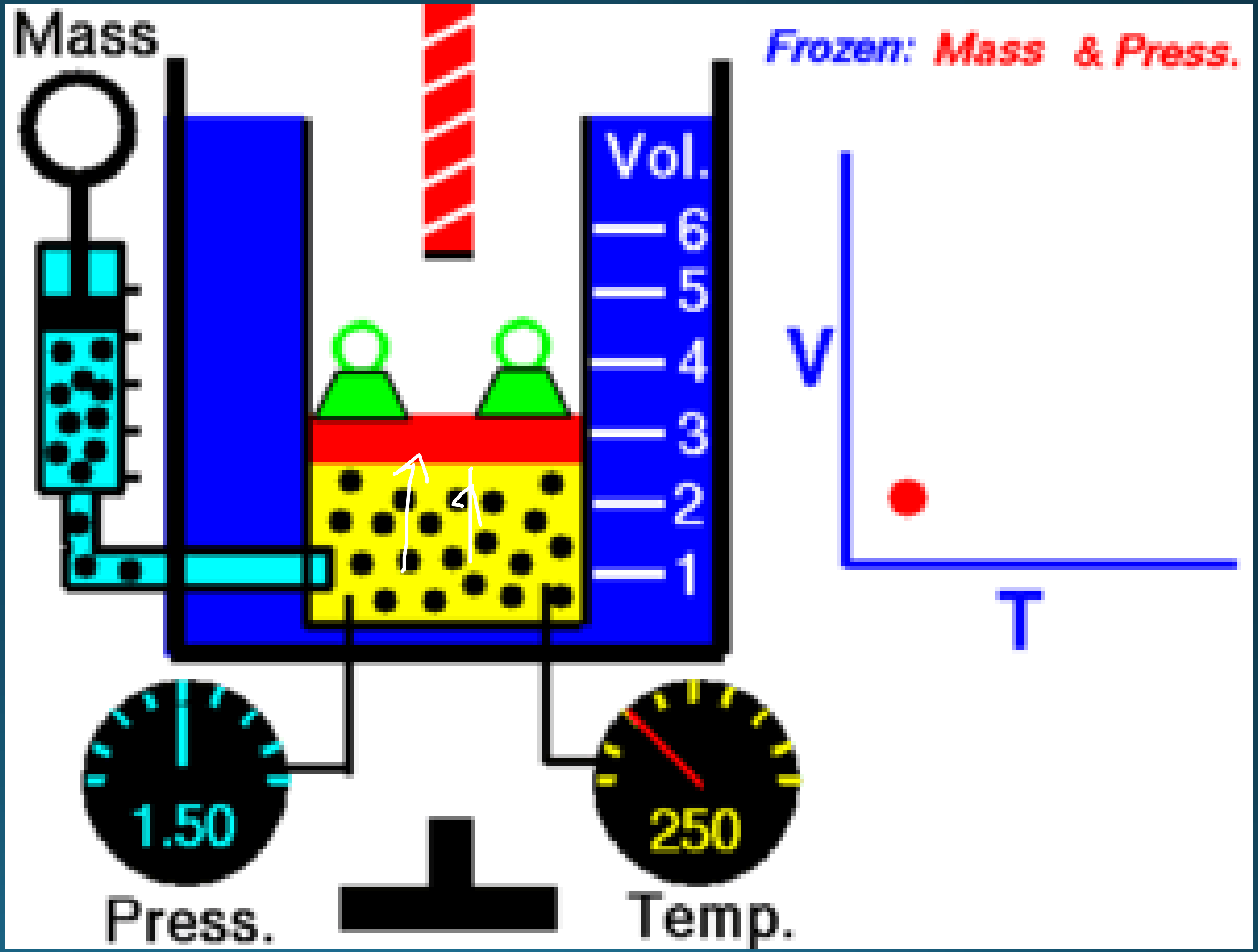
$V_1 = 100$

$V_2 = 500$

$T_1 = ?$ $T_2 = 10°C$ ⇒ $T_1 = 2°C$ ⇒ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$



Graph:


Mass
Frozen: Mass & Press.
Vol.
6
5
4
3
2
1
V
T
1.50
Press.
250
Temp.

AVOGADRO HYPOTHESIS

⇒ At Constant :- Pressure & Temp

Volume $\propto$ no. of moles

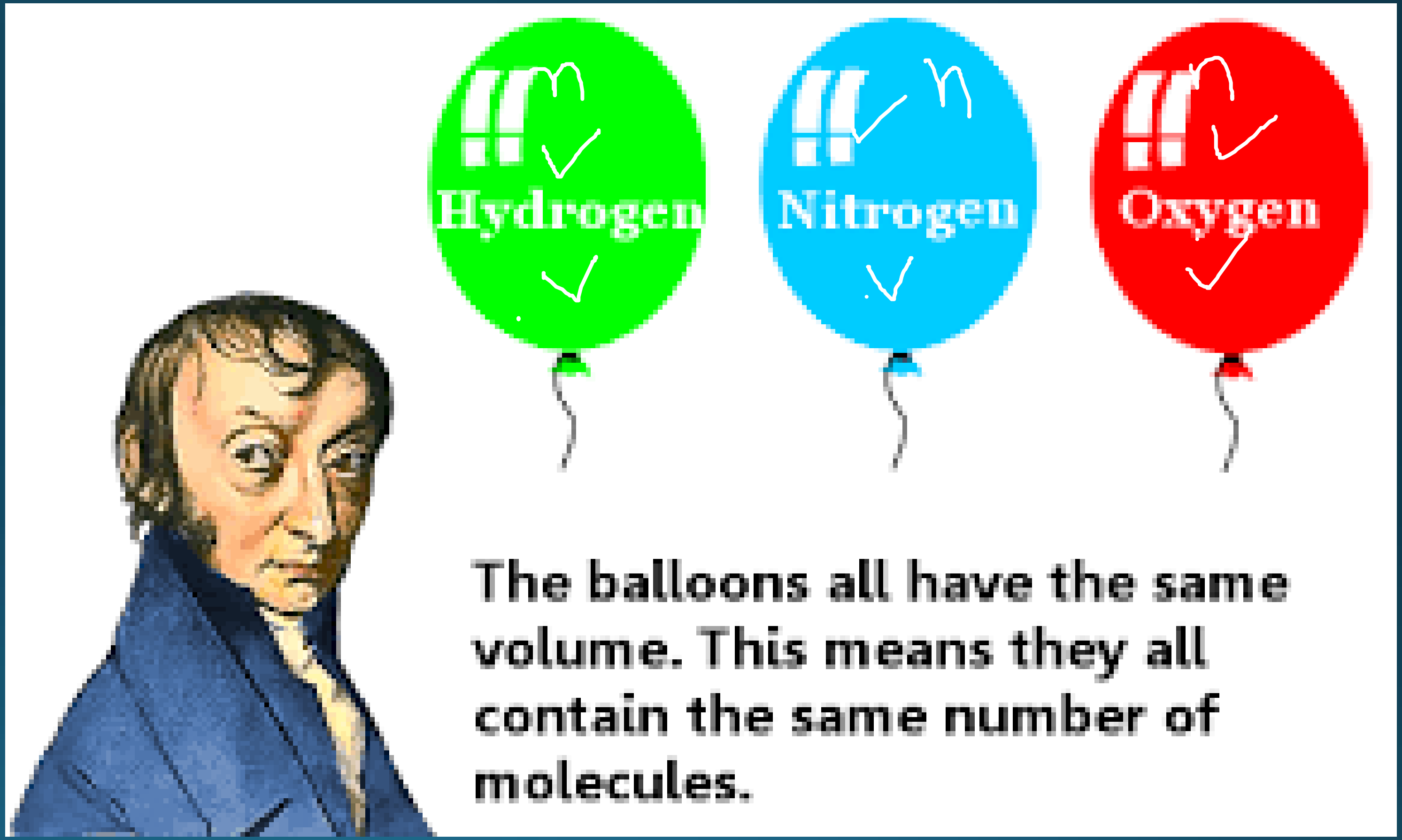
$PV = nRT$

$V = \frac{nRT}{P}$

$V \propto n$

$V_1 = 10$ unit $V_2 = 25$ unit

$n_1 = 1000$ $n_2 = 2500$


Hydrogen
Nitrogen
Oxygen
The balloons all have the same volume. This means they all contain the same number of molecules.

KINETIC THEORY

* Total internal Energy of a Gas is always in the form of → Kinetic Energy.

* Kinetic Energy depends on Temp.

* Elastic collision
  - B/w Gas molecules.
  - b/w wall of Piston & Gas molecules.

⇓

No Loss of Energy.

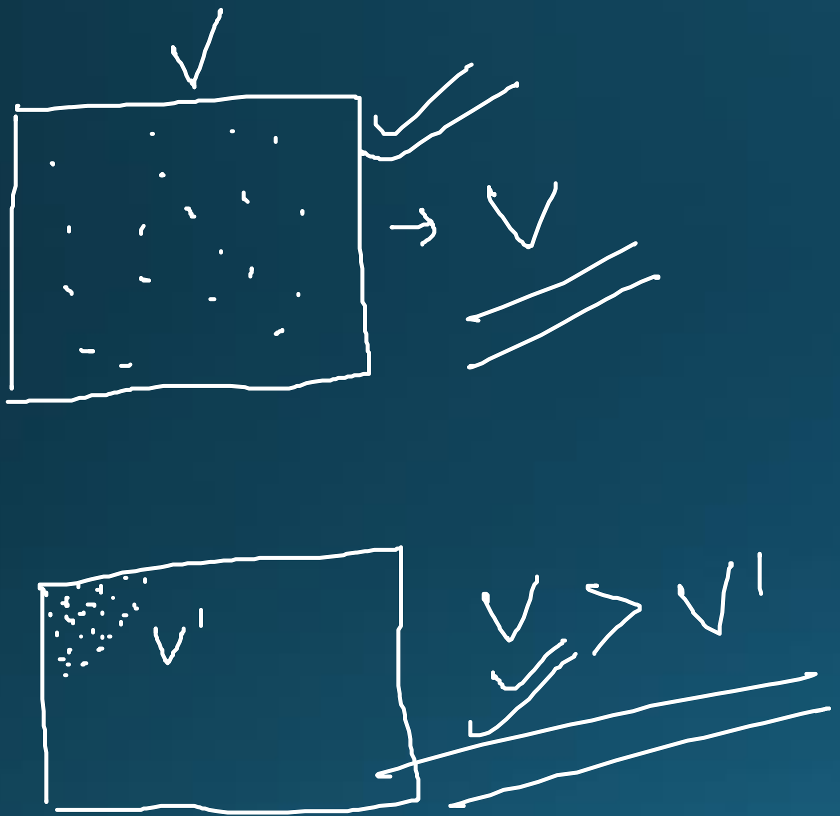
* Pressure → collission b/w wall & Gas molecules.

* 

⇓

free to move in all directions & with equal energy.

* Total volume of the gas molecules is negligible in comparison to volume of gas.



* Gas:

Intermolecular force → Always negligible

*

① $PV = nRT$ ✓

② $PV = \frac{1}{3} n m v_{rms}^2$ ✓ ✓ ⇒ Root Mean Square Velocity

(m → mass of Gas molecules.)

$$v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \dots + v_n^2}{n}}$$

$$v_{rms} = \sqrt{\frac{3PV}{nm}} = \sqrt{\frac{3\cancel{n}RT}{\cancel{n}m}}$$

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$v_{rms} \propto \sqrt{T}$$

* Formula:-

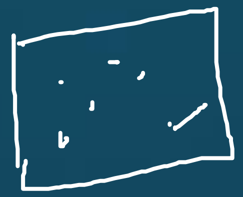
$$\frac{(v_{rms_1})^2}{(v_{rms_2})^2} = \sqrt{\frac{T_1}{T_2}}$$

v_{rms}

⇒ mass vary ∇ Temp Constant

⇒ $$\frac{v_{rms_1}}{v_{rms_2}} = \sqrt{\frac{m_2}{m_1}}$$

* Average Velocity:-



$$\langle v_{avr} \rangle \text{ or } \bar{v} = \frac{v_1 + v_2 + \cdots + v_n}{n}$$

$$\langle v_{avr} \rangle = \sqrt{\frac{8kT}{\pi m}}$$

* v_{mps} (most Probable speed):-

$$v_{mps} = \sqrt{\frac{2kT}{m}}$$

100 → 90 particle → 500 m/s; 10 particle → 100 m/s

* v_{rms}

$\langle v \rangle$

v_{mps} ?

$$v_{rms} = \sqrt{\frac{3RT}{m}} = \sqrt{3} = 1.7$$

$$\langle v_{av} \rangle = \sqrt{\frac{8RT}{\pi m}} = \sqrt{8/\pi} \Rightarrow 2$$

$$\langle v_{mps} \rangle = \sqrt{\frac{2RT}{m}} = \sqrt{2} \Rightarrow 1.4$$

$$v_{rms} > v_{avr} > v_{mps}$$

Kinetic Theory:

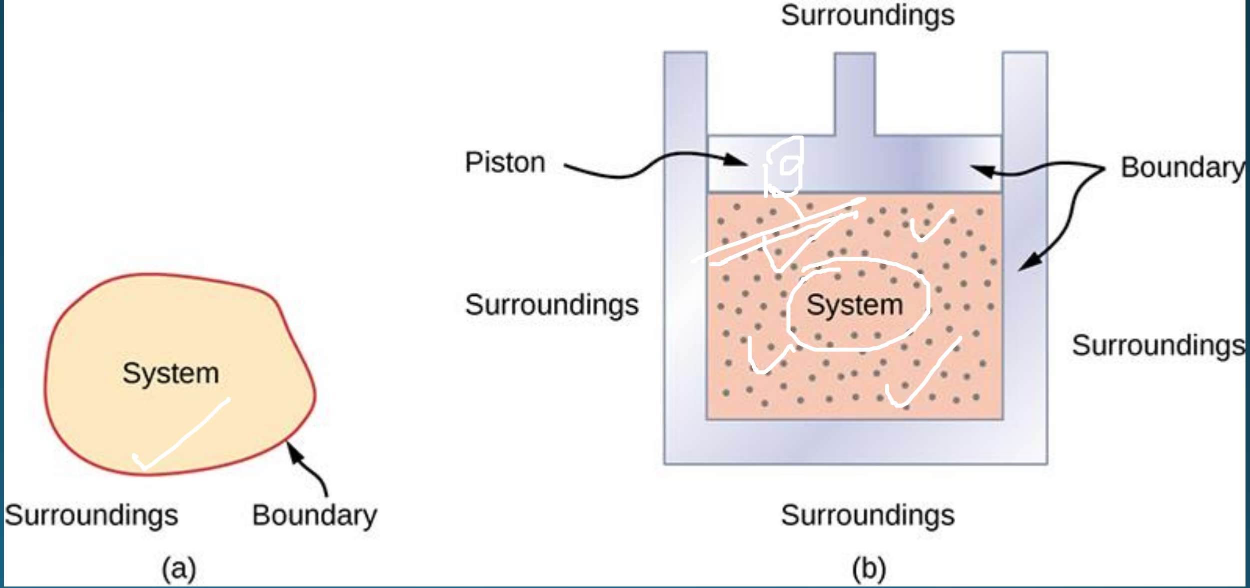
$$\bar{E} = \frac{1}{2} m v^2$$ ✓

At medium:

Gas = $\frac{1}{2} m v_{rms}^2$

Thermodynamical System

- An assembly of an extremely large number of particles whose state can be expressed in terms of pressure, volume and temperature, is called thermodynamic system.



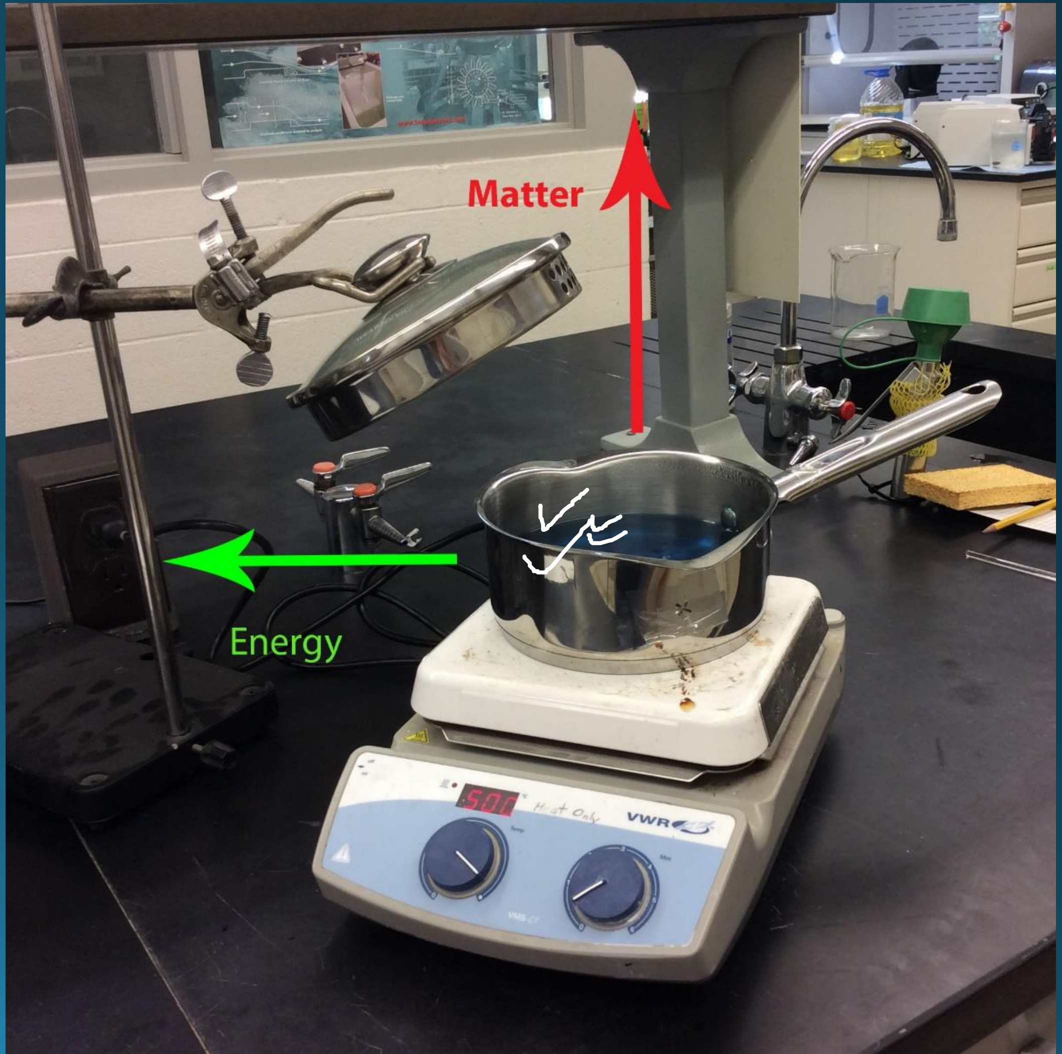
- Thermodynamic system is classified into the following three systems

- (i) **Open System** It exchange both energy and matter with surrounding.

Energy + matter

ऊर्जा + पदार्थ

⇒ 100°C

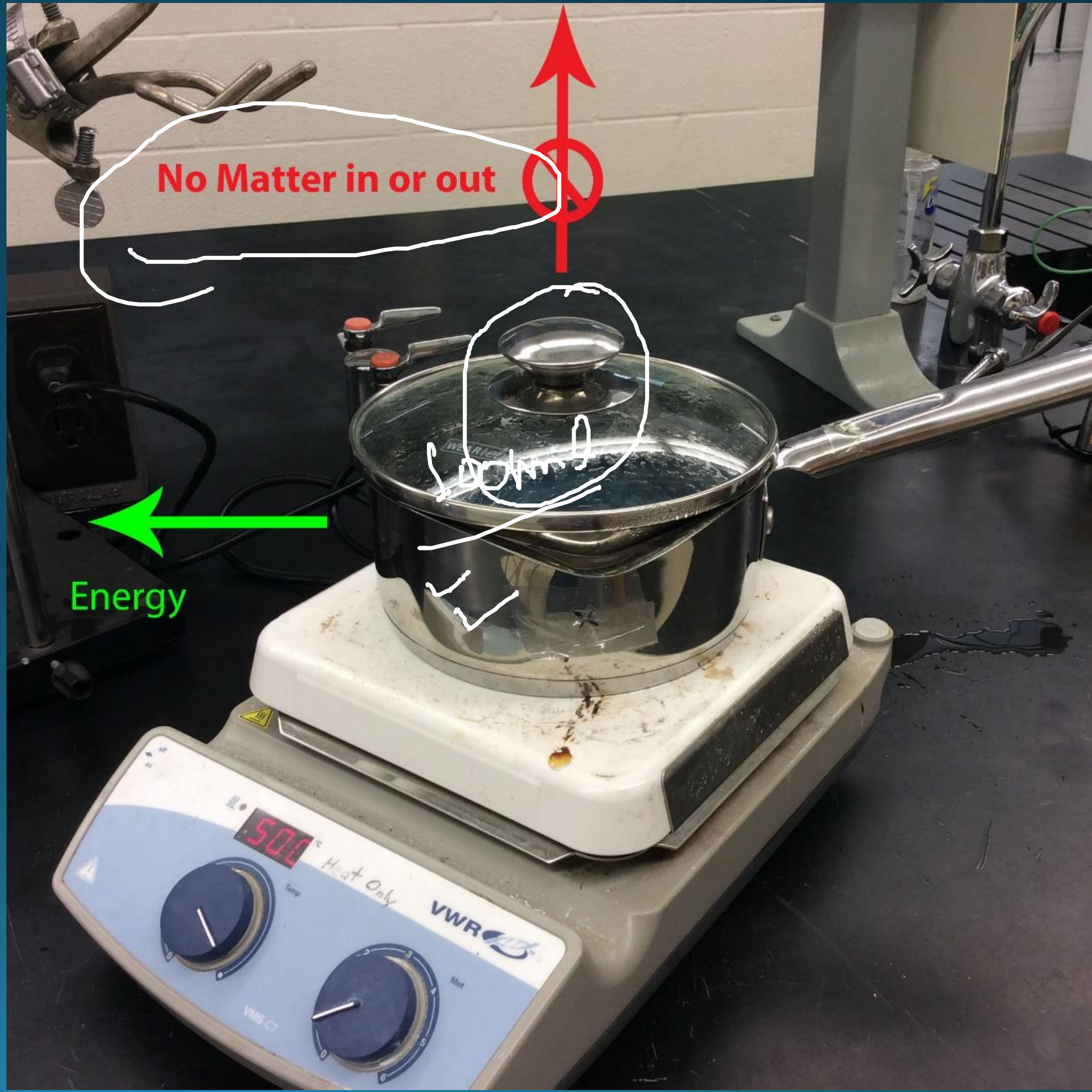


- (ii) **Closed System** It exchanges only energy (not matter) with surroundings.

Energy only → Transfer

matter → No "

- .



- (iii) **Isolated System** It exchanges neither energy nor matter with the surrounding

Energy & matter
⇓
Both are not Transfered

- **(i) Isothermal Process**
- A process taking place in a thermodynamic system at constant temperature is called an isothermal process.
- Isothermal processes are very slow processes.
- These process follows Boyle's law, according to which pV = constant.
- **Examples**
- (a) Melting process is an isothermal change, because temperature of a substance remains constant during melting.
- (b) Boiling process is also an isothermal operation.

(ii) Adiabatic Process

- A process taking place in a thermodynamic system for which there is no exchange of heat between the system and its surroundings.

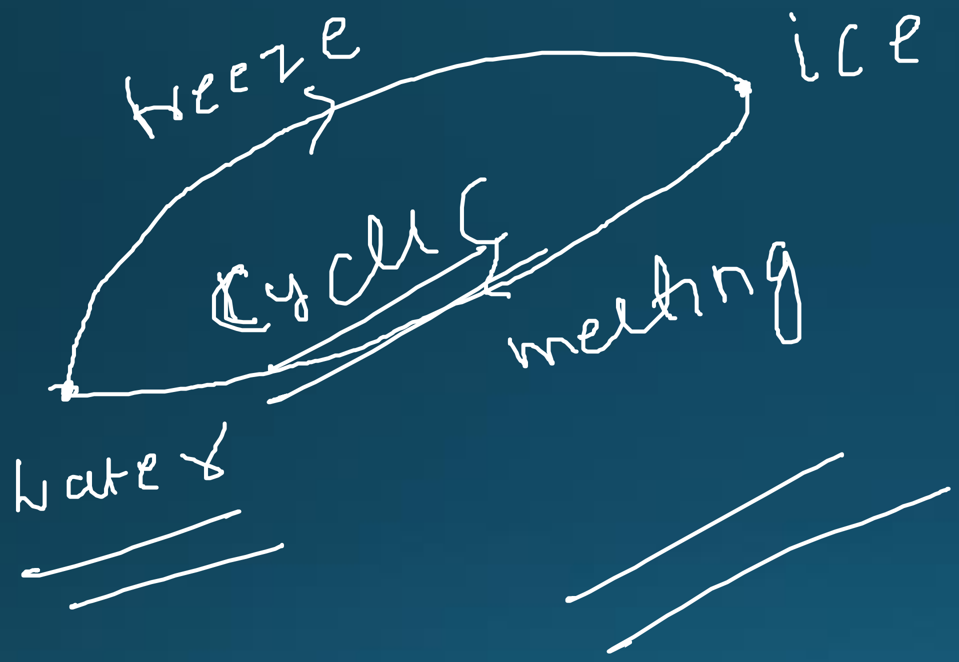
- Adiabatic processes are very fast processes.

- These process follows Poisson’s law, according to which

- **(iii) Isobaric Process** A process taking place in a thermodynamic system at constant pressure is called an isobaric process.

- **<u>(iv) Isochoric Process</u>** A process taking place in a tlaermodynars system at constant volume is called an isochoric process

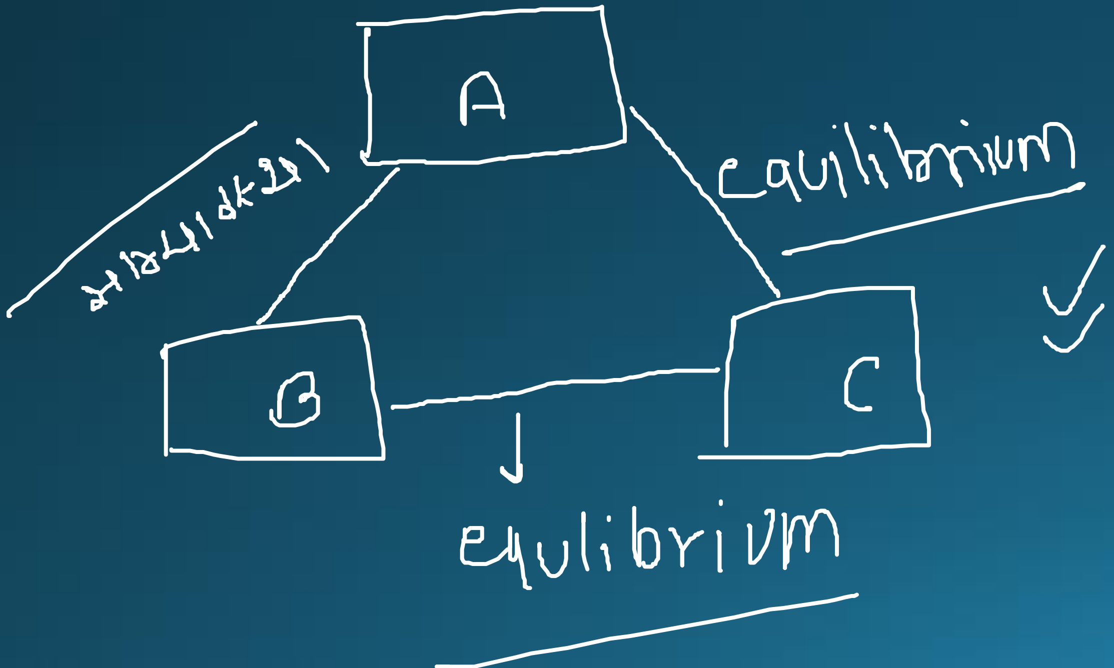
- **(v) Cyclic Process** When a thermodynamic system returns to its initial state after passing through several states, then it is called cyclic process.

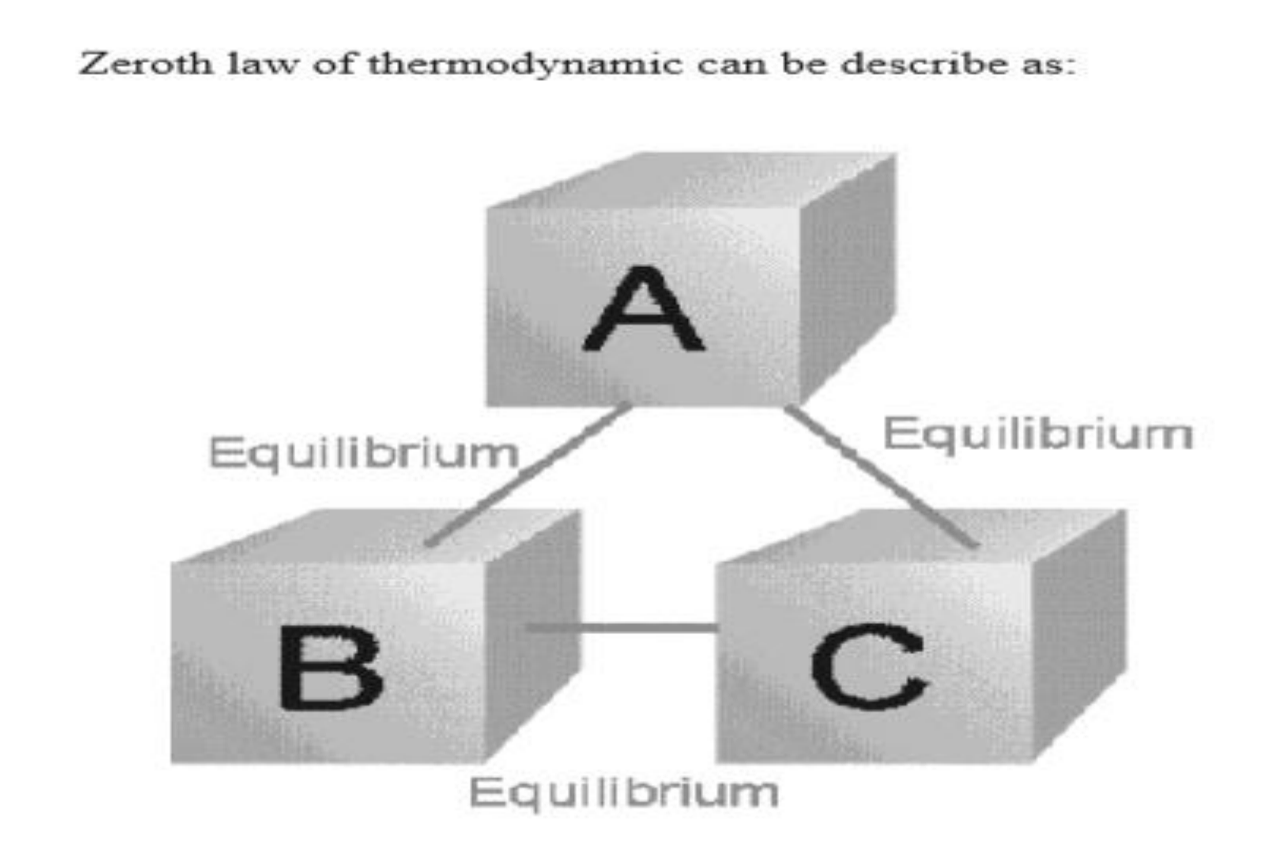


Zeroth Law of Thermodynamics

- According to this law, two systems in thermal equilibrium with a third system separately are in thermal equilibrium with each other. Thus, if A and B are separately in equilibrium with C, that is if T = T and T = T, then this implies that T = T i.e., the systems A and B are also in thermal equilibrium.

A = B & B = C ⇒ A = C

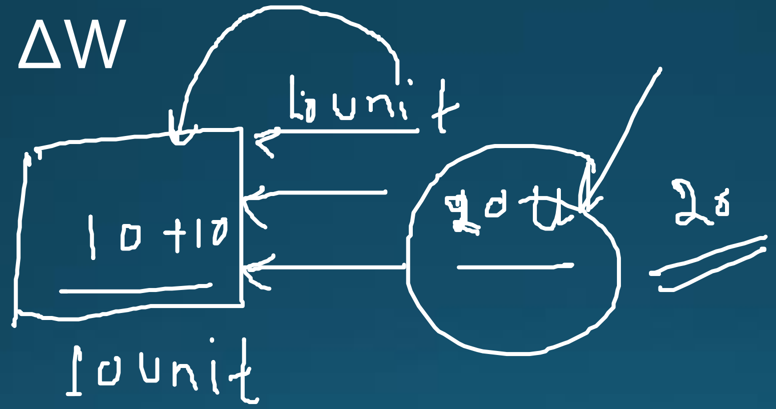




First Law of Thermodynamics

- Heat given to a thermodynamic system (ΔQ) is partially utilized in doing work (ΔW) against the surrounding and the remaining part increases the internal energy (ΔU) of the system.

- Therefore, $\Delta Q = \Delta U + \Delta W$



- In isothermal process, change in internal energy is zero ($\Delta U = 0$). Therefore, $\Delta Q = \Delta W$

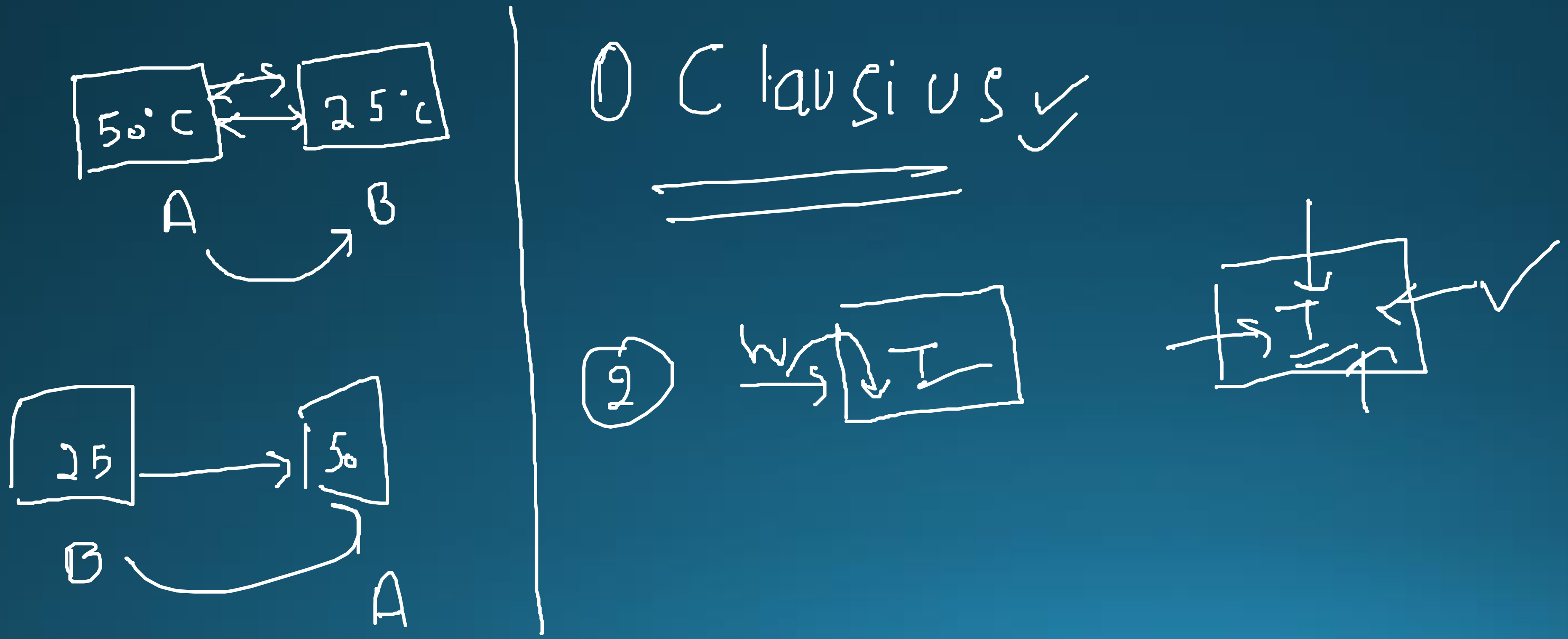
- In adiabatic process, no exchange of heat takes place, i.e., $\Delta\theta = O$. Therefore, $\Delta U = -\Delta W$

- In adiabatic process, if gas expands, its internal energy and hence, temperature decreases and vice-versa.

- In isochoric process, work done is zero, i.e., $\Delta W = 0$, Therefore $\Delta Q = \Delta U$

- # Second Law of Thermodynamics

- The second law of thermodynamics gives a fundamental limitation to the efficiency of a heat engine and the coefficient of performance of a refrigerator. It says that efficiency of a heat engine can never be unity (or 100%). This implies that heat released to the cold reservoir can never be made zero.



- **Kelvin's Statement**
- It is impossible to obtain a continuous supply of work from a body by cooling it to a temperature below the coldest of its surroundings.

- **Clausius' Statement**
- It is impossible to transfer heat from a lower temperature body to a higher temperature body without use of an extenal agency.

- **Planck's Statement**
- It is impossible to construct a heat engine that will convert heat completely into work.

- All these statements are equivalent as one can be obtained from the other.

- **Entropy** ⇒ Disorderness

- Entropy is a physical quantity that remains constant during a reversible adiabatic change.

- Change in entropy is given by $dS = \delta Q / T$

- Where, δQ = heat supplied to the system and T = absolute temperature.

- Entropy of a system never decreases, i.e., $dS \geq 0$.

- Entropy of a system increases in an irreversible process www.Youtube.com/safaltaclass

www.Facebook.com/safaltaclass

www.Instagram.com/safaltaclass

Google Play Store

SAFALTACLASS