Thermal Physics

→ Specific heat capacity - amount of energy required to increase the temperature of 1 kg of a substance by 1°C/1K without changing its state.

$Q = mc\Delta\theta$

Q → energy, m → mass, c → specific heat capacity, $\Delta\theta$ → temperature

→ Specific latent heat - amount of energy required to change the state of 1kg of material, without changing its temperature

→ latent heat of fusion
- converting from solid to liquid.

→ latent heat of vaporisation
- converting from liquid to gas.

$l_v > l_f$

$Q = ml$

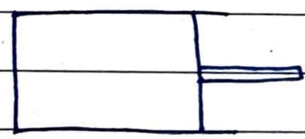
Q → energy, m → mass, l → latent heat

→ Internal energy : sum of all kinetic energy and potential energy

→ First law of thermodynamics

$\Delta U = Q + W$

ΔU → internal energy, Q → thermal energy, W → work done



$+W$ = work done on the system

$-W$ = work done by the system

$P\uparrow$ $\Delta U\uparrow$ $W\uparrow$

$P\downarrow$ $\Delta U\downarrow$ $W\downarrow$

$V\uparrow$ $\Delta U\downarrow$ $W\downarrow$

$V\downarrow$ $\Delta U\uparrow$ $W\uparrow$

→ Thermal equilibrium - Thermal energy is transferred from an area of higher temperature to lower temperature
- Energy transfer takes place until they reach the same temperature, called Thermal Equilibrium.

Zeroth law → A and B are in thermal equilibrium, B and C are in th eq.
∴ A and C are also in th eq.

VK NOTES

→ Thermodynamic Scale or kelvin scale is an absolute scale of temperature that does not depend on the property of any substance.

→ at 0K, particles have no kenergy, volume and pressure of a gas are 0.

$$K = {}^{\circ}C + 273.15$$

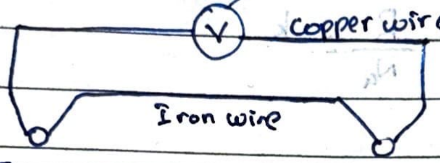
⇒ Practical Thermometers

→ Thermo couple → less thermal capacity, less stability

→ emf is formed, calculate temp change

calibration curve.

Large range.



T_1 ← Temp to be measured

T_2 → constant temp

→ Thermistor (semi conductor) → narrow range

→ easier to use, very stable, large thermal capacity

→ as its resistance ↑ the temperature ↓

→ you can calculate the resistance of thermistor using calibration curve to calculate temperature.

⇒ $pV = nRT$

T → Boyle's law

$$= p \propto \frac{1}{V} \quad = pV = k$$

$$p_1V_1 = p_2V_2$$

P → Charle's law

$$= V \propto T \qquad \frac{V}{T} = k$$

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

V → Gay Lussac's law

$$p \propto T \qquad \frac{P}{T} = k$$

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

VK NOTES

$pV = nRT$

$n =$ no. of moles

$R =$ gas constant $= 8.31$

$pV = NkT$ | $N =$ number of atoms

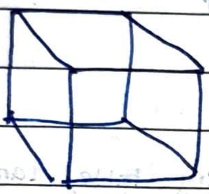
$k =$ boltzmann constant $= 1.38 \times 10^{-23}$

$n = \frac{N}{N_a}$

$pV = \frac{N}{N_a} \times R \times T$

$\frac{R}{N_a} = k$

$pV = N \times k \times T$



distance $= 2L$

speed $= C_x$

time $= \frac{2L}{C_x}$

$mv - mu = mc_x - (-mc_x)$

$= 2mc_x$

$F = \frac{mv - mu}{t} = \frac{2mc_x}{2L/c_x} = \frac{2mc_x^2}{2L} = \frac{mc_x^2}{L}$

$F = \frac{mc_x^2}{L}$

$P = \frac{F}{A}$

$P = \frac{mc_x^2}{L \times L^2} = \frac{mc_x^2}{L^3}$

$p = \frac{mc_x^2}{V}$ for one particle

$p = \frac{Nmc_x^2}{V}$ for all particles

$c^2 = c_x^2 + c_y^2 + c_z^2$

Mean square velocity

$\langle c^2 \rangle = 3\langle c_x^2 \rangle$

$\frac{\langle c^2 \rangle}{3} = \langle c_x^2 \rangle$

$\langle c_x^2 \rangle = \langle c_y^2 \rangle = \langle c_z^2 \rangle$

VK NOTES

$$p = \frac{Nm\langle c^2\rangle}{3V} \qquad \frac{Nm}{V} = \rho$$

$$p = \frac{\rho}{3} \times \frac{\langle c^2\rangle}{3}$$

$$\boxed{PV = \frac{1}{3} Nm\langle c^2\rangle}$$

$$PV = \frac{2}{3} \times \frac{1}{2} Nm\langle c^2\rangle$$

$$PV = \frac{2}{3} N \times k_e$$

$$PV = \frac{2}{3} N k_e$$

$$PV = nRT$$

$$\therefore nRT = \frac{2}{3} N k_e$$

$$\frac{3nRT}{2N} = k_e$$

$$\frac{3}{2} \times \frac{n}{N} \times RT \qquad n = \frac{N}{N_a}$$

$$\frac{3}{2} \times \frac{\cancel{N}}{\cancel{N} \times N_a} \times RT$$

$$\frac{3}{2} \times \frac{R}{N_a} \times T \qquad \frac{R}{N_a} = k$$

$$\boxed{K_e = \frac{3}{2} kT}$$

$$\frac{1}{2} m\langle c^2\rangle = \frac{3}{2} kT$$

$$\langle c^2\rangle = \frac{3kT}{m}$$

$$\sqrt{\langle c^2\rangle} = \sqrt{\frac{3kT}{m}}$$

VK NOTES

⇒ Temperature, Thermodynamics, Ideal Gases

1. $Q = mc\Delta\theta$
2. $Q = ml$ (l_v or l_f)
3. $\Delta U = q + \omega$ (internal energy = thermal energy + work done)

$P\uparrow \quad \Delta U\uparrow \quad \omega\uparrow$

$V\downarrow \quad \Delta U\uparrow \quad \omega\uparrow$

$P\downarrow \quad \Delta U\downarrow \quad \omega\downarrow$

$V\uparrow \quad \Delta U\downarrow \quad \omega\downarrow$

4. avogadro's constant = 6.02×10^{23} mol
5. $P_1V_1 = P_2V_2$
6. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
7. $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
8. $PV = nRT$ ($R = 8.3$)

Used when temp changes

$V = \text{og}V \times \frac{(\text{New temp})}{(\text{Old temp})}$

$\omega = P\Delta V$ → dependent

$P = E \propto T$

9. $n = \frac{N}{N_a}$, $pV = \frac{N}{N_a} \times R \times T$, $\frac{R}{N_a} = k$

$pV = NkT$ | $k = 1.38 \times 10^{-23}$

10. distance = $2L$

Speed = C_x

time = $\frac{2L}{C_x}$

$mv - mu = mc_x - (-mc_x)$

$= 2mc_x$

$F = \frac{mv - mu}{t} = \frac{2mc_x}{2L/c_x} = \frac{2mc_x^2}{2L}$

$P = \frac{F}{A} = \frac{mc_x^2}{L \times L^2} = \frac{mc_x^2}{L^3}$

$\boxed{F = \frac{mc_x^2}{L}}$

$p = \frac{mc_x^2}{V}$ for one particle, $p = \frac{Nmc_x^2}{L}$ for N particles

→