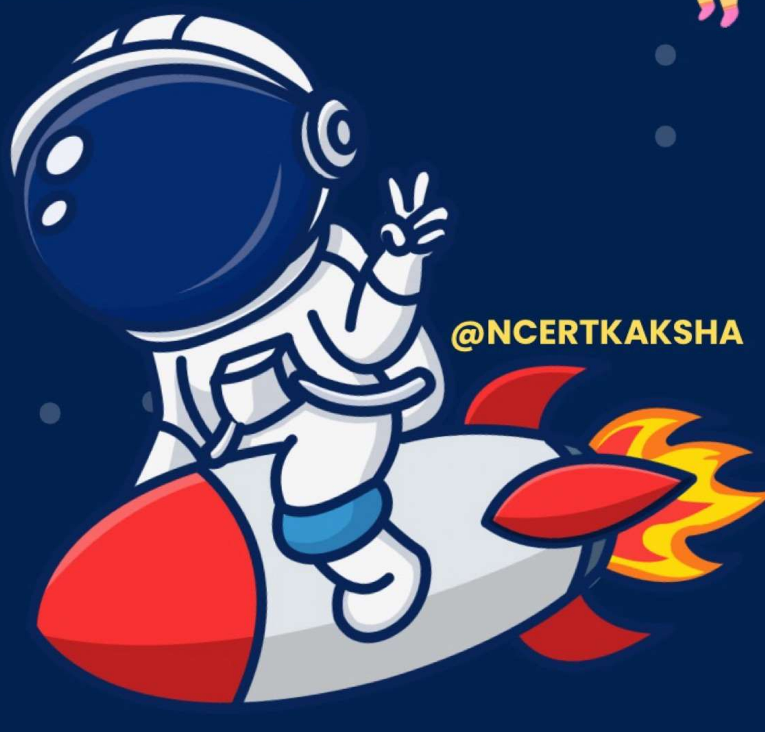
2025 - 2026

PHYSICS FORMULA SHEET

CLASS - 11



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Umesh Bhaiya


WARNING

Class XI – 2025 - 2026

INDEX

UNIT-1 (PHYSICAL WORLD AND MEASUREMENT)

CHAPTER-1

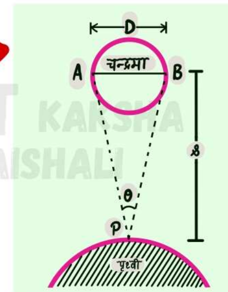
Units and Measurement

- **Determination of Radius of atom using avagadro hypothesis** $r = \left(\dfrac{VM}{2\pi N m}\right)^{1/3}$

  V = Volume
  M = Molecular weight
  N = Avagadro's No.

- **Diameter of moon** $D = s\theta$

  θ = Angle of Deviation, s = mean distance of the earth from the moon



- **Absolute Error** $\Delta a_n = a_{mean} - a_n$ $\qquad a_{mean} = \sum_{i=1}^{n} \dfrac{a_i}{n}$

- **Mean Absolute Error** Δa_{mean} OR $\Delta\bar{a} = \dfrac{1}{n}\sum_{i=1}^{n} |\Delta a_i|$

- **Relative OR Fractional Error** $\dfrac{\Delta a_{mean}}{a_{mean}}$ $\qquad a = a_{mean} \pm \Delta a_{mean}$

- **Percentage Error** $\delta a = \dfrac{\Delta a_{mean}}{a_{mean}} \times 100\%$

- Angle = $\dfrac{\text{Curve}}{\text{Radius}}$

- **Error in addition and subtraction** $\Delta Z_{max} = \Delta A + \Delta B$

- **Error in Multiplication and Divison** $\left|\dfrac{\Delta Z}{Z}\right|_{max} = \dfrac{\Delta A}{A} + \dfrac{\Delta B}{B}$

- **Error in a power of measured quantity**

  If $Z = A^m$ $\qquad \left|\dfrac{\Delta Z}{Z}\right|_{max} = m\dfrac{\Delta A}{A}$

  If $Z = \dfrac{A^m B^n}{C^p}$ $\qquad \left|\dfrac{\Delta Z}{Z}\right|_{max} = m\dfrac{\Delta A}{A} + n\dfrac{\Delta B}{B} + p\dfrac{\Delta C}{C}$

- **Experimental % Error** $\dfrac{\text{Real Value} - \text{Experimental Value}}{\text{Real Value}} \times 100\%$

- **SI Base quantities and unit**

Base quantity	Name	symbol
Length	Meter	m
Mass	Kilogram	Kg
Time	Second	s
Electric	Ampere	A
Thermodynamic Temperature	Kelvin	K
Amount of Substance	Mole	Mol
Luminous Intensity	Candela	cd

CHAPTER - 2

Motion in a straight line

➡ Speed $v = \frac{s}{t}$

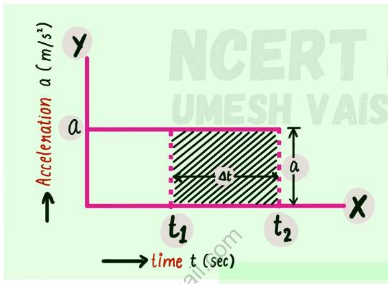
➡ Average speed $\bar{v} = \frac{\Delta s}{\Delta t}$

➡ Average velocity $\vec{v}_{av} = \frac{\vec{\Delta s}}{\Delta t}$

➡ Instantaneous speed $v = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

➡ Instantaneous velocity $\vec{v} = \lim_{\Delta t \to 0} \frac{\vec{\Delta s}}{\Delta t} = \frac{d\vec{s}}{dt}$

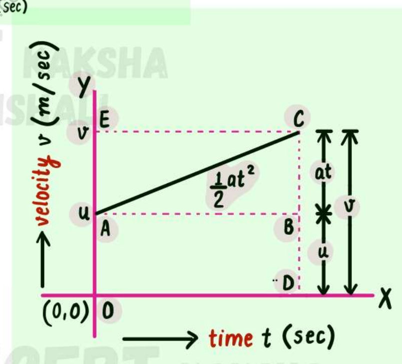
➡ Acceleration $a = \frac{\Delta v}{\Delta t}$



➡ Instantaneous Acceleration $\vec{a} = \frac{d(\vec{v})}{dt}$ OR $a = \frac{d^2s}{dt^2}$

$\vec{v}_{av} = \frac{\vec{u} + \vec{v}}{2}$ OR $\vec{v}_{av} = \frac{\vec{v}_1 t_1 + \vec{v}_2 t_2}{t_1 + t_2}$

➡ Equations of Motion OR Equations of Kinematics



$v = v_0 + at$ $\quad s = v_0 t + \frac{1}{2}at^2$ $\quad v^2 = v_0^2 + 2as$

➡ Equation of Motion when particle start from initial Position S_0

$v = v_0 + at$ $\quad s = s_0 + v_0 t + \frac{1}{2}at^2$ $\quad v^2 = v_0^2 + 2a(s - s_0)$

➡ Motion under gravity

(A) When down to up $\quad s = h,\ a = -g$

$v = v_0 - gt$ $\quad h = v_0 t - \frac{1}{2}gt^2$ $\quad v^2 = v_0^2 - 2gh$

(B) When up to down $\quad s = h,\ a = g$

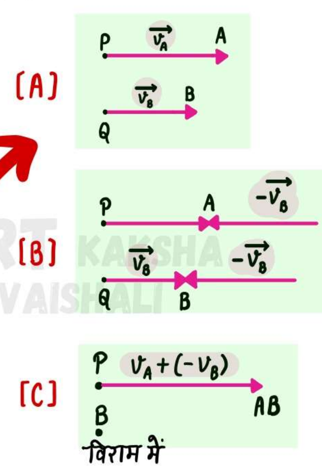
$v = v_0 + gt$ $\quad h = v_0 t + \frac{1}{2}gt^2$ $\quad v^2 = v_0^2 + 2gh$

➡ Stopping distance of vehicles $d_s = \frac{-v_0^2}{2a}$

➡ Distance traveled in n^{th} sec $\Delta S = v_0 + \frac{1}{2}a(2n-1)$

➡ Relativity velocity A to B $\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$ $\quad \vec{V}_{AB} = \vec{V}_A + \vec{V}_B$

$\vec{V}_{AB} = -\vec{V}_{BA}$



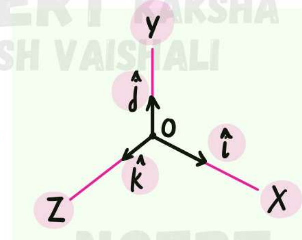
(Object move in the opposite direction)

UNIT- II (KINEMATICS)

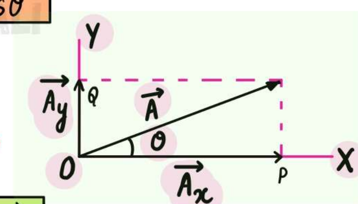
CHAPTER- 3

Motion in a plane

- **Equal vectors** $\vec{A} = \vec{B} = \vec{C}$
- **Opposite vectors** $\vec{A} = -\vec{D}$
- **Unit vector** $\hat{A} = \frac{\vec{A}}{|\vec{A}|} = \frac{\vec{A}}{A}$
- **Orthogonal unit vector** $|\hat{i}| = |\hat{j}| = |\hat{k}| = 1$



- $\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$
- **Magnitude** $A = \sqrt{A_x^2 + A_y^2 + A_z^2}$
- **Vector addition** $\vec{R} = \vec{A} + \vec{B}$
- **Vector subtraction** $\vec{R} = \vec{A} - \vec{B}$
- **Analytical Method** $R = A^2 + B^2 + 2AB\cos\theta$ $\tan\alpha = \frac{B\sin\theta}{A + B\cos\theta}$
- **Resolution of vectors** $A = \sqrt{A_x^2 + A_y^2}$ $\theta = \tan^{-1}\frac{A_y}{A_x}$



- **Properties of vectors**

1. $|\lambda A| = \lambda|A|$ If $\lambda > 0$ (λ = Real no.)
2. $\vec{A} + \vec{B} = \vec{B} + \vec{A}$
3. $\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$ $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$
4. $(\vec{A} + \vec{B}) + \vec{C} = \vec{A} + (\vec{B} + \vec{C})$
5. $\vec{A} - \vec{A} = \vec{0}$ $|\vec{0}| = 0$ (zero vector)
6. $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$ $\lambda\vec{0} = \vec{0}$ $0\vec{A} = \vec{0}$
7. $\vec{A} + \vec{0} = \vec{A}$
8. $0\vec{A} = \vec{0}$
9. $\lambda\vec{0} = \vec{0}$

- **Scalar or dot products of two vectors** $\vec{A} \cdot \vec{B} = AB\cos\theta$
- **Properties of scalar product**

1. (a) $\theta < 90^\circ$ $\vec{A} \cdot \vec{B}$ (+ve) (b) $\theta = 90^\circ$ $\vec{A} \cdot \vec{B}$ (zero) (c) $\theta > 90^\circ$ $\vec{A} \cdot \vec{B}$ (-ve)
2. $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$ (Commutative)
3. $\vec{A} \cdot (\vec{B} + \vec{C}) = \vec{A} \cdot \vec{B} + \vec{A} \cdot \vec{C}$ (Distributive)
4. $\vec{A} \cdot \vec{B} = 0$ $\theta = 90^\circ$ (two perpendicular vectors)

$$\vec{A}\cdot(\lambda\vec{B}) = \lambda(\vec{A}\cdot\vec{B})$$

$$\vec{v} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} + \frac{dz}{dt}\hat{k} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$$

$$\vec{a} = \frac{dv_x}{dt}\hat{i} + \frac{dv_y}{dt}\hat{j} + \frac{dv_z}{dt}\hat{k} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$$

5. $\vec{A}\cdot\vec{B} = AB$ $\quad\theta = 0$ (two parallel vectors)
   $\vec{A}\cdot\vec{B} = -AB$ $\quad\theta = 180^\circ$

6. $\vec{A}\cdot\vec{A} = A^2$ (Product of a vector with itself is equal to square)

7. $\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$ $\qquad \hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$ (unit orthogonal vector relations)

8. $\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$ (two vectors is equal to the sum of the product)

➡ **Vector or cross product of two vectors** $\quad \vec{A}\times\vec{B} = AB\sin\theta\,\hat{n}$

➡ **Properties of vector product**

1. $\vec{A}\times\vec{B} = -\vec{B}\times\vec{A}$ (not commutative) $\qquad \vec{A} = |\vec{A}|\,\hat{n}$ $\hat{n}$ is a unit vector along $\vec{A}$

2. $\vec{A}\times(\vec{B}+\vec{C}) = \vec{A}\times\vec{B} + \vec{A}\times\vec{C}$ (Distributive)

3. $(m\vec{A})\times\vec{B} = \vec{A}\times(m\vec{B}) = mAB\sin\theta\,\hat{n}$ (two vector is multiplied by scalar)

4. $|\vec{A}\times\vec{B}| = AB$ $\quad\theta = 90^\circ$ (two perpendicular vectors)

5. $\vec{A}\times\vec{B} = 0$ $\quad\theta = 0$ (two parallel vectors)

6. $\vec{A}\times\vec{A} = 0$ (Product of a vector by itself)

7. $\hat{i}\times\hat{j} = -\hat{j}\times\hat{i} = \hat{k}$ $\qquad \hat{j}\times\hat{k} = -\hat{k}\times\hat{j} = \hat{i}$ $\qquad \hat{k}\times\hat{i} = -\hat{i}\times\hat{k} = \hat{j}$

$\hat{i}\times\hat{i} = \hat{j}\times\hat{j} = \hat{k}\times\hat{k} = 0$

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

where $\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$
$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

➡ **Motion in a plane**

Position vector $\quad \vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ $\qquad |\vec{r}| = \sqrt{x^2+y^2+z^2}$

Displacement vector $\quad \Delta\vec{r} = \vec{r}' - \vec{r} = \Delta x\hat{i} + y\hat{j} + z\hat{k}$

Velocity $\quad \vec{v} = \frac{\Delta\vec{r}}{\Delta t}$ $\qquad \vec{v} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$

Acceleration $\quad \vec{a} = \frac{\Delta\vec{v}}{\Delta t}$ $\qquad \vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$ $\qquad |\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

➡ **Motion in plane with constant velocity** $\quad \vec{r} = \vec{r}_0 + \vec{v}t$

Motion in plane with constant acceleration

$\vec{v} = \vec{v}_0 + \vec{a}t$

$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$

In direction of x-axis

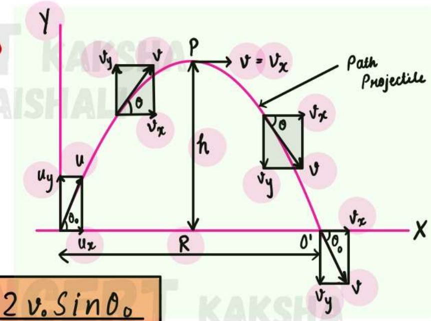
$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

where $\vec{r}_0$ is initial position vector form where particle start their motion.

Projectile Motion

horizontal component $u_x = v_0 \cos\theta_0$

vertical component $u_y = v_0 \sin\theta_0$



Path of Projectile

$$y = (\tan\theta_0)x - \frac{g}{2v_0^2\cos^2\theta_0}x^2$$

Flight time of Projectile

$$t = \frac{v_0\sin\theta_0}{g} \qquad T = 2t = \frac{2v_0\sin\theta_0}{g}$$

Height of Projectile

$$h = \frac{v_0^2\sin^2\theta_0}{2g} \qquad h_{max} = \frac{v_0^2}{2g}$$

Range of Projectile

$$R = \frac{v_0^2\sin 2\theta_0}{g}$$

If $\theta = 45^\circ$ $\quad R_{max} = \frac{v_0^2}{g}$

Uniform circular motion

$$a_c = \frac{v^2}{R} \qquad a_c = \omega^2 R \qquad a_c = 4\pi^2\nu^2 R$$

a_c = Centripetal force
R = Radius of Circle
ν = frequency

Angular velocity

$$\omega = \frac{d\theta}{dt} \qquad \omega = 2\pi\nu \qquad v = 2\pi R\nu$$

Relation between v and ω

$$v = r\omega$$

v = linear velocity
ω = Angular velocity

Centripetal force

$$F = \frac{mv^2}{r} \qquad F = mr\omega^2 \quad \because (v = r\omega)$$

Motion of conical Pendulum

$$\text{Time period } (T) = 2\pi\sqrt{\frac{l\cos\theta}{g}}$$

Motion of particle tied to a string in a vertical circle

$$v = \sqrt{(3 + 2\cos\theta)gl} \qquad T = 3mg(1 + \cos\theta)$$

1. If $\theta = 0^\circ$ $\quad v = \sqrt{5gl}$ $\quad T = 6mg$ (At bottom of circle)
2. If $\theta = 90^\circ$ $\quad v = \sqrt{3gl}$ $\quad T = 3mg$
3. If $\theta = 180^\circ$ $\quad v = \sqrt{gl}$ $\quad T = 0$ (At top of circle)

UNIT-III (LAWS OF MOTION)

CHAPTER-4

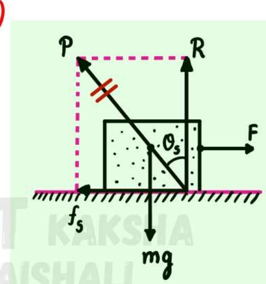
Laws of motion

- **Momentum** $p = m \times v$
- **Force** $F = ma = \frac{dp}{dt}$ $\quad \vec{F}_{AB} = -\vec{F}_{BA}$

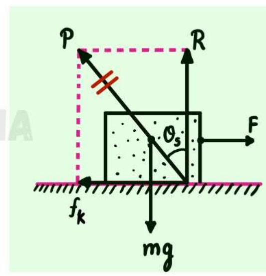
(Newton's second law of motion)

- **Impulse** $J = mv$
- **Law of conservation of momentum** $\vec{p} = \text{constant}$ [if $F_{ext} = 0$]
- **Equilibirium of a particle** $\vec{F_1} + \vec{F_2} + \vec{F_3} = 0$ $\quad$ Total force $= 0$
- **Limiting friction** $f_s = \mu_s N$
- **Kinetic friction** $f_k = \mu_k N$

μ_s = Coefficient of static friction
μ_k = Coefficient of kinetic friction
N = Normal Reaction force



$f_s = \mu_s R$

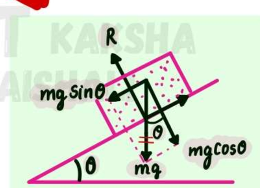


$f_k = \mu_k R$

- **Angle of friction** $\tan\theta_s = \mu_s$
- **Friction on an inclined plane** $\mu_s = \tan\theta_s$ $\quad \mu_k = \tan\theta_k$

$$\mu_s = \frac{f_s}{R} = \frac{f_s}{mg} \qquad f = \frac{mv^2}{R}$$

- **Motion of a car on a level rod** $v_{max} = \sqrt{\mu_s R g}$
- **Motion of a car on a banked rod** $v_{max} = \left[Rg\,\frac{\mu_s + 1\tan\theta}{1 - \mu_s \tan\theta}\right]^{1/2}$



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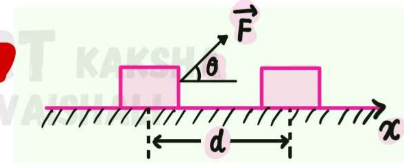
UNIT-IV (WORK, ENERGY AND POWER)

CHAPTER - 5

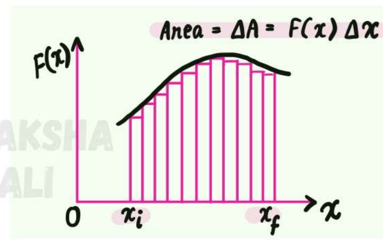
Work, Energy and Power

- Work Energy Theorem $K_f - K_i = W$ OR $\Delta K = W$



- Work $W = \vec{F}\cdot\vec{S} = FS\cos\theta$
- Kinetic Energy $K = \frac{1}{2}mv^2$
- Work done by a variable force $W = \int_{x_1}^{x_2} F\,dx$
- Power $P = \frac{dW}{dt}$ OR $P = \vec{F}\cdot\vec{v}$
- Gravitational Potential Energy $V = mgh$
- Hookey's law $F = -kx$
- Potential Energy of spring $V = \frac{1}{2}kx^2$
- Maximum speed $v_m = \sqrt{\frac{k}{m}}\,x_m$
- Conservation Forces as Negative gradient of Potential Energy

$F = -\frac{dV}{dx}$ OR $\frac{dV}{dx} = F'$ $\qquad V_i - V_f = \int_{x_i}^{x_f} F(x)\,dx$



- Equivalence of Mass and Energy $E = mc^2$
- Conservation of Energy

$W = K_f - K_i = V_i - V_f$ $\quad \Delta K + \Delta U = 0$ OR $\Delta E = 0$ OR $K_i + U_i = K_f + U_f$

- Mechanical Energy of a ball, fall freely from a height H
- At maximum Height (H) $E_H = mgH$
- At mediator Height (h) $E_h = mgh + \frac{1}{2}mv_h^2$
- At ground level (h = 0) $E_h = \frac{1}{2}mv_f^2$
- From Energy conservation $E_H = E_0$ OR $v_f = \sqrt{2gH}$ and $E_H = E_h$ OR $v_h = 2g(H-h)$
- Elastic collision in 1D

$u_1 - u_2 = v_2 - v_1 = -(v_1 - v_2)$

$v_1 = \left[\frac{m_1 - m_2}{m_1 + m_2}\right]u_1 + \left[\frac{2m_2}{m_1 + m_2}\right]u_2$

$v_2 = \left[\frac{2m_2}{m_1 + m_2}\right]u_2 + \left[\frac{m_1 - m_2}{m_1 + m_2}\right]u_1$

- Elastic collision in 2D

Along X - axis $m_1u_1 = m_1v_1\cos\theta + m_2v_2\cos\theta$

Along Y - axis $0 = m_1v_1\sin\theta + m_2v_2\sin\theta$

- Perfectly inelastic collision

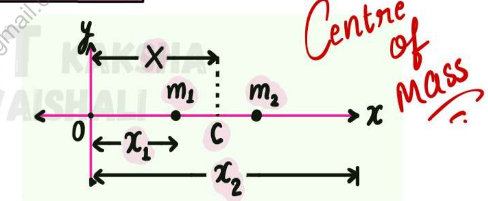
$m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $\qquad \frac{K_2}{K_1} = \frac{m_1}{m_1 + m_2}$

1. If $m_1 = m_2 = m$ then $v_1 = u_2$ and $v_2 = u_2$
2. If m_2 is in rest i.e. $u_2 = 0$ $\quad v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1$ $\quad v_2 = \left(\frac{2m_1}{m_1 + m_2}\right)u_2$

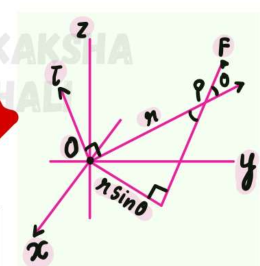
CHAPTER-6

System of particle and Rotational motion

- Centre of Mass of a two-particle system: $\vec{r}_{cm} = \dfrac{m_1 r_1 + m_2 r_2}{m_1 + m_2}$
- Centre of Mass of a system of n-particles: $\vec{r}_{cm} = \dfrac{m_1 \vec{r_1} + m_2 \vec{r_2} + \ldots\ldots + m_n \vec{r_n}}{m_1 + m_2 + \ldots\ldots + m_n}$ $\Downarrow$ $\vec{r}_{cm} = \dfrac{\sum m_i r_i}{\sum m_i}$, $\sum m_i = M$
- Centre of Mass of a Rigid body: $\vec{r}_{cm} = \dfrac{1}{M}\int \vec{r}\, dm$
- Centre of Mass of a uniform rod: $x_{cm} = \dfrac{l}{2}$
- Motion of the centre of mass: $\vec{V}_{cm} = \dfrac{1}{M}\left(m_1\vec{v_1} + m_2\vec{v_2} + \ldots\ldots + m_n\vec{v_n}\right)$ and $M\vec{a}_{cm} = \vec{F}_{ext}$
- Momentum conservation: $\vec{P} = M\vec{v}_{cm}$
- Centre of Mass motion: $\dfrac{d\vec{P}}{dt} = \vec{F}_{ext}$; if $\vec{F}_{ext} = 0$, $\vec{P} = \text{constant}$



- Acceleration of centre of Mass: $\vec{a}_{cm} = \dfrac{\vec{F}}{M}$
- Angular Acceleration: $\alpha = \dfrac{d\omega}{dt}$, $a = r\alpha$
- $v = r\omega$ & $\vec{v} = \vec{\omega} \times \vec{r}$
- Torque: $\vec{\tau} = \vec{r} \times \vec{F}$



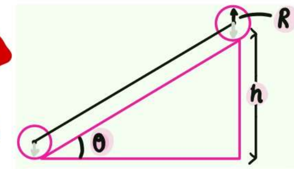
- Equations of Rotational Motion

$\omega = \omega_0 + \alpha t$ $\quad$ $\theta = \omega_0 t + \dfrac{1}{2}\alpha t^2$ $\quad$ $\omega^2 = \omega_0^2 + 2\alpha\theta$

- Moment of Inertia: $I = \sum_{i=1}^{n} m r^2$
- Radius of gyration: $k = \sqrt{\dfrac{I}{M}}$
- Relation between τ and α: $\vec{\tau} = \vec{I} \times \vec{\alpha}$ OR $\tau = I\alpha$
- Theorem of Parallel axis: $I = I_{cm} + Ma^2$
- Theorem of Perpendicular axis: $I_z = I_y + I_x$
- Relation between L and I: $\vec{L} = \vec{I} \times \vec{\omega}$ & $\vec{L} = \vec{r} \times \vec{P}$
- Rate of change of angular momentum: $\dfrac{d\vec{L}}{dt} = \vec{\tau}_{ext}$
- Law of conservation of Angular momentum: $\vec{L} = \text{constant}$ If $(\vec{\tau}_{ext} = 0)$
- Equilibirium of rigid body: 1. $\sum_{i=1}^{n} \vec{F_i} = 0$ $\quad$ 2. $\sum_{i=1}^{n} \vec{\tau_i} = 0$ For rotational equilibrium

sum of all forces & Torque must be zero.

- **Kinetic Energy of rotation** $K = \frac{1}{2} I\omega^2 = \frac{1}{2} M r^2 \omega^2$



- **Condition of Rolling of a body without sliding over an inclined Plane**

$f_s = \frac{I a}{r^2}$ $\qquad a = \frac{g \sin\theta}{\left(1 + \frac{K^2}{R^2}\right)}$

(i) If the rolling body is a solid cylinder $\mu_s = \frac{1}{3} \tan\theta$

(ii) If the rolling body is a solid sphere $\mu_s = \frac{2}{7} \tan\theta$

- **Total Energy of a body rolling without slipping** $K_{total} = K_{rot} + K_{trans}$

and

$K_{total} = \frac{1}{2} I\omega^2 + \frac{1}{2} M v^2$

- **Rolling Motion** $V_{cm} = R\omega$

1. Rolls without slip $V_{cm} = R\omega$
2. Rolls with slipping in forward direction $V_{cm} > R\omega$
3. Rolls with slipping in backward direction $V_{cm} < R\omega$

- **Angular momentum** $\vec{L} = \sum_{i=1}^{n} \vec{r}_i \times \vec{P}_i$

- **Kinematics equations for rotational motion with uniform angular acceleration**

$\omega = \omega_0 + \alpha t$ $\qquad \theta = \omega_0 t + \frac{1}{2} \alpha t^2$ $\qquad \omega^2 = \omega_0^2 + 2\alpha\theta$

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UNIT- VI (GRAVITATION)

CHAPTER-7

Gravitation

- **Kepler's law**

First law (law of orbits) Planet move in elliptical orbits around sun.

Second law (law of areal velocity) $\boxed{\dfrac{dA}{dt} = \dfrac{L}{2m}}$ L → Angular momentum

Third law (law of Periods) $\boxed{T^2 \propto a^3}$ a = semi major axis $\boxed{T^2 = \left(\dfrac{4\pi}{GM_s}\right)R^3}$ M_s → Mass of sun

- **Universal law of Gravitation** $\boxed{F = G\dfrac{m_1 m_2}{r^2}}$

Vector form → $\boxed{\vec{F} = -G\dfrac{m_1 m_2}{|\vec{r}|^3}\hat{r}}$

$G = 6.67 \times 10^{-11}\ N\text{-}m^2/Kg^2$
(Universal Gravitational constant)

- **Intensity of Gravitational field** $\boxed{\vec{I} = \dfrac{\vec{F}}{m}}$

- **Force between earth & object of mass m at surface** $\boxed{F = \dfrac{GM_e m}{R_e^2}}$

- **Relation between 'g' and 'G'** $\boxed{g = \dfrac{GM_e}{R_e^2}}$

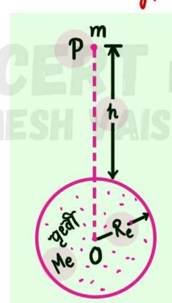
g = Acceleration due to earth's gravity
M_e = Mass of earth
R_e = Radius of earth
ρ = Density of earth

- **Computation of Mass and Density of Earth** $\boxed{M_e = \dfrac{gR_e^2}{G}}$ $\boxed{\rho = \dfrac{3g}{4\pi R_e G}}$

$M_e = 6.0 \times 10^{24}$ $\rho = 5.5 \times 10^3\ Kg/m^3$

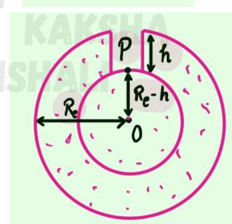
- **Variation in acceleration due to gravity above the surface of the earth**

$$\boxed{g' = \frac{g}{\left(1 + \frac{h}{R_e}\right)^2}} \quad \text{OR} \quad \boxed{g' = \frac{GM_e}{(R_e + h)^2}}$$

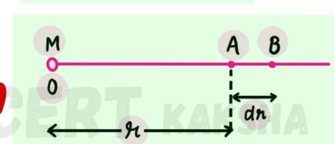


- **Variation in acceleration due to gravity below the surface of the earth**

$$\boxed{g' = g\left(1 - \frac{h}{R_e}\right)} \quad \text{OR} \quad \boxed{g' = \frac{GM_e}{R_e^2}\left(1 - \frac{h}{R_e}\right)}$$



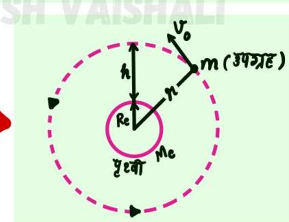
- **Gravitational Potential** $\boxed{V = -\dfrac{W}{m}}$ OR $\boxed{V = -\dfrac{GM}{r}}$



- **Gravitational Potential Energy** $\boxed{U = -\dfrac{GMm}{r}}$

- **Speed of Satellite** $\boxed{v_0 = \sqrt{gR_e}}$ v_0 = orbital velocity

- **Period of Revolution of Satellite** $\boxed{T = \sqrt{\dfrac{3\pi}{G\rho}}}$



➡ Total Energy of Satellite $\boxed{E = -\frac{1}{2}\frac{GM_e m}{R_e}}$

➡ Binding Energy of Satellite $= \boxed{+\frac{1}{2}\frac{GM_e m}{R_e} = +\frac{1}{2} mgR_e}$

➡ Geostationary Satellite $\boxed{R_e + h = \left(\frac{T^2 g R_e}{4\pi^2}\right)^{1/3}}$ for $T = 24$ hours
$h \simeq 35745$ km

➡ Escape Energy $= \boxed{+\frac{GM_e m}{R_e}}$ Escape Velocity $\boxed{v_e = \sqrt{\frac{2GM_e}{R_e}}}$ OR $\boxed{v_e = \sqrt{2gR_e}}$

➡ Relation between v_0 and v_e $\boxed{v_e = \sqrt{2}\, v_0}$

➡ Total Energy of a system of Mass M & circularly moving mass m about M of radius a

$\boxed{E = -\frac{GMm}{2a}}$ $\boxed{K.E. = \frac{GMm}{2a}}$ $\boxed{P.E. = -\frac{GMm}{a}}$

Your only limit is your mind

UNIT- VII (PROPERTIES OF BULK MATTER)

CHAPTER - 8

Mechanical properties of solids

- Stress $= \dfrac{\text{Restoring force}}{\text{Area}} = \dfrac{F}{A}$

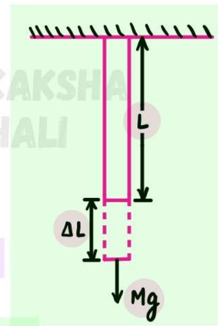
- Strain
  - Longitudinal strain $= \dfrac{\Delta L}{L}$
  - Shearing strain $= \dfrac{\Delta x}{L} = \tan\theta$
  - Volume strain $= \dfrac{\Delta V}{V}$

- Hookey's law: Stress $\propto$ Strain

- $E = \dfrac{\text{Stress}}{\text{Strain}}$ E = Modulus of elasticity

- Young's modulus of elasticity: $Y = \dfrac{\sigma}{\varepsilon} = \dfrac{MgL}{\pi r^2 \Delta L}$ $\quad Y_{steel} > Y_{rubber}$

  σ = longitudinal stress , ε = longitudinal strain

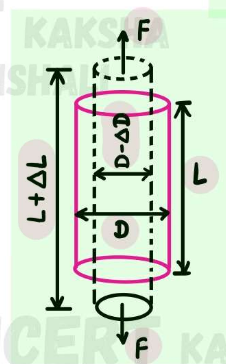


- Bulk modulus of elasticity: $B = \dfrac{\text{Normal Stress}}{\text{Volume strain}} = -\dfrac{PV}{\Delta V}$

- Compressibility: $\beta = \dfrac{1}{B} = \dfrac{-\Delta V}{PV}$

- Modulus of Rigidity OR Shear Modulus: η or $G = \dfrac{F}{A\theta}$

- Poisson's Ratio: $\sigma = \dfrac{\Delta r L}{\Delta L r}$



- Force produced in cooling a wire stretched between two rigid supports: $F = YA\alpha\Delta t$

- Work done in stretching a wire and Elastic Potential Energy

  $W = U = \dfrac{1}{2} \times \text{Stress} \times \text{Strain} \times \text{Volume}$ $\qquad W = \dfrac{1}{2}\dfrac{YA}{L}x^2$

- Energy density: $u = \dfrac{1}{2} \times \text{Stress} \times \text{Strain}$ and $u = \dfrac{1}{2} \times \text{Young's Modulus} \times (\text{Strain})^2$

- Bend in a road (bar) of length (l) by a load W at centre

  $\delta = \dfrac{Wl^3}{4bd^3Y}$

  b = breadth of bar
  d = depth of bar
  Y = Young's Modulus

UNIT- VII (PROPERTIES OF BULK MATTER)

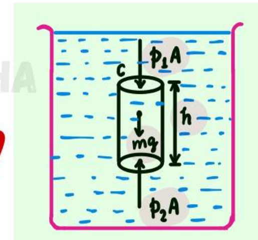
CHAPTER - 9

Mechanical properties of fluids

- **Pressure** $\boxed{P = \frac{F}{A}}$ OR $\boxed{P = \frac{dF}{dA}}$

- **Volume density** $\boxed{\rho = \frac{m}{V}}$

- **Effect of gravity on fluid pressure** $\boxed{P = P_2 - P_1 = h\rho g}$



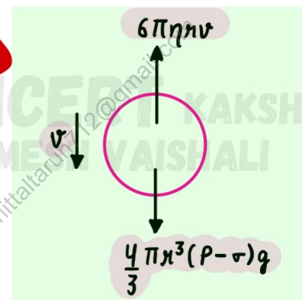
η = viscosity , D = Diameter of pipe , R_e = Reynold No.

- **Critical velocity of a liquid** $\boxed{v_c = \frac{R_e \eta}{\rho D}}$

- **Reynold number** $\boxed{R_e = \frac{\rho v d}{\eta}}$

- **Coefficient of viscosity** $\boxed{F = \pm \eta A \frac{\Delta v_x}{\Delta z}}$ $\boxed{\eta = \frac{F l}{v A}}$ $\boxed{\frac{\text{Stress}}{\text{Strain rate}}}$

- **Terminal velocity** $\boxed{v = \frac{2}{9} \frac{r^2(\rho - \sigma) g}{\eta}}$



- **Principal of continuity** $\boxed{A \times v = \text{constant}}$

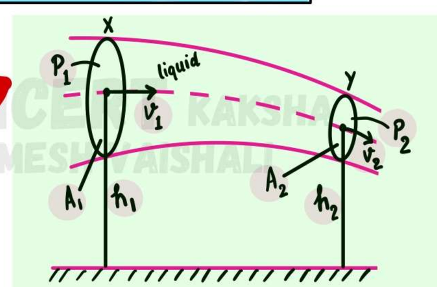
- **Kinetic Energy** $\boxed{K = \frac{1}{2}\rho v^2}$

- **Potential Energy** $\boxed{U = \rho g h}$

- **Bernoulli Theorem**

$\boxed{P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}}$ OR $\boxed{P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2}$

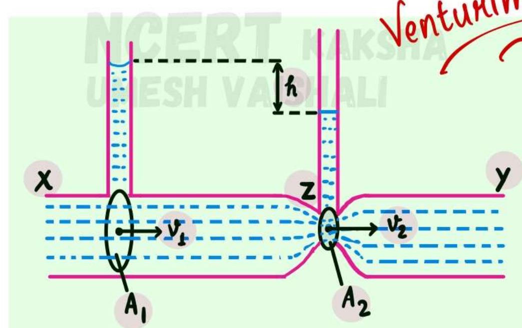
$\boxed{\frac{P}{\rho g} + \frac{v^2}{2g} + h = \text{constant}}$



$\boxed{P + \frac{1}{2}\rho v^2 = \text{constant}}$ If $h_1 = h_2$

$\boxed{\frac{P}{\rho g} = \text{Pressure head}}$ $\boxed{\frac{v^2}{2g} = \text{velocity head}}$ $\boxed{h = \text{gravitational head}}$

Venturimeter



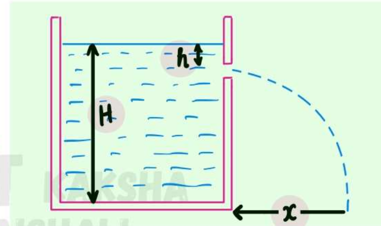
- **Venturimeter** $\boxed{v_1 = \sqrt{\frac{2\rho_m g h}{\rho}} \left[\left(\frac{A}{a}\right)^2 - 1\right]^{-1/2}}$

- **Velocity gradient** = $\boxed{\frac{\Delta v}{\Delta z}}$

- **Velocity of Efflux of a liquid** $\boxed{v = \sqrt{2gh}}$ (Torricell's Theorem)

$$\boxed{t = \sqrt{\frac{2(H-h)}{g}}} \qquad \boxed{x = 2\sqrt{h(H-h)}} \qquad \boxed{x_{max} = H}$$

H = height of fluid level
h = height of orifice from top



- **Work done in increasing the surface area of free space of the liquid**

$$\boxed{F = T \times 2l} \qquad \boxed{W = T \times 2l \times \Delta x} \qquad \boxed{W = T \times \Delta A}$$

- **For drops and bubbles** $\boxed{P_i - P_o = 2\frac{S_{la}}{r}}$

- **Angle of contact** $\boxed{S_{la}\cos\theta + S_{al} = S_{sa}}$

S_{la} = Interfacial tension at liquid - Air interface
S_{sl} = Interfacial tension at solid - liquid interface
S_{sa} = Interfacial tension at solid - Air interface

- **Excess of Pressure**

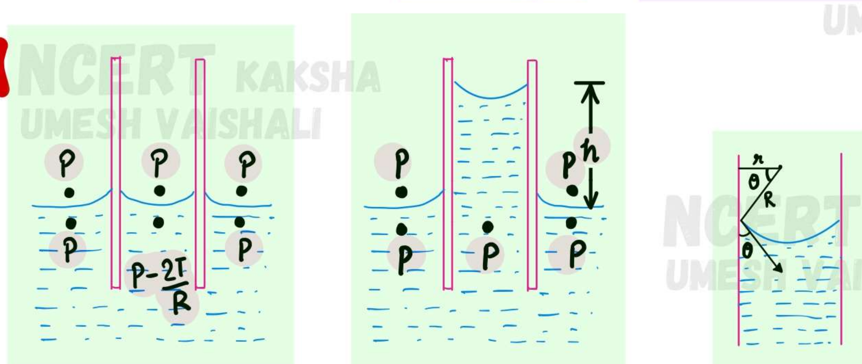
(i) Excess of Pressure inside a liquid drop $\boxed{P = \frac{2T}{R}}$

(ii) Excess of Pressure inside in an air bubble in a liquid $\boxed{P = \frac{2T}{R}}$

(iii) Excess of Pressure inside a bubble of a soap solution $\boxed{P = \frac{4T}{R}}$

- **Capillary** $\boxed{h\rho g = \frac{2T}{R}}$ $\boxed{h = \frac{2T\cos\theta}{r\rho g}}$

r = radius of capillary
R = radius of meniscus



UNIT- VII (PROPERTIES OF BULK MATTER)

CHAPTER- 10

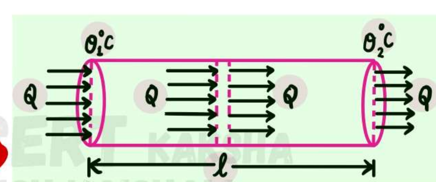
Thermal properties of matter

- **Scale of Temperature** $T_F = 32^\circ + \frac{9}{5} T_C$
- **Ideal gas Equation** For 1 mole, $PV = RT$ For μ mole, $PV = \mu RT$
- **Absolute Temperature** $T = T_C + 273.15$ (T in kelvin, T_C in °C)

  $R = 8.31\ J\ Mol^{-1} K^{-1}$ (Universal gas constant)
- **Thermal Expansions of solids**
- **Coefficient of linear Expansion** (α OR α_e) $\alpha_e = \frac{\Delta L}{L \times \Delta t}$
- **Coefficient of Superficial Expansion** (β OR α_A) $\alpha_A = \frac{\Delta A}{A \times \Delta t}$
- **Coefficient of Volume Expansion** (γ OR α_V) $\alpha_V = \frac{\Delta V}{V \times \Delta t}$
- **Relation between α and β** $\beta = 2\alpha$ OR $\alpha_A = 2\alpha_e$
- **Relation between γ and α** $\gamma = 3\alpha$ OR $\alpha_V = 3\alpha_e$
- **Relation between β and γ** $3\beta = 2\gamma$ OR $3\alpha_A = 2\alpha_V$
- **Relation between α, β and γ** $\alpha : \beta : \gamma = 1 : 2 : 3$ OR $\alpha_e : \alpha_A : \alpha_V = 1 : 2 : 3$
- **Variation of density with temperature of liquids** $d_t = d_0(1 - \gamma_r t)$
- **Heat Capacity** $S = \frac{\Delta Q}{\Delta t}$ **Specific Heat Capacity** $s = \frac{S}{m} = \frac{1}{m}\frac{\Delta Q}{\Delta t}$
- **Heat Capacity per mole** $C = \frac{S}{\mu} = \frac{1}{\mu}\frac{\Delta Q}{\Delta t}$ **Calorimeter** $W = mc$
- **Principal of Calorimeter** Heat lost = Heat taken OR $m_1 c_1 (t_1 - t) = m_2 c_2 (t - t_2)$
- **Coefficient of thermal conductivity** $Q = KA\frac{(\theta_1 - \theta_2)t}{l}$

  Q = Heat flowed

  K = thermal conductivity



- **Latent Heat** $L = \frac{Q}{m}$
- **Rate of Heat flowed** OR **Heat current** $H = \frac{Q}{t} = KA\frac{\theta_1 - \theta_2}{l}$ OR $H = KA\frac{T_C - T_D}{L}$
- **Thermal Radiation** $I \propto \frac{1}{\lambda^2}$ $\lambda_{radiation} > \lambda_{light}$

➡ Thermal Resistance $R = \frac{\theta_1 - \theta_2}{H} = \frac{l}{KA}$

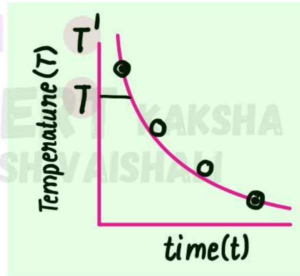
➡ Emissivity $e = \frac{Q}{A \times t}$

➡ Kirchoff's law $\frac{e_\lambda}{a_\lambda} = E_\lambda$

e_λ = Spectral Emissive power
a_λ = Spectral absorption power
E_λ = Emissive power of black body
σ = Stefan's constant

➡ Stefan's law $E = \sigma T^4$

➡ Newton's law of colling $\frac{-dQ}{dt} = K(T_2 - T_1)$ and $\log_e(T_2 - T_1) = -KT + c$



➡ Wien's law $\lambda_m \times T = b$ λ_m = wave length , T = Temperature

Note : 1. $T_{low} \leq T_{mixture} \leq T_{High}$

2. $T_{mixture} = \frac{m_1 s_1 T_1 + m_2 s_2 T_2}{m_1 s_1 + m_2 s_2}$

Take the Risk
OR
Loose the chance

UNIT-VIII (THERMODYNAMICS)

CHAPTER-11

Thermodynamics

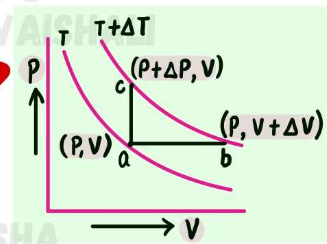
➡ Equivalence of Work and heat $\boxed{W = JH}$

➡ Work $\boxed{W = P(V_2 - V_1)}$ OR $\boxed{W = P\Delta V}$

➡ First law of thermodynamics $\boxed{\Delta U = \Delta Q - \Delta W}$ OR $\boxed{\Delta U = \Delta Q - P\Delta V}$

➡ Mayer's formula $\boxed{C_p - C_v = R}$ $\boxed{C_v = \left(\frac{\Delta Q}{\Delta t}\right)_v = \left(\frac{\Delta U}{\Delta t}\right)_v}$ $\boxed{C_p = \left(\frac{\Delta Q}{\Delta t}\right)_p = \left(\frac{\Delta U}{\Delta t}\right)_p + P\left(\frac{\Delta V}{\Delta T}\right)_p}$

➡ Isothermal process (T constant) $\boxed{W = \mu RT \ln \frac{V_2}{V_1}}$



➡ Isochoric process $\boxed{V = \text{constant}}$

➡ Isobaric process $\boxed{P = \text{constant}}$ $\boxed{W = P(V_2 - V_1) = \mu R(T_2 - T_1)}$

➡ Adiabatic process $\boxed{PV^\gamma = \text{constant}}$ $\boxed{TV^{\gamma-1} = \text{constant}}$ $\boxed{\frac{T^\gamma}{P^{\gamma-1}} = \text{constant}}$

$\boxed{\gamma = \frac{C_p}{C_v}}$ $\boxed{W = \frac{\mu R(T_1 - T_2)}{\gamma - 1}}$

➡ Cyclic Process $\boxed{\Delta U = 0}$

➡ Total Internal Energy of an ideal gas $\boxed{U = \frac{1}{2} fRT}$

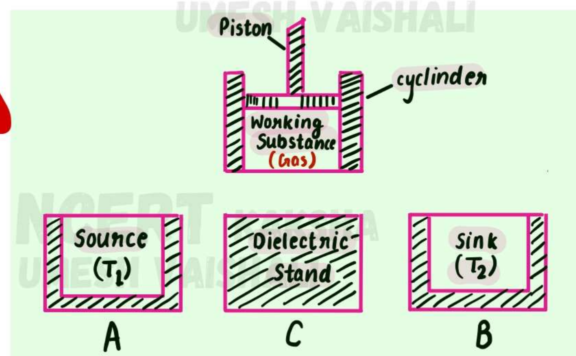
$\boxed{C_v = \frac{1}{2} fR}$ $\boxed{C_p = \left(\frac{f}{2} + 1\right)R}$ $\boxed{\gamma = 1 + \frac{2}{f}}$

➡ Refrigerators and heat pump

$\boxed{\alpha = \frac{Q_2}{W}}$ $\boxed{Q_1 = W + Q_2}$ $\boxed{\alpha = \frac{Q_2}{Q_1 - Q_2}}$

➡ Heat Engine $\boxed{W = Q_1 - Q_2}$ $\boxed{\eta = \frac{W}{Q_1}}$

$\boxed{\eta = \frac{1}{2} fR}$ OR $\boxed{\eta = 1 - \frac{T_2}{T_1}}$ $\because \frac{Q_1}{Q_2} = \frac{T_1}{T_2}$



➡ Second law of thermodynamics

Efficiency of a heat engine can't be unity

i.e. $\eta \neq 1$ for heat engine

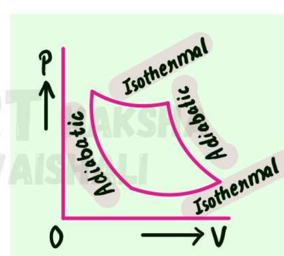
➡ Carnot cycle

1. Isothermal Expansion $\boxed{W_1 = RT_2 \log_e \frac{V_2}{V_1}}$ (T = constant)

2. Adiabatic Expansion $\boxed{W_2 = \frac{R}{1-\gamma}(T_2 - T_1)}$ (PV^γ = constant)

3. Isothermal Compression $\boxed{W_3 = -RT_2 \log_e \frac{V_3}{V_4}}$

4. Adiabatic Compression $\boxed{W_4 = \frac{R}{1-\gamma}(T_1 - T_2)}$



➡ Important Rules

If $Q > 0$ heat is added to the system.

If $Q < 0$ heat is removed to the system.

If $W > 0$ is done by the system.

If $W < 0$ is done on the system.

UNIT- IX (BEHAVIOUR OF PERFECT GASES AND KINETIC THEORY OF GASES)

CHAPTER- 12

Kinetic theory

- **Boyel's law** At constant T $\boxed{V \propto \frac{1}{P}}$ OR $\boxed{PV = \text{constant}}$ $\boxed{P_1V_1 = P_2V_2}$

- **Charle's law** At constant P $\boxed{V \propto T}$ OR $\boxed{\frac{V}{T} = \text{constant}}$ $\boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$

- **Ideal Gas Equation** $\boxed{PV = \mu RT}$ For μ mole $\boxed{PV = RT}$ For 1 mole

$\boxed{\mu = \frac{M}{M_0} = \frac{N}{N_A}}$

M = Mass of Gas , R = 8.31 J/ Mol - K (Universal Gas constant)
N = No. of molecules
N_A = Avagadro's no.

- **Dalton's law of Partial Pressure** $\boxed{P = \mu_1\frac{RT}{V} + \mu_2\frac{RT}{V} + \ldots\ldots = P_1 + P_2 + \ldots\ldots}$

$\boxed{P = \frac{\rho RT}{M_0}}$ M_0 = Molar Mass

- **Formula for the pressure of an ideal gas** V ← Volume $\boxed{P = \frac{1}{3}\frac{mn}{V}\overline{v^2}}$ OR $\boxed{P = \frac{1}{3}\rho\overline{v^2}}$

for Per unit volume, $\boxed{P = \frac{1}{3}mn\overline{v^2}}$

- **Root mean square velocity** $\boxed{\overline{v^2} = \frac{3RT}{M}}$ $\boxed{v_{rms} = \sqrt{\frac{3RT}{M}}}$ $\boxed{v_{rms} \propto \sqrt{T}}$

- **Kinetic Interpretation of Temperature** $\boxed{\frac{E}{N} = \frac{3}{2}K_BT}$

If $n = 1$ $\boxed{E = \frac{3}{2}K_BT}$ (K.E. for 1 atom)

- **Real gas Equation** $\boxed{\left(P + \frac{a}{V^2}\right)(V - b) = RT}$

- **Graham's law of diffusion** $\boxed{\frac{v_{1\,rms}}{v_{2\,rms}} = \frac{R_1}{R_2} = \sqrt{\frac{M_2}{M_1}}}$ R = Rate of diffusion

- **Law of Equipartition of Energy**

$\boxed{E_t = \frac{1}{2}mv_x^2 + \frac{1}{2}mv_y^2 + \frac{1}{2}mv_z^2}$ $\boxed{E_{xyz} = \frac{3}{2}K_BT}$ OR $\boxed{E_x = E_y = E_z = \frac{1}{2}K_BT}$

K_B = Boltzmann's constant

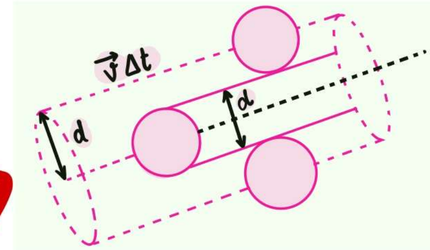
- **Specific Heat Capacity**

1. Monoatomic Gas $\boxed{C_p = \frac{5}{2}R}$ $\boxed{C_v = \frac{3}{2}R}$ $\boxed{\gamma = \frac{5}{3}}$ (γ → Gamma)
2. Diatomic Gas $\boxed{C_p = \frac{7}{2}R}$ $\boxed{C_v = \frac{5}{2}R}$ $\boxed{\gamma = \frac{7}{5}}$
3. Polyatomic Gas $\boxed{C_p = (4+f)R}$ $\boxed{C_v = (3+f)R}$ $\boxed{\gamma = \frac{4+f}{3+f}}$

4. Specific heat capacity of solids $\boxed{C = 3R}$

5. Specific heat capacity of water $\boxed{C = 9R}$

→ Mean free Path $\boxed{\lambda \text{ OR } \bar{l} = \dfrac{1}{\sqrt{2}\,\pi d^2 n}}$



for N atoms, $\boxed{\lambda = \dfrac{K_B T}{\sqrt{2}\,\pi d^2 p}}$ where, $n = \dfrac{N}{V} = \dfrac{p}{K_B T}$

Good things take time

UNIT- X (OSCILLATIONS AND WAVES)

CHAPTER- 13

Oscillations

➡ **Relation between ν and T** (ν ↳ frequency) $\boxed{\nu = \frac{1}{T}}$

➡ **Time period** $\boxed{T = \frac{2\pi}{\omega}}$

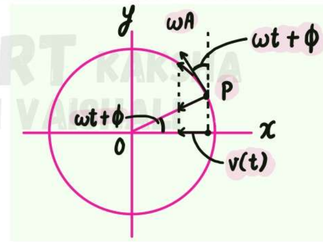
➡ **Displacement Equation of Simple Harmonic Motion** (S.H.M.)

$$\boxed{x(t) = A\cos(\omega t + \phi)}$$

$$\boxed{y(t) = A\sin(\omega t + \phi)}$$

➡ **Velocity in S.H.M.** $\boxed{v(t) = -\omega A\sin(\omega t + \phi)}$ $\boxed{v(t) = \frac{d}{dx}x(t)}$

➡ **Acceleration in S.H.M.** $\boxed{a = -\omega^2 x(t)}$



➡ **Time - Displacement curve of S.H.M.** $\boxed{y = a\sin\left[2\pi\frac{t}{T}\right]}$

➡ **Force law in Simple Harmonic motion (spring)**

$\boxed{F = -kx}$ $\boxed{\omega = \sqrt{\frac{k}{m}}}$ $\boxed{T = 2\pi\sqrt{\frac{m}{2k}}}$

ω = angular frequency
T = Time period

➡ **Potential Energy in S.H.M.** $\boxed{U = \frac{1}{2}m\omega^2 y^2}$ OR $\boxed{U = \frac{1}{2}KA^2\cos^2(\omega t + \phi)}$

➡ **Kinetic Energy in S.H.M.** $\boxed{K = \frac{1}{2}m\omega^2(a^2 - y^2)}$ OR $\boxed{K = \frac{1}{2}KA^2\sin^2(\omega t + \phi)}$

➡ **Total Energy in S.H.M.** $\boxed{E = \frac{1}{2}m\omega^2 a^2 = 2\pi^2 mn^2 a^2}$ OR $\boxed{E = \frac{1}{2}KA^2}$

➡ **Time period of S.H.M.** $\boxed{T = 2\pi\sqrt{\frac{m}{K}}}$ & $\boxed{\omega = \sqrt{\frac{mgL}{I}}}$

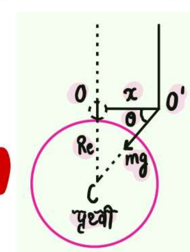
➡ **Motion of body suspended by two springs** $\boxed{T = 2\pi\sqrt{\frac{m}{K_1 + K_2}}}$ $\boxed{T = 2\pi\sqrt{m\left(\frac{1}{K_1} + \frac{1}{K_2}\right)}}$

➡ **Time period of simple pendulum** $\boxed{T = 2\pi\sqrt{\frac{l}{g}}}$

➡ **Second's Pendulum** $\boxed{l = \frac{g}{\pi^2} \simeq 1\,m}$

R_e = Radius of Earth (6.4×10^6 m)

➡ **Time period of a Simple Pendulum of infinite length** $\boxed{T = 2\pi\sqrt{\frac{R_e}{g}}}$

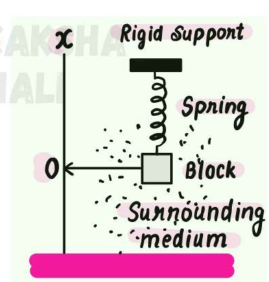


➡ **Electromagnetic Resonance frequency** $\boxed{f = \frac{1}{2\pi\sqrt{LC}}}$

➡ **Damped Simple Harmonic motion** $\boxed{x(t) = Ae^{-bt/2m}\cos(\omega' t + \phi)}$

$\boxed{\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}}$ $\boxed{E(t) = \frac{1}{2}KA^2 e^{-bt/m}}$

ω' = angular frequency



➡ **Forced oscillations** $\boxed{F(t) = F_0\cos\omega_d t}$ $\boxed{x(t) = A\cos(\omega_d + \phi)}$

$$A = \frac{F_0}{\{m^2(\omega^2-\omega_d^2)^2 + \omega_d^2 b^2\}^{1/2}}$$

ω = natural frequency
ω_d = driven frequency
A = Amplitude

&

$$\tan\phi = \frac{-v_0}{\omega_d x_0}$$

(a) Small Damping, driving frequency far from natural frequency $\boxed{A = \frac{F_0}{m(\omega^2-\omega_d^2)}}$

(b) Driving frequency close to natural frequency $\boxed{A = \frac{F_0}{\omega_d b}}$

Note :- Amplitude oscillations is greatest when $\boxed{\omega_d = \omega}$

This is the condition for Resonance.

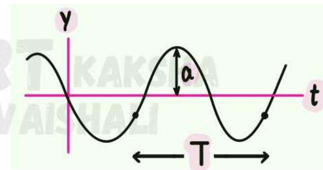
Failure is Success in Progress

UNIT-X (OSCILLATIONS AND WAVES)

CHAPTER-14

Waves

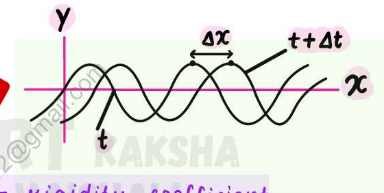
- **Wave Speed** $v = \frac{\lambda}{T}$ OR $v = n\lambda$
- **Time Period** $T = \frac{2\pi}{\omega}$
- **Wave number** $\bar{\nu} = \frac{1}{\lambda}$
- **Angular frequency** $\omega = 2\pi n$
- **Propagation constant** $K = \frac{2\pi}{\lambda}$ OR $v = \frac{\omega}{k}$
- **frequency** $\nu = \frac{\omega}{2\pi} = \frac{1}{T}$
- **Wave Equation** $y(x,t) = a \sin(kx \pm \omega t + \phi)$



$$y(x,t) = A \sin(kx - \omega t) + B \cos(kx - \omega t)$$

$$a = \sqrt{A^2 + B^2} \qquad \tan\theta = \frac{B}{A}$$

- **The speed of travelling wave** $v = \lambda\nu = \frac{\lambda}{T}$



- **Speed of transverse wave in solid** $v = \sqrt{\frac{\eta}{d}}$ — η = rigidity coefficient
- **Speed of transverse wave in stretched string** $v = \sqrt{\frac{T}{\mu}}$ — T = tension of the string, μ = linear mass density
- **Speed of longitudinal wave in liquid** $v = \sqrt{\frac{\beta}{\rho}}$ — β = Bulk modulus
- **Speed of longitudinal wave in solid** $v = \sqrt{\frac{Y}{\rho}}$ — Y = Young's modulus
- **Speed of longitudinal wave in gases OR sound in gases** $v = \sqrt{\frac{P}{\rho}}$ — P = initial Pressure
- **Laplace correction** $v = \sqrt{\frac{\gamma P}{\rho}}$ — ρ = density
- **Effect of temperature on the speed of longitudinal wave** $v = \frac{\gamma RT}{M}$ OR $\frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}}$
- **Relation between v and v_{rms}** $v = \left(\sqrt{\frac{\gamma}{3}}\right) v_{rms}$
- **Principle of Superposition** $y(x,t) = y_1(x,t) + y_2(x,t)$
- **Relation between Phase difference and Path difference of two particles in progressive wave**

$$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x \qquad \Delta\phi = \frac{2\pi}{\lambda} \times \Delta t$$

- **Velocity Amplitude and Acceleration amplitude of a particle in a progressive wave**

Velocity Amplitude $u_{max} = \omega a$ — Acceleration Amplitude $f_{max} = -\omega^2 a$

- **Equation of Stationary wave** $y = 2a \cos\frac{2\pi x}{\lambda} \sin\frac{2\pi t}{T}$ — $y = -2a \sin\frac{2\pi x}{\lambda} \cos\frac{2\pi t}{T}$

Beat frequency $\nu_{beat} = \nu_1 - \nu_2$

Normal Modes $\nu = \frac{nv}{2L}$ & $\nu = \left(n + \frac{1}{2}\right)\frac{v}{2L}$

Modes of Vibration of Air column in closed organ pipe $\lambda = \frac{4l}{2m-1}$

1. First mode of vibration $m = 1$ $\lambda_1 = 4l$ $f_1 = \frac{v}{4l}$
2. Second mode of vibration $m = 2$ $\lambda_2 = \frac{4l}{3}$ $f_2 = \frac{3v}{4l}$ $\Rightarrow$ $f_2 = 3f_1$
3. Third mode of vibration $m = 3$ $\lambda_3 = \frac{4l}{5}$ $f_3 = \frac{5v}{4l}$ $\Rightarrow$ $f_3 = 5f_1$

Modes of Vibration of Air column in open organ pipe

$\lambda = \frac{2l}{m}$ $f_m = \frac{v}{\lambda_m} = \frac{mv}{2l}$ $f_1 : f_2 : f_3 = 1 : 2 : 3$

End Correction

Open Pipe $f = \frac{v}{2(l + 1.2r)}$

Closed Pipe $f = \frac{v}{4(l + 0.6r)}$

Doppler Effect

1. Source moving observer stationary $\nu = \nu_0\left(1 + \frac{v_s}{v}\right)$ $\nu = \nu_0\left(1 - \frac{v_s}{v}\right)$
2. Observer moving source stationary $\nu = \nu_0\left(1 + \frac{v_o}{v}\right)$
3. Both source and observer moving $\nu = \nu_0\left(\frac{v + v_o}{v + v_s}\right)$

ν = frequency of wave
ν_0 = frequency at $t = \sqrt{0}$
v = velocity of wave
v_s = velocity of source
v_o = velocity of observer

Umesh Bhaiya ❤
Always with you

Vaishali Didi ❤
Always with you

PHYSICAL QUANTITIES	FORMULAS	DIMENSION FORMULA	SI UNIT
Electric current (I)	Fundamental unit	$[M^0L^0T^0A]$	A (ampere)
Electric current density (j)	$\frac{\text{current}}{\text{area}}$	$[M^0L^{-2}T^0A]$	$A\,m^{-2}$
Electric charge (q)	current X time	$[M^0L^0T^0A]$	C (coulomb)
Electric potential (V)	$\frac{\text{work}}{\text{charge}}$	$[ML^2T^{-3}A^{-1}]$	V (volt)
Electric field intensity (E)	$\frac{\text{force}}{\text{charge}}$	$[MLT^{-3}A^{-1}]$	NC^{-1}
Permittivity of free space (ε_0)	$\frac{\text{charge} \times \text{charge}}{\text{force} \times \text{distance}^2}$	$[M^{-1}L^{-3}T^{-4}A^{-2}]$	C^2Nm^{-2}
Electric flux (ϕ_E)	electric field X area	$[ML^3T^{-3}A^{-1}]$	Nm^2C^{-1}
Electric capacitance (C)	$\frac{\text{charge}}{\text{potential difference}}$	$[M^{-1}L^{-2}T^4A^{-2}]$	F (farad)
Surface charge density (σ)	$\frac{\text{charge}}{\text{area}}$	$[M^0L^{-2}TA]$	$C\,m^{-2}$
Volume charge density (ρ)	$\frac{\text{charge}}{\text{volume}}$	$[M^0L^{-3}TA]$	$C\,m^{-3}$
Electric dipole moment (P_e)	charge X length	$[M^0LTA]$	C m
Electric resistance (R)	$\frac{\text{potential difference}}{\text{current}}$	$[ML^2T^{-3}A^{-2}]$	Ω (ohm)
Resistivity (ρ)	$\frac{\text{resistance} \times \text{area}}{\text{length}}$	$[ML^3T^{-3}A^{-2}]$	$\Omega\,m$
Electric conductance (G)	$\frac{1}{\text{resistance}}$	$[M^{-1}L^{-2}T^3A^2]$	S (siemen) or Ω^{-1} (mho)
Conductivity (σ)	$\frac{1}{\text{resistivity}}$	$[M^{-1}L^{-3}T^3A^2]$	Sm^{-1} or $\Omega^{-1}m^{-1}$
Coefficient of self induction (L) or mutual induction (M)	$\frac{\text{e.m.f.} \times \text{time}}{\text{current}}$	$[ML^2T^{-2}A^{-2}]$	H (henry)
Inductive reactance (X_L)	ωL	$[ML^2T^{-2}A^{-2}]$	Ω

Capacitive reactance (X_C)	$\frac{1}{\omega C}$	$[ML^2T^{-3}A^{-2}]$	Ω
Power factor ($\cos\phi$)	Trigonometric ratio	Dimensionless	No unit
Resonant angular frequency (ω_0)	$\frac{1}{\sqrt{LC}}$	$[M^0L^0T^{-1}]$	Hz
Quality factor (Q)	$\frac{\omega_0 L}{R}$	$[M^0L^0T^0]$	No unit
Permeability of free space (μ_0)	$\frac{2\pi \times \text{force} \times \text{distance}}{\text{current}^2 \times \text{length}}$	$[MLT^{-2}A^{-2}]$	NA^{-2} or $Wb\,A^{-1}\,m^{-1}$
Magnetic pole strength (m)	$\frac{4\pi \times \text{force} \times \text{distance}^2}{\mu_0}$	$[M^0LT^0A]$	A m
Magnetic dipole moment (P_m)	pole strength × distance	$[M^0L^2T^0A]$	A m^2
Magnetic induction (B)	$\frac{\mu_0 \times \text{current}}{2\pi \times \text{distance}}$	$[ML^0T^{-2}A^{-1}]$	$Nm^{-1}A^{-1}$ or tesla (T)
Magnetic flux (ϕ_B)	B × area	$[ML^2T^{-2}A^{-1}]$	NmA^{-1} or weber (Wb)
Coefficient of self induction (L) or mutual induction (M)	$\frac{\text{magnetic flux}}{\text{current}}$	$[ML^2T^{-2}A^{-2}]$	H (henry)
Magnetic intensity (H)	$\frac{\text{magnetic induction}}{\mu_0}$	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$
Intensity of magnetisation (I)	$\frac{\text{magnetic moment}}{\text{volume}}$	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$
Coercivity	H (opposing)	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$
Retentivity	I (residual)	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$

Thank You