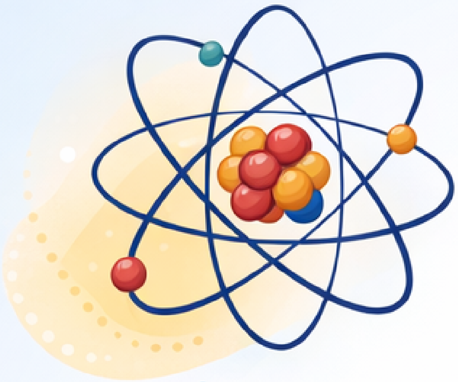
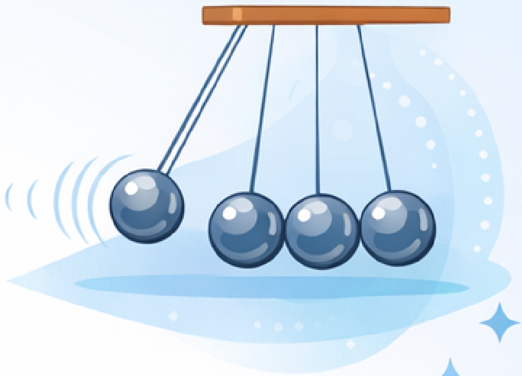
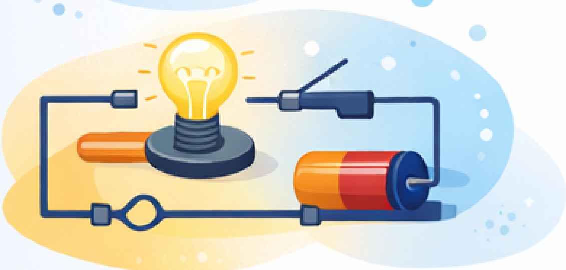
STUDY MATERIAL





PHYSICS

(For PM SHRI Schools)



Prepared By: Dr. Dinesh Kumar, Lecturer Physics, Govt. Victoria Girls Senior Secondary School, Patiala (Mob: 9501399770)

Reviewed By: Sh. Hemraj, Lecturer Physics, SOE GSSS Kapurthala.

Supervised By: Smt. Jasvinder Kaur Assistsnt Director State Sr. Sec. Science Co- ordinator (PCB)

PM SHRI SCHOOL

Academic Session **2025–26**

CLASS: 11th

1. Least count of Screw Gauge

$$= \frac{\text{Value of one part on main scale } (S)}{\text{Number of parts on circular scale } (n)}$$

2. Average Speed, $v_{av} = \dfrac{\text{Distance travelled } (\Delta s)}{\text{Time taken } (\Delta t)}$

Average Velocity, $\vec{v}_{av} = \dfrac{\text{Displacement } (\Delta \vec{r})}{\text{Time taken } (\Delta t)}$

3. Averege Acceleration,

$$\vec{a}_{av} = \frac{\text{Change in Velocity } (\Delta \vec{v})}{\text{Time taken } (\Delta t)}$$

4. Instantaneous Speed, $v = \lim_{\Delta t \to 0} \dfrac{\Delta s}{\Delta t} = \dfrac{ds}{dt}$

. Instantaneous Velocity, $\vec{v} = \lim_{\Delta t \to 0} \dfrac{\Delta \vec{r}}{\Delta t} = \dfrac{d\vec{r}}{dt}$

5. When a particle covers one-third distance at speed v_1, next one-third at speed v_2 and last one-third at speed v_3, then

$$v_{av} = \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$$

6. For uniformly accelerated motion ($\vec{a}$ = constant) equations of motion are as under

$$\vec{v} = \vec{u} + \vec{a}t \qquad \text{...(i)}$$

$$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2 \qquad \text{...(ii)}$$

$$\vec{v} \cdot \vec{v} = \vec{u} \cdot \vec{u} + 2\vec{a}\vec{s} \qquad \text{...(iii)}$$

Where

$\vec{u}$ = initia; velocity, $\vec{v}$ = velocity at time t

$\vec{s}$ = displacement of particle at time t

7. When particle is not uniformly accelerated ie, acceleration of particle is not constant or acceleration is a function of time then the following relations hold for 1-dimensional motion.

(i) $v = \dfrac{ds}{dt}$ (ii) $a = \dfrac{dv}{dt} = v\dfrac{dv}{ds}$

(iii) ds = vdt (iv) dv = adt or vdv = ads

8. For straight line motion upward and downward motion under the effect of gravity, then

$$v = u \pm gt \qquad h = ut \pm \frac{1}{2}gt^2$$

$v^2 = u^2 \pm 2gh$ where g = acceleration due to gravity and take +ve to downward and - ve to upward motion,

9. For two particles having displacement-time graph with slope θ_1 and for θ_2 possesses velocities v_1 and v_2 respectively, then $\dfrac{v_1}{v_2} = \dfrac{\tan\theta_1}{\tan\theta_2}$

10. For a particle accelerated for a time t_1 with acceleration a_1 and for t_2 with acceleration a_2, then average acceleration is $a_{av} = \dfrac{a_1t_1 + a_2t_2}{t_1 + t_2}$

11. Scalar or Dot Product of Unit Vectors

(i) $\hat{i} \cdot \hat{i} = \hat{j} \cdot \hat{j} = \hat{k} \cdot \hat{k} = 1$ (ii) $\hat{i} \cdot \hat{j} = \hat{j} \cdot \hat{k} = \hat{k} \cdot \hat{i} = 0$

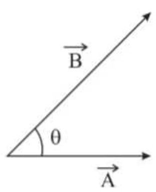
where $\hat{i}$, $\hat{j}$ and $\hat{k}$ are orthogonal unit vectors.

12. Vector Product or Cross Product of Unit Vectors

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

(ii) $\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$

13. $\vec{A} \cdot \vec{B} = AB\cos\theta$

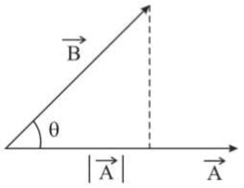


and $\cos\theta = \dfrac{\vec{A} \cdot \vec{B}}{|\vec{A}||\vec{B}|}$

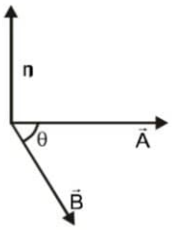
θ = angle between A and B

14. Projection of vector $\vec{B}$ in the direction of vector A

$$B\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|\vec{A}|}$$



15. (i) $\vec{A}\times\vec{B} = AB\sin\theta\hat{\eta}$



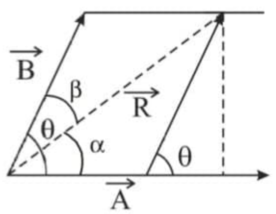
where $\hat{\eta}$ is perpendicular vector

(ii)If $|\vec{V}_1+\vec{V}_2| = |\vec{V}_1-\vec{V}_2|$ and v_2 is finite, then v_1 and v_2 perpendicular to each other..

16. Parallelogram Law of Vector Addition

(i) $R = \sqrt{A^2+B^2+2AB\cos\theta}$

(ii) $\tan\alpha = \dfrac{B\sin\theta}{(A+B\cos\theta)}$



where A and B magnitudes of vectors,

R = magnitude of resultant vectors,

θ = angle between vectors A and B,

α = angle between resultant vector R and vector A.

17. Projectile Motion

Suppose a particle is projected from origin on horizontal ground with a velocity u at angle θ from the horizontal

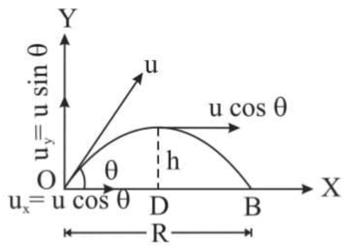
(i) Trajectory of the projectile

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

(ii) Time of flight, $T = \dfrac{2u\sin\theta}{g}$

(iii) Range, $R = \dfrac{u^2\sin 2\theta}{g}$

and $R_{\max} = \dfrac{u^2}{g}$ (Here θ = 45^0)



(iv) Height attained, $H = \dfrac{u^2\sin^2\theta}{2g}$

(v) Kinetic energy of the projectile at the highest point of trajectory $K' = K\cos^2\theta$

where K = Kinetic energy at the point of launch

(vi) A projectile is thrown with a speed v at an angle θ has a range R on the surface of earth for same value of v and θ its range on the surface of the moon will be 6R.

18. Circular Motion

(i) Angular velocity, $\vec{\omega} = \dfrac{d\vec{\theta}}{dt}$

(ii) Angular acceleration, $\alpha = \dfrac{d\omega}{dt} = \dfrac{d^2\theta}{dt^2}$

(v) Centripetal force, $F = \dfrac{mv^2}{r} = mr\omega^2$

19. * Force, F = $\dfrac{dp}{dt}$ = ma

Where a = acceleration produced in a body.

* **<u>Weight in a Lift</u>**

(i) Apparent weight, R = m (g + a)

where a = upward acceleration of the lift.

(ii) R = m (g - a)

where a = downward acceleration of the lift.

(iii) If free fall under the action of gravity, a = g

$\therefore$ R = 0

(iv) When lift is at rest or moving uniformly,a =0

$\therefore$ R = mg

20. Recoil Velocity of Gun, $v_2 = -\frac{m_1 v_1}{m_2}$

where m_2 = mass of gun, m_1 = mass of bullet and v_1 = velocity of bullet.

Impulse

(i) Impules = $F \times t$

where F = force and t = time.

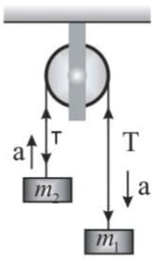
(ii) Impules = m (v - u)

where v = final velocity

and u = initial velocity

21. Pulleys

Unequal mass $(m_1 > m_2)$ suspended from a pulley

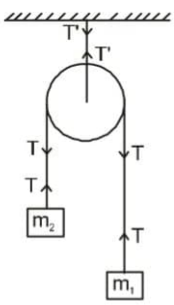


(a) Acceleration, $a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$

(b) Tension, $T = \left(\frac{2m_1 m_2}{m_1 + m_2}\right) g$

* If $M_1 > M_2$ then accn of the block $a = \frac{(m_1 - m_2)g}{(m_1 + m_2)}$

Tension in the string $T = \frac{2m_1 m_2 g}{(m_1 + m_2)}$

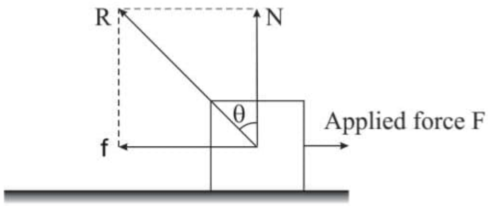


*Tension in the string by which pully attached

$T' = \frac{4m_1 m_2 g}{(m_1 + m_2)}$

22. Friction

(i) Angle of friction, $\tan\theta = \mu_s$



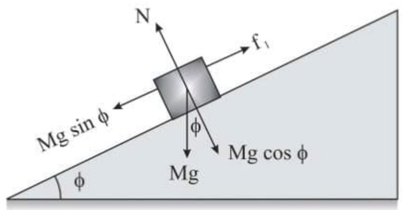
(ii) Coefficient of friction $\mu = \frac{f}{N}$

Where f = force of friction,

N = normal reaction.

(iii) Angle of repose

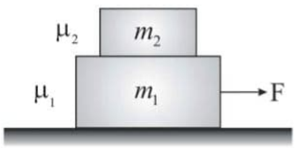
Angle of friction (θ) = angle of repose ϕ



(iv) Acceleration of a body down a rough plane

$$a = g(\sin\phi - \mu\cos\phi)$$

(v) When force is applied on lower block common acceleration, $a = \mu g$



23. * Work

W = $\vec{F} \cdot \vec{s} = Fs\cos\theta$

where F = constant force,

s = displacement of body,

θ = angle between displacement and force.

* Energy

(i) Kinetic energy, KE = $\frac{1}{2}mv^2$

where m = mass of the body,

v = velocity of the body.

(ii) Potential energy

(a) Elastic potential energy, $U = \frac{1}{2}kx^2$

Where k = spring constant

x = compression or expansion in spring

(b) Gravitational potential energy,

$U = -Gm_1m_2/r$

(c) Electrostatic potential energy,

$$U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$$

* Power

(i) $P_{av} = \frac{W}{\Delta t}$ (ii) $P_{inst} = \frac{dW}{dt}$

(iii) $P = \vec{F}\cdot\vec{v}$

* Collision

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

(when linear momentum is conserved)

where m_1 and m_2 = masses of the body which undergo collision,

u_1 = initial velocity of body of mass m_1,

u_2 = initial velocity of body of mass m_2,

v_1 = final velocity of body of mass m_1,

v_2 = final velocity of body of mass m_2.

(i) Inelastic collision

(a) $v_1 = \left(\frac{m_1 - em_2}{m_1 + m_2}\right)u_1 + \left(\frac{(1+e)m_2}{m_1 + m_2}\right)u_2$

(b) $v_2 = \left(\frac{(1+e)m_2}{m_1 + m_2}\right)u_1 + \left(\frac{m_2 - em_1}{m_1 + m_2}\right)u_2$

(ii) Elastic collision

(a) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

(b) $v_1 = \frac{(m_1 - m_2)u_1}{m_1 + m_2} + \frac{2m_2u_2}{m_1 + m_2}$

(c) $v_2 = \frac{2m_1u_1}{m_1 + m_2} + \frac{(m_2 - m_1)u_2}{m_1 + m_2}$

(iii)Coefficient of Restiution,

$$e = \frac{|\vec{v_2} - \vec{v_1}|}{|\vec{u_1} - \vec{u_2}|}$$

(iv) Energy Loss in Collision

(i) Elastic collision, for first (incident) particle

$$\frac{K_f}{K_i} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$$

$$\frac{\Delta K_{lost}}{K_i} = \frac{4m_1m_2}{(m_1 + m_2)^2}$$

$$\frac{\Delta K_{lost}}{K_i} = 100\% \qquad \text{(if } m_1 = m_2\text{)}$$

(ii) Inelastic collision, loss in KE

$$K_{lost} = \frac{1}{2}\frac{m_1m_2}{m_1 + m_2}(u_1 - u_2)^2(1 - e^2)$$

24. Equation of Rotational Motion

$$(\omega = \omega_0 + \alpha t),(\theta = \omega_0 t + \frac{1}{2}\alpha t^2),(\omega^2 - \omega_0^2 = 2\alpha\theta)$$

* Centre of Mass

(i) Centre of mass of N particle system

$$x_{CM} = \frac{m_1x_1 + m_2x_2 + \dots\dots\dots + m_nx_n}{m_1 + m_2 + \dots\dots\dots + m_n}$$

where $x_1, x_2 \dots\dots x_n$ are the distances from the centre of masses $m_1, m_2 \dots\dots m_n$.

(ii) Velocity of centre of mass

$$\vec{v} = \frac{m_1\vec{v_1} + m_2\vec{v_2} + \dots\dots\dots + m_n\vec{v_n}}{m_1 + m_2 + \dots\dots\dots + m_n}$$

where $v_1, v_2 \dots\dots v_n$ be velocities of the partices having masses $m_1, m_2 \dots\dots m_n$.

(iii) Acceleration of the centre of mass

$$\vec{a} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2 + ... + m_n\vec{a}_n}{m_1 + m_2 + ... + m_n}$$

where $a_1, a_2 .... a_n$ be accelerations of the partices having masses $m_1, m_2 .... m_n$.

(iv) Momentum of centre of mass

$$\vec{p} = \frac{m_1\vec{p}_1 + m_2\vec{p}_2 + ... + m_n\vec{p}_n}{m_1 + m_2 + ... + m_n}$$

25. Moment of Inertia

(i) MI of n particle system

$$I = \sum_{i=1}^{n} m_i r_i^2$$

(ii) MI of a body $I = MK^2$

Where M = total mass, K = radius of gyration.

Kinetic Energy of Rotation $K_R = \frac{1}{2} I\omega^2$

Kinetic Energy of Rolling Body

(i) KE of rolling body,

$$E_{rolling} = E_{translation} + E_{rotational}$$

$$E_{rolling} = \frac{1}{2}mv^2 + \frac{1}{2}mK^2\omega^2$$

(ii) Total kinetic energy of a rolling body

$$= \frac{1}{2}mv^2\left(1 + \frac{K^2}{r^2}\right)$$

Rolling of a Body on an Inclined Plane without Slipping

(i) Acceleration of the body $a = \dfrac{g\sin\theta}{1 + \frac{K^2}{r^2}}$

(ii) Velocity of the body, when it reaches the bottom

$$v = \sqrt{\frac{2gh}{1 + \frac{K^2}{r^2}}} = \sqrt{\frac{2gl\sin\theta}{1 + \frac{K^2}{r^2}}}$$

(iii) Time taken by a rolling body to reach the bottom

$$t = \frac{1}{\sin\theta}\sqrt{\frac{2h\left(1 + \frac{K^2}{r^2}\right)}{g}}$$

26. Torque

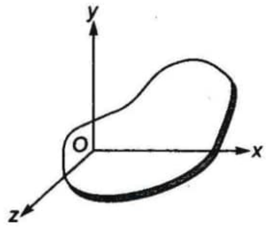
(i) torque of a body, $\vec{\tau} = \vec{r} \times \vec{F}$

(ii) Work done by a body, W = $\vec{\tau} \cdot \vec{d\theta}$

(iii) Power, P = $\vec{\tau} \cdot \vec{\omega} = \vec{\tau} \cdot 2\pi n$

(iv) Power of torque = $\tau \times \frac{2\pi}{T}$

Theorem of Perpendicular Axis,



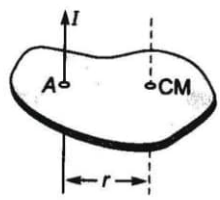
$$I_Z = I_X + I_Y$$

where I_Z = MI of the body about axis perpendicular to the plane of lamina,

I_X and I_Y = MI of the lamina about two mutually perpendicular axis of lamina.

Theorem of Parallel Axis,

$$I = I_{CM} + Mr^2$$



where I = MI of the body about an axis passing through any point,

I_{CM} = MI of the body about an axis passing through centre of mass of the body,

M = Mass of the body,

r = Distance between two parallel axis.

27. Angular Momentum

$$\vec{L} = I\vec{\omega} \quad \& \quad \vec{L} = \vec{r} \times \vec{p}$$

Law of conservation of angular momentum

$$I_1\omega_1 = I_2\omega_2$$

* The angular momentum of electron in nth orbit is given by $L = \frac{nh}{2\pi}$

28. Newton`s Law of Gravitation

$$F=\frac{Gm_1m_2}{r^2}$$

* Acceleration due to Gravity

$$g=\frac{GM}{R^2} \qquad \text{weight} \qquad W = mg$$

* Variation of g

(i) due to shape $g_{equator} < g_{pole}$

(ii) due to rotation of earth

$$g_{pole}=\frac{GM}{R^2} \qquad \text{(no efect)}$$

$$g_{equator}=\frac{GM}{R^2}-\omega^2 R$$

$$g_{equator} < g_{pole}$$

$$\omega^2 R = 0.034\ ms^{-2}$$

If $\omega = 17\omega_0$ or duration of day T = $\frac{24}{17}$ = 1.4 h

then objects would float on equator.

(iv) Variation at depth d

$$g^{\backslash}=g\left(1-\frac{d}{R}\right) \qquad \frac{g-g^{\backslash}}{g}=\frac{d}{R}$$

* Gravitational Field

(i) $\vec{g}=\vec{F}/m_0$ (ii) $\vec{g}=-\frac{GM}{r^2}\hat{r}$

(Outside)

(iii) $\vec{g}=-\frac{GM}{R^3}r\cdot\hat{r}$ (Inside)

* Gravitational Potential Energy of Mass m

$$U(r)=\frac{-GMm}{r}$$

At the surface of the earth $U_0=-\frac{GMm}{R}$

* Escape Velocity

(i) $v_e=\sqrt{\frac{2GM}{R}}$ (ii) $v_e=\sqrt{2gR}$

(iii) $v_e=\sqrt{gD}$ (iv) $v_e=R\sqrt{\frac{g\pi G\rho}{3}}$

29. Orbital Velocity of Satellite

(i) $v_0=\sqrt{\frac{GM}{r}}$ (ii) $v_0=v_e\sqrt{\frac{M}{2(R+h)}}$

(iii) $v_0=\frac{v_e}{\sqrt{2}}$ (for h<<R)

* Time Period of Satellite

(i) $T=2\pi\sqrt{\frac{(R+h)^3}{GM}}$ (ii) $T=2\pi\sqrt{\frac{R}{g}}$ (h<<R)

*. Energy of Satellite

(i) Kinetic energy K = $\frac{GMm}{2r}$

(ii) Potential energy U = $-\frac{GMm}{r}$

(iii) Total energy E = $-\frac{1}{2}\frac{GMm}{r} = \frac{U}{2}=-K$

(iv) Binding energy BE = - E = $\frac{1}{2}\frac{GMm}{r}$

*. Geosynchronous Satellite

(i) T = 24 h (ii) $T^2=\frac{4\pi^2}{GM}(R+h)^3$

(iii) $h=\left(\frac{GMT^2}{4\pi^2}\right)^{1/3}-R$ (iv) h = 36000 km

*. Two planets A and B have the same material density. If the radius of A is twice that of B, then the ratio of escape velocity $\frac{v_A}{v_B}$ is 2.

30. Kepler`s Laws

(i) Law of orbits : orbits are elliptical.

(ii) Law of areas : equal area swept in equal time

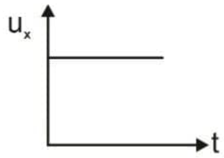
$$\frac{\Delta A}{\Delta t}=\frac{L}{2m} \qquad v_{max}\, r_{min} = v_{min}\, r_{max}$$

(iii) Law of periods

$$T^2 \propto r^3 \qquad T^2=\left(\frac{4\pi^2}{GM}\right)r^3$$

* The acceleration due to gravity at a depth d where g is acceleration due to gravity on the surface of earth, will be $g\left(1-\frac{d}{R}\right)$.

* The graph between horizontal velocity and time t in a projectile motion is given by :



Stress = $\frac{\text{Deforming force}}{\text{Cross - sectional area}}$

31. Strain

(i) Tensile or longitudinal strain $= \frac{\Delta L}{L}$

(ii) Shearing strain = ϕ

(iii) Volume strain = $\frac{\Delta V}{V}$

* Hooke`s Law

(i) For stretching stress = $Y \times strain$

$$Y = \frac{FL}{A(\Delta L)}$$

(ii) For shear stress = $\eta \times$ strain

$$\eta = \frac{F}{A\phi}$$

(iii) for volume elasticity stress = $K \times$ strain

$$K = -\frac{p}{(\Delta V / V)}$$

* Compressibility $\beta = \frac{1}{K}$

* Elongation of a Wire due to its Own Weight

$$\Delta I = \frac{1}{2}\frac{MgL}{YA} \quad = \frac{1}{2}\frac{L^2 \rho g}{Y}$$

32. Bulk Modulus of Ideal Gas

(i) $K_{isothermal} = p$ (ii) $K_{adiabatic} = \gamma p$

33. Thermal stress

(i) Thermal stress = $Y\alpha(\Delta t)$

(ii) Force = $YA\alpha(\Delta t)$

34. Work Done in Stretching

(i) W = $\frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume}$

(ii) W = $\frac{1}{2} \times \text{ Y}(\text{strain})^2 \times \text{volume}$

(iii) W = $\frac{1}{2} \times \frac{(\text{stress})^2}{Y} \times \text{volume}$

(iv) Potential energy stored

U = $\frac{1}{2} \times (\text{stress}) \times (\text{strain}) \times \text{volume}$

(v) Potential energy stored per unit volume U = $\frac{1}{2} \times (\text{stress}) \times (\text{strain})$

35. Loaded Beam

(i) Depression $\delta = \frac{WI^3}{4Ybd^3}$ (rectangular)

$\delta = \frac{WI^3}{12Y\pi d^3}$ (cylindrical)

* Poisson`s Ratio

(i) Lateral strain = $\frac{-\Delta D}{D} = \frac{-\Delta r}{r}$

(ii) Longitudinal strain = $\frac{\Delta L}{L}$

$$\sigma = \frac{\text{lateral strain}}{\text{longitudinal strain}}$$

$-1 < \sigma < 0.5$ (theoretical limit)

$\sigma = 0.2 - 0.4$ (experiments)

36. Principle of Continuity

Av = Constant

where A = area of cross-section,

v = velocity of flow.

* Bernoulli`s Theorem

$$p+\frac{1}{2}\rho v^2+\rho gh = \text{constant}$$

where p = pressure

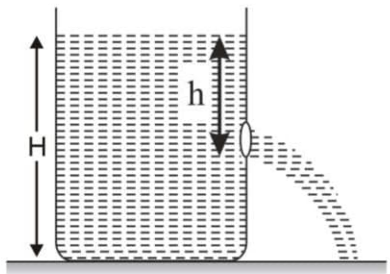
$\frac{1}{2}\rho v^2$ = kinetic energy per unit volume

ρgh = potential energy per unit volume

* Velocity of Efflux

$$v=\sqrt{2gh}$$

where h = height of the hole.



The time taken by the liquid to reach the base level in above case

$$t=\sqrt{\frac{2(H-h)}{g}}$$

where H = height of vessel.

37. Viscous Force

$$F=-\eta A\frac{dv}{dy}$$

where η = coefficient of viscosity,

A = area of layer of fluid in contact,

$\frac{dv}{dy}$ = velocity gradient between the layers.

38. Poiseuille`s Formula $\frac{dQ}{dt}=\frac{\pi pR^4}{8\eta L}$

where L = length of the capillary tube,

R = radius of the capillary tube,

p = pressure difference across the tube.

* Terminal Velocity, $v_T=\frac{2}{9}\frac{r^2(\rho-\sigma)g}{\eta}$

where r = radius of the body,

ρ = density of material of the body,

σ = density of fluid,

η = coeffidient of viscosity.

40. Surface Tension, $T=\frac{F}{L}$

where F = force per unit length.

* Force due to Surface Tension

(i) Force required to lift a thin wire from surface of the water $F=T\times 2l$

where l = length of thin wire.

(ii) Force required to lift a rectangular plate from surface of the water $F = 2T(l+b)$

where l = length of rectangular plate,

b = breadth of rectangular plate.

(iii) Force required to lift a circular plate from surface of water $F=T\times 2\pi r$

(iv) Force required to lift a ring from surface of water

$$F=T(2r_1+2r_2)$$

where r_1 = inner radius, r_2 = outer radius.

(v) Force required to separate two glass plates of area A containing a liquid film of thickness d between them,

$$F=\frac{2TA}{d}$$

41. Work done to Increase the Area of Surface Film by A

$$W=T\times A$$

* Work done in blowing a soap bubble of radius r

$$W=8\pi r^2T$$

* Work done in splitting a liquiddrop of radius r into n identical drops $W=4\pi Tr^2\left(n^{1/3}-1\right)$

* Work done in combining n identical drop of radius r to form a big drop of radius R

$$W=4\pi T\left(nr^2-R^2\right)=4\pi Tr^2\left(n-n^{2/3}\right)$$

42. Capillary Rise or Fall of a Liquid

$$h = \frac{2T\cos\theta}{r\rho g}$$

where h = height of liquid column in capillary,

T = surface tension of the liquid,

θ = angle of contact,

r = radius of the capillary tube and d is the density of the liquid.

For pure liquid $\theta = 0^\circ$ $\quad h = \dfrac{2T}{r\rho g}$

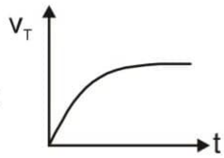
(a) If $\theta < 90^0$, then there will be a capillary rise.

(b) If $\theta = 90^0$, there will be neither rise nor fall.

(c) If $\theta > 90^0$, then there will be a depression.

43 When temperature of water increases its viscosity decreases.

* Variation of terminal velocity v_T and time for a long column of a viscous fluid will be :



44. Excess Pressure

(i) Excess pressure in a liquid drop of radius, r

$$p = \frac{2T}{r}$$

(ii) excess pressure in a soap bubble of radius r

$$p = \frac{4T}{r}$$

(iii) Excess pressure in a soap bubble of radius r, when it is inside a liuid $\quad p = \dfrac{2T}{r}$

45. If two soap bubbles of radii r_1 and r_2 $(r_1 > r_2)$ are in contact with each other, then the radius of curvature of their interface $\quad r = \dfrac{r_1 r_2}{r_1 - r_2}$

* If two soap bubble of radii r_1 and r_2 combine in vacuum to form a single bubble of radius r under isothermal condition, then

$$r = \sqrt{r_1^2 + r_2^2}$$

*. If a number of small droplets of water, all of the same radius r, coalesce to form a single drop of radius R, then

Rise in temperature = $\dfrac{3T}{J\rho s}\left(\dfrac{1}{r} - \dfrac{1}{R}\right)$

where s = specific heat, ρ = density.

* The radii of two limbs of a U-tube are r_1 and r_2. A liquid of density ρ and surface tension T is poured in it. The difference between the levels of the liquid.

$$h = \frac{2T}{\rho g}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

46. (i) $\quad \dfrac{C}{100} = \dfrac{F-32}{180}$

$$\Rightarrow \quad F = \frac{9}{5}C + 32 \quad \Rightarrow \quad C = \frac{5}{9}(F - 32)$$

(ii) $K = C + 273$ $\qquad$ (iii) $\quad K = \dfrac{5}{9}(F - 459.4)$

47. (i) Triple point of water $T_3 = 273.16\,K$

(ii) Absolute zero $0K \equiv -273.15^0 C$

48. (i) Isobaric, p = constant; $\dfrac{V}{T}$ = constant

(ii) Isochoric (isometric)

V = constant; $\dfrac{p}{T}$ = constant

(iii) Isothermal T = constant; pV = constant

(iv) Adiabatic pV^γ = constant; $TV^{\gamma-1}$ = constant;

$p^{1-\gamma}T^\gamma$ = constant

*. (i) Isobaric slope : Zero

(ii) Isochoric slope : Infinite

(iii) Isothermal : Slope = $-\dfrac{p}{V}$

(iii) Adiabatic : Slope = $-\dfrac{\gamma p}{V}$

48. (i) Isobaric $W = p(V_1 - V_2)$

(ii) Isochoric $W = 0$

(iii) Isothermal $W = nRT\log_e(V_2/V_1)$

$$W = nRT(2.303)\log_{10}(V_2/V_1)$$

$$W = nRT(2.303)\log_{10}(p_1/p_2)$$

(iv) Adiabatic: W = $\dfrac{nR(T_1 - T_2)}{\gamma - 1}$

(iv) In expansion

$$W_{adiabatic} < W_{isothermal} < W_{isobaric}$$

(vi) In compression

$$W_{adiabatic} > W_{isothermal} > W_{isobaric}$$

Work done depends on path on *pV* diagram.

49. (i) Isobaric $Q = nC_p\Delta T$

(ii) Isochoric $Q = nC_V\Delta T$

(iii) Isothermal $Q = W = nRT\log_e(V_2/V_1)$ etc.

(iv) Adiabatic Q = 0

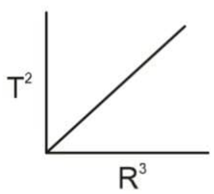
50. (i) Isobaric $\Delta U = nC_V\Delta T$

(ii) Isochoric $\Delta U = nC_V\Delta T$

(iii) Isothermal $\Delta U = 0$

(iv) Adiabatic $\Delta U = -W = \dfrac{nR(T_2 - T_1)}{\gamma - 1}$

51. The graph between motion of planet and time period of revolution is given by :



52. Work done per mol in an isothermal change is

W = RT $\log_e \dfrac{V_2}{V_1}$

* (i) Isothermal bulk modulus $K = p$

(ii) Adiabatic bulk modulus $K = \gamma p$

* (i) Work ΔW = area enclosed in *pV* diagram

$$\Delta U = 0 \qquad \Delta Q = \Delta W$$

* (i) $U = \dfrac{3}{2}RT$ (one mole)

(ii) $U = \dfrac{3}{2}nRT$ (n mole)

(iii) Change $\Delta U = \dfrac{3}{2}nR\Delta T$

54. $\Delta Q = \Delta U + \Delta W$, $\Delta U = \Delta Q - \Delta W$

Both ΔQ, ΔW depends on path, but ΔU does not depend on the path.

(i) Isothermal $\Delta Q = \Delta W$, $\Delta U = 0$

(ii) Adiabatic $\Delta Q = 0$, $\Delta U = -\Delta W$

(iii) Isochoric $\Delta W = 0$, $\Delta Q = \Delta U = nC_v\Delta T$

(iv) Isobaric $\Delta Q = \Delta U + \Delta W$,

$\Delta Q = nC_p\Delta T$,

$\Delta U = nC_v\Delta T$,

$\Delta W = nR\Delta T$

(v) Cyclic $\Delta U = 0$, $\Delta Q = \Delta W$

(vi) Free expansion $\Delta U = 0$, $\Delta Q = 0$, $\Delta W = 0$

(vii) Specific heat s = $\dfrac{\Delta Q}{m\Delta T}$

(viii) Change of state $\Delta Q = mL$

(ix) Work converts into heat

W = JH (J = 4.1860J.cal^{-1})

(x) Memorable point

$2^{0.4}$ = 1.32, $2^{1.4} = 2\times 2^{0.4}$ = 2.64

55. (i) Efficiency of engine, $\eta = 1 - \dfrac{Q_2}{Q_1} = 1 - \dfrac{T_2}{T_1}$

where Q_1 = amount of heat absorbed by the working substance from the source at T_1K.

Q_2 = amount of heat rejected to the sink at T_2K

(ii) Coefficient of performance,

$$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

where W = net amount of external work done.

* Entropy $S = \dfrac{dQ}{T}$

where T = absolute temperature,

m = mass of substance,

56. Pressure Exerted by an Ideal Gas

Pressure p = $\frac{1}{3}\frac{m n c^2}{V}$

where m = mass of each molecule,

n = number of molecules in the enclosure,

c = root mean square velocity of molecules,]

V = volume of container enclosed mass M of gas.

*. According to the kinetic theory of gases total energy of a gas is equal to kinetic energy.

57. (i) Boyle's law p $\propto \frac{1}{V}$ ($\because$ n & T = constant)

(ii) Charles'law $V \propto T$ ($\because$ n & p = constant)

(iii) Avogadro law $\frac{V_1}{N_1} = \frac{V_2}{N_2}$

(iv) Ideal gas equation pV = nRT

where p = pressure of gas,

V = volume of gas,

n = no.of moles

R = ideal gas constant,

T = temperature of gas,

(v) Dalton's law of partial pressures

$$p_T = p_1 + p_2 + p_3 + ...$$

where p_T = total pressure,

p_1, p_2 ... = partial pressure of the number of gases.

58. (i) For monoatomic gas = 3/2 kT (per molecule)

and 3/2 RT (per mole)

(ii) For diatomic gas = 5/2 kT (per molecule)

and 5/2 RT (per mole)

(iii) For triatomec gas = 3kT (per molecule)

and = 3RT (per mole)

59. (iv) Emissive power $E = \frac{Q}{A \cdot t}$

*. $\left(\frac{e_\lambda}{a_\lambda}\right) = \left(\frac{e_\lambda}{a_\lambda}\right) = ... = E_\lambda$

*. $E = \sigma T^4 \quad \left(\sigma = 5.67 \times 10^{-8}\ \text{Wm}^{-2}\ \text{K}^{-4}\right)$

(i) $E = \sigma\left(T^4 - T_0^4\right)$ (for a black body)

(ii) $e = \varepsilon\sigma\left(T^4 - T_0^4\right)$ (for a body)

* (i) $\frac{d\theta}{dt} = \frac{\varepsilon A\sigma}{ms}\left(\theta^4 - \theta_0^4\right)$

(ii) $\frac{d\theta}{dt} = \frac{\varepsilon A\sigma}{V\rho s}\left(\theta^4 - \theta_0^4\right)$

* Newton's Law of Cooling

(ii) $\frac{\theta_1 - \theta_2}{t} = K\left(\frac{\theta_1 + \theta_2}{2} - \theta_0\right)$

* $\lambda_m T = b \qquad \left(b = 2.9 \times 10^{-3}\ \text{m-K}\right)$

60. (i) $v = n\lambda$ (ii) n = 1 / T

. (ii) $v = \sqrt{\frac{T}{m}}$, m = mass per unit length

(iii) v = $\sqrt{\frac{T}{\pi r^2 d}}$

(iv) In rods v = $\sqrt{\frac{Y}{\rho}}$

In liquids v = $\sqrt{\frac{B}{\rho}}$

In gases v = $\sqrt{\frac{\gamma P}{\rho}}$

(vii) {v_{sound}/v_{rms} = $\sqrt{\gamma / 3}$}

61. (i) y = a sin (ωt - kx),

(ii) Wave velocity v = ω/k

(iii) Particle velocity $v_{particle}$ = $\frac{\delta y}{\delta t}$

(iv) Maximum particle velocity $(v_{particle})_{max}$ = ωa

(v) Strain in medium = $-\frac{\delta y}{\delta x}$

(vii) When a longitudinal wave propagate through a material medium then energy and linear momentum always remains constant.

(viii) I = $2\pi^2 \rho v n^2 a^2$ $\qquad$ $\text{I} \propto n^2 a^2$

(ix) Intensity level in decibel = 10 log $\left(\frac{I}{I_0}\right)$

62 (i) Resultant amplitude

$$a = \sqrt{a_1^2 + a_2^2 + 2a_1 a_2 \cos\phi}$$

(ii) Resultant intensity

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

(iii) Constructive interference

$\phi = 2n\pi$ $\quad a_{max} = a_1 + a_2$

$$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$$

(iv) Destructive interference

$\phi = (2n-1)\pi$ $\quad a_{min} = a_1 - a_2$

$$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$$

(v) Beat frequency $= n_1 - n_2$

63. (i) $y = -2a \sin kx \cos \omega t$ (ii) $y = 2a \cos kx \sin \omega t$

(iii) Vibrations of a string

$$n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} \quad \text{(fundamental)}$$

$$n_p = \frac{p}{\lambda}\sqrt{\frac{T}{m}} \quad (p^{th} \text{ harmonic})$$

The ratio of successive harmonics frequencies

$n_1 : n_2 : n_3 : ... = 1 : 2 : 3 : ...$

$m = \pi r^2 d$

(iv) Closed pipe Fundamental $n_1 = v / 4L$

Only odd harmonics present

$n_1 : n_2 : n_3 : ... = 1 : 3 : 5 : ...$

(v) Open pipe Fundamental $n_1 = v / 2L$

Both even and odd harmonics are present

$n_1 : n_2 : n_3 = 1 : 2 : 3 : ...$

(vi) Both ends open, clamped in middle

(a) Fundamental $n_1 = v / 2l$

(b) First oertone $n_2 = 3n_1$

(c) Ratio of frequencies $n_1 : n_2 : n_3 = 1 : 3 : 5 :$.

(vii) One end clamped

(a) Fundamental $n_1 = v / 4l$

(b) First overtone $n_2 = 3n_1$ etc.

(c) Ratio of frequencies

$n_1 : n_2 : n_3 = 1 : 3 : 5 : ...$

(ix) Tuning fork $\quad n = \dfrac{t}{l^2}\sqrt{\dfrac{E}{\rho}}$

where t = thickness, l = length of prong,
E = elestic constant and ρ = density

64. Doppler's Effect

(i) Observer stationary and source moving

(a) Source approaching

$$\lambda' = \frac{v - v_s}{v}\lambda, \qquad n' = \frac{v}{v - v_s}n$$

(b) Source receding

$$n' = \frac{v}{v + v_s}n \qquad \lambda' = \frac{v + v_s}{v}\lambda$$

(ii) Source stationary and observer moving

(a) Observer approaching source

$$n' = \frac{v + v_0}{v}n \qquad \lambda' = \lambda$$

(b) Observer receding away from source

$$n' = \frac{v - v_0}{v}n \qquad \lambda' = \lambda$$

(iii) Source and Observer both are moving

(a) S and O moving toward each other

$$n' = \frac{v + v_0}{v - v_s}n$$

(b) S and O moving away from each other

$$n' = \frac{v - v_0}{v + v_s}n$$

(c) S and O in same direction, O ahead of S

$$n' = \frac{v - v_0}{v - v_s}n$$

(d) S and O in same directon, S ahead of O

$$n' = \frac{v + v_0}{v + v_s}n$$

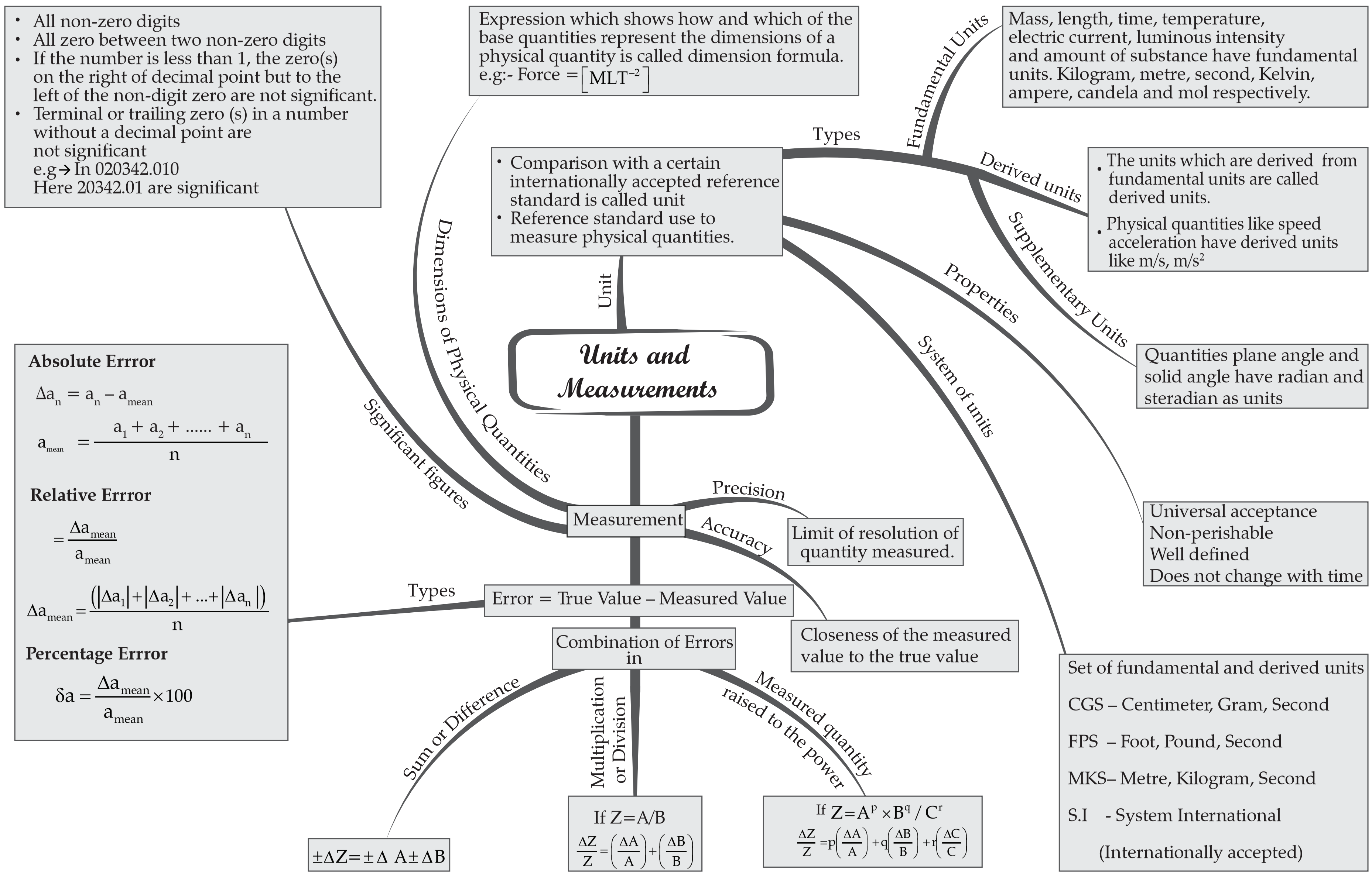
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 1

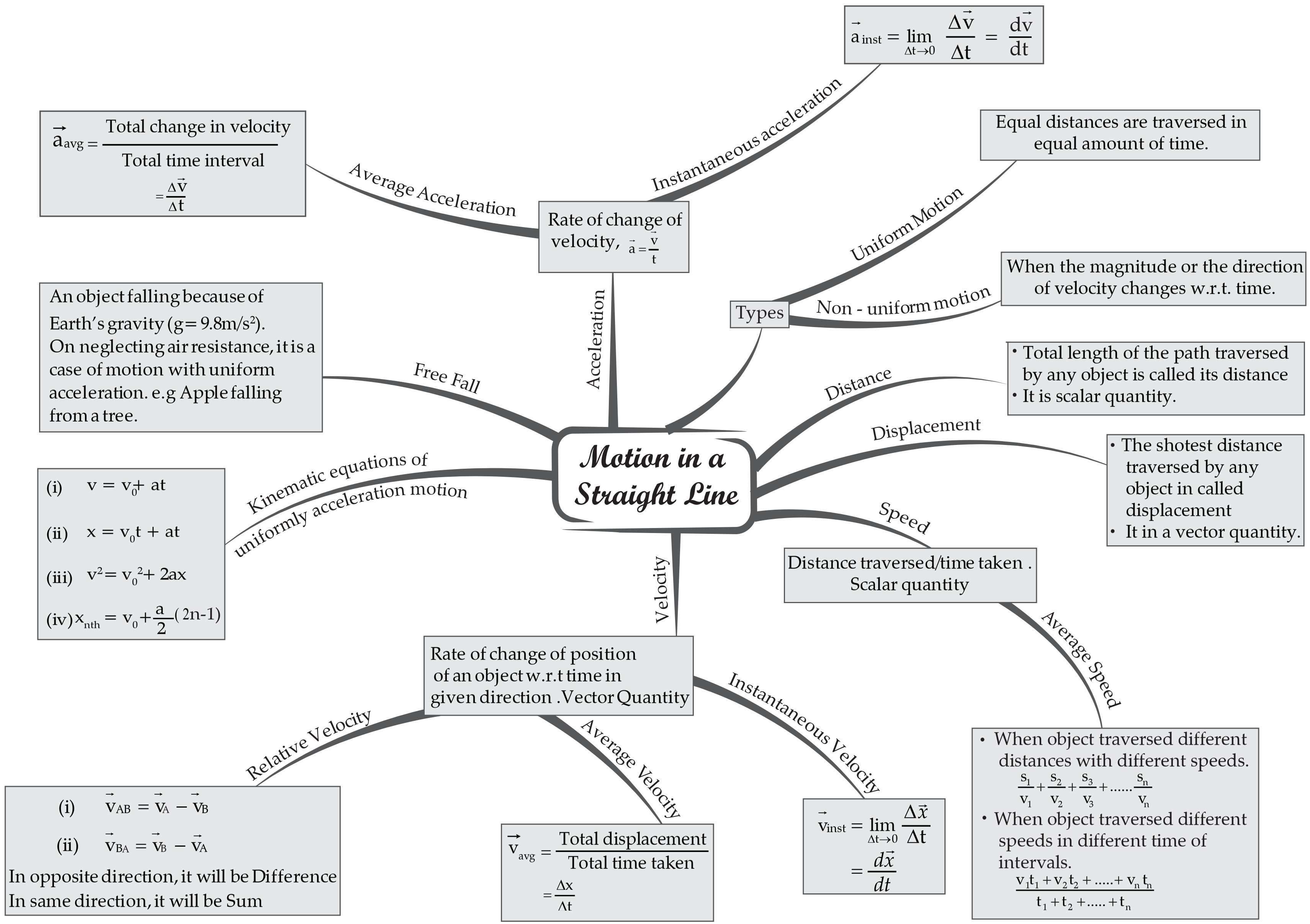
Physical World

- **Fundamental Forces of Nature**
  - Electromagnetic Force
    - Force between the charged particles
    - Both attractive and repulsive
    - It is 10^{36} times stronger than gravitational force between two protons, for any fixed distance.
  - Strong Nuclear Force
    - Very short range, strongest force
    - Attractive in nature
    - Range – 10^{-15} m
    - Strongest among all fundamental forces.
  - Weak Nuclear Force
    - Very short range (10^{-16} m) weak force
    - Not weak as gravitational force but much weaker than the strong nuclear force and electromagnetic forces.
  - Gravitational Force
    - Force of mutual attraction between any two objects by virtue of their masses
    - Plays a key role in large scale.
    - The phenomena of the universe, such as formation of and evolution of stars, galaxies and galactic clusters are by gravitational force governed.
- **Science**
  - Any subject is said to be science when it is studied in sequence pattern. The experimenting, exploring and predicting from what we see around us.
  - Scientific method
    - Systematic observations, controlled experiments, qualitative and quantitative reasoning, mathematical modelling, prediction and verification or falsification of theories.
- **Physics**
  - Study of the basic laws of nature and manifestation in different natural phenomenon
    - Physics, Technology and Society
      - Technology gives rise to new physics; similarly physics gives rise to new technologies.
    - Scope and Excitement of Physics
      - Classical Physics deals with macroscopic phenomenon and includes subject like Mechanics, Electrodynamics, Optics and Thermodynamics. Quantum Physics deals with microscopic phenomena at the minute scales of atoms, molecules and nucleus.
    - Principal Thrust
      - Unification
        - To explain diverse physical phenomena in terms of concepts and laws.
      - Reduction
        - To derive the properties of bigger and more complex system from the properties of its constituent into simpler parts.

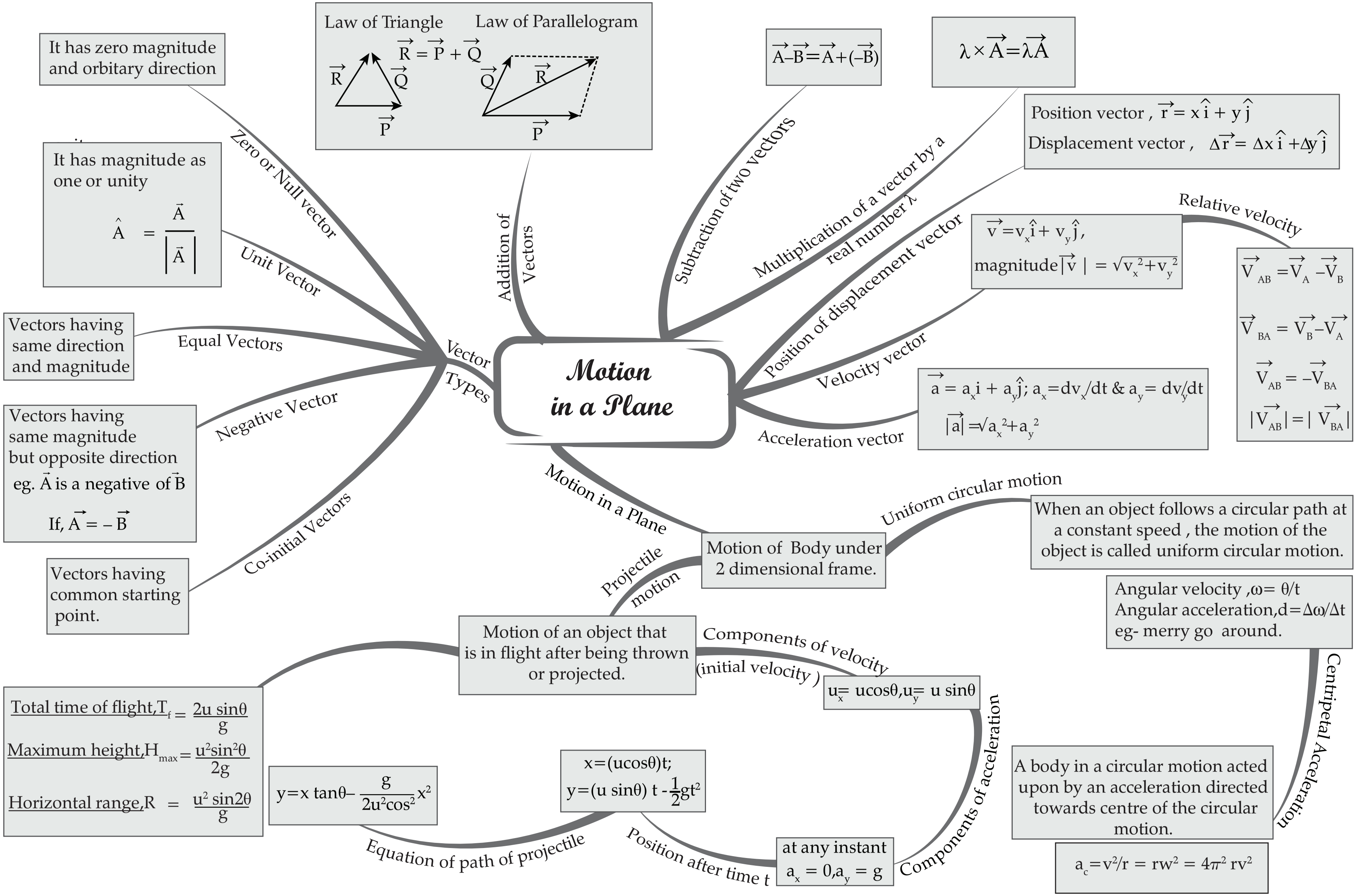
MIND MAP : LEARNING MADE SIMPLE CHAPTER - 2



MIND MAP : LEARNING MADE SIMPLE CHAPTER - 3



MIND MAP : LEARNING MADE SIMPLE CHAPTER - 4



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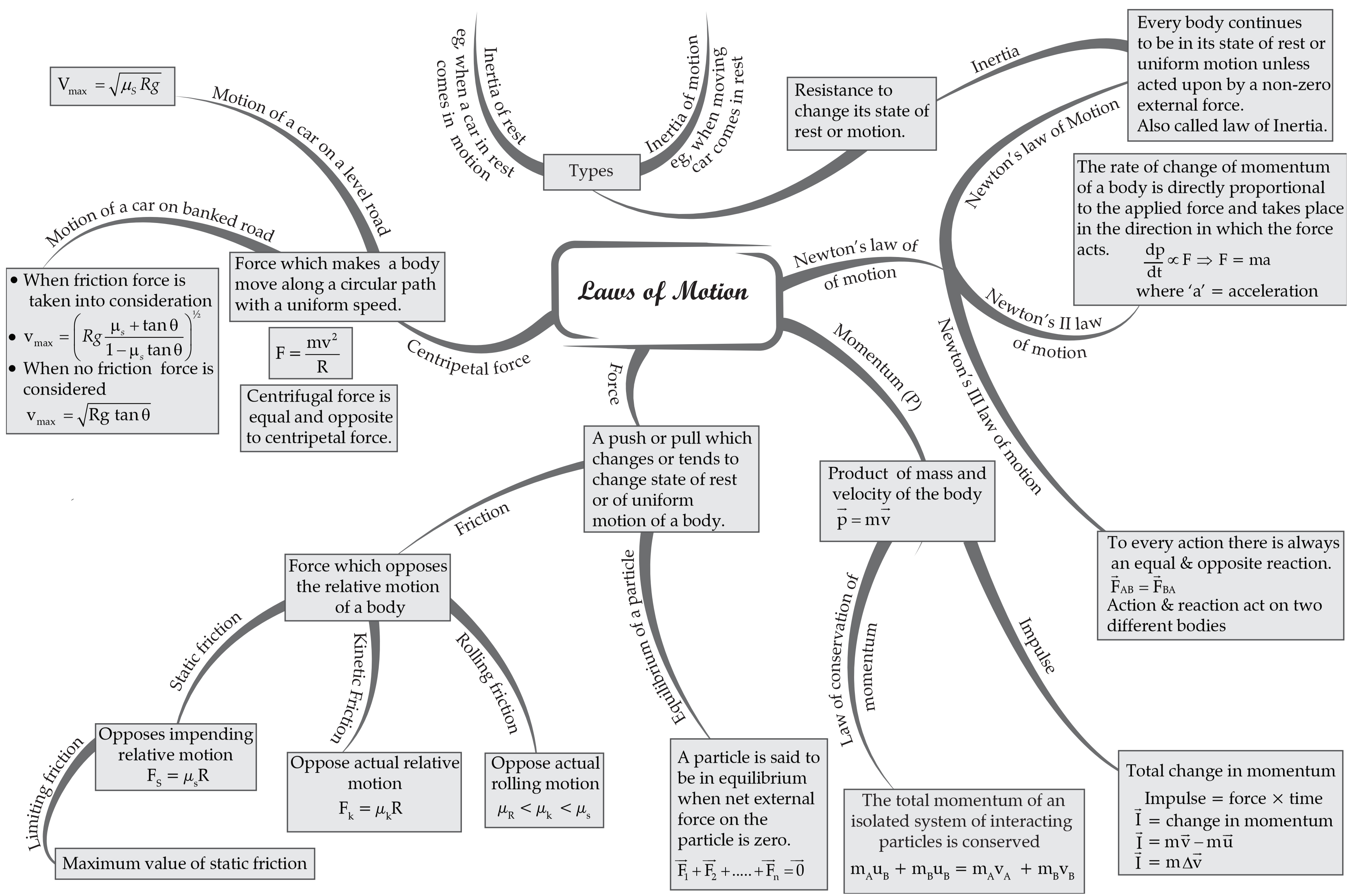

MIND MAP : LEARNING MADE SIMPLE CHAPTER - 6

Work, Energy and Power

- **Power (P)**
  - Rate of doing work
  - $P = \dfrac{\text{Work}(w)}{\text{Time}(t)}$
  - $P_{inst.} = \vec{F}\cdot\dfrac{\vec{ds}}{dt} = \vec{F}\cdot\vec{v}$
  - 1hp=746watt
  - 1kWH=3.6×10^6J
- **Energy**
  - Capacity of doing work
    - Various forms
      - Formula: Equivalence of mass and Energy $E=\Delta mc^2$
      - Heat Energy
      - Chemical Energy
      - Electrical Energy
      - Nuclear Energy
    - Law of conservation of energy: Energy can neither be created nor destroyed; it can only be transformed from one form to another.
    - Work Energy theorem: Change in Kinetic Energy = Work done by net force on the body i.e; $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = W$
    - Types of mechanical energy
      - Kinetic Energy: By virtue of velocity $E_K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$
      - Potential Energy: By virtue of position $E_p = mgh$
        - Potential Energy of Spring: $U = \frac{1}{2}kx^2$, k= spring constant
- **Work (W)**
  - Work is said to be done when force produces displacement.
  - Work done by constant force $W = Fs\cos\theta = \vec{F}\cdot\vec{s}$
  - Work done by a variable force $W = \int_{s_1}^{s_2} Fds\cos\theta = \int_{s_1}^{s_2}\vec{F}\cdot\vec{ds}$
  - Types
    - Positive work: When force (F) and displacement (S) are in same direction. *W* will be +*ve* when $0<\theta<\frac{\pi}{2}$
    - Negative work: When force (F) and displacement (S) are in opposite direction. *W* will be *(-ve)* when $\frac{\pi}{2}<0<\pi$
    - Zero work: When force and displacement are perpendicular to each other. W = zero when $\theta = \frac{\pi}{2}$
- **Collision**
  - An instance of one moving body striking against another
  - Types
    - Perfectly Elastic Collision
      - Total mechanical/kinetic energy is conserved.
      - Momentum is conserved.
    - Perfectly Inelastic Collision
      - Total energy and linear momentum conserved.
      - Kinetic energy not conserved.

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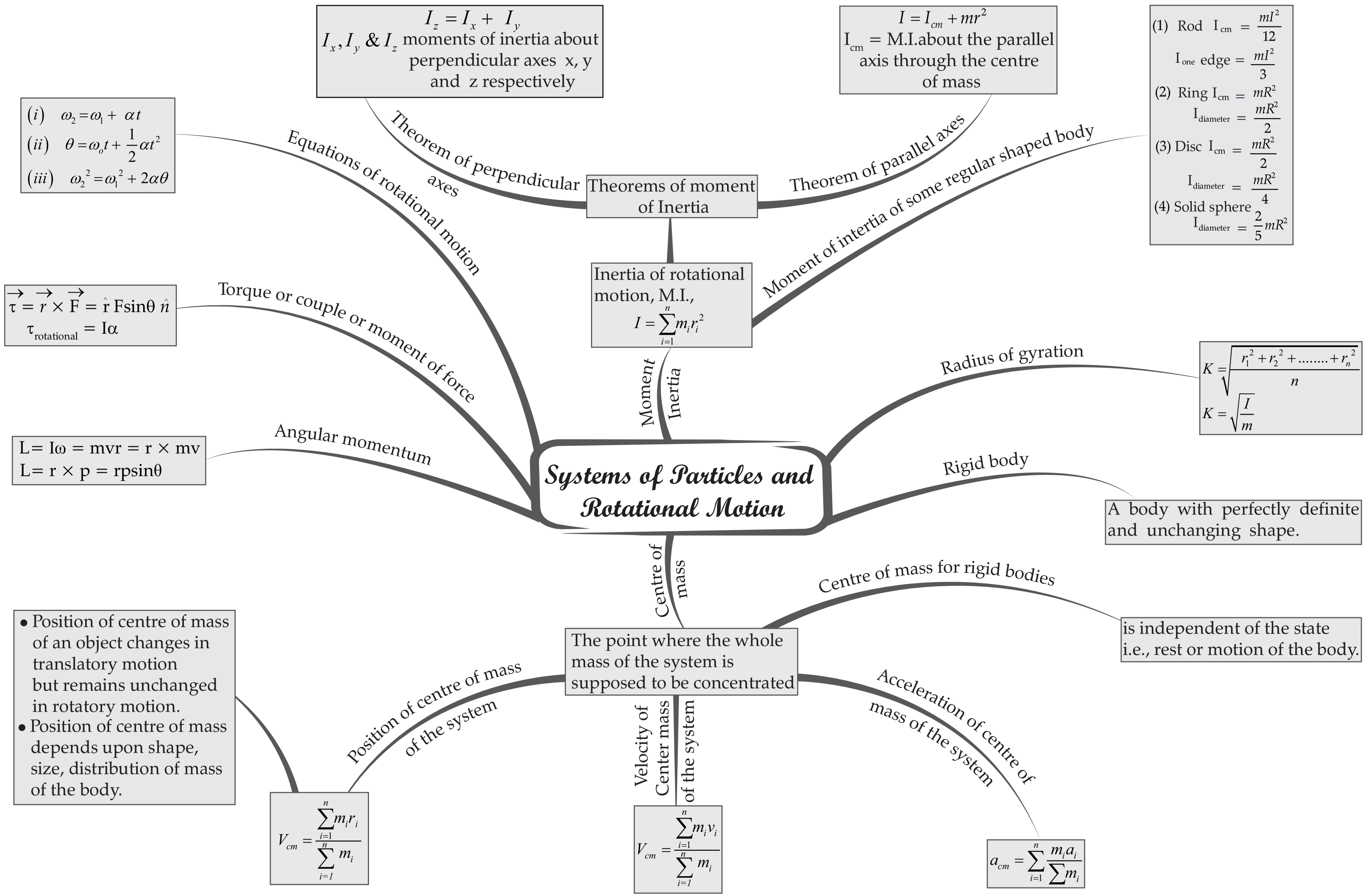
CHAPTER - 7



MIND MAP : LEARNING MADE SIMPLE CHAPTER - 8

Gravitation

Satellite

Heavenly object that revolves around a planet

Geostationary satellite

Height from surface of earth =36000km
Radius of orbit = 42,400km
Time periods = 24 hours
Orbital velocity = 3.1km/s

Polar satellite

Height from earth's surface = 880km
Time period = 84min
Orbital velocity = 7.92km/s

Escape speed $v_{esc} = \sqrt{2GM/R} = \sqrt{2gR}$

Earth 's v_{esc} = 11.2km/s

Orbitals speed $v_{orb} = \sqrt{gR} = \frac{v_e}{\sqrt{2}}$

Total Energy of a satellite

E = K.E + P.E

$= \left(\frac{GMm}{2r}\right) + \left(\frac{-GMm}{r}\right) = -\frac{1}{2}G\frac{Mm}{r}$

Weightlessness

During free fall under gravity inside a spacecraft or satellite a body is weightless i.e., effective weight becomes zero.

Acceleration due to gravity (g)

Acceleration possessed by an object during free fall due to earth's gravitational pull,

$$g = \frac{GM_e}{R_e^2}$$

Variation in acceleration due to gravity (g)

(i) with height $g' = g\left(1 - \frac{2h}{R_E}\right)$,
i.e. g decreases with height

(ii) with depth $g' = g\left(1 - \frac{d}{R_E}\right)$,
i.e. g decreases with depth

(iii) with rotation of earth about its own axis
$g' = g - R\omega^2 \cos^2 \lambda$,
At poles, $\lambda = 90^0$, g maximum
At equator, $\lambda = 0^0$, g minimum

Kepler's Law-of planetary motion

(i) Law of Orbit: Every planet revolves around the Sun in an elliptical orbit and Sun is at its one focus.

(ii) Law of Area: The radius vector drawn from the Sun to a planet sweeps out equal areas in equal intervals of time.

$$\frac{dA}{dt} = \frac{L}{2m} = \text{Constant}$$

(iii) Law of Periods: $T^2 \propto a^3$
where, a = length of semi-major axis

Gravitational Field and potential

• Gravitational field Intensity

$$I = \frac{Gm}{r^2}$$

• Gravitational potential

$$V_g = \frac{\text{work done}}{\text{mass}} = \frac{-Gm}{r}$$

• Gravitational Potential Energy

$$U = \frac{-GMm}{r}$$

Newton's universal law of Gravitation

When two mass bodies are separted by a distance, they experience an attractive force which is directly proportional to the product of their masses and inversaly proportional to the square of their separation.

$$F = \frac{Gm_1m_2}{r^2}, \; G = 6.67\times10^{-11} Nm^2kg^{-2}$$

Characteristics of gravitational force

(i) Weakest force in Nature.
(ii) Central as well as conservative.
(iii) Always attractive in nature.
(iv) Applicable for all bodies irrespective of their shape, size and position.

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 9

Mechanical Properties of Solids

Elasticity

Property of material by virtue of which it regains it original shape & size after the removal of deforming force

Relation between Y, B, η & σ

(i) Y=3B (1 − 2 σ)

(ii) Y=2η (1 + σ)

(iii) $\sigma = \frac{3B - 2\eta}{2\eta + 6B}$

(iv) $\frac{9}{Y} = \frac{1}{B} + \frac{3}{\eta}$ or $Y = \frac{9B\eta}{\eta + 3B}$

Poision's ratio(σ) $= \frac{\text{Laternal strain } (\beta)}{\text{Longitudinal strain } (\alpha)} = \frac{\Delta d / d}{\Delta l / l}$

Value of σ lies between 0 and 0.5

Elastic Potential energy

Elastic potential energy in a stretched wire $= \frac{1}{2} \times$ stress × strain × volume of the wire

Hooke's law

Within the elastic limit, stress is directly proportional to strain. i.e., stress ∝ strain

Stress

Restoring force per unit area i.e., stress= $\frac{F}{A}$

Types

(i) Longitudinal stress

$= \frac{\text{Deforming force applied normal}}{\text{Area}} = \frac{F_n}{A}$

(ii) Volumetric stress

$= \frac{\text{Force Changing Volume}}{\text{Area}} = \frac{F_V}{A}$

(iii) Shearing area or tangential stress

$= \frac{\text{Tangential Force}}{\text{Area}} = \frac{F_t}{A}$

Strain

Ratio of change in configuration to original configuration

Strain $= \frac{\text{change in configuration}}{\text{original configuration}}$

Types

(i) Longitudinal strain $= \frac{\text{change in length}}{\text{original length}} = \frac{\Delta l}{l_o}$

(ii) Volumetric strain $\varepsilon_V = \frac{\text{change in volume}}{\text{original volume}} = \frac{\Delta V}{V_o}$

(iii) Shearing strain=angular displacement of the plane perpendicular to the fixed surface = θ

Types of Modulus of Elasticity

Young's Modulus

Young's modulus of elasticity

$Y = \frac{\text{longitudinal stress}}{\text{longitudinal strain}} = \frac{F / A}{l / \Delta l}$

$Y = \frac{F\Delta l}{Al} = \frac{Mg\Delta l}{\pi r^2 l}$

Bulk Modulus

Bulk modulus or volume modulus of elasticity

$B = \frac{\text{hydraulic stress}}{\text{volume strain}}$

$B = -\frac{\Delta P}{\frac{\Delta V}{V}}; \frac{1}{B} = \text{compressibility}$

Modulus of Rigidity

Rigidity or shear modulus of elasticity

$\eta = \frac{\textit{tangential stress}}{\textit{shearing strain}}$

$\eta = \frac{\sigma_s}{\varepsilon_s} = \frac{\frac{F}{A}}{\theta} = \frac{F}{A\theta}$

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 10

Mechanical Properties of fluids

That can flow like liquids and gases

Applications

Venturimeter

Device used to measure the rate of flow of liquid.
Volume of liquid flowing per second

$$Q = a_1 a_2 \sqrt{\frac{2h\rho_m g}{\rho\left(a_1^2 - a_2^2\right)}}$$

Toricell's Law

Velocity of efflux of liquid through an orifice
$V = \sqrt{2gh}$

- Lift of an aircraft wing.
- Sprayer or atomizer
- Blowing off the roofs during windstorm.

Bernoulli's principle

For an incompressible non-viscous streamline,irrotational flow of fluid,
$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$

Viscosity

Opposing force between different layers of fluid in relative motion
Viscous drag $F = -\eta A \frac{dv}{dx}$
η=coefficient of viscosity

Stroke's law $F = 6\,\eta vr$

Formulae

- Surface tension $S = \frac{F}{l}$
- Surface Energy $= \frac{\text{work done in increasing area}}{\text{increase in surface area}} = \frac{W}{\Delta A}$
- Capillary rise or fall, $h = \frac{2S\cos\theta}{r\rho g}$
- Excess Pressure inside a drop (liquid)
  $P_{excess} = \frac{2S}{R}$
- Excess Pressure inside a bubble (soap)
  $P_{excess} = \frac{4S}{R}$

Flow of fluids

Streamline : In liquid flow when the Velocity is less than critical velocity, each particle of the liquid passing through a point travels along the same path and same velocity as the preceding particles.
Turbulent : When velocity of liquid flow is greater than critical velocity and particles follow zig-zag path.

Laws of Fluids

- **Equation of continuity**
  $m = a_1 v_1 \rho_1 = a_2 v_2 \rho_2$
  for an incompressible liquid,
  $\rho_1 = \rho_2$ then $a_1 v_1 = a_2 v_2$
  or av=constant
- **Pascal's law :** The pressure exerted at any point on an enclosed liquid is transmitted equally in all direction. Hydraulic brakes and hydraulic lifts are based on Pacal's law.

Pressure

$\text{Pressure}(P) = \frac{\text{thrust}(F)}{\text{area}(A)} = \lim_{\Delta A \to 0} \frac{\Delta E}{\Delta A} = \frac{dF}{dA}$
Pressure exerted by a liquid column of height h, $(p) = h\rho g$

Density$(\rho) = \frac{\text{Mass(m)}}{\text{Volume(v)}}$

Density of water at 4°C i.e., maximum density of water$=1.0\times10^3$ kg/m^3

Relative Density or specific gravity $= \frac{\text{density of substance}}{\text{density of water at } 4^\circ C}$

Atmospheric Pressure(Pa)

Pressure (atm) exerted by the atmosphere.
At sea level, 1 atm=pressure exerted by 0.76m of Hg$=h\rho g = 0.76\times13.6\times10^3\times9.8 = 1.013\times10^5\,Nm^{-2}$
=101.3kPa

Absolute Pressure(P)

Total or actual pressure at a point.
Absolute pressure= atmospheric pressure + gauge pressure

Gauge Pressure (Pg)

Difference between the absolute pressure at a point and the atmospheric pressure.
Pg=absolute pressure(P) – atmospheric pressure(Pa)

MIND MAP : LEARNING MADE SIMPLE — CHAPTER - 11

Thermal Properties of Matter

Heat
A form of energy, transferred between two systems by virtue of temperature difference.

- **Latent Heat**
  - Heat required to change the state of unit mass substance without changing its temperature, $L = \frac{Q}{m}$
  - For water, latent heat of fusion, $L_f = 3.33\times10^5 J/kg$
  - Latent heat of vapourisation, $L_v = 22.6\times10^5 J/kg$
- **Specific Heat**
  - Specific heat capacity $C = \frac{s}{m} = \frac{Q}{m\Delta T}$
  - Heat capacity $s = \frac{\Delta Q}{\Delta T}$
  - Molar specific heat capacity, $c = \frac{s}{n} = \frac{\Delta Q}{n\Delta T}$

Thermal conductivity
$(K) = \frac{Qx}{A(T_2 - T_1)t}$

Thermal Laws
- **Krichoff's law**: At any given temperature $\frac{e_\lambda}{a_\lambda} = E_\lambda$ = constant
- **Wien displacement law**: $\lambda_m \frac{1}{T}$ or $\lambda_m = \frac{b}{T}$; b(wine's constant) $= 2.9\times10^{-3}$ mK
- **Stefan's Boltzmann law**: $E \propto T^4$; $E = \sigma T^4$; $\sigma = 5.672\ Js^{-1}m^{-2}k^4$; For a perfectly black body $E = \sigma(T^4 - T_0^4)$
- **Newton's law of cooling**: For small temperature difference between a body and its surroundings, the loss of heat is given by $-\frac{dQ}{dt} = k(T_2 - T_1)$

Mode of heat transfer
- (i) **Conduction :** heat transfer through molecular collisions without any actual motion of matter.
- (ii) **Convection :** heat transfer by actual motion of matter within the medium. Land breeze, sea breeze, trade winds based on natural convection are some examples.
- (iii) **Radiation :** method of heat transfer requiring no material medium.

Temperature
Degree of hotness or coldness of a body measuring device = Thermometer

Relation among different temperature scales

$$\frac{T_C - 0}{100 - 0} = \frac{T_F - 32}{212 - 32} = \frac{T_K - 273.15}{373.15 - 273.15} = \frac{R - 0}{80 - 0}$$

Principle of calorimetry
Heat lost = Heat Gain

Thermal Expansion
Increase in dimensions due to increase in temperature

- **Thermal Stress**: $\frac{\Delta F}{A} = Y\left(\frac{\Delta l}{l}\right)$, Y = Young's modulus
- **Types (In solids)**
  - **Linear expansion**: Increase of length of a solid on heating. Coefficient of linear expansion $\alpha = \frac{\Delta l}{l_0 \Delta T} = \frac{L - l_0}{l_0(T - T_0)}$
  - **Superficial or area Expansion**: Increase in area of a solid on heating. Coefficient of superficial expansion $\beta = \frac{\Delta A}{A\Delta T} = \frac{dA}{A\,dT} = \frac{A - A_0}{A_0(T - T_0)}$
  - **Relation**: $\gamma = 2\beta = 3a$ or $a:b:\gamma = 1:2:3$
  - **Cubical or volume expansion**: Increase in volume of a solid on heating. Coefficient of cubical expansion. $\gamma = \frac{\Delta V}{V_0 \Delta T} = \frac{dV}{V_0 dT} = \frac{V - V_0}{V_0(T - T_0)}$

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 12

Thermodynamics

Branch of Science which deals with concepts of heat & temperature and their interconversion by thermodynamic process

Laws

Zeroth Law of Thermodynamics

If two systems A&B are in thermal equilibrium with a third system C, then A&B are in thermal equilibrium with each other.

Thermodynamic state variable

(i) Extensive – indicate the size of the system. e.g. U, volume, total mass.
(ii) Intensive – do not indicate size of the system. e.g. , pressure & temperature

Thermal Equilibrium

Two systems are in thermal equilibrium with each other if they have the same temperature.

First law of thermodynamics

It is the statement of law of conservation of Energy; $\Delta Q = \Delta U + \Delta W$
$= \Delta U + P\Delta U$ (Here, $\Delta U = P\Delta U$)

Second law of thermodynamics

It is impossible for an engine working between a cyclic process to extract heat from a reservoir and convert completely into work.

Entropy (S)

Measure of molecular disorder of a system.
Change in entropy $\delta S = \frac{\delta Q}{T}$

Specific heat capacity Relation

- $\frac{C_P}{C_V} = \gamma$
- Mayer's Equation
  $C_P - C_V = R$

Reversible & Irreversible Process

Any process made to proceed in the reverse direction by changing its conditions is called **Reversible Process.**
Any process which cannot be retraced in the reverse direction exactly is called **Irreversible Process.**

Carnot' Engine

An Ideal engine works on a reversible cycle of four operations in succession.
(i) isothermal expansion ,
(ii) adiabatic expansion,
(iii) isothermal compression,
(iv)adiabatic compression.

Efficiency of Carnot's engine

$$\eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_2}$$

Heat Engine

Converts continuously heat into mechanical energy in cyclic process.

Efficiency $\eta = \frac{W}{Q} = 1 - \frac{Q_2}{QT_1} = 1 - \frac{T_2}{T_1}$

Refrigerator and heat pump

Refrigerator is a heat engine working in the reverse direction. Coefficient of performance,

$$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

Isothermal Process

Temperature = Constant
PV= Constant = n RT

$$W = \int_{V_1}^{V_2} \frac{nRT}{V} dv$$

Adiabatic Process

A thermally insulated system neither gains nor loses heat
$PV^{\gamma} =$ Constant
$TV^{\gamma - 1} =$ Constant
$\frac{P^{n-\gamma}}{T^{\gamma}} =$Constant; $\frac{C_p}{C_v} = \gamma$

Isochoric Process

Volume = Constant
$\frac{P}{T} =$ Constant
$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Isobaric Process

Pressure = Constant
$\frac{V}{T} =$ Constant
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Cyclic Process

In this process, system returns to initial state for a cyclic process
$\Delta U = 0$ (zero)

Quasi-static process

Infinity slow process such that systems remain in thermal & mechanical equilibrium with the surroundings throughout.

Property

The pressure (P) & temperature (T) of the environment can differ from those of the system only infinitesimally.

MIND MAP : LEARNING MADE SIMPLE — CHAPTER - 13

Kinetic Theory

- **Behaviour of Gases**
  - An ideal gas satisfies equation $PV = nRT$ at all pressure and temperature n = no. of moles, $R = N_A k_B$ universal gas constant
  - **Guy Lussac's Law**
    - $P \propto T$ (If V = constant)
    - $\frac{P}{T}$ = constant
    - or $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
  - **Charles's Law**
    - $V \propto T$ (If P = constant)
    - $\frac{V}{T}$ = constant
    - or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
  - **Boyle's Law**
    - $P \propto \frac{1}{V}$ (If T = constant)
    - PV = constant
    - or $P_1V_1 = P_2V_2$
  - **Avogadro's law**
    - Under the same condition of temperature and pressure equal volumes of all gases contain equal no. of molecules. i.e. $N_1 = N_2$
  - **Dalton's Law of Partial Pressure**
    - Total pressure of a mixture of non - reacting gases, $P = P_1 + P_2 + \ldots\ldots + P_n$
- **Pressure exerted by gas**
  - $P = \frac{1}{3}\rho v_{rms}^2$
- **Relation between Pressure (P) and Kinetic Energy (E)**
  - $E = \frac{3}{2}PV$
- **Degree of freedom (f)**
  - For monoatomic gas: $f = 3$
  - For diatomic gas :
    - (i) at room temperature, $f = 5$
    - (ii) at high temperature, $f = 7$
  - For polyatomic gas:
    - (i)at room temperature, $f = 6$
    - (ii)at high temperature, $f = 8$
- **Mean Free Path**
  - $\lambda = \frac{1}{\sqrt{2}\pi n d^2} = \frac{k_B T}{\sqrt{2}\pi d^2 P}$
- **Law of Equipartition Energy**
  - Energy associated with each degree of freedom per molecule $= \frac{1}{2}kT$
- **Assumption of Kinetic Theory of Gases**
  - All the molecules of a gas are identical.
  - The molecules of different gases are different.
  - The molecules of gases are in a state of random motion.
  - The collisions of gases molecules are perfectly elastic.
- **Specific Heat Capacity**
  - Specific Heat Capacity for an ideal gas, $C_p - C_v = R$
  - for monoatomic $\frac{C_p}{C_v} = \gamma = \frac{5}{3}$
  - for diatomic $\frac{C_p}{C_v} = \gamma = \frac{7}{5}$
  - for polyatomic gases, $\frac{C_p}{C_v} = \gamma = \frac{(4+f)}{(3+f)}$
  - Hence, f is the degree of freedom
- **Most probable Speed**
  - $v_{mp} = \sqrt{\frac{2RT}{M}} = \left(\sqrt{\frac{2}{3}}\right) v_{rms} = 0.816\ v_{rms}$
- **Average Speed**
  - $v_{av} = \frac{v_1 + v_2 + v_3 + \ldots + v_N}{N}$
  - $v_{av} = \sqrt{\frac{8RT}{\pi M}} = \left(\sqrt{\frac{8}{3\pi}}\right) v_{rms} = 0.92\ v_{rms}$
- **Root mean square Speed**
  - $v_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3RT}{M}}$

MIND MAP : LEARNING MADE SIMPLE — CHAPTER - 14(A)

Oscillations

- Every oscillatory motion is periodic, but every periodic motion need not be oscillatory.
- To and fro motion repeatedly about a fixed point in a definite interval of time.

SHM

Simple Harmonic Motion is the simplest form of oscillatory motion

Displacement in SHM

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

A= Amplitude i.e.,maximum displacement of particles.

Phase

Time varying quantity $(\omega t + \phi)$

Phase constant or Phase angle (ϕ)

- It depends upon velocity (v) and displacement of particle at t = 0

Time period (T)

The smallest interval of time after which the motion is repeated

Frequency

The number of oscillations per second

i.e., $f = \frac{1}{T} = \frac{\omega}{2\pi}$

Velocity in SHM

$v = \frac{dx}{d(t)} = -\omega A \sin(\omega t + \varphi)$

$v_{max} = \omega A$

Acceleration in SHM

$a = \frac{dv}{dt} = -\omega^2 A \cos(\omega t + \varphi)$

$a_{max} = \omega^2 A$

Energy in SHM

Kinetic Energy

K.E $= \frac{1}{2} m\omega^2 A^2 \sin^2(\omega t + \varphi)$

Potential Energy

P.E $= \frac{1}{2} m\omega^2 A^2 \cos^2(\omega t + \varphi)$

Total energy, T.E.=K.E.+ P.E.

$= \frac{1}{2} kA^2[\cos^2(\omega t + \varphi) + \sin^2(\omega t + \varphi)]$

Force law equation for SHM

$F = -k(x), k = m\omega^2$

$\therefore \omega = \sqrt{\frac{k}{m}}$

Simple pendulum

Time period $T = 2\pi\sqrt{\frac{I}{mgl}} = 2\pi\sqrt{\frac{l}{g}}$

Oscillations due to a spring

Time period $T = 2\pi\sqrt{\frac{m}{k}}$

Here, $k = \frac{F}{x}$ = *spring constant*

Damped Oscillations

Oscillation of a body whose amplitude goes on decreasing with time.

Damping force $F_d = -bv$, b = damping constant

Displacement of damped oscillator

$x = x_m e^{-bt/2m} \sin(\omega t + \varphi)$

Amplitude decreases with time as

$x = x_m e^{-(b/2m)t}$

Forced Oscillations

Driving force, $F(t) = F_o \cos\omega_d t$

Displacement, $x(t) = A\cos(\omega_d t + \varphi)$

Amplitude, $A = \frac{F_o}{\left\{m^2(\omega^2 - \omega_d^2)^2 + \omega_d^2 b^2\right\}^{\frac{1}{2}}}$

$\tan\varphi = \frac{-v_o}{\omega_d x_o}$

Resonance

When frequency of external force is equal to natural frequency of oscillator.

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 14(B)

Waves

- **Stationary Waves**
  - Stationary waves
    (i) In string: Fundamental Frequency, $\nu = \frac{1}{2l}\sqrt{\frac{T}{m}}$
    (ii) In organ pipe:
    (a) Open at both ends,
    Fundamental freq. or I harmonic $\nu = \frac{v}{2l}$
    (b) Closed at one end $\nu = \frac{v}{4l}$
    (iii) • In open organ pipe, higher harmonics, both odd & even.
    • In closed organ pipe, higher harmonics, odd only.
- **Dopoler Effect**
  - General Formula, Apparent Frequency
    $n^1 = n\left(\frac{v \pm v_s \pm v_m}{v \mp v_0 \pm v_m}\right)$
    Here, v = speed of sound,
    v_0 = observer speed
    v_s = source speed
    v_m = medium speed
- **Relation b/w wave velocity (v), wavelength (λ) & frequency (ν)**
  - $v = \nu\lambda$
    Time period (T) $= \frac{1}{\text{Frequency}} = \frac{1}{\nu}$
    Angular Frequency (ω) $= 2\pi\nu$
    Wave number, $v = \frac{1}{\text{wavelength}} = \frac{1}{\lambda}$
- **Displacement relation in a plane progressive wave**
  - $y(x, t) = A \sin(-kx + t)\, \omega_\phi$
    $y(x,t) = A \sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$
    Velocity amplitude $v_0 = A\omega^2$
    Acceleration Amplitude $a_0 = A\omega^2$
- **Beats**
  - Difference in frequencies of two superposing waves, $\nu_{beat} = \nu_1 \sim \nu_2$
- **Principle of superposition of waves**
  - When two or more waves are propagating with different displacements then the net displacement of collective wave is given as $Y = y_1 + y_2 + y_3 + \ldots + y_n$
- **Types**
  - **Matter Waves**
    - Waves associated with particles like-electrons, protons, neutrons, atoms, molecules etc.
  - **Electromagnetic Waves**
    - Do not require any material medium for their propagation e.g., light waves
  - **Mechanical Waves**
    - Require material medium for their propagation
      - **Properties**: Essential properties for propagation
        - Elasticity
        - Inertia
        - Minimum friction
      - **Transverse waves**: Individual particles of the medium oscillate perpendicular to the direction of propagation of wave
        - Speed of transverse wave in a stretched string $V = \sqrt{\frac{T}{m}}$, T = tension & M = mass/length
      - **Longitudinal waves**: Individual particles of the medium oscillate along the direction of propagation of wave.
        - Speed of a longitudinal wave speed of sound, $V = \sqrt{\frac{B}{\rho}} = \sqrt{\frac{Y}{\rho}} = \sqrt{\frac{P}{\rho}} = \sqrt{\frac{\gamma P}{\rho}}$ for air, $\gamma = 7/5$

SAMPLE PAPER CLASS - 11TH SUB: PHYSICS

Time:-3 hr **M.M:-70**

INSTRUCTIONS :

1.QUESTIONS NO. 1 will be carrying 20 Questions of 1 marks each.
2.Question NO. 2 to 8 will be carrying 2 marks each .
3.Question No. 9 to 15 will be carrying 3 marks each.
4. Question No. 16 will be comprehension type.
5.Question No. 17 and 18 will be carrying 5 marks each.

(Marking Scheme: Unit 1 = 3, Unit 2 = 9, Unit 3 = 10, Unit 4 = 11, Unit 5 = 5, Unit 6 = 5, Unit 7 = 8, Unit 8 = 7, Unit 9 = 4, Unit 10 = 8, Numericals = 15, Total = 70)

Section A: 1 Mark Questions

Q1. Multiple Choice questions:
i) Dimensional formula of torque is
(a) $[ML^2 T^{-1}]$ (b) $[M^{-1}L^2T^{-1}]$ (c) $[ML^2T^{-2}]$ (d) $[M^{-1} L^{-2} T^{-2}]$
ii) Slope of vel – time graph gives
(a) distance (b) speed (c) acceleration (d) none of these
iii) SI unit of impulse is (a) N (b) Ns (c) Nm (d) Nsm
iv) If a light body and heavy body have same kinetic energy, then which one has greater linear momentum?
(a) Lighter body (b) Heavier body (c) Both have same momentum (d) Can't be predicted
v) A pair of equal and opposite forces with different lines of action produces
(a) Rotation without translation (b) Both Translation and rotation (c) Translation without rotation (d) Neither translation nor rotation
vi) The areal velocity of a planet around the sun is constant, this is called as
(a) Law of areas (b) Law of periods (c) Law of orbits (d) Law of gravitation
vii) What does the slope of stress versus strain graph give?
(a) Strain (b) stress (c) modulus of elasticity (d) none of the above
viii) For a given fluid in laminar flow, at a particular temperature, the shearing stress is:
(a) directly proportional to strain (b) directly proportional to (strain)2 (c) directly proportional to strain rate (d) inversely proportional to strain rate
ix) For an adiabatic process, which of the following is true?
(a) $\Delta P = 0$ (b) $\Delta V = 0$ (c) $\Delta U = 0$ (d) $\Delta Q = 0$
x) The monoatomic molecules have only three degrees of freedom because they can possess
(a) only translatory motion (b) only rotatory motion (c) both translatory and rotatory motion (d) translatory, rotatory and vibratory motion
xi) The function of time which is not periodic among the following is
(a) sin ωt (b) cos ωt (c) e-ωt (d) sin ωt + cos ωt
xii) A particle is executing SHM of amplitude A. At what displacement from the mean position is the energy half kinetic and half potential? (a) A (b) $\frac{A}{2}$ (c) $\frac{A}{\sqrt{2}}$ (d) $\sqrt{2}$ A
xiii) In the relation $\mu = PV/RT$, μ is (a) Number of molecules (b) Atomic number (c) Mass number (d) Number of moles
xiv) When two systems are in thermal equilibrium, the quantity which remains same in the two system is (a) volume (b) pressure (c) temperature (d) density
xv) Water rises in a capillary tube to a height of h. If the area of cross-section of the tube is made one-fourth, then the water will rise to a height of: (a) h (b) $\frac{h}{2}$ (c) 2h (d) 4h
xvi) What is the effect on escape speed if the object is taken on the surface of another planet having same radius as earth but density 4 times the density of earth?

(a) remains same (b) becomes half (c) becomes twice (d) becomes four times
xvii) Which motion does not require force to maintain it?
(a) Uniform circular motion (b) Elliptical motion (c) Uniform straight line motion (d) Projectile motion
xviii) A body cannot have (a) A constant speed and varying velocity (b) an acceleration and a constant speed (c) A uniform velocity and varying speed (d) non zero speed and zero acceleration
xix) If $x = a + bt^2$ where x is in metres and t is in seconds, find the units of b?
(a) m (b) ms^{-2} (c) ms^{-1} (d) $m^2\ s^{-1}$
xx) A body oscillates with S.H.M according to the equation: $x(t) = 5 \cos(2\pi t + \pi/4)$, where x is in metres and t is sec. Calculate frequency (a) 5 Hz (b) 10 Hz (c) 1 Hz (d) 2π

Section B: 2 Marks Questions

Q2. Define light year and astronomical unit?

OR

Check whether the following equation is dimensionally correct $\frac{1}{2} mv^2 = mgh$

Q3. Derive relations between angular velocity (ω), frequency (ν) and time period (T)?

OR

A bomb is dropped from an aeroplane when it is directly above a target at a height of 1000 m. The aeroplane is moving horizontally with a speed of 500 kmh^{-1}. By how much distance will the bomb miss the target?

Q4. Two masses of 1 g and 4 g are moving with equal K.E. Calculate the ratio of magnitude of their momenta?

OR

If the linear momentum of a body increases by 50%, what will be the % increase in the kinetic energy of the body?

Q5. What do you mean by angle of contact? Give at least one example of the cases where angle of contact is (i) acute (ii) obtuse

Q6. What is an adiabatic process? Give two conditions for an adiabatic process to take place?

Q7. Calculate the value of C_P, C_V and γ for diatomic gas?

Q8. Define simple harmonic motion. Give an example. At which position is the acceleration of the particle executing SHM is maximum and minimum?

Section C: 3 Marks Questions

Q9. A bullet of mass 0.04 kg moving with a speed of 90 ms^{-1} enters a heavy wooden and is stopped after a distance of 0.6 m. What is the average resistive force exerted by the block on the bullet?

OR

A body rolled on ice with a velocity of 8 ms^{-1} comes to rest after travelling 4m. Compute the coefficient of friction? Given g = 9.8 ms^{-2}

Q10. Define Power. Is it a scalar or a vector quantity? Define SI unit of power?

Q11. Define radius of gyration of a body about some axis of rotation. Derive an expression for it.

Q12. Define orbital velocity? Derive an expression for orbital velocity of a satellite?

OR

If the earth has a mass 9 times and radius twice that of a planet Mars, calculate the minimum velocity required by a rocket to pull out of gravitational force of Mars. Take the escape velocity on the surface of earth to be 11.2 km s^{-1}.

Q13. Define C_P and C_V? Derive $C_P - C_V = R$.

OR

A Carnot engine takes 3 x10^6 cal of heat from a reservoir at 627^0C and gives it to a sink at 27^0C. Find the work done by the engine ?

Q14. The amplitude of a simple harmonic oscillator is doubled. How does this affect i) periodic time ii) maximum velocity iii) maximum acceleration?

Q15. What do you mean by specific heat capacity of substance? What is its formula? Write units and dimensions of specific heat capacity. What is the advantage of large value of specific heat of water?

Section D: Comprehension type question

Q16. Read the following paragraph carefully and answer the following questions:

The work done by a conservative force such as gravity depends on the initial and final positions only. In the previous chapter we have worked on examples dealing with inclined planes. If an object of mass mass m is released from rest, from the top of a smooth (frictionless) inclined plane of height h, its speed at the bottom is $\sqrt{2gh}$ irrespective of the angle of inclination. Thus, at the bottom of the inclined plane it acquires a kinetic energy, mgh. If the work done or the kinetic energy did depend on other factors such as the velocity or the particular path taken by the object, the force would be called non- conservative. The dimensions of potential energy are $[ML^2T^{-2}]$ and the unit is joule (J), the same as kinetic energy or work. To reiterate, the change in potential energy, for a conservative force, ΔV is equal to the negative of the work done by the force $\Delta V = - F(x)\,\Delta x$

Que 1: What do you mean by conservative force? Give an example.

Que 2: If an object of mass mass m is released from rest, from the top of a smooth (frictionless) inclined plane of height h, its speed at the bottom is _______.

Que 3: The kinetic energy acquired by the body at the bottom of a frictionless inclined plane of height h is _______.

Que 4: What do you mean by non conservative force?

Que 5: Write the relation between force and potential energy.

Section E: 5 Marks Questions

Q17. What is a projectile? A projectile is fired with a velocity u making an angle θ with the horizontal .Show that its trajectory is a parabola? Derive expressions for its: i) time of flight ii) maximum height iii) horizontal range?

OR

State parallelogram law of vector addition .Give analytical treatment to find the magnitude and direction of a resultant vector using this law.

Q18. What do you mean by angle of banking? What is its need? Find expression of the safe limit of velocity with which a car can take a turn on a banked road. Also discuss the case when friction is absent and hence find expression of angle of banking. (1+1+2+1)

OR

State and prove law of conservation of linear momentum. Write this law for a two body system. Hence explain the recoil of a gun during firing and find the expression of velocity of recoil of the gun. (1,1,1,1,1)

ANSWER KEY

Q1.Multiple choice questions

i) (c) $[ML^2T^{-2}]$
ii) (c) acceleration
iii) (b) Ns
iv) (b) Heavier body
v) (a) Rotation without translation
vi) (a) Law of areas
vii) (c) Modulus of elesticity
viii) (d) Directly proportional to strain rate
ix) (d) $\Delta Q = 0$
x) (a) Only translatory motion
xi) (b) $e^{-\omega t}$
xii) (c) $A/\sqrt{2}$
xiii) (d) Number of moles
xiv) (c) Temperature
xv) (b) h/2
xvi) (c) Becomes twice
xvii) (c) Uniform straight line motion
xviii) (c) A uniform velocity and varying speed
xix) (b) ms^{-2}
xx) (c) 1 Hz

Q2. $\frac{1}{2}mv^2 = mgh$

$[M][LT^{-1}]^2 = [M][LT^{-2}][L]$

$[ML^2T^{-2}] = [ML^2T^{-2}]$

AS L.H.S =R.H.S

So given equation is dimensionally correct

Q3. u=500 km/h = 138.88 m/s

H=1000 m , g=9.8 ms^{-2}

$R = u\sqrt{\frac{2h}{g}} = 1984.13$ m

Q4. $\frac{P_1}{P_2} = \frac{\sqrt{2m_1E}}{\sqrt{2m_2E}} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

OR

$K = \frac{P^2}{2m}$

Increase in linear momentum = 50% of P = $\frac{P}{2}$

Final momentum = $P + \frac{P}{2} = \frac{3P}{2}$

Final K.E = $\frac{9}{4}\frac{P^2}{2m} = \frac{9}{4}$ K

Increase in kinetic energy (K') = $\frac{9}{4}k - k = \frac{5}{4}k$

%increase in K.E= $\frac{K'-K}{K}$ X 100 = $\frac{\frac{5}{4}K}{K}$ X 100 = 125 %

Q5. Angle of contact is the angle between the tangents to the liquid surface and solid surface inside the liquid surface.
For glass – water surface, angle of contact is acute.
For mercury – glass surface, angle of contact is obtuse.

9. Using $v^2 - u^2 = 2aS$, $0^2 - 90^2 = 2(-a) \times 0.6$, a = - 6750 m/s^2, F = ma = - 0.04 × 6750 = - 270 N

OR

Using $v^2 - u^2 = 2aS$, $0^2 - 8^2 = 2(-a) \times 4$, a = - 8 m/s^2, frictional force, F = -ma = μR
-ma = μmg, $\mu = \frac{-a}{g} = \frac{8}{9.8} = 0.82$

Q12. $M_e = 9\ M_m$, $R_e = 2\ R_m$
V_e = 11.2 km/s

$V_e = \sqrt{\frac{2\ GM_e}{R_e}}$

$V_m = \sqrt{\frac{2GM_m}{R_m}}$

$\frac{V_m}{V_e} = \sqrt{\frac{M_m\ X\ R_e}{M_e\ X\ R_m}} = \frac{\sqrt{2}}{3}$

$V_m = \frac{\sqrt{2}}{3}$ x 11.2 = 5.3 km/s

Q13. T_1 = 627 ^{0}C = 627 + 273 = 900 K
T_2 = 27+ 273 = 300 K
Q_1= 3 X10^6 Cal

$\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$

Q_2= 10^6 cal
Work done by the engine
W= $Q_1 - Q_2$ = 3 X 10^6 - 10^6
W= 2 X 10^6 cal
W = 8.4 x 10^6 J