11 TH PHYSICS MINIMUM MATERIAL (ENGLISH MEDIUM)

2 MARKS QUESTIONS

1. **FUNDAMENTAL QUANTITIES DERIVED QUANTITIES**
   - **FUNDAMENTAL QUANTITIES**
     The quantities, which cannot be expressed in term of any other physical quantities are called fundamental or base quantities e.g length, mass, time, temperature, current
   - **DERIVED QUANTITIES**
   - Quantities that can be expressed in term of fundamental quantities are called derived quantities e.g : area, volume, velocity, force.
2. **ACCURACY AND PERCISION**
   - **ACCURACY :**
   - measurements close to the value.
   - All the accuracy values are précised
   - **PRECISION** :
   - Measurements close to each other.
   - All the précised values are not accurate.
3. **ABSOLUTE ERROR, PERCENTAGE ERROR AND RELATIVE ERROR**
   - the magnitude of difference between true value and measured value of a quantity is called absolute error.(a_m)
   - The relative error expressed in percentage is called percentage error
   - Percentage error $=\frac{\Delta a_m}{a_m} x\ 100\%$
   - The ratio between mean absolute error to the mean value is called relative error or fractional error.
4. **SCALAR , VECTOR**
   - A physical quantity which can be described only by magnitude is called scalar. e.g : mass, speed, time, distance
   - A physical quantity which can be described by both magnitude and direction is called vector . e.g :force velocity, displacement
5. **SYSTEMATIC STEPS ARE FOLLOWED FOR DEVELOPING FBD**
   - Identify the forces acting on the object
   - represent the object as a point.
   - Draw the vectors representing the forces acting on the object.
6. **ANGLE OF REPOSE AND ANGLE OF FRICTION**
   - The angle of friction is defined as the angle between the normal force(N) and resultant force (R) of normal force and maximum friction force (f_s^{max}).
   - The angle of repose is defined as the angle of the inclined plane at which the object starts to slide.
7. **APPLICATIONS OF ANGLE OF REPOSE**
   - Antlions make sand traps in such way that its angle of inclination is made equal to angle of repose. So that insects enter the edge of the trap start to slide towards the bottom where the antlions hide itself.
   - Children sliding boards are always inclined just above the angle of repose. So that children playing on that slide smoothly. At the same time, much greater inclined angle may hurt the sliding children.
8. **LAMI'S THEOREM**
   - If a system of three concurrent and coplanar forces is in equilibrium, each force is directly proportional to sine of the angle between the other two forces.
9. **COEFFICIENT OF RESTITUTION (E)**
   - The ratio of velocity of separation after collision to the velocity of approach before collision.
   - COR values lies between 0<e<1
   - For perfect elastic collision e=1.
   - For perfect inelastic collision e=0
10. **CENTER OF MASS AND POINT MASS**
    - CENTER OF MASS.
    - A point where the entire mass of the body appears to be concentrated.
    - POINT MASS
    - A point mass is a hypothetical point which has non-zero mass and no size or shape.
11. **MOMENT OF INERTIA AND RADIUS OF GYRATION**
    - The root mean square (rms) distance of the particles of the body from the axis of rotation.
    - $K = \sqrt{\frac{r_1^2+r_2^2+r_3^2+r_4^2 ...+r_n^2}{n}}$
12. **NEWTON'S UNIVERSAL LAW OF GRAVITATION**
    - The force of attraction between any two bodies in the universe is directly proportional to the product of their masses and is inversely proportional to the square of the distance between them.
    - $F = G\frac{m_1 m_2}{r^2}$
13. **HOOKE'S LAW OF ELASTICITY.**
    - The stress is directly proportional to the strain within the elastic limit of the body. σ α ε
14. **PASCAL'S LAW**
    - If the pressure in a liquid is changed at a particular point, the change is transmitted to the entire liquid without being diminished in magnitude.
15. **POISSON'S RATIO**
    - The ratio of relative contraction (lateral strain) to the relative expansion(longitudinal stain)
16. **REYNOLD'S NUMBER**
    - Reynold's number is a dimensionless number, which is used to find out the nature of flow of the liquid.
    - $R_c = \frac{\rho v D}{\eta}$
    - where ρ – density of the liquid
    - v – the velocity of flow of liquid
    - D- diameter of the pipe
    - η- the coefficient of viscosity of the fluid

17. TERMINAL VELOCITY

- The maximum constant velocity acquired by a body while falling freely through a viscous medium is called the terminal velocity.

18. STREAMLINED FLOW AND TURBULENT FLOW

- When a liquid flows such that each particle of the liquid passing through a point moves along the same path with the same velocity as its predecessor then the flow of liquid is said to be a streamlined flow,
- When the speed of the moving fluid exceeds the critical speed, the motion becomes irregular. This flow of liquid is called turbulent flow.

19. WIEN'S DISPLACEMENT LAW

- Wien's law states that, the wavelength of maximum intensity of emission of a black body radiation is inversely proportional to the absolute temperature of the black body.
- $\lambda_m = \frac{b}{T}$
- Where b=2.898 x 10^{-3} m K^{-1}
- b Wien's constant

20. THREE MODES OF HEAT TRANSFER

- Conduction : conduction is the process of direct transfer of heat through matter due to temperature difference.
- Convection : convection is the process in which heat transfer is by actual movement of molecules in fluids such as liquids and gases.
- Radiation : Radiation is a form of energy transfer form one body to another by electromagnetic waves.

21. DEGREE OF FREEDOM

- The minimum number of independent coordinates needed to specify the position and configuration of a thermo-dynamical system in space is called the degree of freedom of the system.
- A free particle moving along x-axis needs only one coordinate to specify it completely. So its degree of freedom is one.
- Similarly, a particle moving over a plane has two degrees of freedom.
- A particle moving in space has three degrees of freedom.

22. BOYLE'S LAW AND CHARLE'S LAW

- **BOYLE'S LAW**
- When the gas is kept at constant temperature, the pressure of the gas is inversely proportional to the volume.
- $P \; \alpha \; \frac{1}{V}$
- **CHARLE'S LAW**
- When the gas is kept at constant pressure, the volume of the gas is directly proportional to absolute temperature.
- **V α T**

23. MEAN FREE PATH AND THE FACTORS AFFECTING THE MEAN FREE PATH

- The average distance travelled by the molecule between collisions is called mean free path (λ)
- $\lambda = \frac{KT}{\sqrt{2}\,\pi d^2 P}$
- Mean free path increases with increasing temperature.
- Mean free path increases with decreasing pressure and diameter of the gas molecules.

24. BROWNIAN MOTION AND THE FACTORS WHICH AFFECT

- The random (Zig - Zag path) motion of pollen suspended in a liquid is called brownian motion.
- The factors affecting the Brownian motion :
- Brownian motion increases with increasing temperature.
- Brownian motion decreases with bigger particle size, high viscosity and density of the liquid 9or) gas.

25. RESONANCE

- When the frequency of external periodic agency is matched with natural frequency of the vibrating body, the body starts to vibrate with maximum amplitude. This is known as Resonance.

26. USES OF CAPILLARITY

- Rising of oil in the cotton wick of earthen lamp.
- Rising of sap from root to plant's leaves and branches.
- Absorption of ink by a blotting paper.
- Draining of tear fluid from the eye.
- Absorption of sweat by cotton dress.

27. DOPPLER EFFECT

- When the source an the observer are in relative motion with respect t each other and to the medium in which sound propagates, the frequency of the sound wave observed is different from the frequency of the source. This phenomenon is called Doppler Effect.

28. SPRING CONSTANT OR FORCE CONSTANT OR STIFFNESS CONSTANT

- Force per unit length of a spring is called stiffness constant or force constant or spring constant (k). It is a measure of stiffness of the spring. Its unit is $Nm^{-1.}$
- K = - $\frac{F}{x}$

29. SIMPLE HARMONIC MOTION (SHM)

- Simple harmonic motion is a special type of oscillatory motion in which the acceleration or force on the particle is directly proportional to its displacement from affixed point and is always directed towards that fixed point.

30. INTENSITY OF SOUND AND LOUDNESS OF SOUND

- The intensity of sound is defined as the power transmitted per unit area taken normal propagation of the sound wave. Its unit is W m^{-2}.

- The loudness of sound is defined as the of sensation of sound produced in the ear perception of sound by the listener.

31. WHAT IS MEANT BY AN ECHO ?

- An echo is a repetition of sound produced by the reflection of sound waves from a wall, mountain or other obstructing surfaces.

32. STEFAN BOLTZMANN LAW

- Stefan Boltzmann law states that, the total amount of heat radiated per second per unit area of a black body is directly proportional to the fourth power of its absolute temperature.
- $E = \sigma\ T^4$
- Where $\sigma = 5.67\ x\ 10^{-8}$ $Wm^{-2}K^{-4}$, Stefan's constant.

33. LAW OF CONSERVATION OF ANGULAR MOMENTUM

- When no external torque acts on the body, the net angular momentum of a rotating rigid body remains constant

34. ARCHIMEDES PRINCIPLE

- It states that when a body is partially or wholly immerse in a fluid, it experiences and upward thrust equal to the weight of the fluid displaced by it and its up thrust acts through the center of gravity of the liquid displaced.

35. NEWTON'S LAW OF COOLING

- Newton's law of cooling states that the rate of loss of heat of a body is directly proportional to the temperature difference between that body and its surroundings.

36. BERNOULLI'S THEOREM

- According to Bernoulli's theorem, the sum of pressure energy, kinetic energy, and potential energy per unit mass of an incompressible, non-viscous fluid in a streamlined flow remains a constant.
- $\frac{P}{\rho} + \frac{1}{2}v^2 + gh = constant$

37. SOLDIERS ARE NOT ALLOWED TO MARCH ON BRIDGE. WHY?

- When Soldiers march on the bridge, their stepping frequency may match on the natural frequency of the bridge. I it so, the bridge will vibrate with larger amplitude due to resonance. This may collapse the bridge.

38. APPLICATION OF VISCOSITY?

- Viscosity of liquids helps in choosing the lubricants for various machinery parts. Low viscous lubricants are used in light machinery parts and high viscous lubricants are used In heavy machinery parts.
- As high viscous liquids damp the motion, they are used in hydraulic brakes as brake oil.
- Blood circulation through arteries and veins depends upon the viscosity of fluids.
- Viscosity is used in millikan's oil-drop method to find the charge of an electron.

39. THE APPLICATION OF STOKE'S LAW

- FLOATATION OF CLOUDS
- Hurting of larger raindrops.
- Parachute riding.

40. PRINCIPLE OF HOMOGENEITY OF DIMENSION ?

- The principle of homogeneity of dimension states that the dimensions of all the terms in a physical expression should be the same.

3 MARKS QUESATIONS

1. WHAT ARE THE LIMITATIONS AND USES OF DIMENTIONAL ANALYSIS ?

- **LIMITATIONS**
- It gives no information about the dimensionless constants like numbers $\pi, e. etc.$, in the formula.
- It cannot decide whether the given quantity is a scalar or vector.
- It is not suitable to derive relations involving trigonometry, exponential and logarithmic functions.
- It cannot be applied to an equation involving more than three physical quantities.
- It can only check dimensional correctness of an equation but not the correctness of the equation.
- **USES OF DIMENTIONAL ANALYSIS**
- Convert a physical quantity from one system of units to another.
- Check the dimensional correctness of a given physical equation.
- **Establish relations among various physical quantities.**

2. WRITE THE RULES FOR DETERMINING SIGNIFICANT FIGURS.

S. NO	RULE	EXAMPLE (SIGNIFICANT FIGURES)
1	All non-zero digits are significant	1234 = 4
2	All zeros between two non-zero digits are significant.	2008 = 4
3	All zeros right to non-zero digit but left to decimal point are significant.	30700. = 5
4	The terminal of trailing zeros in the number without decimal point are not significant.	30700 = 3
5	All zeros are significant if the number given with measurement unit.	30700 m = 5
6	If a number is less than 1, the zeros between decimal point and first non-zero digit are not	i) 0.00345 = 3 ii) 0.030400 = 5 III) 40.00 = 4

	significant but the zeros right to last non-zero digit are significant.	
7	The number of significant figures doesn't depend on the system of units used.	1.53 cm, 0.0153 m 0.00000153 km all have **3** significant figures

3. **EXPLAIN THE PROPAGATION OF ERRORS IN ADDITION AND MULTIPLICATION.**

- **ADDITION:**
- ∆A and ∆B be the absolute errors in two quantities A and B respectively.
- Measured value of A =A ±∆A
  Measured value of B = B ±∆B
  The sum Z = A+B
- The error ∆Z in Z is given by,
  Z± ∆Z = (A±∆A) + (B ±∆B)
  Z±∆Z = (A+B) ±(∆A+ ∆B)
  Z±∆Z = Z ±(∆A+ ∆B) [Z=A+B]
  ∆Z = ∆A + ∆B
- The maximum possible error in the sum of two quantities is equal to the sum of the absolute rrors in the individual quantities.
- **MULTIPLICATION :**
- ∆A AND ∆b be the absolute errors in the two quantities A and B respectively.
- Measured value of A = A ± ∆A
  Measured value of B = B ± ∆B
  Consider the product Z = A.B ---(1)
- The error ∆z in z is given by,
  Z±∆Z = (A ±∆A).(B ±∆B)
  Z±∆Z = AB ± A . ∆B ± B. ∆A ± ∆A . ∆B ----(2)
  Divding equation (2) by (1) we get,

  1 ±∆Z/Z = 1 ± ∆B/B ± ∆A/A ± ∆A/A. ∆B/B

  As $\frac{\Delta A}{A}$ And $\frac{\Delta B}{B}$ Are both smaller values, their $\frac{\Delta A}{A}$, $\frac{\Delta B}{B}$ can now be neglected. The maximum fractional error in z is

  $$\boxed{\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}}$$

- The maximum fractional error in the product of two quantities is equal to the sum of the fractional errors in the individual quantities.

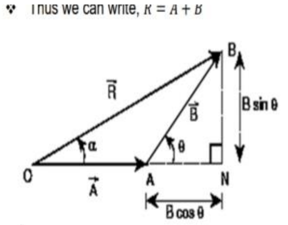
4. **DISCUSS THE PROPERTIES OF SCALAR AND VECTOR PRODUCTS.**

S. NO	SCALAR PRODUCT	VECTOR PRODUCT
1	C =$\vec{A}.\vec{B}$	$\vec{C}$=$\vec{A}X\vec{B}$
2	It obeys commutative law $\vec{A}.\vec{B} = \vec{B}.\vec{A}$	It does not obeys commutative law $\vec{A}.\vec{B} \neq \vec{B}.\vec{A}$
3	It obeys distributive law $\vec{A}.(\vec{B}+\vec{C}) = \vec{A}.\vec{B} + \vec{A}.\vec{C}$	It obeys distributive law $\vec{A}\,X(\vec{B}+\vec{C}) = \vec{A}\,X\,\vec{B} + \vec{A}X\,\vec{C}$
4	When $\vec{A}$&$\vec{B}$ are parallel $\theta = 0^0$ $(\vec{A}.\vec{B})_{max} = AB$	When $\vec{A}$&$\vec{B}$ are parallel $\theta = 0^0$ $(\vec{A}.\vec{B})_{min} = 0$
5	When $\vec{A}$&$\vec{B}$ are perpendicular $\theta = 90^0$ $(\vec{A}.\vec{B}) = 0$	When $\vec{A}$&$\vec{B}$ are perpendicular $\theta = 90^0$ $(\vec{A}.\vec{B})_{max} = AB\hat{n}$
6	Self dot product of a unit vector is one $\hat{n}.\hat{n} = 1$	Self dot product of a unit vector is one $\hat{n}.\hat{n} = 0$
7	Dot product of orthogonal unit vectors $\hat{\imath}.\hat{\jmath} = \hat{\jmath}.\hat{k} = \hat{k}.\hat{\imath} = 0$	cross product of orthogonal unit vectors $\hat{\imath}X\hat{\jmath} = \hat{k}$ $\hat{\jmath}X\hat{k} = \hat{\imath}$ $\hat{k}X\hat{\imath} = \hat{\jmath}$

5. **EXPLAIN IN DETAIL THE TRIANGLE LAW OF ADDITION.**

- **TRIANGLE LAW OF ADDITION.**
  If two vectors are represented by two adjacent sides of a triangle in same order, then the resultant is given by the third side of the triangle in opposite order.
- Let $\vec{A}$ *and* $\vec{B}$ are two vectors they are inclined at angle θ between them.
  $\vec{R}$ *be theresultant vector*
  $\vec{R} = \vec{A} + \vec{B}$
- **MAGNITUDE OF RESULTANT VECTOR :**
  FROM ∆ ABN
  COS θ = $\frac{AN}{B}$; AN=B COS θ

  SIN θ = $\frac{BN}{B}$; BN=B SIN θ



FROM ∆ OBN
$OB^2 = ON^2 + BN^2$

$$R^2 = (A + Bcos\theta)^2 + (Bsin\theta)^2$$
$$R^2 = A^2 + B^2cos^2\theta + 2ABcos\theta + B^2sin^2\theta$$

$$\boxed{R = |\vec{A} + \vec{B}| = \sqrt{A^2 + B^2 + 2AB\,cos\theta}}$$

DIRECTION OF RESULTANT VECTAOR :
FROM ∆ OBN
tan α = $\frac{BN}{ON} = \frac{BN}{OB+AN}$

$$\boxed{\tan\alpha = \frac{B\,sin\theta}{A+Bcos\theta}}$$

6. **EXPLAIN TYPES OF INERTIA.**
   The inability of an object to change its state of rest or motion.

- **Inertia of rest :**
  The inability of an object to change its state of rest is called inertia of rest

Example : when a bus start to move from rest position, all the passengers inside the bus suddenly will be pushed back.

- **Inertia of motion :**
- The inability of an object to change its state of motion on its own is called inertia of motion.
  Example : When a bus in motion suddenly braked, all the passengers inside the bus will move forward.
- **Inertia of direction :**
- The inability of an object to change its state of direction on its own is called inertia of direction
  Example : When a stone attached to a string is in whirling motion suddenly cut out, the stone will move in the tangential direction of the circle.

7. COMPARISON OF TRANSLATION AND ROTATION MOTION.

S. NO	TRANSLATION MOTION	ROTATION MOTION.
1	Displacement x	Angular displacement θ
2	Mass m	Moment of inertia I
3	Force F= ma	Torque $\tau = I\,\alpha$
4	Linear momentum p = m.v	Angular momentum L= I.ω
5	Work done by force w= F.s	Work done by torque w = $\tau.\theta$
6	Kinetic energy K.E = ½ mv²	Rotational K.E = ½ Iω²
7	Power P = F.v	Rotational power P = $\tau\omega$

8. STATE NEWTON'S THREE LAWS.

FIRST LAW :
Every body continues its state of rest or in uniform motion external force acting on it.
Example :
One's body movement to the side when a car makes a sharp turn
SECOND LAW :
The force acting on an object is equal to the rate of change of its momentum.
Example :
Acceleration of the rocket is due to the force applied, known as thrust.
THIRD LAW :
For every action there is an equal and opposite reaction.
Examples:
Rockets move forward by expelling gas backward at a high velocity.

9. DIFFERENCES BETWEEN STATIC AND KINETIC FRICTION

S.NO	STATIC FRICTION	KINETIC FRICTION
1	It opposes initiation of motion.	It opposes relative motion of the object with respect to the surface.
2	Independent of surface contact.	Independent of surface contact.
3	μ_s depends on the nature of material in mutual contact.	μ_k depends on the nature of material and temperature of the surface.
4	Depends on the magnitude of applied force.	Independent of magnitude of applied force.
5	It takes values from 0 to $\mu_s N$	It is always equal to $\mu_k N$
6	$f_s^{max} > \mu_k$	$\mu_k < f_s^{max}$
7	$\mu_s > \mu_k$	$\mu_k < \mu_s$

10. DIFFERENCES BETWEEN CENTRIPTAL AND CENTRIFUGAL FORCES

S. N O	CENTRIPTAL FORCES	CENTRIFUGAL FORCES
1	It is a real force given by external agencies like gravitational force, tensional force, normal force, etc.	It is a pseudo force or fictitious force cannot be derived from any external agencies.
2	Acts in both inertial and non-inertial frames	Acts only in non-inertial frames (rotating frames)
3	It acts towards the axis of rotation or center of the circular motion.	It acts away from the axis of rotation or center of the circular motion.
4	Real force and has real effects.	Pseudo force but has real effects.
5	It originates from interaction of two objects.	It originates from inertia of the object.
6	It is included in free body diagram for both inertial and non-inertial frames.	It is included in free body diagram for only non-inertial frames.
7	Magnitude is equal to centrifugal force.	Magnitude is equal to centripetal force.

11. DIFFERENCES BETWEEN CONSERVATIVE AND NON- CONSERVATIVE FORCE.

S.NO	CONSERVATIVE FORCE	NON-CONSERVATIVE FORCE
1	It is independent of path.	It depends on the path.
2	Work done in a round trip is zero.	Work done in around trip is not zero
3	Work done is completely recoverable.	Work done is not completely recoverable.

4	Total energy remains constant.	Energy dissipated as heat energy.
5	Force is the negative gradient of potential energy.	No such relation exist.

12. EXPLAIN THE CHARACTERISTICS OF ELEASTIC AND INELASTIC COLLISION.

S.NO	ELEASTIC COLLISION	INELASTIC COLLISION
1	Total momentum is conserved	Total momentum is conserved
2	Total kinetic energy is conserved	Total kinetic energy is not conserved.
3	Forces involved are conservative forces.	Forces involved are non-conservative forces.
4	Mechanical energy is not dissipated	Mechanical energy is dissipated into heat, light , sound, etc.

13. EXPLAIN THE TYPES OF EQUILIBRIUM WITH SUITABLE EXAMPLES.

S.NO	TYPES OF EQUILIBRIUM	CONDITIONS
1	Translational Equilibrium	i) Linear momentum is constant ii) Net force is zero
2	Rotational Equilibrium	i) angular momentum is constant ii) Net torque is zero
3	Static Equilibrium	i) Linear and angular momentum are zero ii) Net force Net torque are zero
4	Dynamic Equilibrium	i) Linear and angular are momentum is constant ii) Net force and net torque are zero

14. WRITE DOWN THE KINEMATIC EQUATIONS FOR LINEAR AND ANGULAR MOTION.

S.NO	LINEAR EQUATION OF MOTION.	ANGULAR EQUATION OF MOTION
1	$v = u + at$	$\omega = \omega_0 + \alpha t$
2	$S = ut + \frac{1}{2}at^2$	$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
3	$v^2 = u^2 + 2as$	$\omega^2 = {\omega_0}^2 + 2\alpha\theta$
4	$S = \left(\frac{u+v}{2}\right)t$	$\theta = \left(\frac{\omega+\omega_0}{2}\right)t$

15. DIFFERENCE BETWEEN SLIDING AND SLIPPING .

S.NO	SLIDING	SLIPPING
1	The translation is more than rotation.	The rotation is more than translation.
2	Relative velocity between point of contact and the surface is non-zero.	Relative velocity between point of contact and the surface is zero.
3	It happens when the moving vehicle suddenly stopped on a slippery road.	It happens when the vehicle is start to move on a slippery road or in mud.

16. STATE KEPLER'S LAWS.
- Law of orbits : each planet moves around the sun in an elliptical orbit with the sun at one of its foci.
- Law of area : the radial vector sweeps equal areas in equal intervals of time.
- Law of period : the square of the time period of revolution of a planet around the sun in its elliptical orbit is directly proportional to the cube of its semi major axis of the ellipse.

17. POLAR SATELLITE AND GEOSTATIONARY SATELLITE.

POLAR SATELLITE :
- The satellites which revolve from north to south of the earth at the height of 500km to 800 km from the earth surface are called polar satellites.

GEOSTATIONARY SATELLITE.:
- The satellites revolving the earth at the height of 36000 km above the equator, are appear to be stationary when seen from earth is called geo-stationary satellites.

18. WHAT IS MEANT BY BANKING OF TRACKS ?
- When the coefficient of static friction is not enough on the leveled circular road, the outer edge of the road is slightly raised compared to the inner edge to avoid skidding. It is called banking of tracks.

19. WHAT ARE THE FACTORS AFFECTING THE SURFACE TENSION OF A LIQUID ?

CONTAMINATION OF IMPURITIES -	INCREASE SURFACE TENSION
DISSOLVED SUBSTANCES -	INCREASE SURFACE TENSION
ELECTRIFICATION -	DECREASE SURFACE TENSION
TEMPERATURE -	DECREASE SURFACE TENSION

20. APPLICATIONS OF VISCOSITY
- To select a suitable lubricant for heavy and light machinery.
- The highly viscous liquid is used to damp the motion of some instruments and is used as brake oil in hydraulic brakes.

- Blood circulation through arteries and veins depends on viscosity of the fluid.

21. EXPLAIN REVERSIBLE AND IRREVERSIBLE PROCESS.

- REVERSIBLE PROCESS :
  A thermo dynamic process, which retrace the path in the opposite direction in such a way that the system and surroundings pass through the same states as in the initial direct process is called reversible process.
- EXAMPLE : a quasi-static isothermal expansion of gas, slow compression and expansion of a spring.
- IRREVERSIBLE PROCESS.
  A thermodynamic process, which does not retrace the path in the opposite direction as like direct process is called irreversible process.
- EXAMPLE : All natural processes are irreversible.

22. LAWS OF SIMPLE PENDULUM

- Law of length : for a given value of acceleration due to gravity, the time period of a simple pendulum is directly proportional to the square root of the length of the pendulum.
- $T \propto \sqrt{l}$
- Law of acceleration : for a fixed length the time period of a simple pendulum is inversely proportional to the square root of acceleration due to gravity.
- $T \propto \frac{1}{\sqrt{g}}$
- Mass of the bob(m) and amplitude of the oscillation (a) are not affect the time period of the pendulum

23. DIFFERENCE BETWEEN TRANSVERSE WAVES AND LOGITUDINAL WAVES

S.NO	TRANSVERSE WAVES	LONGITUDINAL WAVES
1	The direction of vibration of particles of the medium is perpendicular to the direction of propagation of waves.	The direction of vibration of particles of the medium is parallel to the direction of propagation of waves.
2	The disturbances are in the form of crests and troughs	The disturbances are in the form of compressions and rarefactions.
3	Transverse waves are possible in elastic medium.	Longitudinal waves are possible in all types of media (solid, liquid and gas)

24. DEFINE THE COP

- Ratio of heat extracted from the cold body (sink) to the external work done by the compressor W

25. DIFFERENCE BETWEEN THE LINEAR AND ANGULAR HARMONIC OSCILLATORS

S.NO	LINEAR HARMONIC	ANGULAR HARMONIC
1	The displacement of the particle is measured in term of linear displacement $\vec{r}$	Measured in terms of angular displacement $\vec{\theta}$
2	Acceleration of the particle is $\vec{a} = -\omega^2\vec{r}$	Angular acceleration of the particles $\vec{\alpha} = -\omega^2\vec{\theta}$
3	Force $\vec{F} = m\,\vec{a}$	Torque $\vec{\tau} = I\,\vec{\alpha}$
4	Restoring force $\vec{F} = -K\,\vec{r}$	Restoring torque$\vec{\tau} = -k\,\vec{\theta}$
5	Angular frequency $\omega = \sqrt{\frac{k}{m}}$	Angular frequency $\omega = \sqrt{\frac{k}{I}}$

26. DISTINGUISH BETWEEN INTENSITY OF SOUND AND LOUDNESS.

S.NO	INTENSITY OF SOUND	LOUDNESS
1	It is sound power transmitted per unit area taken normal to the propagation of the sound wave	It is degree of sensation of sound produced in the ear or the perception of sound by the listener.
2	For a given sound source, it is constant.	For a given sound source, it may vary.
3	It does not depend on observer.	It depends both on intensity of sound and observer.

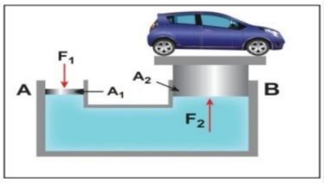
27. CHARACTERISTICS OF PROGRASSIVE WAVES

- Particles in the medium vibrate about their mean positions with the same amplitude.
- The phase of every particle ranges from 0 to 2π
- No particle remains at rest permanently. During wave propagation, particles come to the rest position only twice at the extreme points.
- Transverse progressive waves are characterized by crests and troughs whereas longitudinal progressive waves are characterized by compressions and rarefactions.
- When the particles pass through the mean position they always move with the same maximum velocity.
- The displacement, velocity and acceleration of particles separated from each other by n λ are the same, where n is an integer, and λ is the wavelength.

28. APPLICATION OF PASCAL'S LAW

- Hydraulic lift and hydraulic break

- *Hydraulic lift use to lift a heavy load with small force.*
- *It is a force multiplier.*



- *A small piston B large piston. A_1, A_2 cross sectional areas of the piston **(A1>A2)***
- *Increase in Pressure of the liquid under the piston A due to downward force F.*
- *$P = F_1/A_1$. This increased pressure P is transmitted equally in all directions undiminished.*
- *Upward force on piston B due to this pressure.*
- *$F_2 = P \times A_2$, $F_2 = F1/A_1 \times A_2$*
- *$F_2 = (A_2/A_1) \times F1$ here (A_2/A_1) mechanical advantage of the lift.*

5 MARKS QUESTIONS

1. WRITE A NOTE ON TRIANGULATION METHOD AND RADAR METHOD TO MEASURE LARGER DISTANCES.

TRIANGULATION METHOD :

- *Let AB = h be the height of the tree or tower.*
- *Let c be the point of observation at distance x from B.*
- *Place a range finder at c and measure the angle of elevation, ACB = θ as shown in figure.*
- *From ABC , tan θ = AB/BC = h/x*
- *h= x tan θ*
- *Knowing the distance x, the height h can be determined.*

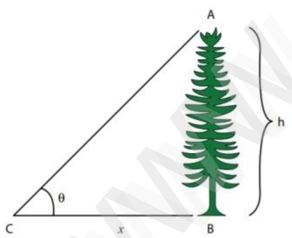
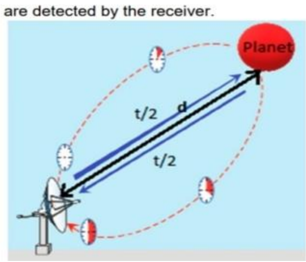


Figure 1.3 Triangulation method

RADAR METHOD :

- *The word radar stands for radio detection and ranging.*
- *In this method, radio waves are sent from transmitters which after reflected from the planet are detected by the receiver.*
- *Bu measuring the time interval between the instants the radio waves are sent and received. The distance of the planet (d) can be determined as,*
- *Distance = speed of radio waves x time taken,*
- ***d*** $= \frac{V \times t}{2}$



2. FIND OUT THE EXPRESSION OF TIME PERIOD OF SIMPLE PENDULUM AND CENTRIPETAL FORCE USING DIMENSIONAL ANALYSIS

EXPRESSION OF TIME PERIOD OF SIMPLE PENDULUM

- $T \,\alpha\, m^a l^b g^c$
- $T = k\, m^a l^b g^c$ -------(1)
- **Here k is dimensional constant, applying dimensions on both sides, we get,**
- $[T]^1 = [M]^a[L]^b[LT]^{-2c}$
- $[M^0 L^0 T^1] = = [M]^a[L]^{b+c}[T]^{-2c}$
- *Comparing the powers of m,l,t on both sides, A=0,b+c=0,-2c=1*
- *Solving it, we get a=0, b=1/2, c=-1/2*
- *From equation (1)*
  $T = 2\pi m^0 l^{1/2} g^{-1/2}$
- $T = 2\,\pi\sqrt{\frac{l}{g}}$

CENTRIPETAL FORCE USING DIMENSIONAL ANALYSIS

- $F \,\alpha\, m^a v^b r^c$
- $F = k\, m^a v^b r^c$ ----(1)
- *Here k is dimensional constant. applying dimensions on both sides, we get,*
- $[M\,L\,T^{-2}] = [M]^a[LT^{-1}]^b[L]^c$
- $[M\,L\,T^{-2}] = [M]^a[L^{b+c}]\ T^{-b}$
- ***Comparing the powers of m,l,t on both sides,***
  a=1, b+c=1,-b=-2
- *Solving it, we get a=1, b=2, c=-1*
- *from equation (1) $F = m^1v^2r^{-1}$*
- $F = \frac{mv^2}{r}$

3. KINEMATIC EQUATION OF MOTION FOR CONSTANT ACCELERATION:

- Consider an object moving along a straight line with uniform or constant acceleration 'a'
- Let 'u' be the initial velocity at time t=0 and 'v' be the final velocity at time t.
- Let's' be the displacement.

1) Velocity -time relation:
   - Acceleration a

$$a = \frac{dv}{dt}$$

dv = a dt

- By integrating both sides, we get,

$$\int_u^v dv = \int_0^t a\,dt$$

$$\int_u^v dv = a\int_0^t dt = a[t]_0^t$$

$$v - u = a[t]_0^t$$

$$\boxed{v = u + a\,t}$$

2) Displacement - time relation :

- Velocty, $v = \frac{ds}{dt}$
  ds = v dt = (u +at) dt [v =u +at]
- By integrating both sides, we get,

$$\int_0^S dS = \int_0^t (u + at)\,dt$$

$$\int_0^S dS = u\int_0^t dt + a\int_0^t t\,dt$$

$$\boxed{S = ut + \frac{1}{2}a\,t^2}$$

3) Velocity - displacement relation :

- Acceleration,

$$a = \frac{dv}{dt} = \frac{dv}{dS}\frac{dS}{dt} = v\frac{dv}{ds}$$

$$dS = \frac{1}{a}v\,dv$$

- By integrating both sides, we get,

$$\int_0^S dS = \int_u^v \frac{1}{a}v\,dv = \frac{1}{a}\left[\frac{v^2}{2}\right]_u^v$$

$$S = \frac{1}{2a}(v^2 - u^2)$$

$$v^2 - u^2 = 2aS$$

$$\boxed{v^2 = u^2 + 2aS}$$

4) Displacement - average velocity relation :

- Final velocity

$$v = u + a\,t$$

$at = v - u$ ------(1)

- We know displacement,

$$S = ut + \frac{1}{2}a\,t^2$$

- Substituting equation (1) we get

$$S = ut + \frac{1}{2}(v - u)\,t$$

$$S = ut + \frac{1}{2}v\,t - \frac{1}{2}u\,t$$

$$\boxed{S = \frac{(u + v)t}{2}}$$

4. EXPRESSION IN THE EVENT OF ANGULAR PROJECATION OF PROJECTILE WITH THE HORIZONTAL (A) MAXIMUM HEIGHT B) TIME OF FLIGHT C)HORIZONTAL RANGE.

(A) MAXIMUM HEIGHT :

The maximum vertical distance travelled by the projectile during its journey is called maximum height.

$$\boxed{h_{max} = \frac{u^2\sin^2\theta}{2g}}$$

B) TIME OF FLIGHT :

The time of flight (tf) is the time taken by the projectile to hit the ground after thrown.

$$\boxed{T_f = \frac{2u\sin\theta}{g}}$$

C) HORIZONTAL RANGE. :

The horizontal range (R) is the maximum horizontal distance distance between the point of projection and the point where the projectile hits the ground.

$$\boxed{R = \frac{u^2\sin 2\theta}{g}}$$

THE MAXIMUM RANGE IS $R = \frac{u^2}{g}$

5. PROVE THE LAW OF CONSERVATION OF LINEAR MOMENTUM.

- ***If there is no external force acting on the system, the total linear momentum of the system is always a constant vector.***
- ***When two particles interact with each other, F_{12} and F_{21} are the forces exerted by the particle 2 on 1 and by the particle 1 on 2 respectively.***
- ***According to Newton's 3rd law,***
  $\vec{F_{12}} = -\vec{F_{21}}$ -------(1)
- ***According to Newton's 2rd law,***
  $\vec{F12} = \frac{d\vec{p1}}{dt}$ and $\vec{F12} = \frac{d\vec{p1}}{dt}$
- ***here p1 and p2 are the linear momentum of particle 1 and 2.***
- ***substituting equation (2) on (1), we get,***
- $\frac{d\vec{p1}}{dt} = \frac{-d\vec{p2}}{dt}$
- $\frac{d\vec{p1}}{dt} + \frac{d\vec{p2}}{dt} = 0$
- $\frac{d}{dt}(\vec{p}1 + \vec{p}2) = 0$
- $\boxed{\vec{p}1 + \vec{p}2 = constant}$
  Hence the total linear momentum ($\vec{p}1 + \vec{p}2$) ***of the system is a constant vector.***

6. THEORY OF WORK AND KINETIC ENERGY.

- Work energy theorem :
  The work done by the force on the body changes the kinetic energy of the body.
- consider a body of mass m at rest on a frictionless horizontal surface.
- The work(W) done by the constant force (F) for a displacement (s) in the same direction is,
  W = F s -----(1)
- The constant force is given by,
- F = m a ----(2)
- The 3rd equation of motion can be written as,

$$v^2 = u^2 + 2aS$$

$$a = \frac{v^2 - u^2}{2s}$$

- *substituting 'a' value in to the equation (2) we get,*
  $F = m\left(\frac{v^2-u^2}{2s}\right)$ -----(3)
- *Substituting 3 into (1)*

$$W = m\left(\frac{v^2-u^2}{2s}\right) s$$

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

- *As the right hand side of the equation represents chang in kinetic energy (ΔK.E) of the body, then we can write,*

$\boxed{W = \Delta K.E}$

Special cases :

- *If the **work done** by the force on the body **is positive** then its **K.E increases.***
- *If the **work done** by the force on the body **is negative** then its **K.E decreases.***
- *If the **no work done** by the force on the body then there is **no change in its K.E***

7. DERIVE AN EXPRESSION FOR ESCAPE SPEED

- *The minimum speed required to throw a body to escape from the gravitational pull is called escape velocity.*
- *Consider an object of mass m thrown up with an initial speed v_i.*
- ***The initial total energy of the object = kinetic energy + potential energy.***
- $E_i = \frac{1}{2}mv_i^2 - \frac{GMM_E}{R_E}$ ---(1)
- *Where M_E -mass of the earth. R_E -radius of the earth*
- *when the object reaches infinity distance, gravitational potential energy is zero U(∞)= 0 and kinetic energy is also zero.*
- *Therefore final total energy of the object become zero **E_f=0***
- *According to the law of energy conservation **$E_i = E_f$ ------- (2)***
- *substituting equation 1 in to 2*

$$\frac{1}{2}mv_i^2 - \frac{GMM_E}{R_E} = 0$$

$\frac{1}{2}mv_e^2 = \frac{GMM_E}{R_E}$ *Where v_e is the escape speed*

- $$v_e^2 = \frac{2GM_E}{R_E} \quad (GM_e = g\,R_e^2)$$
- $$v_e^2 = 2\,g\,R_E$$

$$\boxed{v_e = \sqrt{2\,g\,R_E}}$$

- *Escape speed depends on i) Acceleration due to the gravity ii) radius of the earth*
- *it is independent of the mass of the earth and direction thrown.*
- *escape speed of the earth= **11.2 kms^{-1}***

8. DERIVE THE ORBITAL VELOCITY AND TIME PERIOD OF SATELLITE ORBITAL THE EARTH.

- ***Satellites revolve around the earth just like the planets revolve around the sun.***
- ***For a satellite of mass M to move in a circular orbit, centripetal force must be acting on the satellite. This centripetal force is provided by the earth's gravitational force.***
- $\frac{Mv^2}{(R_E+h)} = \frac{GMM_E}{(R_E+h)^2}$
- $v^2 = \frac{GM_E}{(R_E+h)}$
- $\boxed{v^2 = \sqrt{\frac{GM_E}{(R_E+h)}}}$

- ***TIME PERIOD OF THE SATELLITE :***
- *The distance covered by the satellite during one rotation in its orbit is equal to 2π (R_E +h) and time taken for it is the time period t. Then*
- *speed v=* $\frac{\text{distance travelled}}{\text{time taken}} = \frac{2\pi(R_E+h)}{T}$ ---(1)
- $\sqrt{\frac{GM_E}{(R_E+h)}} = \frac{2\pi(R_E+h)}{T}$
- $T = \frac{2\pi(R_E+h)^{\frac{3}{2}}}{\sqrt{GM_E}}$ ----(2)
- *squaring both sides of the equation (2) we get* $T^2 = \frac{4\pi^2}{GM_E}(R_E+h)^3$
- $\frac{4\pi^2}{GM_E} = constant\ say\ c$,
- $T^2 = c(R_E+h)^3$ ---(3)
- *Equation (3) implies that a satellite orbiting the Earth has the same relation between time and distance as that of kepler's law of planetary motion. For a satellite orbiting near the surface of the earth, h is neglibible compared to the radius of the earth R_E. Then* $T^2 = \frac{4\pi^2}{GM_E}(R_E)^3$
- $T^2 = \frac{4\pi^2}{\frac{GM_E}{R_E^2}}R_E$
- $T^2 = \frac{4\pi^2}{g}R_E$ *since* $\frac{GM_E}{R_E^2} = g$
- $\boxed{T = 2\pi\sqrt{\frac{R_E}{g}}}$

9. THE EXPRESSION FOR MOMENT OF INERTIA OF A UNIFORM ROD.

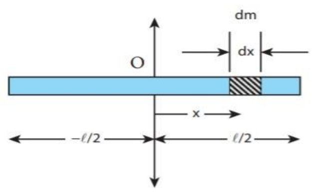


Figure 5.21 Moment of inertia of uniform rod

- *consider a uniform rod of mass M and length' l' as shown in figure.*
- *let us consider the rod is along the x-axis and the moment of inertia of the rod is*

found about the axis, which passes through center of mass of the rod 'O'.

- now the moment of inertia of an infinitesimal small mass 'dm' of length dx of the rod, which is at a distance 'x' from O can be expressed as,
  $dI = (dm)x^2$------(1)
- the moment of inertia(I) of the entire rod can be found by integrate in the equation (1) as,

$$I = \int dI = \int_{-\frac{l}{2}}^{\frac{l}{2}} dm\, x^2 ----(2)$$

- If λ is linear mass density the small mass dm can be written as,
  $dm = \lambda\, dx = \frac{M}{l} dx$
- substituting the 'dm' value in equation (2) we get

$$I = \int dI = \int_{\frac{-l}{2}}^{\frac{l}{2}} \left(\frac{M}{l} dx\right) x^2$$

$$I = \int dI = \frac{M}{l} \int_{\frac{-l}{2}}^{\frac{l}{2}} x^2\,(dx)$$

$$I = \frac{M}{l}\left[\frac{x^3}{3}\right]_{\frac{-l}{2}}^{\frac{l}{2}}$$

$$I = \frac{M}{l}\left[\frac{l^3}{24} + \frac{l^3}{24}\right]$$

$$I = 2\frac{M}{l}\left[\frac{l^3}{24}\right]$$

$$\boxed{I = \frac{1}{12} M\, l^2}$$

10. DESCRIBE NEWTON'S FORMULA FOR VELOCITY OF SOUND WAVES IN AIR AND ALSO DISCUSS THE LAPLACE'S CORRECTION.

- **NEWTON'S FORMULA :**
- **Newton assumed that when sound propagates in air the formation of compression and rarefaction takes place in a very slow manner so that the process is isothermal in nature.**
- **Heat produce during compression (pressure increases volume decreases), and heat lost during rarefaction (pressure decreases, volume increases) occur over a period of time such that the temperature of the medium remain constant .**
- **Obey boyle's law PV=constant ----(1)**
- **Differentiating equation (1) we get**
- **PdV +VdP = 0 or** $P = -V\frac{dP}{dV} = B_T$ ---
  (2) **where b_t is an isothermal bulk modulus of air.** $V = \sqrt{\frac{B}{\rho}}$ **the speed of sound in air is** $V_T = \sqrt{\frac{B_T}{\rho}} = V = \sqrt{\frac{P}{\rho}}$ **---(3)**
- **Since p is the pressure of air whose value at NTP is 76 cm of mercury, we have**
- $P = (0.76 \times 13.6 \times 10^3 \times 9.8)\ nm^{-2}$
- $P = 1{,}293\ kg\ m^{-3}$
- $V = \sqrt{\frac{=(0.76 \times 13.6 \times 10^3\ X 9.8)}{1.293}} = 279.80\ ms^{-1}$
- **But the speed pf sound in air at 0^0c is experimentally observed as 332 ms^{-1} which is close up to 16% more than theoretical value**
- **LAPLACE'S CORRECTION :**
- **Laplace assumed that when the sound propagates through a medium, the particles oscillate very rapidly such that the compression and rarefaction occur very fast.**
- **Since, temperature is no longer considered as a constant here, sound propagation is an adiabatic process. By adiabatic considerations, the gas obeys poissson's law which is**
- $PV^\gamma = Constant$ **---(4)**
- **Where** $\gamma = \frac{C_P}{C_V}$, **which is the ratio between specific heat at constant pressure and specific heatat constant volume.**
- $V^\gamma dP + P(\gamma V^{\gamma-1} dV) = 0$
- $P\gamma = -V\frac{dp}{dv} B_A$
- **Where b_a is the adiabatic bulk modulus of air.** $V = \sqrt{\frac{B}{\rho}}$ **The speed of sound in air is v_a** $= \sqrt{\frac{B_T}{\rho}} V = \sqrt{\frac{P\gamma}{\rho}} = \sqrt{\gamma}\, V_T$
- $V_a = 331 ms^{-1}$

11. WRITE DOWN THE FACTORS AFFECTING SPEED OF SOUND IN GASES.

- **Effect of pressure : for a fixed temperature, speed of sound is independent of pressure.**
- **Effect of temperature : the speed of sound is directly proportional to square root of temperature in kelvin.** $v\ \alpha \sqrt{T}$
- **Effect of density : the speed of sound is inversely proportional to square root of density.** $v\ \alpha \frac{1}{\sqrt{\rho}}$
- **Effect of moisture or humidity : the speed of sound increases with rise in humidity.**
- **Effect of wind : the speed of sound increases in the direction of wind blowing and it decreases in opposite direction of wind blowing**

12. STATE AND PROVE PARALLEL AXIS THEOREM.

- **Statement:**
- **The moment of inertia of a body about any axis I equal to the sum of its moment of inertia about a parallel axis**

through its center of mass and the product of the mass of the body and the square of the perpendicular distance between the two axes.

- ***Proof:***
- ***Let us consider a rigid body as shown in figure.***

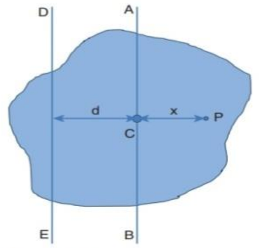


Figure 5.25 Parallel axis theorem

- *Let I_C be the moment of interia of the body about an axis AB, which passes through center of mass.*
- *Consider i is the moment o interia of the body; to be found about an axis DE, which is parallel to AB,and d is the perpendicular distance between DE and AB.*
- *Let P be the point mass of mass m, which is located at a distance x from its center of mass.*
- *The moment of inertia o fth epoint mass about the axis DE is ,*
  $dI = m(x + d)^2$
-
- *The moment of inertia of the wole body about the axis DE is,*

$$I = \sum m(x+d)^2$$
$$I = \sum m(x^2 + d^2 + 2xd)$$
$$I = \sum mx^2 + md^2 + 2xdm$$
$$I = \sum mx^2 + \sum md^2 + 2d\sum mx$$

- *Here,*
  $\sum mx^2 = I_C$, the moment o finertia of the body about the center of mass and

$$\sum m(x) = 0$$

- *The moment of inertia of the whole body about the DE can be expressed as,*
  $I = I_C + \sum m\, d^2$
- *But $\sum m = M$, mass of the whole body.*
  Thus
  $\boxed{I = I_C + M\, d^2}$
-
- Hence *the parallel axis theorem is proved.*

13. STATE AND PROVE PERPENDICULAR AXIS THEOREM.

- *Statement :*
  The moment of inertia of a plane laminar body about an axis perpendicular to its plane is equal to the sum of moments of inertia about two perpendicular axes lying in the plane of the body such that all the three axes are mutually perpendicular and concurrent.
- *Consider a plane laminar object of negligible thickness on which; the origin O lies. The mutually perpendicular axes X and Y are lying on the plane and Z-axis is perpendicular to plane as shown in figure.*

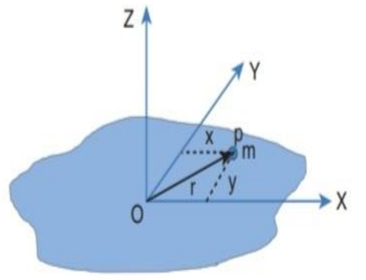


Figure 5.26 Perpendicular axis theorem

- Let us consider a point mass P of mass m , which is at a distance r from origin O.
- The moment of inertia of the point mass about the Z-axis is ,
  $d\, I_Z = m\, r^2$
- *The moment of inertia of the whole body about the z-axis is*
  $I_Z = \sum m\, r2$
- ***Here $r^2 = x^2 + y^2$ so that***
- $I_Z = \sum m(x^2 + y^2)$
- $I = \sum mx^2 + \sum my^2$
- ***BUT*** $\sum mx^2 = I_Y$ *the moment o finertia of the body about the Y-axis and* $\sum my^2 = I_x$, ***THE MOMENT OF INERTIA OF THE BODY ABOUT THE X-AXIS***
- ***THEREFORE,*** $I_Z = I_Y + I_x$

$$\boxed{I_Z = I_x + I_Y}$$

14. EXPLAIN THE VARIATION of g WITH LATTITUDE

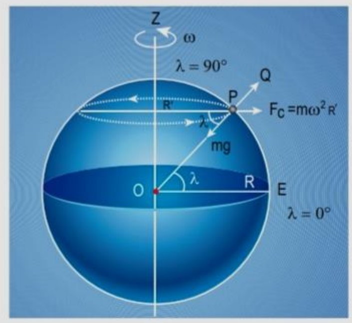


Figure 6.18 Variation of g with latitude

- ***Whenever we analyze the motion of objects in rotating frames, we must take into account the centrifugal force.***
- ***Even though we treat the earth as an inertial frame, it is not exactly correct because the earth spins about its own axis.***
- ***So when an object is on the surface of the earth, it experiences a centrifugal force that depends on the latitude of the object on earth.***

- ***If the earth were not spinning, the force on the object would have be mg.***
- ***However, the object experiences an additional centrifugal force due to spinning of the earth.***
- ***This centrifugal force is given by*** $m\omega^2 R'$
- $R' = R\cos\lambda$ ***------(1)***
- *Where* λ *is the latitude. The component of centrifugal acceleration experienced by the object in the direction opposite to g is*
- $a_c = \omega^2 R' \cos\lambda$
- $a_c = \omega^2 R\cos^2\lambda$ ***since*** $R' = R\cos\lambda$
- $\boxed{g' = g - \omega^2 R\cos^2\lambda}$
- *From the expression (2) we can infer that at equator,* $\lambda = 0$ $g' = g - \omega^2 R$.
  The acceleration due to gravity is minimum.
- *at poles* $\lambda = 90$ $g' = g$.
  It is maximum. At the equator ,g' *is minimum*

15. EXPLAIN THE VARIATION of g WITH ALTITUDE AND DEPTH FROM THE EARTH'S SURFACE

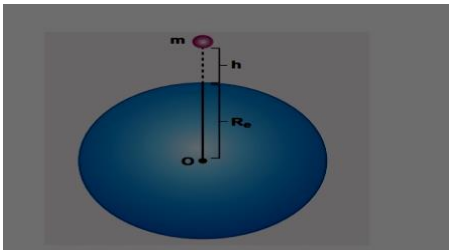


Figure 6.17(a) Mass at a height h from the center of the Earth

- consider a particle of mass m at a
- height 'h' from the surface of earth.
- acceleration experienced by the object due to earth

$$g' = \frac{GM}{(R_e + h)^2}$$

$$g' = \frac{GM}{R_e^2(1 + \frac{h}{R_e})^2}$$

$$g' = \frac{GM}{R_e^{\,2}}(1 + \frac{h}{R_e})^{-2}$$

- h<<R_e using binomial expansion, neglecting the higher orders, we get

$$g' = \frac{GM}{R_e^{\,2}}(1 - 2\frac{h}{R_e})$$

$$g' = g(1 - 2\frac{h}{R_e})$$

it is found $g' < g$ **as altitude increases, g decreases.**

- *DEPTH FROM THE EARTH'S SURFACE*

consider the following points.

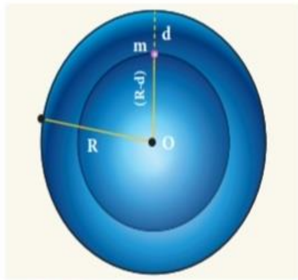


Figure 6.17(b) Particle in a mine

- consider a particle of mass m at a depth 'd'
- acceleration due to gravity at depth d is

$$g' = \frac{GM'}{(R_e - d)^2}$$

M' *is the mass of the earth of radiu* $(R_e - d)$

- density of earth ρ is constant.

$$\rho = \frac{M}{V}$$

$$\frac{M'}{V'} = \frac{M}{V} \qquad M' = V'X\left(\frac{M}{V}\right)$$

$$M' = \left[\frac{M}{\frac{4}{3}\pi R_e^{\,3}}\right]\left(\frac{4}{3}\pi(R_e - d)^3\right)$$

$$M' = \left[\frac{M}{R_e^{\,3}}\right](R_e - d)^3$$

$$g' = \frac{G}{(R_e - d)^2}\left[\frac{M}{R_e^{\,3}}\right](R_e - d)^3$$

$$g' = \left[\frac{GM}{R_e^{\,3}}\right]R_e(1 - \frac{d}{R_e})$$

$$g' = \left[\frac{GM}{R_e^{\,2}}\right](1 - \frac{d}{R_e}) \qquad \text{thus}$$

$$\boxed{g' = g(1 - \frac{d}{R_e})} \qquad (g = \frac{GM}{(R_e)^2})$$

- **here** $g' < g$ **as depth increases** g' ***decreases***

16. DIFFERENT TYPES OF MODULUS OF ELASTICITY.

1) YOUNG'S MODULUS
2) BULK MODULUS
3) SHEAR OR RIGIDITY MODULUS

1) YOUNG'S MODULUS :

- The ratio of longitudinal stress to the longitudinal strain is known as young's modulus
- $Y = \frac{longitudinal\ stress}{longitudinal\ strain}$
- $longitudinal\ stress\ \sigma_t = \frac{F}{\Delta A}$
- $longitudinal\ \ strain\ \epsilon_t = \frac{\Delta L}{L}$

$$Y = \frac{\sigma_t}{\epsilon_t} = \frac{\frac{F}{\Delta A}}{\frac{\Delta L}{L}}$$

$$Y = \frac{F}{\Delta A} X \frac{\Delta L}{L}$$

2) BULK MODULUS :

- The ratio of the volume stress to the volume strain is called bulk modulus.
- $K = = \frac{normal\ stress}{volume\ \ strain}$
- $normal\ stress\ \sigma_n = \frac{F}{\Delta A} = \Delta P$
- $volume\ \ strain\ \epsilon_v = \frac{\Delta V}{V}$

$$K = \frac{\sigma_n}{\epsilon_n} = -\frac{\frac{F}{\Delta A}}{\frac{\Delta V}{V}}$$

- $K = -\frac{\Delta P}{\frac{\Delta V}{V}}$ $\boxed{K = -\ \ \Delta PX\left(\frac{V}{\Delta V}\right)}$

3) Rigidity modulus:

- The ratio of shearing stress to the shearing strain is called rigidity modulus.

$$\eta_R = \frac{shearing\ \ stress}{shearing\ strain}$$

$$\sigma_s = \frac{F_t}{\Delta A}$$

$$\epsilon_s = \frac{x}{\mathrm{h}} = \ \theta$$

$$\eta_R = \frac{\sigma_s}{\epsilon_s} = \frac{F_t}{\Delta A\ \ \theta}$$

17. STATE AND PROVE BERNOULLI'S THEOREM

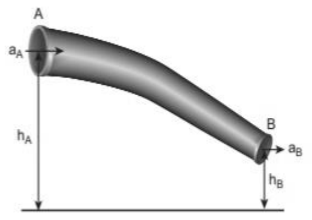


Figure 7.33 Flow of liquid through a pipe AB

- **BERNOULLI'S THEOREM :**
- the sum of pressure energy, kinetic energy, potential energy per unit mass of an incompressible, non-viscous fluid in a streamlined flow remains a constant.
- Proof :
- A,B terminals of the pipe
- a_A, a_B cross sectional area of the pipe
- h_A, h_B height of the terminals
- v_A, v_B velocity of the liquid at A,B
- P_A,P_B liquid pressure at A,B
- Pressure energy of the liquid at A, $E_{PA} = P_A V = m\frac{P_A}{\rho}$
- Potential energy of the liquid at A, $PE_A = m\ g\ h_A$
- Kinetic energy of the liquid at A, $K.E_A = \frac{1}{2}m{v_A}^2$
- Total energy of the liquid at A, $E_A = m\frac{P_A}{\rho} + \frac{1}{2}m{v_A}^2 + m\ g\ h_A$
- similarly total energy at B
- $E_B = m\frac{P_B}{\rho} + \frac{1}{2}m{v_B}^2 + m\ g\ h_B$
- from law of conservation of energy $E_A = E_B$
- $m\frac{P_A}{\rho} + \frac{1}{2}m{v_A}^2 + m\ g\ h_A = m\frac{P_B}{\rho} + \frac{1}{2}m{v_B}^2 + m\ g\ h_B$
- $\boxed{m\frac{P}{\rho} + \frac{1}{2}mv^2 + m\ g\ h = constant}$

18. DERIVE MEYER'S RELATION FOR AN IDEAL GAS.

- ***MEYER'S RELATION***
- ***Consider μ mole of an ideal gas in a container with volume v, pressure p and temperature t.***
- ***When the gas is heated at constant volume the temperature increases by dT. Asno work is doneby the gas, the heat that flows into the system will increase only the internal energy.***
- ***Let the change in internal energy be dU.***
- ***If c_v is the molar specific heat capacity at constant volume,***
  $dU = \ \mu C_V dT$ ----(1)
- ***Suppose the gas is heated at constant pressure so that the temperature increase by dT. If 'q' is the heat supplied in this process and 'dV' the change in volume of the gas. $Q = \mu C_P dT$ -----(2)***
- ***If w is the work done by the gas in this process, then $W = PdV$ ----(3)***
- ***But from the first law of thermodynamics, $Q = dU + w$ ---(4)***
- ***$\mu C_P dT = \mu C_V dT + PdV$ --- (5)***
- ***For mole of ideal gas, the equation of state is given by $PV = \mu RT$***
- ***$PdV + VdP = \ \mu RdT$***
- ***Since the pressure is constant, $dP = 0$***
- ***$C_P dT = C_V dT + RdT$***
- ***$C_P = C_V + R$ or $C_P - C_V = R$***
- ***This relation is called meyer's relation.***

19. WRITE DOWN THE POSTULATES OF KINETIC THEORY OF GASES.

- ***All the molecules of a gas are identical, elastic spheres.***
- ***The molecules of different gases are different.***
- ***The number of molecules in a gas is very large and the average separation between them is larger than size of the gas molecules.***
- ***The molecules of a gas are in a state of continuous random motion.***

- *The molecules collide with one another and with the walls of the container.*
- *These collisions are perfectly elastic so that there is no loss of kinetic energy during collisions.*
- *Between two successive collisions, a molecule moves with uniform velocity.*
- *The molecules do not exert any force of attraction or repulsion on each other except during collision. the molecules do not possess any potential energy and the energy is wholly kinetic.*
- *The collisions are instantaneous.*
- *These molecules obey newton's laws of motion even though they move randomly.*

20. STATE AND EXPLAIN NEWTON'S LAW OF COOLING.

- *STATEMENT :*
- *The rate of loss of heat of a object is directly proportional to the difference in the temperature between that object and its surroundings.*
- $\frac{dQ}{dt}\ \alpha\ -(T-T_s)$
- *PROOF :*
- *Consider an object of mass m, specific heat capacity s at temperature T, T_S be the temperature of the surroundings. If the temperature falls by a small amount dT in time dt, then the amount of heat lost is,*
- $dQ = ms\ dT$ *---(1)*
- *DIVIDING BOTH SIDES OF THE ABOVE EQUATION BY dt*
  $\frac{dQ}{dt} = \frac{msdT}{dt}$*------(2)*
- *From newton's law of cooling*
- $\frac{dQ}{dt}\ \alpha\ -(T-T_s)$
- $\frac{dQ}{dt} = -a(T-T_s)$ *---=(3)*
- $-a(T-T_s) = \frac{msdT}{dt}$
- $\frac{dT}{(T-T_S)} = \frac{-adt}{ms}$
- *Integrating the bove equation on both sides*
- $\int \frac{dT}{(T-T_S)} = \int \frac{-adt}{ms}$
- $ln\ (T-T_s) = \frac{-a\ t}{ms} + b_1$
  b_1 *integration constant*
- *Taking exponential on both sides,* $T = \boxed{T_S + b_2 e^{-\frac{a}{ms}t}}$
- *here* $b_2 = e^{b_1}$ *= constant*

21. EXPRESSION FOR TERMINAL VELOCITY OF A SPHERE MOVING IN A HIGH VISCOUS FLUID USING STOKE'S FORCE.

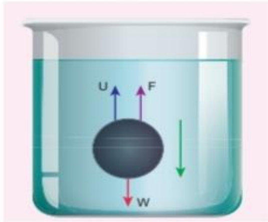


Figure 7.19 Forces acting on the sphere when it falls in a viscous liquid

- Consider a sphere of radius r which falls freely through a highly viscous fluid of coefficient of viscosityη.
- $\rho -$ density of the sphere
- $\sigma -$ density of the fluid.
- Gravitational force acting on the sphere.
- F_g= m g = $\frac{4}{3}\pi r^3 \rho g$(downward force)
- Up thrust U = $\frac{4}{3}\pi r^3 \sigma g$(Upward force)
- viscous force at terminal velocity v_t
- $F = 6\pi\eta r v_t$
- the net downward force is equal to the net up ward forces.
- F_g= U + F   F = F_g - U
- $\frac{4}{3}\pi r^3 \rho g - \frac{4}{3}\pi r^3 \sigma g = 6\pi\eta r v_t$
  $\frac{2r^2(\rho-\sigma)g}{9\eta} = v_t$
  $\boxed{v_t\ \ \alpha\ \ r^2}$
- Terminal speed of the sphere is directly proportional to the square of the radius.

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