TOPIC WISE MULTIPLE CHOICE QUESTIONS

5.1 ANGULAR DISPLACEMENT

(1) When object moves in a circular path, then its direction is

(a) remain same **(b)** continuously changing

(c) at rest **(d)** none of these

(2) One radian is equal to

(SWL 2015) (SGD 2015) (LHR 2013, 15(G-I), (GRW 2015, 19 (G-I)

(a) 5.73° **(b)** 0.73°

(c) 57.3° **(d)** 2π

(3) A wheel of radius 2 m turns through an angle of 57.3°. It lays out a tangential distance: **LHR-2016 (G-I)**

(a) 2m **(b)** 4m

(c) 57.3m **(d)** 114.6m

(4) 2 radian = ------ **MTN-2019 (G-II), LHR-2017 (G-I)**

(a) 114.6° **(b)** 57.3°

(c) 75.3° **(d)** 37.5°

(5) Solid angle subtended at centre by a sphere is **LHR-2018 (G-II)**

(a) 2π **(b)** 4π

(c) 6π **(d)** 8π

(6) 2 revolutions are equal to: **LHR-2019 (G-I)**

(a) π rad **(b)** $\frac{3\pi}{2}$ rad

(c) 4π rad **(d)** 2π rad

(7) The angle subtended by one complete circle at its center in radians is: **FSD-2016 (G-I)**

(a) 360 **(b)** 2π

(c) π **(d)** $\frac{\pi}{2}$

(8) 2° is equal to: **RWP-2019 (G-I)**

(a) 0.035 rad **(b)** 0.30 rad

(c) 0.35 rad **(d)** 0.0035 rad

(9) The angle subtended at the centre by circumference of a circle is: **(SWL 2015)**

(a) π rad **(b)** 3π rad

(c) 2π rad **(d)** $\frac{\pi}{2}$ rad

(10) A wheel of diameter 1 m makes 60 rev/min. The linear speed of a point on its rim in ms^{-1} is **DGK-2016 (G-I)**

(a) π **(b)** 2π

(c) $\frac{\pi}{2}$ **(d)** 3π

(11) π Radian=________. **BWP-2017 (G-I)**

(a) 53.7° **(b)** 57.3°

(c) 180° **(d)** 35.7°

(12) A wheel of radius 2 m turns through an angle of 57.3°, it lays out a tangential distance of **SWL-2017**

(a) 2 m **(b)** 4 m

(c) 57.3 m (d) 114.6 m

(13) Angle 30° is equal to: **BWP-2019 (G-I)**

(a) $\frac{\pi}{2}$ rad **(b)** $\frac{\pi}{3}$ rad

(c) $\frac{\pi}{4}$ rad (d) $\frac{\pi}{6}$ rad

(14) For a small θ, angular displacement is quantity

(a) scalar **(b)** vector

(c) neither scalar nor vector **(d)** none

(15) For positive angular displacement the rotation would be

(a) clockwise **(b)** anti-clockwise

(c) parallel **(d)** perpendicular

(16) The direction of angular displacement along the axis of rotation is given by

(a) right hand rule **(b)** left hand rule

(c) head to tail rule **(d)** none of these

(17) The S.I unit of angular displacement

(a) degree **(b)**radian

(c) revolution **(d)** all of these

(18) The dimension of angular displacement is

(a)$[ML^{-1}]$ **(b)** $[ML^{-2}]$

(c) $[LT^{-1}]$ **(d)** dimensionless

(19) Radian is defined as the angle subtended at the center of a circle by an

(a) arc whose length is parallel to the radius of circle

(b) arc whose length is greater than the radius of circle

(c) arc whose length is less than the radius of circle

(d) arc whose length is equal to the radius of circle

(20) A satellite orbiting around the earth is an example of

(a) circular motion **(b)** vibratory motion

(c) rectilinear velocity **(d)**all of these

(21) $\frac{\pi}{6}$ radian is equal to

(a) 30^o **(b)** 60^o

(c) 90^o **(d)** 45^o

5.2 ANGULAR VELOCITY

(22) When a body moves in a circle, the angle between its linear velocity 'v' and angular velocity 'ω' is always.

(a) 180^o **(b)** 0^o
(c) 90^o **(d)** 45^o

(23) A Wheel of radius 50 Cm having an angular speed of 5 rad S^{-1} have linear speed **(GRW 2014), LHR-2018 (G-II)**

(a) $1.5mS^{-1}$ **(b)** $3.5mS^{-1}$
(c) $4.5mS^{-1}$ **(d)** $2.5mS^{-1}$

(24) Revolution per minute is unit for **(GRW 2014)**

(a) angular displacement **(b)** angular velocity
(c) angular acceleration **(d)** time

(25) If a car moves with a uniform speed of 2m/sec. in a circle of radius 0.4 m its angular speed is **(LHR 2014)**

(a) 4rad/sec **(b)** 5rad/sec
(c) 1.6 rad / sec **(d)** 2.8 rad / sec

(26) $1\frac{rev}{min}$ **is equal to:** **LHR 2015(G-II)**

(a) $\frac{\pi}{6} rad\ s^{-1}$ **(b)** $\frac{\pi}{15} rad\ s^{-1}$
(c) $\frac{\pi}{20} rad\ s^{-1}$ (d) $\frac{\pi}{30} rad\ s^{-1}$

(27) The time rate of change of angular displacement is called: **LHR-2017 (G-I)**

(a) Linear velocity **(b)** Linear speed
(c) Angular speed **(d)** Angular velocity

(28) The angular velocity of the minute hand of a clock is: **FSD-2017**

(a) $2\pi rad s^{-1}$ **(b)** $\pi rad s^{-1}$
(c) $\frac{\pi}{60} rad s^{-1}$ **(d)** $\frac{\pi}{1800} rad s^{-1}$

(29) Which one of the following is correct? **(SWL 2015)**

(a) $\omega = vr$ **(b)** $v = \frac{r}{\omega}$
(c) $v = r\omega$ **(d)** $\omega = \frac{r}{v}$

(30) When a body moves in a circle, the angle between linear velocity $\bar{v}$ **and angular** $\bar{w}$ **is:** **(MTN 2015)**

(a) 180° **(b)** 90°
(c) 60° **(d)** 45°

(31) A body starting from rest attains angular acceleration of 5 rad s^{-2} in 2 second. Final angular velocity will be: **BWP-2017 (G-II)**

(a) 10 rad s^{-1} **(b)** 7 rad s^{-1}
(c) 3 rad s^{-1} **(d)** 2 rad s^{-1}

(32) For a particle moving in a horizontal circle with constant angular velocity
(a) the linear momentum is constant but the energy varies
(b) the energy is constant but the linear momentum varies
(c) both energy and linear momentum are constant
(d) neither the linear momentum nor the energy is constant

(33) Unit of angular velocity is
(a) rev / sec **(b)** rad/sec
(c) degree / sec **(d)** all

(34) The average angular velocity is defined by the relation
(a) $\omega_{av} = \frac{\Delta t}{\Delta \theta}$ **(b)** $\omega_{av} = \frac{\Delta \theta}{\Delta t}$
(c) $\omega_{av} = \frac{\Delta \theta^2}{\Delta t}$ **(d)** $\omega_{av} = \Delta\theta \times \Delta t$

(35) The direction of angular velocity of a body moving in a circle is
(a) towards the axis of rotation **(b)** away from the axis of rotation
(c) along the axis of rotation **(d)**above the axis of rotation

(36) The angular speed of fly wheel making 120 revolutions per minutes is
(a) π rad/s **(b)** 3π rad/s
(c) 6π rad/s **(d)** 4π rad/s

(37) The dimension of angular velocity is
(a) $[LT^{-1}]$ **(b)** [LT]
(c) $[T^{-2}]$ **(d)** $[T^{-1}]$

(38) In the limit when Δt approaches to zero, the angular displacement would be
(a) zero **(b)** infinitesimally small
(c) infinitesimally large **(d)** none of these

(39) If a rotating body is moving counter clockwise, direction of angular velocity will be
(a) along linear velocity
(b) perpendicular to both radius and linear velocity
(c) towards the center
(d) away from center

5.3 ANGULAR ACCELERATION

(40) The direction of angular acceleration is same as that of _______ while velocity is increasing
(a) linear velocity **(b)** linear momentum
(c) angular velocity **(d)** tangential acceleration

(41) The rate of change of angular velocity is called: **LHR-2016 (G-II)**
(a) angular velocity **(b)** angular acceleration
(c) angular displacement **(d)** angular speed

(42) Direction of angular acceleration is always along: **LHR-2017 (G-II)**
(a) x-axis **(b)** y-axis
(c) z-axis **(d)** the axis of rotation

(43) The instantaneous angular acceleration is defined by the relation
(a) $\alpha_{ins} = \frac{\Delta \theta}{\Delta t}$ **(b)** $\alpha_{ins} = \frac{\Delta t}{\Delta \theta}$
(c) $\alpha_{ins} = \lim_{\Delta t \to 0} \frac{\Delta \theta}{\Delta t}$ **(d)** $\alpha_{ins} = \lim_{\Delta t \to 0} \frac{\Delta \omega}{\Delta t}$

(44) The direction of angular acceleration is

(a) perpendicular to radius of circle **(b)** along the axis of rotation
(c) along the radius of circle **(d)** both a and b

(45) Dimension of angular acceleration is

(a) $[LT^{-2}]$ **(b)** $[LT^{-1}]$
(c) $[T^{-2}]$ **(d)** $[T^{-1}]$

(46) Angular acceleration is expressed in units of

(a) ms^{-2} **(b)** rad s^{-1}
(c) rev s^{-1} **(d)** rad s^{-2}

(47) The average angular acceleration is defined by the relation

(a) $a_t = \frac{1}{\alpha r}$ **(b)** $\alpha_{av} = \frac{\Delta t}{\Delta \omega}$
(c) $\alpha_{av} = \frac{\Delta \omega}{\Delta t}$ **(d)** $\alpha_{av} = \frac{\Delta \theta}{\Delta \omega}$

(48) The angular acceleration is produced due to

(a) centripetal force **(b)** Torque
(c) Force **(d)** centrifugal force

5.4 RELATION BETWEEN ANGULAR AND LINEAR VELOCITIES

(49) The relation between linear acceleration and angular acceleration is

(a) $\vec{\alpha} = \vec{a} \times \vec{r}$ **(b)** $\vec{a} = \vec{\alpha} \times \vec{r}$
(c) $\vec{a} = \vec{r} \times \vec{\alpha}$ **(d)** $\vec{r} = \vec{a} \times \vec{\alpha}$

(50) Choose the quantity which plays the same role in angular motion as that of mass in linear motion: **GRW-2019 (G-II)**

(a) moment of inertia **(b)** torque
(c) angular acceleration **(d)** angular momentum

(51) When a body is in circular motion the angle between linear and angular velocity is **MTN-2018 (G-II)**

(a) 180° **(b)** 90°
(c) 45° **(d)** 0°

(52) The angle between angular velocity and angular acceleration when angular velocity decreases is

(a) 30^o **(b)** 45^o
(c) 180^o **(d)** 90^o

(53) The acceleration of a motor car is 8 m/s^2. If the diameter of its wheel be 2m. It's angular acceleration will be

(a) 8 rad/s^2 **(b)** 10 m/s^2
(c) 16 rad/s^2 **(d)** 10 rad/s^2

(54) Relation between linear and angular velocity is

(a) $\omega = \frac{r}{v}$ **(b)** $\omega = \frac{a_c}{v}$
(c) $\omega = \frac{v}{r}$ **(d)** both b and c

(55) Which of the following is correct relation?

(a) $\vec{v} = \vec{r} \times \vec{\omega}$ **(b)** $\vec{v} = \vec{\omega} \times \vec{r}$

(c) $\vec{\omega} = \vec{v} \times \vec{r}$ **(d)** $\vec{\omega} = \vec{r} \times \vec{v}$

(56) The relation between tangential and angular acceleration is expressed by

(a) $a_t = r\alpha$ **(b)** $a_t = \frac{r}{\alpha}$

(c) $a_t = \frac{\alpha}{r}$ **(d)** $a_t = \frac{1}{\alpha r}$

(57) When a wheel 1m in diameter makes 30 rev/min, the linear speed of point on it's rim in ms^{-1} is

(a) 2π **(b)** $\frac{\pi}{2}$

(c) 3π **(d)** 4π

(58) If a car moves with uniform speed of 2m/s in a circle of radius 0.4 m. It's angular speed is

(a) 4 rad/s **(b)** 5 rad/s

(c) 6 rad/s **(d)** 7 rad/s

(59) When the axis of rotation is fixed then all the angular vectors have

(a) same direction **(b)** directionless

(c) different direction **(d)** none of these

(60) The linear velocity in circular path is also called

(a) tangential velocity **(b)** instantaneous velocity

(c) relative velocity **(d)** angular velocity

(61) The direction of motion changes continuously in

(a) rectilinear motion **(b)** circular motion

(c) linear motion **(d)** none of these

5.5 CENTRIPETAL FORCE

(62) The direction of centripetal force is

(a) towards the center **(b)** away from center

(c) along the tangential velocity **(d)** along the axis of rotation

(63) When a body is whirled in a horizontal circle by means of a string, the centripetal force is supplied by: **(LHR 2014)**

(a) mass of a body **(b)** velocity of a body

(c) tension in the string **(d)** centripetal acceleration

(64) The expression for centripetal force is given by: **LHR-2019 (G-II)**

(a) $mr\omega^2$ **(b)** $\frac{m^2v^2}{r}$

(c) $\frac{m^2v^2}{r^2}$ **(d)** $\frac{mv^2}{r^2}$

(65) The centripetal acceleration is also called: **LHR 2015(G-II)**

(a) tangential **(b)** radial

(c) angular **(d)** rotational

(66) **A body rotating with angular velocity of 2 radian/s and linear velocity is also $2ms^{-1}$, then radius of circle is:** **LHR-2017 (G-II)**

(a) 1 m **(b)** 0.5 m
(c) 4 m **(d)** 2 m

(67) **Centripetal force is directed along:** **RWP-2019 (G-I)**

(a) Tangent to circle **(b)** radius
(c) axis of rotation **(d)** x-axis

(68) **Centripetal force performs:** **DGK-2016 (G-II)**

(a) minimum work **(b)** no work
(c) maximum work **(d)** negative work

(69) **If a body revolves under centripetal force, its angular acceleration is:** **BWP-2017 (G-II)**

(a) non zero **(b)** variable
(c) increasing **(d)** zero

(70) **Rotational counter part of force is**

(a) torque **(b)** angular velocity
(c) angular momentum **(d)** momentum

(71) **The force required to bend the normally straight path into a circular path is called**

(a) gravitational force **(b)** electrical force
(c) centripetal force **(d)** electromagnetic force

(72) **The mud flies off the tyre of a fast moving car in the direction**

(a) parallel to the moving tyre **(b)** anti parallel to the moving tyre
(c) tangent to the moving tyre **(d)** none of these

(73) **The force which provides the necessary centripetal force to keep the mud in circular path is called**

(a) cohesive force **(b)** frictional force
(c) adhesive force **(d)** gravitational force

(74) **The relation for centripetal acceleration is given by**

(a) $\frac{v^2}{r}$ **(b)** $r\omega^2$
(c) $v\omega$ **(d)** all of these

(75) **A body is rotated in a vertical circle by a string. The tension in the string is minimum at the**

(a) top **(b)** bottom
(c) Midway between top and bottom **(d)** remains same

(76) **A body is rotated in a vertical circle by a string. The tension in the string is maximum at the**

(a) top **(b)** bottom
(c) Midway between top and bottom **(d)** remains same

(77) **The centripetal force acting on a body of mass m in a circle of radius r is**

(a) $\frac{mv^2}{r}$ **(b)** $mr^2\omega$
(c) $mr\omega^2$ **(d)** both a and c

(78) **The necessary centripetal force to the moving car round a corner track is provided by**

(a) centrifugal force **(b)** gravitational force
(c) frictional force **(d)** electric force

(79) The period of circular motion is

(a) $T = \frac{2\pi}{\omega}$ **(b)** $T = \frac{\omega}{2\pi}$

(c) $T = 2\pi\omega$ **(d)** $T = \frac{\pi\omega}{2}$

(80) A car of mass 1000kg traveling at 40 ms^{-1} rounds a curve of radius 100m. what is the F_C

(a) 100 N **(b)** 1.6×10^4N

(c) 1.6×10^6N **(d)** 8×10^4N

(81) If the radius of the circular path of a moving body is half without changing speed of rotation then the F_C becomes

(a) half **(b)** doubled

(c) one third **(d)** one forth

(82) The curved flight of fighter planes at high speed requires a large

(a) gravitational force **(b)** centripetal force

(c) frictional force **(d)** centrifugal acceleration

(83) The centripetal force has the same dimension as the

(a) angular acceleration **(b)** centrifugal force

(c) centripetal acceleration **(d)** centrifugal acceleration

(84) The vector form of centripetal force is

(a) $m\vec{\omega}r$ **(b)** $-m\vec{r}\omega^2$

(c) $m\vec{\omega}r$ **(d)** $m\vec{\omega}r^2$

(85) The centripetal acceleration directed along the radius

(a) away from the centre of the circle **(b)** perpendicular to the centre of the circle

(c) towards the centre of the circle **(d)** parallel the centre of the circle

(86) The dimensions of centripetal force is

(a) $[MLT^{-2}]$ **(b)** $[MLT^{-1}]$

(c) $[LT^{-2}]$ **(d)** $[LT^{-1}]$

(87) A body is moving in a circle of radius "r" with constant angular speed "ω". It's centripetal acceleration is

(a) $\frac{\omega}{r}$ **(b)** $r\omega^2$

(c) $r^2\omega^2$ **(d)** $\frac{\omega^2}{r^2}$

(88) Tangential and centripetal accelerations are always

(a) parallel to each other **(b)** perpendicular to each other

(c) anti - parallel (d) none of these

5.6 MOMENT OF INERTIA

(89) Moment of Inertia is equal to

(a) $I = mr^2$ **(b)** $I = mr$

(c) $I = m^2r$ **(d)** $I = m^2r^2$

(90) The ratio of moment of inertia of disc and hoop is:

LHR-2017 (G-I), GRW-2019 (G-I)

(a) $\frac{1}{2}$ **(b)** $\frac{1}{4}$

(c) $\frac{3}{4}$ **(d)** $\frac{1}{3}$

(91) In rotational motion analogous of force is: **FSD 2019 (G-I)**

(a) torque **(b)** inertia

(c) velocity **(d)** momentum

(92) The ratio of moment of inertia of a disc and sphere of same radius is **SWL-2018**

(a) $\frac{2}{5}$ **(b)** $\frac{5}{4}$

(c) $\frac{1}{2}$ **(d)** $\frac{5}{2}$

(93) Moment of inertia of rod of length L and mass m is

(a) $\frac{1}{6}mL$ **(b)** $\frac{1}{12}mL$

(c) $\frac{1}{6}mL^2$ **(d)** $\frac{1}{12}mL^2$

(94) The unit of moment of inertia is

(a) $kgms^{-1}$ **(b)** kgm^{-2}

(c) $kg^{-1}m^2$ **(d)** kgm^2

(95) The moment of inertia of a body comes in action in

(a) circular path **(b)** curved path

(c) straight line **(d)** parallel

(96) The relation between torque 'τ' and the moment of inertia 'I' is given by

(a) $\tau = mr^2\alpha$ **(b)** $\tau = I\alpha$

(c) $\tau = mr\omega^2$ **(d)** both a and b

(97) Moment of inertia of hoop

(a) I = $\frac{1}{3}mr^2$ **(b)** I = mr^2

(c) I = $\frac{2}{3}mr^2$ **(d)** I = $I\alpha$

(98) The dimensions of moment of inertia is

(a) $[ML^{-1}]$ **(b)** $[MT^{-2}]$

(c) $[MT^{-1}]$ **(d)** $[ML^2]$

(99) Moment of inertia of disc

(a) I = $\frac{1}{3}mr^2$ **(b)** I = $\frac{1}{2}mr^2$

(c) I = $\frac{2}{3}mr^2$ **(d)** I = mr^2

(100) Moment of inertia of sphere is **MTN-2016 (G-II)SGD-2016 (G-II) (FSD 2015)**

(a) mr^2 **(b)** $\frac{mr^2}{2}$

(c) $\frac{2}{5}mr^2$ **(d)** $\frac{5}{2}mr$

(101) If two cylinders of equal mass roles, the one with the larger diameter has the

(a) smaller rotational inertia **(b)** larger rotational inertia

(c) zero rotational inertia **(d)** none of these

(102) Moment of inertia is rotational counter part of

(a) mass **(b)** energy

(c) torque **(d)** work

5.7 ANGULAR MOMENTUM

(103) Angular momentum of a body under a centripetal force is

(a) zero **(b)** maximum

(c) minimum **(d)** constant

(104) The value of angular momentum is maximum when θ is **GRW-2016 (G-I)**

(a) 90^o **(b)** 60^o

(c) 45^o **(d)** 0^o

(105) The angular momentum $\vec{L}$ is given by: **FSD-2016 (G-I)**

(a) $\vec{r}\times\vec{p}$ **(b)** $\vec{L}\times\vec{r}$

(c) $\vec{r}\times\vec{F}$ **(d)** $\vec{F}\times\vec{p}$

(106) If External Torque on a body is zero, then which of these quantities is constant: **BWP-2019 (G-II)**

(a) Force **(b)** Linear Momentum

(c) Linear Velocity **(d)** Angular Momentum

(107) The rate of change of angular momentum of a body is equal to

(a) moment of force **(b)** the applied force

(c) the applied torque **(d)** impulse

(108) Dimensions of angular momentum are

(a) [MLT] **(b)** $[MLT^{-1}]$

(c) $[ML^2T^{-1}]$ **(d)** $[MLT^{-2}]$

(109) The magnitude of angular momentum is given by

(a) L = mvr **(b)** $L = mvr\sin\theta$

(c) L = mp **(d)** L = mv

(110) The direction of angular momentum is

(a) along the axis of rotation **(b)** perpendicular to the radius of circle

(c) perpendicular to the velocity of object **(d)** all of these

(111) The expression for angular momentum is given by

(a) $L = I\omega$ **(b)** $L = mr^2\omega$

(c) $L = mvr$ **(d)** all of these

(112) The unit of angular momentum is **MTN-2019 (G-I) BWP-2019 (G-II)**

(a) $kg\ m^2/s$ **(b)** Js^{-1}

(c) Js **(d)** both a and c

(113) Which of the following is a vector quantity?

(a) speed (b) angular momentum
(c) time (d) mass

(114) The angular momentum of anybody about a fixed point is conserved when the angular acceleration of the body

(a) go on decreasing (b) go on increasing
(c) must remain constant (d) must be zero

(115) The angular momentum associated with the motion of a body along a circular path is called

(a) spin angular momentum (b) orbital angular momentum
(c) tangential angular momentum (d) linear angular momentum

5.8 LAW OF CONSERVATION OF ANGULAR MOMENTUM

(116) Law of conservation of angular momentum states that if no ________ acts on a system, the total angular momentum of the system remain constant

(a) external force (b) external torque
(c) external couple (d) none of these

(117) The diver spins faster when moment of inertia becomes:

(a) smaller (b) greater
(c) constant (d) equal

(118) The axis of rotation of an object will not change its orientation unless an _________ causes it to do so.

(a) external force (b) external torque
(c) external couple (d) none of these

(119) The law of conservation of angular momentum can explain

(a) the rotational motion of earth (b) spin motion of diver using divers board
(c) generation of stars in the universe (d) all of these

(120) When we drop ink into beaker in a coasting rotating system then it angular velocity

(a) increases (b) decreases
(c) remain same (d) none of these

(121) Earth moves around the sun according to

(a) law of conservation of charge (b) law of conservation of angular momentum
(c) law of conservation of mass (d) law of conservation of momentum

(122) The direction of angular momentum along the axis of rotation

(a) remain fixed (b) changes continuously
(c) become zero (d) none of these

5.9 ROTATIONAL KINETIC ENERGY

(123) The rotational K.E of any hoop of radius r is given by

(a) $1/2\ I\omega^2$ (b) $1/3\ I\omega$
(c) $1/2\ mr^2$ (d) $2/3\ Ir^2$

(124) The linear velocity of disc moving down an inclined plane is DGK-2016 (G-II) (LHR 2013)

(a) $\sqrt{gh}$ (b) $\sqrt{\frac{4}{3}gh}$
(c) $\sqrt{\frac{2}{3}gh}$ (d) $\sqrt{\frac{gh}{2}}$

(125) Moment of inertia of solid sphere is **DGK-2018 (G-II)**

(a) mr^2 **(b)** $\frac{2}{5}mr^2$

(c) $\frac{1}{12}mr^2$ **(d)** $\frac{1}{2}mr^2$

(126) The ratio of rotational K.E of hoop to its translational K.E is

(a) 1:2 **(b)** 2:1

(c) 1:1 **(d)** 1:4

(127) When a disc of mass m rolling down on an inclined plane then its K.E is

(a) $\frac{1}{2}mv^2$ **(b)** $\frac{3}{4}mv^2$

(c) $\frac{1}{4}mv^2$ **(d)** $\frac{2}{5}mv^2$

(128) Speed of hoop at the bottom of inclined plane is **(MTN 2015)**

(a) $v=\sqrt{2gh}$ **(b)** $v=\sqrt{gh}$

(c) $v=\sqrt{\frac{3}{4}gh}$ **(d)** $v=\sqrt{\frac{4}{3}gh}$

(129) A hoop of radius 1m and mass 2kg rolls down an inclined plane of height 10m its speed on reaching the ground is

(a) 4m/sec **(b)** 2m/sec

(c) 10m/sec **(d)** $1.5ms^{-1}$

(130) Speed of disc at the bottom of inclined plane is

MTN-2018 (G-II),(RWP 2015)

(a) $v=\sqrt{gh}$ **(b)** $v=\sqrt{2gh}$

(c) $v=\sqrt{\frac{3}{4}gh}$ **(d)** $v=\sqrt{\frac{4}{3}gh}$

(131) The rotational K.E of disc is _________ of translational K.E **BWP-2019 (G-I)**

(a) 1/2 times **(b)** two times

(c) same **(d)** 1/4 times

(132) When a body of cylindrical shape is rolled down on an inclined plane of height ‘h’, it contains

(a) only rotational K.E **(b)** only translational K.E

(c) both ‘a’ and ‘b’ **(d)** none of these

(133) When a hoop of mass m rolling down on an inclined plane then its rotational K.E is

(a) $\frac{1}{2}mv^2$ **(b)** $\frac{3}{4}mv^2$

(c) $\frac{1}{4}mv^2$ **(d)** $\frac{2}{5}mv^2$

(134) If no energy is lost against friction, then rotational K.E of the disc or hoop on reaching the bottom of inclined plane must be

(a) equal to P.E at top **(b)** greater than P.E at top

(c) less than P.E at top **(d)** zero

5.11 REAL AND APPARENT WEIGHT

(135) Apparent weight of a body in the inertial frame is
(a) real weight **(b)** zero
(c) double **(d)** half

(136) Weight of a 60 kg man in moving elevator (downward) with constant acceleration of $\frac{1}{2}g$ where $(g = 10ms^{-2})$ **(LHR 2014)**
(a) Zero **(b)** 300N
(c) 600N (d) 200N

(137) Weight of a body at the center of Earth is: **(GRW 2015)**
(a) maximum **(b)** minimum
(c) zero (d) infinite

(138) As we go from pole to equator of earth, the value of "g" **LHR-2018 (G-I)**
(a) increases **(b)** decreases
(c) remains constant **(d)** zero

(139) A mass of 1 kg is free falling. The force of gravity is: **MTN-2016 (G-II)**
(a) 1 N **(b)** 9.8 N
(c) 0.5 N **(d)** zero

(140) Apparent weight of a man in upward accelerated lift will: **BWP-2017 (G-II)**
(a) increase **(b)** decrease
(c) remains same **(d)** increase then decrease

(141) A man in an elevator descending with acceleration will conclude that his weight has
(a) increased **(b)** decreased
(c) remain same **(d)** zero

(142) An elevator is moving upward with acceleration 'a' the apparent weight of an object inside the elevator is
(a) mg-ma **(b)** mg + ma
(c) ma-mg **(d)**-mg - ma

(143) The weight of an object at the poles of the earth as compared to equator of earth
(a) larger **(b)** smaller
(c) same **(d)** infinite

(144) When the elevator moving down with an acceleration of $9.8ms^{-2}$ then the weight of a person becomes
(a) remain same **(b)** 2 times increases
(c) zero **(d)** half

(145) The apparent weight of the body in spaceship in orbiting the earth is
(a) less than its weight **(b)** greater than its weight
(c) weightlessness **(d)** no change

(146) The spaceship accelerates
(a) towards the center of the earth **(b)** away from the center of the earth
(c) with zero acceleration **(d)** none of these

(147) The system in which no force is required to hold an object falling in the frame of reference of the space craft or satellite is called
(a) orbital system **(b)** gravitational system
(c) virtual system **(d)** gravity free system

(148) **Generally, the weight of an object is measured by a**
(a) ordinary balance **(b)** spring balance
(c) both 'a' and 'b' **(d)** none of these

(149) **When the lift is at rest, Newton's second law tells us that acceleration is**
(a) zero **(b)** minimum
(c) maximum **(d)** equal to g

(150) **A man weighs 1000 N is in a stationary lift. What will be it's weight if the lift starts moving up with an acceleration 10 m/s^2**
(a) 2000 N **(b)** 3000 N
(c) 1500 N **(d)** 1000 N

(151) **The weight of the object on the surface of moon is**
(a) gravitational pull of moon on the object
(b) gravitational pull of earth on the object
(c) one sixth of the gravitational pull of earth
(d) both a and c

5.13 ORBITAL VELOCITY

(152) **The expression for orbital velocity is given by**
FSD 2019 (G-I), MIRPUR (AJK) 2015
(a) $v=\sqrt{\frac{gM}{R}}$ **(b)** $v=\sqrt{\frac{GM}{gh}}$
(c) $v=\sqrt{\frac{gM}{G}}$ **(d)** $v=\sqrt{\frac{GM}{r}}$

(153) **The ratio of orbital velocity to escape velocity is** **(LHR 2014)**
(a) $\sqrt{2}$ **(b)** $\frac{1}{\sqrt{2}}$
(c) $\frac{1}{2}$ (d) **2**

(154) **Orbital velocity near surface of earth is given by:** **MTN-2016 (G-II)**
(a) $\sqrt{2gR}$ **(b)** $\sqrt{gR}$
(c) $\sqrt{\frac{2g}{R}}$ **(d)** $\sqrt{\frac{g}{R}}$

(155) **The mass of the satellite is unimportant in describing the**
(a) earth's orbit **(b)** satellite's orbit
(c) earth's radius **(d)** earth's gravity

(156) **The close orbiting satellite orbit the Earth at height of about**
(a) 36×10^4 m **(b)** 3.9×10^5 m
(c) 4×10^5 m **(d)** 4.3×10^5m

(157) **A satellite moving around the earth constitutes**
(a) an inertial frame of reference **(b)** non inertial frame of reference
(c) neither inertial and non-inertial **(d)** Both inertial and non-inertial

ANSWER KEYS

(Topic Wise Multiple Choice Questions)

1	b	16	a	31	a	46	d	61	b	76	b	91	a	106	d	121	b	136	b	151	d
2	c	17	b	32	b	47	c	62	d	77	d	92	b	107	c	122	a	137	c	152	d
3	a	18	d	33	d	48	b	63	c	78	c	93	d	108	c	123	a	138	b	153	b
4	a	19	d	34	b	49	b	64	a	79	a	94	d	109	a	124	b	139	b	154	b
5	b	20	a	35	c	50	a	65	b	80	b	95	a	110	a	125	b	140	a	155	b
6	c	21	a	36	d	51	b	66	a	81	b	96	b	111	d	126	c	141	b	156	b
7	b	22	c	37	d	52	d	67	a	82	b	97	b	112	d	127	c	142	b	157	b
8	a	23	d	38	b	53	a	68	b	83	b	98	d	113	b	128	b	143	a		
9	c	24	b	39	b	54	c	69	a	84	b	99	b	114	c	129	c	144	c		
10	a	25	b	40	d	55	b	70	a	85	c	100	c	115	b	130	d	145	c		
11	c	26	d	41	b	56	a	71	c	86	a	101	b	116	b	131	a	146	a		
12	a	27	d	42	d	57	b	72	c	87	b	102	a	117	a	132	c	147	d		
13	d	28	d	43	d	58	b	73	c	88	b	103	d	118	b	133	a	148	b		
14	b	29	c	44	b	59	a	74	a	89	a	104	a	119	d	134	a	149	a		
15	b	30	b	45	c	60	d	75	a	90	a	105	a	120	b	135	a	150	a		

SHORT QUESTIONS
(From Textbook Exercise)

5.1 Explain the difference between tangential velocity and the angular velocity. If one of these is given for a wheel of known radius, how will you find the other?

SGD-16 (G-II)

Ans:

TANGENTIAL VELOCITY	ANGUALR VELOCITY
• Velocity of a body along the tangent is known as tangential velocity or linear velocity. • Its unit is m/s • Its direction is along tangent • $v_t = \frac{\Delta d}{\Delta t}, v = r\omega$	• Angular velocity of a body is the rate of change of angular displacement. • Its unit is radian/sec • Its direction is along the axis of rotation. • $\omega = \frac{\Delta \theta}{\Delta t} \omega = \frac{v}{r}$

If one of them is given for a wheel of known radius, then other can be calculated using the relation v = r ω

5.2 Explain what is meant by centripetal force and why it must be furnished to an object if the object is to follow a circular path?

FSD-15 (G-I), LHR-15 (G-I), DGK-16 (G-I), LHR -16 (G-I), BWP-19 (G-I & II)

Ans: Definition

"The force needed to bend normally the straight path of the particle into a circular path is called centripetal force"

Centripetal Force only changes the direction of motion

When a force acts perpendicular to the direction of motion of a body then that force changes only the direction of motion of the body. When a body moves in a circular path then at every instant its direction of motion changes. It means that a force always acts perpendicular to the direction of motion which keeps the body moving in the circular path. This force is called centripetal force. If we stop applying the centripetal force, body will move along the straight path. Hence it must be furnished so that direction of motion of body changes continuously due to which straight path bends into circular path.

5.3 What is meant by moment of inertia? Explain its significance.

G-II), DGK-15(G-I), MTN-15(G-II), RWP-15(G-I), FSD-15(G-I), GRW-15(G-I), LHR-15(G-II), MIRPUR (AJK)-15, DGK-16 (G-II), BWP-17 (G-II), FSD-17, LHR-17 (G-II), GRW-18, RWP-19 (G-I), SWL-19, MTN-19 (G-I & II)

Ans: Definition:

"The rotational analogous of linear mass is called moment of inertia"

It is denoted by I.

Significance:

It plays same role in angular motion which inertia plays in linear motion. It resists angular / circular motion as inertia resists linear motion.

It may be noted that moment of inertia depends not only on mass m but also on r^2.

5.4 What is meant by angular momentum? Explain the law of conservation of angular momentum.
BWP-15(G-I), SWL-18

Ans: Angular Momentum:

The moment of linear momentum of a body about a point is called angular momentum. OR

The cross product of position vector $\vec{r}$ and linear momentum $\vec{P}$ of an object is called angular momentum. It is denoted by $\vec{L}$

Mathematically, $\vec{L} = \vec{r} \times \vec{p}$

Law of conservation of angular momentum:

It states that if no external torque acts on a system, the total angular momentum of the system remains constant.

$\vec{L}_{Total} = \vec{L}_1 + \vec{L}_2 + --------- = \text{constant}$

$I_1\omega_1 = I_2\omega_2 = \text{constant}$ (For an isolated system)

5.5 Show that orbital angular momentum L_0 = mvr

LHR-13(G-I), LHR-14(G-I), SGD-15(G-II), MTN-15(G-I), GRW-15(G-I), GRW-15(G-I), LHR-15(G-II), DGK-16 (G-I)&(G-II), BWP-16 (G-I), SWL-17, BWP-17 (G-II), DGK-18 (G-I), LHR-18 (G-I), BWP-19 (G-I & II)

Ans: Proof

Consider a body of mass m is moving in a circular path of radius r with speed V, the angular momentum of the body is given by

$$\vec{L_o} = \vec{r} \times \vec{P}$$

The magnitude of angular momentum is given by

$$L_o = r\,p\sin\theta$$

$(\because \theta = 90^0)$ because angle between $\vec{r}$ and $\vec{p}$ is 90°

$$L_o = r\,p\sin 90^0$$

$$L_o = r\,p \qquad (\therefore \sin 90^0 = 1)$$

As, $p = mv$

So,

$$L_0 = rmv$$

Hence, proved, $L_0 = mvr$

5.7 State the direction of the following vectors in simple situation; angular momentum and angular velocity.

MIRPUR (AJK)-15, SGD-16 (G-II), LHR-16 (G-II)

Ans: The direction of angular momentum and angular velocity is determined by right hand rule.

For Angular Momentum:

- We know that:

  $\vec{L} = \vec{r} \times \vec{p}$

- This shows that the direction of angular momentum is perpendicular to the plane containing $\vec{r}$ and $\vec{p}$.
- In case of circular motion, angular momentum is perpendicular to the plane of circle and is along axis of rotation.

For Angular velocity:

The direction of angular velocity is perpendicular to the plane of the circle and is along the axis of rotation.

5.9 When mud flies off the tyre of a moving bicycle, in what direction does it fly? Explain.

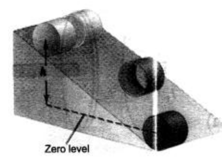
SGD-15(G-I)&(G-II), DGK-15(G-I), MTN-15(G-I), LHR-15(G-I), BWP-16 (G-I), SGD-16 (G-I), LHR-16 (G-I), FSD-17, LHR-17 (G-I) & (G-II), LHR-18 (G-II), FSD-19 (G-I)

Ans: When tyre of bicycle moves, then initially mud rotates with the tyre. The adhesive force between mud and the tyre provides necessary centripetal force to rotate the mud along with tyre. When speed of tyre increases, more centripetal force is required by mud to rotate with tyre. Since, adhesive force is not enough to provide necessary centripetal force, therefore, the mud flies off the tyre in a direction of tangent to the circular path.

5.10 A disc and hoop start moving down from the top of an inclined plane at the same time. Which one will be moving faster on reaching the bottom?

MIRPUR (AJK)-15, MTN-16 (G-I), RWP-16 (G-I), LHR-16 (G-I), MTN-18 (G-I), 19 (G-II)

Ans: When a disc and a hoop start moving down from the top of the inclined plane, then the speed of disc is greater than the speed of hoop on reaching the ground because moment of inertia of disc is lesser than that of hoop.



For DISC For HOOP

$$v=\sqrt{\frac{4}{3}gh} \qquad v=\sqrt{gh}$$

$$\frac{V_{disc}}{V_{hoop}}=\frac{\sqrt{\frac{4}{3}gh}}{\sqrt{gh}}=\frac{2}{\sqrt{3}}\frac{\sqrt{gh}}{\sqrt{gh}}$$

$$V_{disc}=\frac{2}{\sqrt{3}}V_{hoop}=1.15V_{hoop}$$

This shows that the speed of disc is greater than that of hoop

5.11 Why does a diver change his body positions before and after diving in the pool?

BWP-15(G-I),SGD-15(G-I), MTN-15(G-II), GRW15(G-I), SWL-16, MTN-16 (G-I) & (G-II), RWP-16 (G-I), GRW-16 (G-I), LHR-16 (G-II), FSD-18, DGK-18 (G-I)&(G-II), SWL-18, GRW-19 (G-I), FSD-19 (G-I), BWP-19 (G-I)

Ans: When a diver jumps off the diving board, he has small angular velocity about the horizontal axis through his center of gravity. When he draws his legs and arms close to his body, his moment of inertia decreases and to conserve angular momentum, his angular velocity increases and he spins faster. This enables the diver to take extra somersaults.

TOPIC WISE SHORT QUESTIONS

5.1 ANGULAR DISPLACEMENT

(1) What is angular displacement? How can we determine its direction?

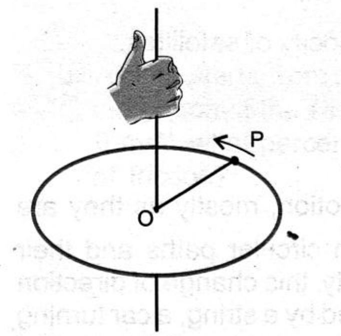
Ans: Angular Displacement

It is the angle subtended at the center of a circle by a particle moving along the circumference in a given time.

Direction:

Its direction can be determined by right hand rule.

Grasp the axis of rotation in right hand with fingers curling in the direction of rotation the thumb points in the direction of angular displacement.



(2) Express the different units of angular displacements?

Ans: Revolution

One complete rotation of a body along the circumference of the circle is called revolution.

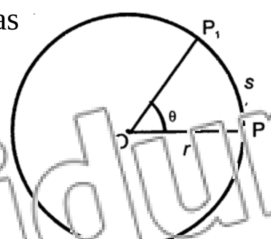
Degree: If the circumference of the circle is divided into 360 equal parts then the angle subtended by each part at the centre of circle is called degree.

Radian: The angle subtended at the centre of a circle by an are equal in length to its radius is said to be one radian.

(3) Prove that $S = r\theta$

MTN-2016 (G-I), MTN-2018 (G-I) LHR-2019 (G-I)

Ans: Consider an arc of length s of a circle of radius r which subtends an angle θ at the centre of circle. Its value in radian is given as



$$\theta = \frac{Arc\,length}{radius}(rad)$$

$$\theta = \frac{S}{r}$$

$$\Rightarrow S = r\theta$$

(4) What will be advantage if angle is measured is radian, rather then in degree?

Ans: Radian

The angle subtended at the centre of a circle by an are equal in length to its radius is said to be one radian.

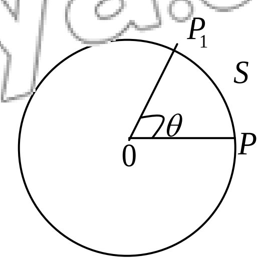
If the angle is measured in radian, then we can easily find out the length of the arc which subtends this angle at the centre.

(5) Prove that 1 Radian = 57.3° **RWP-2019 (G-I)**

Ans: Consider an arc of length s of a circle of radius r which subtends an angle θ at the centre of circle. Its value in radian is given as

$$\theta = \frac{Arc\,length}{radius}(rad)$$

$$\theta = \frac{S}{r}$$



If OP is rotating, the point P covers a distance S = 2πr in one revolution.

In radian it would be $\frac{S}{r} = \frac{2\pi r}{r} = 2\pi$

1 Revolution = 2π rad = 360°

$$1\text{rad} = \frac{360^o}{2\pi}$$

$$1\text{rad} = 57.3^o$$

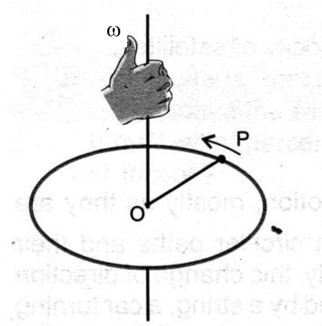
5.2 ANGULAR VELOCITY

(6) What is sign convention of angular velocity?

Ans: **Direction:**

Its direction can be determined by right hand rule.

Grasp the axis of rotation in right hand with fingers curling in the direction of rotation the thumb points in the direction of angular velocity.



If the body is rotating anticlockwise then the angular velocity is taken as positive. If the body is rotating clockwise then it is negative.

5.3 ANGULAR ACCELERATION

(7) Define instantaneous angular acceleration

Ans: Instantaneous angular acceleration is the limiting value of the ratio $\frac{\Delta\omega}{\Delta t}$ as Δt approaches zero. Therefore it is given by

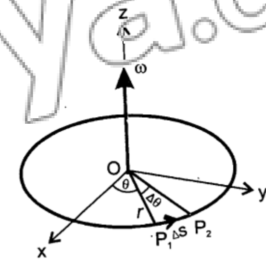
$$\alpha_{ins} = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t}$$

Its direction is along the axis of rotation. It is expressed in rad/s^2.

5.4 RELATION BETWEEN LINEAR & ANGULAR VELOCITIES

(8) Prove the relation in $a_t = r\alpha$.

Ans: If reference line of OP is rotating with an angular acceleration α , the point P will also have linear acceleration a_t.



We know that $a_t = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t}$

but $v = r\omega$

$$a_t = \lim_{\Delta t \to 0} \frac{\Delta(r\omega)}{\Delta t}$$

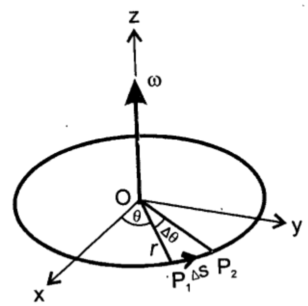
$$= \lim_{\Delta t \to 0} r\frac{\Delta\omega}{\Delta t}$$

As $\lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t} = \alpha$

Hence $a_t = r\alpha$

(9) Show that v = r ω **BWP-2019 (G-II)**

Ans: Suppose during the course of its motion, the point P moves through a distance $P_1P_2 = \Delta s$ in a time interval Δt during which reference line OP has an angular displacement Δθ radian during this interval. Δs and Δθ are related by Eq.



$$\Delta S = r\Delta\theta$$

Dividing both sides by Δt

$$\frac{\Delta S}{\Delta t} = r\frac{\Delta\theta}{\Delta t} \quad \text{..........(i)}$$

In the limit when $\Delta t \to 0$ the ratio $\Delta S/\Delta t$ represents v, the magnitude of the velocity with which point P is moving on the circumference of the circle. Similarly $\Delta\theta/\Delta t$ represents the angular velocity ω of the reference line OP. So equation (i) becomes.

$$v = r\omega$$

5.5 CENTRIPETAL FORCE

(10) Give some examples of centripetal force?

Ans: (i) Tension in a string for the mass attached with it and moving in a circle, provides the centripetal force.

(ii) Gravitational force provides the centripetal force for planets, moving round the sun.

(iii) The force of friction for a car turning round a corner, provides the centripetal force.

(11) What is centripetal acceleration?

Ans: The instantaneous acceleration of an object travelling with uniform speed in a circle is directed towards the centre of the circle and is called centripetal acceleration.

$$a_c = \frac{v^2}{r} = r\omega^2 = v\omega \quad \because v = r\omega$$

Vector form:

$$\overrightarrow{a_c} = \frac{v^2}{r}(-\hat{r})$$

$$\overrightarrow{a_c} = -\frac{v^2}{r^2}\left(\vec{r}\right)$$

(12) Express the centripetal force in terms of angular velocity?

Ans: We know that $F_c = \frac{mv^2}{r}$

As $v = r\omega$

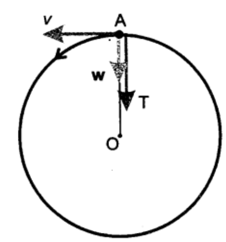
$v^2 = r^2\omega^2$

$$F_c = \frac{mr^2\omega^2}{r} = \text{mr}\,\omega^2$$

This is the expression for centripetal force in terms of angular velocity.

(13) If a body is whirled in a vertical loop then at what position tension in the string has its maximum and minimum values?

Ans: Expression for tension in the string for a body moving in a vertical loop is $T = \frac{mv^2}{r} - mg\cos\theta$. Where θ is the angle between tension and weight of the body.



At the highest point of the vertical loop. The tension in the string is minimum.

$$T_{\min} = \frac{mv^2}{r} - mg \qquad \theta = 0^o$$

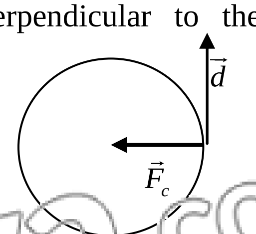
θ

At the lowest point, the tension in the string is maximum, and is

$$T_{\max} = \frac{mv^2}{r} + mg \qquad \theta = 180^o$$

(14) Is any work done by centripetal force?

Ans: No, in circular motion, centripetal force is always acting perpendicular to the displacement of the moving body



$W = \vec{F}.\vec{d}$

$= F\ d\ cos\theta \qquad \theta = 90^o$

$= F\ d\ cos\ 90^o$

$W = 0$

Hence, work done by the centripetal force is zero.

(15) Why banked tracks are needed for turns? **LHR-2013**

Ans: When car turn on road alone friction cannot provide energy for necessary centripetal force by making banked tracks extra centripetal force is provided to car which enable car to turn quickly on road.

5.6 MOMENT OF INERTIA

(16) Show that $\tau = I\alpha$

Ans: Let the rigid body is made up of n small pieces of masses m_1, m_2,…i….m_n at distances r_1, r_2,………..r_n from the axis of rotation. If rigid body is rotating, then the magnitude of torque acting on m_1, is

$$\tau_1 = m_1 r_1^2 \alpha$$

Similarly torque on m_2 is

$$\tau_2 = m_2 r_2^2 \alpha$$

$$\tau_{Total} = \left(m_1 r_1^2 + m_2 r_2^2 + ... + m_n r_n^2\right)\alpha$$

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

$$\tau = I\alpha$$

(17) What happens to the moment of inertia of a body about a particular axis when its velocity is doubled?

Ans: Moment of inertia:

It is the product of mass of a body and square of distance from the axis of rotation $I = mr^2$

It depends on

(i) Mass of a body

(ii) Square of radius

Equation show that moment of inertia does not depends on velocity of the body, so it remains unaffected by doubling its velocity.

(18) Why brake drum of vehicles are of large diameters?

Ans: Drum Brake:

A drum brake is a brake that uses friction caused by a set of shoes or pads that press on the inner surface of the drum.

The break drum of vehicles are made of large diameter having large radius to produce greater rotational inertia. Hence opposing torque will increase according to equation

$\tau = I\ \alpha$

(19) On what factors, moment of inertia depends? GRW-2014

Ans: We know that $I = mr^2$

Factors:

(i) Mass of object (ii) Distance of object from the center

(20) What will be the effect on moment of inertia of a cylinder of about its axis if its diameter is doubled? SWL-2017

Ans:

$$I_{cylinder} = \frac{1}{2}mr^2 = \frac{1}{2}m\left(\frac{d}{2}\right)^2 = \frac{1}{8}md^2$$

$$d' = 2d$$

$$I' = \frac{1}{8}md'^2 = \frac{1}{8}m(2d)^2 = \frac{1}{8}m\ \ 4d^2$$

$$I' = 4\left(\frac{1}{8}md^2\right) = 4I$$

Its moment of inertia will become four times the previous.

5.7 ANGULAR MOMENTUM

(21) Convert kgm^2s^{-1} into Js.

Ans: $kgm^2s^{-1} \times \frac{s}{s}$

$$= \frac{kgm^2.s}{s^2}$$

$$= \frac{kgm.m.s}{s^2}$$

As $kg\,m/s^2 = N$

= N. m .s

As N m = J

Hence

$Kgm^2s^{-1} = Js$

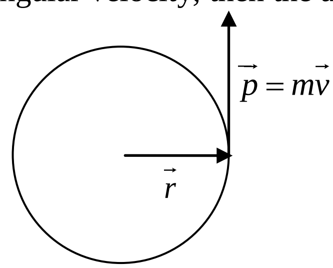
(22) Differentiate between spin angular momentum and orbital angular momentum.

Ans:

Spin Angular Momentum	Orbital Angular Momentum
• Spin angular momentum is the angular momentum of spinning body. • It is denoted by L_s. • (Earth rotates about its own axis has spin angular momentum. • Formation of days and nights is due to spin angular momentum of earth about its own axis.	• Orbital angular momentum is associated with the motion of a body along a circular path. • It is denoted by L_o. • Earth revolves about the sun has some orbital angular momentum. • Formation of years is due to orbital angular momentum of earth around sun.

(23) Show that L = Iω

Ans: If a particle is moving in a circle of radius r with uniform angular velocity, then the angle between v and r is 90°.



$\vec{L} = \vec{r} \times \vec{p}$

$L = rp\sin\theta$

$\therefore \quad P = mv$

$L = mvr\sin\theta$

$= mvr\sin(90^o)$

$= mvr$

As $v = r\omega$

$L = mr^2\omega$

As $I = mr^2$

Hence L = Iω

(24) Define angular momentum and give its dimensions. **LHR-2016 (G-II)**

Ans: Angular momentum is the cross product of position vector $\vec{r}$ and linear momentum $\vec{p}$.

$$\vec{L} = \vec{r} \times \vec{p}$$

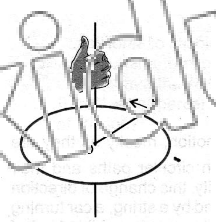
A particle is said to possess an angular momentum about a reference axis if it so moves that it's angular position changes relative to that reference axis.

Dimension:

$[ML^2T^{-1}]$

(25) How would you determine the direction of angular momentum? Give example. **FSD-2017**

Ans: Direction can be determined by right hand rule. Grasp the axis of rotation in right hand with fingers curling in the direction of rotation the thumb points in the direction of angular momentum.



5.8 LAW OF CONSERVATION OF ANGULAR MOMENTUM

(26) Why does the coasting rotating system slow down as water drips into the beaker?

Ans: When water drips into the beaker, the mass of the contents in the beaker increases which increases the moment of inertia. So the angular velocity ω decreases according to law of conservation of momentum.

5.9 ROTATIONAL KINETIC ENERGY

(27) Find the velocity of a disc rolls down along an inclined plane of height 10m?

Ans: Velocity of a disc rolls down along an inclined plane of height h is

$v = \sqrt{\frac{4gh}{3}}$

h = 10m

v = ?

$= \sqrt{\frac{4\times 9.8\times 10}{3\times 10}}$

$v = \sqrt{\frac{392}{3}}$

v = 11.43 m/s

(28) State the practical use of rotational K.E. by fly wheels. **LHR-2017 (G-II)**

Ans: Rotational kinetic energy is put to practical use by fly wheels, which are essential parts of many engines. A fly wheel stores energy between the power stokes of the pistons, so that the energy distributed over the full revolution of the crankshaft and hence, the rotation remains smooth.

(29) Explain Rotational K.E of a Disc and a Hoop. **MTN-2013**

Ans: Rotational kinetic energy of a body is given by $\frac{1}{2}I\omega^2$

For disc:	For hoop:
$I = \frac{1}{2}mr^2$	$I = mr^2$
$K.E_{rot} = \frac{1}{2}\left(\frac{1}{2}mr^2\right)\omega^2$	$K.E_{rot} = \frac{1}{2}\left(mr^2\right)\omega^2$
$= \frac{1}{4}mr^2\omega^2 \quad \therefore v^2 = r^2\omega^2$	$= \frac{1}{2}mr^2\omega^2 \quad \therefore v^2 = r^2\omega^2$
$= \frac{1}{4}mv^2$	$= \frac{1}{2}mv^2$

Rotational K.E of disc is $\frac{1}{4}$mv^2 and rotational K.E of hoop is $\frac{1}{2}$mv^2

(30) What type of energies are possessed by a hoop moving down frictionless inclined plane? **SWL-2017**

Ans: When hoop is moving down on frictionless inclined plane, gravitational potential energy is converted into translational and rotational kinetic energies.

If no energy is lost against friction then

$$P.E = K.E_{tran} + K.E_{rot}$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}mv^2$$

5.11 REAL AND APPARENT WEIGHT

(31) If a body of mass 10kg is allowed to fall freely then what will be its apparent weight?

Ans: m = 10kg

$g = a = 9.8 m/s^2$

T = mg – mg

= 10 (9.8) – 10 (9.8)

= 0N

(32) Differentiate between Real and apparent weight of a body.

SGD-2015, FSD-2014, 2019 (G-I)

Ans:

Real Weight	Apparent Weight
(i) It means gravitational pull of earth on that object.	(i) The force which prevent the body from freely falling is called apparent weight.
(ii) It is measured as w = mg	(ii) It is measured as tension in the spring balance.

(33) If a person is falling in an elevator freely. What will be his weight? Measured by himself.

Ans: The force required to prevent a body from free fall is called its apparent weight. If a person is falling freely in an elevator, its apparent weight is zero. Therefore he will be in weightlessness. It means that a freely falling body in an elevator feels no weight by himself.

(34) A body of mass 'm' is suspended from the ceiling of an elevator. If the elevator is ascending with and acceleration 'a', what would be the value of 'T' acting on the body? **LHR-2017 (G-I)**

Ans: When the lift is moving upwards with an acceleration a, then

Net Force = T-W

By newton 2^{nd} law

F = ma

$$T - W = ma$$

$$T = W + ma$$

Above eq. shows that apparent weight of body will increased by ma than its real weight

5.13 ORBITAL VELOCITY

(35) What will be effect on the speed of satellite by increasing its mass?

Ans: We know that orbital speed of the satellite is

$$v = \sqrt{\frac{GM}{r}}$$

Dependence:

(i) Mass of the planet

(ii) Radius of the orbit

This relation shows that speed of satellite is independent of the mass of the satellite. Therefore, change of mass will not effect its speed.

(36) What is relation between escape velocity and orbital velocity? **FSD-2013**

Ans: we know that

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

$$v_{orbital} = \sqrt{\frac{GM}{r}}$$

$$\frac{v_{esc}}{v_{orbital}} = \frac{\sqrt{\frac{2GM}{R}}}{\sqrt{\frac{GM}{r}}} = \sqrt{2}\,\frac{\sqrt{\frac{GM}{R}}}{\sqrt{\frac{GM}{r}}} = \sqrt{2}\ v_{orbital}$$

This equation shows that escape velocity is 1.41 times of orbital velocity.