Exercise - I (Conceptual Questions) Build Up Your Understanding

KINEMATICS OF ROTATIONAL MOTION

1. Which of the following pairs do not match :-
(1) rotational power–Joule/sec
(2) torque-Newton meter
(3) angular displacement-radian
(4) angular acceleration - radian/sec

PRM001

2. All the particles of a rigid rotating body move in a circular path when the axis of rotation:-
(1) passes through any point in the body
(2) is situated outside the body
(3) situated any where
(4) passes through the centre of mass

PRM002

3. On account of the earth rotating about its axis :-
(1) the linear velocity of objects at equator is greater than at other places.
(2) the angular velocity of objects at equator is more than that of objects at poles.
(3) the linear velocity of objects at all places at the earth is equal, but angular velocity is different.
(4) at all places the angular velocity and linear velocity are uniform.

PRM003

4. The quantity not involved directly in rotational motion of the body is
(1) moment of inertia (2) torque
(3) angular velocity (4) mass

PRM004

MOMENT OF INERTIA

5. The moment of inertia of a body about a given axis of rotation depends upon :-
(1) the distribution of mass
(2) distance of particle of body from the axis of rotation
(3) shape of the body
(4) all of the above

PRM005

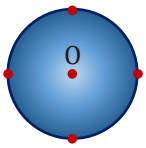
6. A fly wheel is so constructed that almost whole of its mass is concentrated at its rim, because:-
(1) it increases the moment of inertia of the fly-wheel
(2) it decreases the moment of inertia of the fly-wheel
(3) it increases the speed of the fly-wheel
(4) it increases the power of the fly-wheel

PRM006

7. The moment of inertia of a solid cylinder about its own axis is the same as its moment of inertia about an axis passing through its centre of gravity and perpendicular to its length. The relation between its length L and radius R is
(1) $L=\sqrt{2}R$ (2) $L=\sqrt{3}R$
(3) L = 3R (4) L = R

PRM007

8. Four similar point masses (each of mass m) are placed on the circumference of a disc of mass M and radius R. The M.I. of the system about the normal axis through the centre O will be:-



(1) $MR^2 + 4mR^2$ (2) $\frac{1}{2}MR^2 + 4mR^2$
(3) $MR^2 + \frac{8}{5}mR^2$ (4) none of these

PRM009

9. By the theorem of perpendicular axes, if a body be in X-Z-plane then :-
(1) $I_x - I_y = I_z$ (2) $I_x + I_z = I_y$
(3) $I_x + I_y = I_z$ (4) $I_y + I_z = I_x$

PRM010

10. The theorem of perpendicular axes is not applicable for determination of moment of inertia along the diameter, for which of the following body :-
(1) sphere (2) disc
(3) ring (4) blade

PRM011

11. The axis X and Z in the plane of a disc are mutually perpendicular and Y-axis is perpendicular to the plane of the disc. If the moment of inertia of the body about X and Y axes is respectively 30 kg m^2 and 40 kg m^2 then M.I. about Z-axis in kg m^2 will be :-
(1) 70 (2) 50 (3) 10 (4) Zero

PRM012

12. A solid sphere and a hollow sphere of the same mass have the same M.I. about their respective diameters. The ratio of their radii will be :-

(1) 1 : 2 (2) $\sqrt{3}:\sqrt{5}$ (3) $\sqrt{5}:\sqrt{3}$ (4) 5 : 4

PRM013

13. The moment of inertia of a square lamina about the perpendicular axis through its centre of mass is 20 kg-m^2. Then, its moment of inertia about an axis touching its side and in the plane of the lamina will be :-

(1) 10 kg-m^2 (2) 30 kg-m^2

(3) 40 kg-m^2 (4) 25 kg-m^2

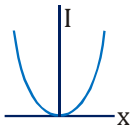
PRM014

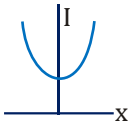
14. The M.I. of a thin rod of length ℓ about the perpendicular axis through its centre is I. The M.I. of the square structure made by four such rods about a perpendicular axis to the plane and through the centre will be :-

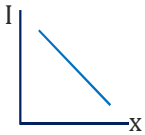
(1) 4I (2) 8I (3) 12I (4) 16I

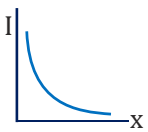
PRM015

15. The curve for the moment of inertia of a sphere of constant mass M versus distance of axis from its centre ?

(1) 

(2) 

(3) 

(4) 

PRM016

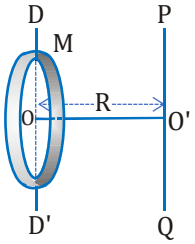
16. The moment of inertia of a ring of mass M and radius R about PQ axis will be :-

(1) MR^2

(2) $\frac{MR^2}{2}$

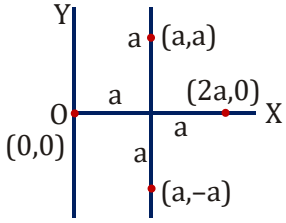
(3) $\frac{3}{2}$MR^2

(4) 2MR^2



PRM017

17. Four point masses (each of mass m) are arranged it the X-Y plane the moment of inertia of this array of masses about Y-axis is



(1) ma^2 (2) 2ma^2 (3) 4ma^2 (4) 6ma^2

PRM018

18. Which of the following has the highest moment of inertia when each of them has the same mass and the same radius ?

(1) a hollow sphere about one of its diameters

(2) a solid sphere about one of its diameters

(3) a disc about its central axis perpendicular to the plane of the disc

(4) a ring about its central axis perpendicular to the plane of the ring.

PRM019

19. If the radius of gyration of a solid disc of mass 10 kg about an axis is 0.40 m, then the moment of inertia of the disc about that axis is

(1) 1.6 kg m^2 (2) 3.2 kg m^2

(3) 6.4 kg m^2 (4) 9.5 kg m^2.

PRM020

20. If I_1, I_2 and I_3 are moments of inertia of solid sphere, hollow sphere and a ring of same mass and radius about geometrical axis, which of the following statement holds good ?

(1) $I_1 > I_2 > I_3$ (2) $I_3 > I_2 > I_1$

(3) $I_2 > I_1 > I_3$ (4) $I_2 > I_3 > I_1$

PRM021

21. Three thin uniform rods each of mass M and length L are placed along the three axis of a cartesian coordinate system with one end of each rod at the origin. The M. I. of the system about z-axis is

(1) $\frac{ML^2}{3}$ (2) $\frac{2ML^2}{3}$

(3) $\frac{ML^2}{6}$ (4) ML^2

PRM022

22. Four particles each of mass m are placed at the corners of a square of side length ℓ. The radius of gyration of the system about an axis perpendicular to the square and passing through centre is :–

(1) $\frac{\ell}{\sqrt{2}}$ (2) $\frac{\ell}{2}$

(3) ℓ (4) $\ell\sqrt{2}$

PRM023

23. The moment of inertia of a rod of mass M and length L about an axis passing through one edge and perpendicular to its length will be :–

(1) $\frac{ML^2}{12}$ (2) $\frac{ML^2}{6}$

(3) $\frac{ML^2}{3}$ (4) ML^2

PRM024

24. A circular disc is to be made by using iron and aluminium so that it acquired maximum moment of inertia about geometrical axis. It is possible with:

(1) aluminium at interior and iron surrounded to it.

(2) iron at interior and aluminium surrounded to it.

(3) using iron and aluminium layers in alternate order.

(4) sheet of iron is used at both external surface and aluminium sheet as internal layer.

PRM025

25. The moment of inertia in rotational motion is equivalent to :–

(1) angular velocity of linear motion

(2) mass of linear motion

(3) frequency of linear motion

(4) current

PRM026

26. Two rods each of mass m and length ℓ are joined at the centre to form a cross. The moment of inertia of this cross about an axis passing through the common centre of the rods and perpendicular to the plane formed by them, is :–

(1) $\frac{m\ell^2}{12}$ (2) $\frac{m\ell^2}{6}$ (3) $\frac{m\ell^2}{3}$ (4) $\frac{m\ell^2}{2}$

PRM027

27. The ratio of the radii of gyration of a circular disc about a tangential axis in the plane of the disc and of a circular ring of the same radius about a tangential axis in the plane of the ring is :–

(1) 2 : 1 (2) $\sqrt{5}:\sqrt{6}$

(3) 2 : 3 (4) $1:\sqrt{2}$

PRM028

28. Three particles, each of mass m are situated at the vertices of an equilateral triangle ABC of side ℓ (as shown in the figure).

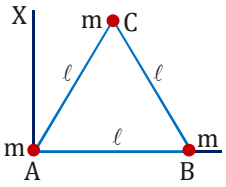
The moment of inertia of the system about a line AX perpendicular to AB and in the plane of ABC, will be :-

(1) $2\ m\ell^2$

(2) $\frac{5}{4}\ m\ell^2$

(3) $\frac{3}{2}\ m\ell^2$

(4) $\frac{3}{4}\ m\ell^2$



PRM029

29. A solid cylinder of mass 20kg has length 1 m and radius 0.2 m. Then its moment of inertia (in kg-m^2) about its geometrical axis is :–

(1) 0.8 kg-m^2 (2) 0.4 kg-m^2

(3) 0.2 kg-m^2 (4) 20.2 kg-m^2

PRM030

30. The moment of inertia of a circular ring (radius R, mass M) about an axis which passes through tangentially and perpendicular to its plane will be:–

(1) $\frac{MR^2}{2}$ (2) MR^2

(3) $\frac{3}{2}MR^2$ (4) $2MR^2$

PRM032

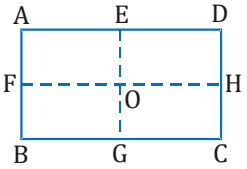
31. What is the moment of inertia of ring about its diameter ?

(1) MR^2 (2) $\frac{MR^2}{2}$

(3) $\frac{3}{4}MR^2$ (4) $\frac{5}{4}MR^2$

PRM033

32. In the rectangular lamina shown in the figure, AB = BC/2. The moment of inertia of the lamina is minimum along the axis passing through :-



(1) AB (2) BC (3) EG (4) FH

PRM034

33. Which of the following bodies of same mass and same radius has minimum moment of inertia ?

(1) Ring (2) Disc
(3) Hollow sphere (4) Solid sphere

PRM035

TORQUE, EQUILIBRIUM OF RIGID BODIES AND TOPPLING

34. A ring and a solid sphere of same mass and radius are rotating with the same angular velocity about their diametric axes then :-

(1) it is easier to stop the ring
(2) it is easier to stop the solid sphere
(3) it is equally difficult to stop both of them
(4) it is not possible to stop a rotating body

PRM036

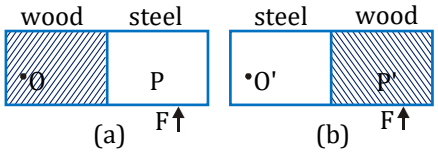
35. For rotational motion, the Newton's second law of motion is indicated by :-

(1) $\omega_2^2 = \omega_1^2 + 2\alpha\theta$ (2) $\vec{F} = \frac{d\vec{p}}{dt}$

(3) $\vec{\tau} = \frac{d\vec{L}}{dt}$ (4) $\vec{F}_{12} = \vec{F}_{21}$

PRM037

36. In the fig. (a) half of the meter scale is made of wood while the other half of steel. The wooden part is pivoted at O. A force F is applied at the end of steel part. In figure (b) the steel part is pivoted at O' and the same force is applied at the wooden end (In horizontal plane) :-



(1) more angular acceleration will be produced in (a)
(2) more angular acceleration will be produced in (b)
(3) same angular acceleration will be produced in both conditions
(4) information is incomplete

PRM038

37. The moment of inertia of a disc of radius 0.5 m about its geometric axis is 2kg-m^2. If a string is tied to its circumference and a force of 10 Newton is applied, the value of torque with respect to this axis will be :-

(1) 2.5 N-m (2) 5 N-m
(3) 10 N-m (4) 20 N-m

PRM039

38. In the above question, if the disc executes rotatory motion, its angular acceleration will be :-

(1) 2.5 rad/sec^2 (2) 5 rad/sec^2
(3) 10 rad/sec^2 (4) 20 rad/sec^2

PRM040

39. In the above question, the value of its angular velocity after 2 seconds will be :-

(1) 2.5 rad/sec (2) 5 rad/sec
(3) 10 rad/sec (4) 20 rad/sec

PRM041

40. In the above question, the change in angular momentum of disc in first 2 seconds (in Nm second) will be -

(1) 2.5 (2) 5
(3) 10 (4) 20

PRM042

41. In the above question, angular displacement of the disc, in first two second will be (in radian) :-

(1) 2.5 (2) 5 (3) 10 (4) 20

PRM043

42. A particle of mass m and radius of gyration K is rotating with an angular acceleration α. The torque acting on the particle is

(1) $\frac{1}{2}mK^2\alpha$ (2) $mK^2\alpha$

(3) mK^2/α (4) $\frac{1}{4}mK^2\alpha^2$

PRM044

43. The grinding stone of a flour mill is rotating at 600 rad/sec. For this, power of 1.2 k watt is used. the effective torque on stone in N–m will be :–
(1) 1 (2) 2 (3) 3 (4) 4
PRM045

44. A rigid body is rotating about an axis. To stop the rotation, we have to apply :-
(1) pressure (2) force
(3) momentum (4) torque
PRM046

45. A wheel has moment of inertia 5×10^{-3} kg m^2 and is making 20 rev/sec. The torque needed to stop it in 10 sec is ..... $\times 10^{-2}$ N-m :–
(1) 2π (2) 2.5π (3) 4π (4) 4.5π
PRM047

46. A wheel having moment of inertia 2 kg–m^2 about its vertical axis, rotates at the rate of 60 rpm about the axis. The torque which can stop the wheel's rotation in one minute would be :–
(1) $\frac{\pi}{12}$ N–m (2) $\frac{\pi}{15}$ N–m
(3) $\frac{\pi}{30}$ N–m (4) $\frac{2\pi}{15}$ N–m
PRM048

47. A constant torque acting on a uniform circular wheel changes its angular momentum from A_0 to 4 A_0 in 4 seconds. The magnitude of this torque is :–
(1) $\frac{3A_0}{4}$ (2) A_0 (3) $4A_0$ (4) 12 A_0
PRM049

48. When constant torque is acting on a body then :–
(1) body maintain its state or moves in straight line with same velocity
(2) acquire linear acceleration
(3) acquire angular acceleration
(4) rotates with a constant angular velocity
PRM051

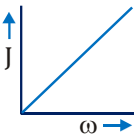
49. If torque on a body is zero, then which is conserved:
(1) force
(2) linear momentum
(3) angular momentum
(4) angular impulse
PRM052

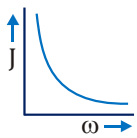
50. If I = 50 kg-m^2, then how much torque will be applied to stop it in 10 sec. Its initial angular speed is 20 rad/sec. :–
(1) 100 N-m (2) 150 N-m
(3) 200 N-m (4) 250 N-m
PRM053

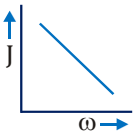
51. A force $\vec{F} = 2\hat{i} - 3\hat{k}$ acts on a particle at $\vec{r} = 0.5\hat{j} - 2\hat{k}$. The torque τ acting on the particle relative to a point with co-ordinates (2.0 m, 0, –3.0 m) is
(1) $(-3.0\hat{i} - 4.5\hat{j} - \hat{k})\text{N} - \text{m}$
(2) $(3\hat{i} + 6\hat{j} - \hat{k})\text{N} - \text{m}$
(3) $(-20\hat{i} + 4.0\hat{j} + \hat{k})\text{N} - \text{m}$
(4) $(-1.5\hat{i} - 4.0\hat{j} - \hat{k})\text{N} - \text{m}$
PRM054

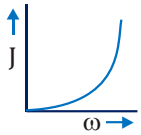
52. If a ladder is not in balance against a smooth vertical wall, then it can be made in balance by :-
(1) Decreasing the length of ladder
(2) Increasing the length of ladder
(3) Increasing the angle of inclination
(4) Decreasing the angle of inclination
PRM055

ANGULAR MOMENTUM

53. The graph between the angular momentum J and angular velocity ω for a body will be :-
(1) 

(2) 

(3) 

(4) 

PRM056

54. When a mass is rotating in a plane about a fixed point, its angular momentum is directed along
(1) the radius
(2) the tangent to orbit
(3) line at an angle of 45° to the plane of rotation
(4) the axis of rotation
PRM057

55. A ring of mass 10 kg and diameter 0.4 meter is rotating about its geometrical axis at 1200 rotations per minute. Its moment of inertia and angular momentum will be respectively:-
(1) 0.4 kg-m^2 and 50.28 J-s
(2) 0.4 kg-m^2 and 0.4 J-s
(3) 50.28 kg-m^2 and 0.4 J-s
(4) 0.4 kg-m^2 and zero

PRM058

56. The rotational kinetic energy of two bodies of moments of inertia 9 kg-m^2 and 1kg-m^2 are same. The ratio of their angular momentum is :-
(1) 3 : 1 (2) 1 : 3 (3) 9 : 1 (4) 1 : 9

PRM059

57. A fan of moment of inertia 0.6 kgm^2 is to run upto a working speed of 0.5 revolution per second. Indicate the correct value of the angular momentum of the fan
(1) $0.6\pi \text{ kg} \times \frac{\text{metre}^2}{\text{sec}}$ (2) $6\pi \text{ kg} \times \frac{\text{metre}^2}{\text{sec}}$
(3) $3\pi \text{ kg} \times \frac{\text{metre}^2}{\text{sec}}$ (4) $\frac{\pi}{6}\text{kg} \times \frac{\text{metre}^2}{\text{sec}}$

PRM060

58. A body of mass m is moving with constant velocity parallel to x-axis. The angular momentum with respect to origin :–
(1) increases with time
(2) decreases with time
(3) does not change
(4) none of above

PRM061

59. In an orbital motion, the angular momentum vector is :–
(1) along the radius vector
(2) parallel to the linear momentum
(3) in the orbital plane
(4) perpendicular to the orbital plane

PRM062

60. Two bodies have their moments of inertia I and 2I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momentum will be in the ratio :–
(1) 1 : 2 (2) $\sqrt{2}:1$
(3) $1:\sqrt{2}$ (4) 2 : 1

PRM063

61. The rotational kinetic energy of a body is K_{rot} and its moment of inertia is I. The angular momentum of body is
(1) IK_{rot} (2) $2\sqrt{IK_{rot}}$
(3) $\sqrt{2IK_{rot}}$ (4) $2IK_{rot}$

PRM064

62. A body of mass 10 kg and radius of gyration 0.1 m is rotating about an axis. If angular speed is 10 rad/s, then angular momentum will be :-
(1) 1 kg m^2/s (2) 0.1 kg m^2/s
(3) 100 kg m^2/s (4) 10 kg m^2/s

PRM065

63. A particle of mass 1.0 kg is rotating on a circular path of diameter 2.0 m at the rate of 10 rotations in 31.4s. The angular momentum of the body,(in kgm^2/s) is :-
(1) 1.0 (2) 1.5 (3) 2.0 (4) 4.0

PRM066

64. A particle of mass m is rotating in a plane in a circular path of radius r. Its angular momentum is L. The centripetal force acting on the particle is
(1) $\frac{L^2}{mr}$ (2) $\frac{L^2m}{r}$ (3) $\frac{L^2}{mr^2}$ (4) $\frac{L^2}{mr^3}$

PRM067

CONSERVATION OF ANGULAR MOMENTUM

65. A stone attached to one end of string is revolved around a stick so that the string winds upon the stick and gets shortened. What is conserved ?
(1) angular momentum
(2) linear momentum
(3) kinetic energy
(4) none of the above

PRM068

66. A rotating table completes one rotation in 10 sec. and its moment of inertia is 100 kg-m^2. A person of 50 kg. mass stands at the centre of the rotating table. If the person moves 2m from the centre, the angular velocity of the rotating table (in rad/sec). will be:
(1) $\frac{2\pi}{30}$ (2) $\frac{20\pi}{30}$ (3) $\frac{2\pi}{3}$ (4) 2π

PRM069

67. On melting of ice on the pole of the earth, its moment of inertia will :-
(1) increase
(2) decrease
(3) remain unchanged
(4) none of these

PRM070

68. If the earth loses its atmosphere suddenly, then the duration of day will :-
(1) increase
(2) decrease
(3) remain unchanged
(4) nothing can be definitely said

PRM071

69. A wheel is rotating about its axis at a constant angular velocity. If suddenly an object sticks to it on the rim, then its M.I. will :-
(1) increase
(2) decrease
(3) remain unchanged
(4) nothing can be said

PRM072

70. In the above question, the angular velocity will :–
(1) increase
(2) decrease
(3) not change
(4) nothing can be said

PRM073

71. An ant is sitting at the edge of a rotating disc. If the ant reaches the other end, after moving along the diameter, the angular velocity of the disc will:-
(1) remain constant
(2) first decreases and then increases
(3) first increases, then decrease
(4) Increase continuously

PRM074

72. The angular momentum of body remains conserved if :–
(1) applied force on body is zero.
(2) applied torque on body is zero.
(3) applied force on body is constant.
(4) applied torque on body is constant.

PRM075

73. A person is standing on the edge of a circular platform, which is moving with constant angular speed about an axis passing through its centre and perpendicular to the plane of platform. If person is moving along any radius towards axis of rotation then the angular velocity will :–
(1) decrease
(2) remain unchanged
(3) increase
(4) data is insufficient

PRM076

74. A thin circular ring of mass M and radius 'r' is rotating about its axis with a constant angular velocity ω. Four objects each of mass m, are kept gently to the opposite ends of two perpendicular diameters of the ring. The angular velocity of the ring will be:–
(1) $\frac{M\omega}{4m}$ (2) $\frac{M\omega}{M+4m}$
(3) $\frac{(M+4m)\omega}{M}$ (4) $\frac{(M+4m)\omega}{M+4m}$

PRM077

75. A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of discs is :–
(1) ω (2) $\frac{I_1\omega}{I_1+I_2}$
(3) $\frac{(I_1+I_2)\omega}{I_1}$ (4) $\frac{I_2\omega}{I_1+I_2}$

PRM078

76. Rate of change of angular momentum with respect to time is proportional to :–
(1) angular velocity
(2) angular acceleration
(3) moment of inertia
(4) torque

PRM079

77. A small steel sphere of mass m is tied to a string of length r and is whirled in a horizontal circle with a uniform angular velocity 2ω. The string is suddenly pulled, so that radius of the circle is halved. The new angular velocity will be
(1) 2ω (2) 4ω (3) 6ω (4) 8ω

PRM080

78. If the earth were to suddenly contract to half its present size, without any change in its mass, the duration of the new day will be
(1) 18 hours (2) 30 hours
(3) 6 hours (4) 12 hours
PRM081

79. A stone is attached to the end of a string and whirled in horizontal circle, then :–
(1) its linear and angular momentum are constant
(2) only linear momentum is constant
(3) its angular momentum is constant but linear momentum is variable
(4) both are variable
PRM082

PURE ROLLING AND KINETIC ENERGY

80. A thin rod of length L is suspended from one end and rotated with n rotations per second. The rotational kinetic energy of the rod will be :
(1) $2mL^2\pi^2n^2$ (2) $\frac{1}{2}mL^2\pi^2n^2$
(3) $\frac{2}{3}mL^2\pi^2n^2$ (4) $\frac{1}{6}mL^2\pi^2n^2$
PRM083

81. The rotational kinetic energy of a body is E. In the absence of external torque, if mass of the body is halved and radius of gyration doubled, then its rotational kinetic energy will be :-
(1) 0.5E (2) 0.25E (3) E (4) 2E
PRM084

82. A particle of mass m is describing a circular path of radius r with uniform speed. If L is the angular momentum of the particle (about the axis of the circle), then the kinetic energy of the particle is
(1) $\frac{L^2}{mr^2}$ (2) mr^2L (3) $\frac{L^2}{2mr^2}$ (4) $\frac{L^2r^2}{m}$
PRM085

83. A particle performs uniform circular motion with an angular momentum L. If the frequency of particle's motion is doubled and its kinetic energy halved, the angular momentum becomes
(1) 2L (2) 4L (3) $\frac{L}{2}$ (4) $\frac{L}{4}$
PRM086

84. A flywheel is making $\frac{3000}{\pi}$ revolutions per minute about its axis. If the moment of inertia of the flywheel about that axis is 400 kgm^2, its rotational kinetic energy is
(1) 2×10^6 J (2) 3×10^3 J
(3) $500\pi^2$ J (4) 12×10^3 J
PRM087

85. A ring is rolling without slipping. Its energy of translation is E. Its total kinetic energy will be :-
(1) E (2) 2E (3) 3E (4) 4E
PRM088

86. A thin hollow cylinder open at both ends slides without rotating and then rolls without slipping with the same speed. The ratio of the kinetic energies in the two cases is
(1) 1 : 1 (2) 1 : 2 (3) 2 : 1 (4) 1 : 4
PRM089

87. A solid sphere of mass M and radius R rolls on a horizontal surface without slipping. The ratio of rotational K.E. to total K.E. is :–
(1) $\frac{1}{2}$ (2) $\frac{3}{7}$ (3) $\frac{2}{7}$ (4) $\frac{2}{10}$
PRM090

88. A disc is rolling on an inclined plane without slipping then what fraction of its total energy will be in form of rotational kinetic energy :–
(1) 1 : 3 (2) 1 : 2 (3) 2 : 7 (4) 2 : 5
PRM091

89. A wheel is rolling along the ground with a speed of 2 m/s. The magnitude of the linear velocity of the points at the extremities of the horizontal diameter of the wheel is equal to
(1) $2\sqrt{10}$ m/s (2) $2\sqrt{3}$ m/s
(3) $2\sqrt{2}$ m/s (4) 2 m/s
PRM092

90. If rotational kinetic energy is 50% of total kinetic energy then the body will be :–
(1) ring (2) cylinder
(3) hollow sphere (4) solid sphere
PRM093

91. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K. If radius of the ball be R, then the fraction of total energy associated with its rotational energy will be :–

(1) $\frac{K^2+R^2}{R^2}$ (2) $\frac{K^2}{R^2}$

(3) $\frac{K^2}{K^2+R^2}$ (4) $\frac{R^2}{K^2+R^2}$

PRM094

92. If the angular velocity of a body rotating about an axis is doubled and its moment of inertia halved, the rotational kinetic energy will changed by a factor of :-

(1) 4 (2) 2 (3) 1 (4) 1/2

PRM095

93. If a sphere is rolling, the ratio of its rotational energy to the total kinetic energy is given by

(1) 7 : 10 (2) 2 : 5 (3) 10 : 5 (4) 2 : 7

PRM096

94. A person, with outstretched arms, is spinning on a rotating stool. He suddenly brings his arms down to his sides. Which of the following is true about system kinetic energy K and angular momentum L ?

(1) Both K and L increase.

(2) Both K and L remain unchanged.

(3) K remains constant, L increases.

(4) K increases but L remains constant.

PRM097

95. A uniform thin ring of mass 0.4 kg rolls without slipping on a horizontal surface with a linear velocity of 10 cm/s. The kinetic energy of the ring is :-

(1) 4×10^{-3} J (2) 4×10^{-2} J

(3) 2×10^{-3} J (4) 2×10^{-2} J

PRM098

96. A body is rotating with angular momentum L. If I is its moment of inertia about the axis of rotation, its kinetic energy of rotation is :-

(1) $\frac{1}{2}IL^2$ (2) $\frac{1}{2}IL$

(3) $\frac{1}{2}(I^2/L)$ (4) $\frac{L^2}{2I}$

PRM099

ROLLING MOTION ON AN INCLINED PLANE

97. A disc rolls down a plane of length L and inclined at angle θ, without slipping. Its velocity on reaching the bottom will be :-

(1) $\sqrt{\frac{4gL\sin\theta}{3}}$ (2) $\sqrt{\frac{2gL\sin\theta}{3}}$

(3) $\sqrt{\frac{10gL\sin\theta}{7}}$ (4) $\sqrt{4gL\sin\theta}$

PRM100

98. A spherical shell and a solid cylinder of same radius rolls down an inclined plane. The ratio of their accelerations will be:-

(1) 15 : 14 (2) 9 : 10

(3) 2 : 3 (4) 3 : 5

PRM101

99. A ring takes time t_1 and t_2 for sliding down and rolling down an inclined plane of length L respectively for reaching the bottom. The ratio of t_1 and t_2 is :-

(1) $\sqrt{2}:1$ (2) $1:\sqrt{2}$

(3) 1 : 2 (4) 2 : 1

PRM102

100. A solid sphere is rolling down on inclined plane from rest and a rectangular block of same mass is also slipping down simultaneously from rest on a similar smooth inclined plane.

(1) both of them will reach the bottom simultaneously

(2) the sphere will reach the bottom first

(3) the rectangular block will reach the bottom first.

(4) depends on density of material

PRM103

101. Calculate the ratio of the times taken by a uniform solid sphere and a disc of the same mass and the same diameter to roll down through the same distance from rest on a inclined plane.

(1) 15 : 14 (2) $\sqrt{15}:\sqrt{14}$

(3) $15^2 : 14^2$ (4) $\sqrt{14}:\sqrt{15}$

PRM104

102. A body of mass m slides down an incline and reaches the bottom with a velocity v. If the same mass were in the form of a ring which rolls down this incline, the velocity of the ring at the bottom would have been

(1) v (2) $v\sqrt{2}$

(3) $\frac{v}{\sqrt{2}}$ (4) $\left(\sqrt{\frac{2}{5}}\right)v$

PRM105

103. When a sphere of moment of inertia I rolls down on an inclined plane the percentage of total energy which is rotational, is approximately

(1) 28 % (2) 72 %

(3) 100 % (4) none of these

PRM106

104. When a body starts to roll on an inclined plane, its potential energy is converted into

(1) translational kinetic energy only

(2) translational and rotational kinetic energy

(3) rotational energy only

(4) none

PRM107

105. A solid cylinder of mass M and radius R rolls without slipping down an inclined plane of length L and height h. What is the speed of its centre of mass when the cylinder reaches its bottom :–

(1) $\sqrt{2gh}$ (2) $\sqrt{\frac{3}{4}gh}$

(3) $\sqrt{\frac{4}{3}gh}$ (4) $\sqrt{4gh}$

PRM108

106. Which of the following is true about the angular momentum of a cylinder rolling down a slope without slipping ?

(1) Its magnitude changes but the direction remains same

(2) both magnitude and direction change

(3) only the direction change

(4) neither change

PRM109

107. A sphere and a disc of same radii and mass are rolling on an inclined plane without slipping. a_s & a_d are acceleration and g is acceleration due to gravity. Then which statement is correct ?

(1) $a_s > a_d > g$ (2) $g > a_s > a_d$

(3) $a_s > g > a_d$ (4) $a_d > a_s > g$

PRM110

EXERCISE-I (Conceptual Questions) ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	4	2	1	4	4	1	2	2	2	1	3	3	3	4	2
Question	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Answer	3	4	4	1	2	2	1	3	1	2	2	2	2	2	4
Question	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Answer	2	4	4	2	3	2	2	1	2	3	2	2	2	4	1
Question	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Answer	2	1	3	3	1	4	3	1	4	1	1	1	3	4	3
Question	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Answer	3	1	3	4	1	1	1	2	1	2	3	2	3	2	2
Question	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Answer	4	4	3	3	3	1	3	4	1	2	2	3	1	3	1
Question	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Answer	3	2	4	4	1	4	1	2	2	3	4	3	1	2	3
Question	106	107													
Answer	1	2													

Exercise - II (Previous Year Questions) AIPMT/NEET

AIPMT 2014

1. A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions/s^2 is :-

(1) 25 N (2) 50 N
(3) 78.5 N (4) 157 N

PRM123

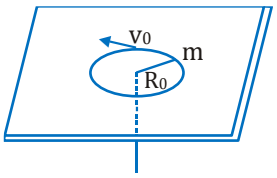
2. The ratio of the accelerations for a solid sphere (mass 'm' and radius 'R') rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is :-

(1) 5 : 7 (2) 2 : 3 (3) 2 : 5 (4) 7 : 5

PRM124

AIPMT 2015

3. A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to a string which passes through a smooth hole in the plane as shown.



The tension in the string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is :-

(1) $\frac{1}{4}mv_0^2$ (2) $2mv_0^2$ (3) $\frac{1}{2}mv_0^2$ (4) mv_0^2

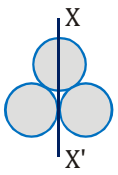
PRM125

4. A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at distance x from A. The normal reaction on A is :-

(1) $\frac{Wd}{x}$ (2) $\frac{W(d-x)}{x}$
(3) $\frac{W(d-x)}{d}$ (4) $\frac{Wx}{d}$

PRM126

5. Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX' which is touching to two shells and passing through diameter of third shell. Moment of inertia of the system consisting of these three spherical shells about XX' axis is :-



(1) 3 mr^2 (2) $\frac{16}{5}mr^2$
(3) 4 mr^2 (4) $\frac{11}{5}mr^2$

PRM127

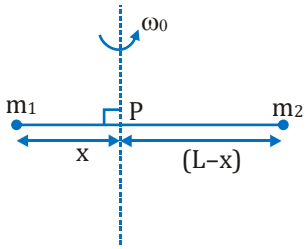
Re-AIPMT 2015

6. An automobile moves on a road with a speed of 54 km/h. The radius of its wheels is 0.45 m and the moment of inertia of the wheel about its axis of rotation is 3 kg-m^2. If the vehicle is brought to rest in 15s, the magnitude of average torque transmitted by its brakes to wheel is :-

(1) 2.86 kg-m^2/s^2 (2) 6.66 kg-m^2/s^2
(3) 8.58 kg-m^2/s^2 (4) 10.86 kg-m^2/s^2

PRM128

7. Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about an axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum, is given by :-



(1) $x=\frac{m_2L}{m_1+m_2}$ (2) $x=\frac{m_1L}{m_1+m_2}$
(3) $x=\frac{m_1}{m_2}L$ (4) $x=\frac{m_2}{m_1}L$

PRM129

8. A force $\vec{F}=\alpha\hat{i}+3\hat{j}+6\hat{k}$ is acting at a point $\vec{r}=2\hat{i}-6\hat{j}-12\hat{k}$. The value of α for which angular momentum about origin is conserved is :-

(1) 1 (2) –1 (3) 2 (4) zero

PRM130

NEET-I 2016

9. From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre ?

(1) 15 MR²/32 (2) 13 MR²/32

(3) 11 MR²/32 (4) 9 MR²/32

PRM131

10. A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad/s². Its net acceleration in m/s² at the end of 2.0 s is approximately :

(1) 8.0 (2) 7.0 (3) 6.0 (4) 3.0

PRM132

11. A disc and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first ?

(1) Disk

(2) Sphere

(3) Both reach at the same time

(4) Depends on their masses

PRM133

NEET-II 2016

12. Two rotating bodies A and B of masses m and 2m with moments of inertia I_A and I_B ($I_B > I_A$) have equal kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then :-

(1) $L_B > L_A$ (2) $L_A > L_B$

(3) $L_A = \frac{L_B}{2}$ (4) $L_A = 2L_B$

PRM134

13. A solid sphere of mass m and radius R is rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation (E_{sphere} / $E_{cylinder}$) will be :-

(1) 1 : 4 (2) 3 : 1

(3) 2 : 3 (4) 1 : 5

PRM135

14. A light rod of length ℓ has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is :-

(1) $(m_1 + m_2)\ell^2$ (2) $\sqrt{m_1 m_2}\,\ell^2$

(3) $\frac{m_1 m_2}{m_1 + m_2}\ell^2$ (4) $\frac{m_1 + m_2}{m_1 m_2}\ell^2$

PRM136

NEET(UG) 2017

15. A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N ?

(1) 0.25 rad/s² (2) 25 rad/s²

(3) 5 m/s² (4) 25 m/s²

PRM137

16. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is:-

(1) $\frac{1}{4}I(\omega_1-\omega_2)^2$ (2) $I(\omega_1-\omega_2)^2$

(3) $\frac{I}{8}(\omega_1-\omega_2)^2$ (4) $\frac{1}{2}I(\omega_1+\omega_2)^2$

PRM138

17. Which of the following statements are **correct** ?
(a) Centre of mass of a body always coincides with the centre of gravity of the body
(b) Centre of mass of a body is the point at which the total gravitational torque on the body is zero
(c) A couple on a body produce both translational and rotation motion in a body
(d) Mechanical advantage greater than one means that small effort can be used to lift a large load
(1) (a) and (b) (2) (b) and (c)
(3) (c) and (d) (4) (b) and (d)

PRM139

NEET (UG) 2018

18. Three objects, A : (a solid sphere), B : (a thin circular disk) and C = (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation :-
(1) $W_C > W_B > W_A$ (2) $W_A > W_B > W_C$
(3) $W_B > W_A > W_C$ (4) $W_A > W_C > W_B$

PRM140

19. The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at (2, 0, –3), about the point (2, –2, –2), is given by:-
(1) $-8\hat{i} - 4\hat{j} - 7\hat{k}$ (2) $-4\hat{i} - \hat{j} - 8\hat{k}$
(3) $-7\hat{i} - 8\hat{j} - 4\hat{k}$ (4) $-7\hat{i} - 4\hat{j} - 8\hat{k}$

PRM141

20. A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio $K_t : (K_t + K_r)$ for the sphere is
(1) 7 : 10 (2) 5 : 7 (3) 10 : 7 (4) 2 : 5

PRM142

21. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere ?
(1) Angular velocity
(2) Moment of inertia
(3) Rotational kinetic energy
(4) Angular momentum

PRM143

NEET(UG) 2019

22. A disc of radius 2m and mass 100 kg rolls on a horizontal floor. Its centre of mass has speed of 20 cm/s. How much work is needed to stop it ?
(1) 3J (2) 30 kJ (3) 2 J (4) 1 J

PRM144

23. A solid cylinder of mass 2 kg and radius 4 cm is rotating about its axis at the rate of 3 rpm. The torque required to stop after 2π revolutions is :
(1) 2×10^{-6} N m (2) 2×10^{-3} N m
(3) 12×10^{-4} N m (4) 2×10^{6} N m

PRM145

NEET(UG) 2019 (Odisha)

24. A solid cylinder of mass 2 kg and radius 50 cm rolls up an inclined plane of angle inclination 30°. The centre of mass of cylinder has speed of 4 m/s. The distance travelled by the cylinder on the incline surface will be : (Take g = 10 m/s^2)
(1) 2.2 m (2) 1.6 m
(3) 1.2 m (4) 2.4 m

PRM146

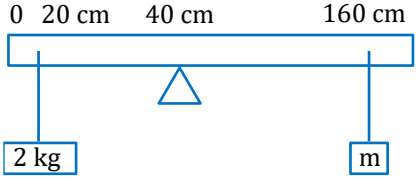
NEET(UG) 2020

25. Find the torque about the origin when a force of $3\hat{j}$ N acts on a particle whose position vector is $2\hat{k}$ m :
(1) $6\hat{k}$ Nm (2) $6\hat{i}$ Nm
(3) $6\hat{j}$ Nm (4) $-6\hat{i}$ Nm

PRM147

NEET(UG) 2021

26. A uniform rod of length 200 cm and mass 500 g is balanced on a wedge placed at 40 cm mark. A mass of 2 kg is suspended from the rod at 20 cm and another unknown mass 'm' is suspended from the rod at 160 cm mark as shown in the figure. Find the value of 'm' such that the rod is in equilibrium. (g= 10 m/s^2)



(1) $\frac{1}{2}$kg (2) $\frac{1}{3}$kg
(3) $\frac{1}{6}$kg (4) $\frac{1}{12}$kg

PRM148

27. From a circular ring of mass 'M' and radius 'R' an arc corresponding to a 90° sector is removed. The moment of inertia of the remaining part of the ring about an axis passing through the centre of the ring and perpendicular to the plane of the ring is 'K' times 'MR²'. Then the value of 'K' is :

(1) $\frac{3}{4}$ (2) $\frac{7}{8}$ (3) $\frac{1}{4}$ (4) $\frac{1}{8}$

PRM149

NEET(UG) 2022

28. The ratio of the radius of gyration of a thin uniform disc about an axis passing through its centre and normal to its plane to the radius of gyration of the dis about its diameter is :

(1) $\sqrt{2}:1$ (2) 4 : 1 (3) $1:\sqrt{2}$ (4) 2 : 1

PRM150

RE-NEET(UG) 2022

29. An energy of 484 J is spent in increasing the speed of a flywheel from 60 rpm to 360 rpm. The moment of inertia of the flywheel is :

(1) 0.7 kg-m² (2) 3.22 kg-m²
(3) 30.8 kg-m² (4) 0.07 kg-m²

PRM151

NEET(UG) 2023

30. The ratio of radius of gyration of a solid sphere of mass M and radius R about its own axis to the radius of gyration of the thin hollow sphere of same mass and radius about its axis is :-

(1) $\sqrt{5}:\sqrt{3}$ (2) $\sqrt{2}:\sqrt{5}$
(3) $\sqrt{5}:\sqrt{2}$ (4) $\sqrt{3}:\sqrt{5}$

PRM164

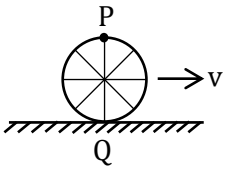
NEET(UG) 2024

31. The moment of inertia of a thin rod about an axis passing through its mid point and perpendicular to the rod is 2400 g cm². The length of the 400 g rod is nearly :

(1) 8.5 cm (2) 17.5 cm
(3) 20.7 cm (4) 72.0 cm

PRM165

32. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively) ?

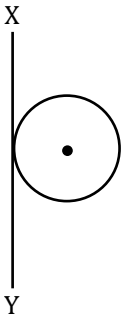


(1) Point P moves slower than point Q.
(2) Point P moves faster than point Q.
(3) Both the points P and Q move with equal speed.
(4) Point P has zero speed.

PRM166

RE-NEET(UG) 2024

33. The radius of gyration of a solid sphere of mass 5 kg about XY is 5m as shown in figure. The radius of the sphere is $\frac{5x}{\sqrt{7}}$ m, then the value of x is:



(1) 5 (2) $\sqrt{2}$ (3) $\sqrt{3}$ (4) $\sqrt{5}$

PRM167

EXERCISE-II (Previous Year Questions) ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	4	1	2	3	3	2	1	2	2	1	2	1	4	3	2
Question	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Answer	1	4	1	4	2	4	1	1	4	4	4	1	1	1	4
Question	31	32	33												
Answer	1	2	4												

Exercise - III (Analytical Questions) Master Your Understanding

1. Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A) : Moment of inertia of a particle is a scalar quantity.

Reason (R) : Moment of inertia of a particle about any axis is given by $m(\vec{r}\cdot\vec{r})$ where m is mass of particle and $\vec{r}$ is position of particle w.r.t. axis.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

(2) Both **(A)** and **(R)** are true and **(R)** is NOT the correct explanation of **(A)**.

(3) **(A)** is true but **(R)** is false.

(4) **(A)** is false but **(R)** is true.

PRM152

2. Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A) : Moment of inertia of a disc about an axis perpendicular to its plane passing through its centre is $\frac{mR^2}{2}$

Reason (R) : Moment of inertia of a disc about any axis passing through its plane remains equal.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

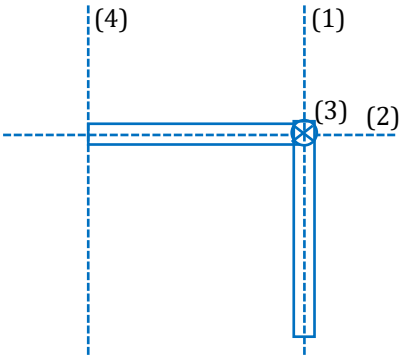
(2) Both **(A)** and **(R)** are true and **(R)** is NOT the correct explanation of **(A)**.

(3) **(A)** is true but **(R)** is false.

(4) **(A)** is false but **(R)** is true.

PRM153

3. In diagram axis (3) is perpendicular to plane. Both rods are mass m and length 'ℓ' then moment of inertial of system



i	About axis (1)	P	$\frac{m\ell^2}{3}$
ii	About axis (2)	Q	$\frac{4m\ell^2}{3}$
iii	About axis (3)	R	$\frac{2m\ell^2}{3}$
iv	About axis (4)		

(1) i – P, ii – P, iii – R, iv – Q

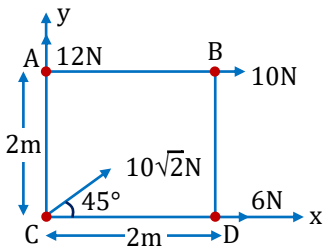
(2) i – Q, ii – Q, iii – P, iv – R

(3) i – R, ii – R, iii – P, iv – Q

(4) i – P, ii – R, iii – Q, iv – P

PRM155

4. Value of net torque about given points.



i	Torque about A	P	$-64\hat{k}$
ii	Torque about B	Q	$32\hat{k}$
iii	Torque about C	R	$-12\hat{k}$
iv	Torque about D	S	$-20\hat{k}$

(1) i – P, ii – Q, iii – R, iv – S

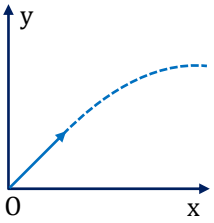
(2) i – Q, ii – P, iii – P, iv – S

(3) i – Q, ii – R, iii – S, iv – P

(4) i – R, ii – S, iii – P, iv – S

PRM156

5. A particle is projected from point 'O' having mass 'm' as shown in figure, moving on projectile path



i	Torque about 'O'	P	Zero
ii	Torque about x-axis	Q	Constant non zero
iii	Angular momentum about O	R	Increasing
iv	Angular momentum about x-axis	S	Decreasing

(1) i – P, ii – Q, iii – R, iv – S
(2) i – R, ii – P, iii – R, iv – P
(3) i – Q, ii – R, iii – R, iv – P
(4) i – P, ii – R, iii – R, iv – S

PRM157

6. Four identical rods each of mass m and length 'ℓ' are joined to form a rigid square, centre is at origin and sides are parallel to x and y axis then moment of inertia about

i	An axis parallel to z-axis and passing through a corner	P	$\frac{5}{3}m\ell^2$
ii	One side	Q	$\frac{2}{3}m\ell^2$
iii	The x-axis	R	$\frac{4}{3}m\ell^2$
iv	The z-axis passing through centre	S	$\frac{10}{3}m\ell^2$

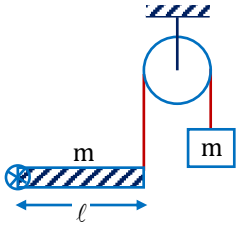
(1) i – S, ii – P, iii – Q, iv – R
(2) i – P, ii – Q, iii – R, iv – S
(3) i – Q, ii – R, iii – p, iv – S
(4) i – S, ii – P, iii – R, iv – Q

PRM158

7. If lamina is in x-y plane then from theorem of perpendicular axis
(A) $I_x - I_y = I_z$
(B) $I_x - I_z = I_y$
(C) $I_x + I_y = I_z$
(D) $I_y + I_z = I_x$
True statements is/are –
(1) B and C
(2) Only D
(3) Only C
(4) C and D

PRM160

8. Hinge is smooth and system is released from rest. Select correct statement –



(A) Acceleration of block is g/2 down ward
(B) Acceleration of block is 3g/8 down ward
(C) Tension in string is mg/2
(D) Tension in string is 5mg/8
True statements is/are
(1) A, C
(2) A, D
(3) B, C
(4) B, D

PRM161

EXERCISE-III (Analytical Questions) ANSWER KEY

Question	1	2	3	4	5	6	7	8
Answer	1	3	1	3	2	1	3	4

Important Notes