Jupiter Academy

Subjects : Physics **PRACTICE PAPER 05**

Total Marks : 180

Physics - Section A (MCQ)

1. Two rings of same mass and radius R are placed with their planes perpendicular to each other and centres at a common point. The radius of gyration of the system about an axis passing through the centre and perpendicular to the plane of one ring is .....

A) $2R$ **B)** $\frac{R}{\sqrt{2}}$
C) $\sqrt{\frac{3}{2}}R$ **D)** $\frac{\sqrt{3}R}{2}$

2. Consider the following statements
Assertion (A) : The moment of inertia of a rigid body reduces to its minimum value as compared to any other parallel axis when the axis of rotation passes through its centre of mass.
Reason (R): The weight of a rigid body always acts through its centre of mass in uniform gravitational field. Of these statements:

A) both A and R are true and R is the correct explanation of A
B) both A and R are true but R is not a correct explanation of A
C) A is true but R is false
D) A is false but R is true

3. The moment of inertia of semicircular ring about its centre is

A) MR^2 **B)** $\frac{MR^2}{2}$
C) $\frac{MR^2}{4}$ **D)** None of these

4. Two men are carrying a uniform bar of length L, on their shoulders. The bar is held horizontally such that younger man gets $(1/4)^{th}$ load. Suppose the younger man is at the end of the bar, what is the distance of the other man from the end

A) $L/3$ **B)** $L/2$ **C)** $2L/3$ **D)** $3L/4$

5. The coordinates of the positions of particles of mass $7,\ 4\text{and}10\ gm$ are $(1,\ 5,\ -3),\ (2,\ 5, 7)$ and $(3, 3,\ -1)\ cm$ respectively. The position of the centre of mass of the system would be

A) $\left(-\frac{15}{7}, \frac{85}{17}, \frac{1}{7}\right) cm$ **B)** $\left(\frac{15}{7}, -\frac{85}{17}, \frac{1}{7}\right) cm$
C) $\left(\frac{15}{7}, \frac{85}{21}, -\frac{1}{7}\right) cm$ **D)** $\left(\frac{15}{7}, \frac{85}{21}, \frac{7}{3}\right) cm$

6. The moment of inertia of a thin circular lamina of mass $1\ kg$ and diameter $0.2\ metre$ rotating about one of its diameter is

A) $5 \times 10^{-3}\ kg - m^2$
B) $2.5 \times 10^{-3}\ kg - m^2$
C) $4 \times 10^{-2}\ kg - m^2$
D) $0.2\ kg - m^2$

7. If $I = 50\ kg - m^2$, then ..... $N - m$ torque will be applied to stop it in $10\ sec$. Its initial angular speed is $20\, rad/sec$

A) 100 **B)** 150 **C)** 200 **D)** 250

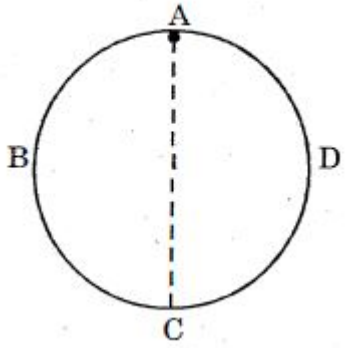
8. Two circular discs $\sqrt{2gh}$ and B are of equal masses and thickness but made of metals with densities d_A and d_B $(d_A > d_B)$. If their moments of inertia about an axis passing through centres and normal to the circular faces be I_A and I_B, then

A) $I_A = I_B$
B) $I_A > I_B$
C) $I_A < I_B$
D) $I_A >=< I_B$

9. The velocity of the centre of mass of a rigid rod with respect to an observer O is $\vec{v} = \left(2\hat{i} + 3\hat{j}\right) ms^{-1}$. The rod has an angular velocity about its centre of mass given by $\vec{\omega} = \left(3\hat{j} + 4\hat{k}\right) s^{-1}$. Let A be a point on the rod with position vector $2\left(\hat{i} + \hat{k}\right) m$ with respect to the centre of mass. The velocity of the point A with respect to O is

A) $6\hat{i} + 11\hat{j} + 6\hat{k}$ **B)** $8\hat{i} + 11\hat{j} - 6\hat{k}$
C) $6\hat{i} - 11\hat{j} + 12\hat{k}$ **D)** $8\hat{i} + 11\hat{j} - 8\hat{k}$

10. A ring is formed by joining two uniform semi circular rings ABC and ADC. Mass of ABC is thrice of that of ADC. If the ring is hinged to a fixed support ,at A, it can rotate freely in a vertical plane. Find the value of $tan\,\theta$, where θ is the angle made. by the line AC with the vertical in equilibrium



A) $\frac{9\pi}{4}$ **B)** $\frac{1}{\pi}$ **C)** $\frac{2}{3\pi}$ **D)** π

11. A rod of mass m and length l is placed on smooth floor pivoted at its centre. A gun is mounted at one end, of mass m without a shot. It fires a shot of mass $\frac{m}{10}$ with velocity v relative to gun. The angular velocity of the rod will be

A) $\frac{6}{23}\frac{v}{l}$ **B)** $\frac{6}{43}\frac{v}{l}$
C) $\frac{3}{23}\frac{v}{l}$ **D)** $\frac{7}{23}\frac{v}{l}$

12. A body is rolling down an inclined plane. If kinetic energy of rotation is 40% of translational kinetic energy, then the body is a

A) Ring **B)** Cylinder
C) Hollow ball **D)** Solid ball

13. The angular momentum of a flywheel having a moment of inertia of $0.4\,kg\,m^2$ decreases from 30 to $20\ kg\ m^2/s$ in a period of 2 second . The average torque acting on the flywheel during this period is ..... $N.m$

A) 10 **B)** 2.5 **C)** 5 **D)** 1.5

14. For a system to be in equilibrium, the torques acting on it must balance. This is true only if the torques are taken about

A) The centre of the system
B) The centre of mass of the system
C) Any point on the system
D) Any point on the system or outside it

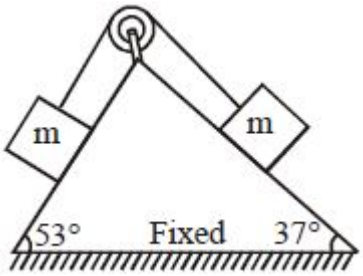
15. Two blocks of masses $5\ kg$ and $2\ kg$ are connected by a spring of negilible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of $7\ m/s$ to the heavier block in the direction of the lighter block. The velocity of the centre of mass is ..... m/s

A) 30 **B)** 20 **C)** 10 **D)** 5

16. A solid cylinder is rolling down on an inclined plane of angle θ. The coefficient of static friction between the plane and the cylinder is μ_s. The condition for the cylinder not to slip is

A) $\tan\theta \geq 3\,\mu_s$
B) $\tan\theta > 3\,\mu_s$
C) $\tan\theta \leq 3\,\mu_s$
D) $\tan\theta < 3\,\mu_s$

17. Two blocks which are connected to each other by means of a massless string are placed on two inclined planes as shown in figure. After releasing from rest, the magnitude of acceleration of the centre of mass of both the blocks is $(g = 10\,m/s^2)$

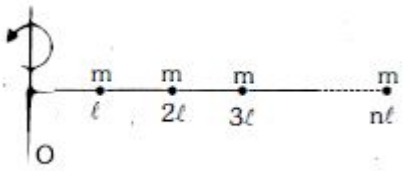


A) $1\,m/s^2$ **B)** $\frac{1}{\sqrt{2}}\,m/s^2$
C) $\sqrt{2}\,m/s^2$ **D)** Zero

18. Consider a particle of mass m having linear momentum $\vec{p}$ at position $\vec{r}$ relative to the origin O . Let $\vec{L}$ be the angular momentum of the particle with respect the origin. Which of the following equations correctly relate $(s)\ \vec{r}$, $\vec{p}$ and $\vec{L}$?

A) $\frac{d\vec{L}}{dt} + \vec{r} \times \frac{\vec{dp}}{dt} = 0$
B) $\frac{d\vec{L}}{dt} + \frac{\vec{dr}}{dt} \times \vec{p} = 0$
C) $\frac{d\vec{L}}{dt} - \frac{\vec{dr}}{dt} \times \vec{p} = 0$
D) $\frac{d\vec{L}}{dt} - \vec{r} \times \frac{\vec{dp}}{dt} = 0$

19. Find moment of inertia about axis OA

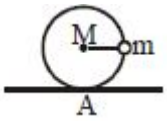


A) $\frac{ml^2}{6}$
B) $\frac{ml^2}{6}n\,(n+1)\,(2n+1)$
C) zero
D) $ml^2\frac{n(n+1)}{2}$

20. The variation of density of a cylindrical thick and long rod, is $\rho = \rho_0\frac{x^2}{L^2}$, then position of its centre of mass from $x = 0$ end is

A) $2L/3$ **B)** $L/2$ **C)** $L/3$ **D)** $3L/4$

21. A uniform body of mass M radius R has a small mass m attached at edge as shown in the figure. The system is placed on a perfectly rough horizontal surface such that mass m is at the same horizontal level as the centre of body. It is assumed that there is no slipping at point A. If I_A is the moment of the inertia of combined system about point of contact A then the normal reaction at point A just after the system is released from rest is ..... N. ($M = 6\ kg$, $m = 2\ kg$, $I_A = 4\ kg\ m^2$, $R = 1\ m$, $g = 10\ m/s^2$)

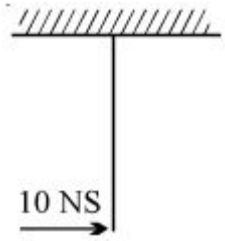


A) 60 **B)** 80 **C)** 75 **D)** 70

22. If a person sitting on a rotating stool with his hands outstretched, suddenly lowers his hands, then his

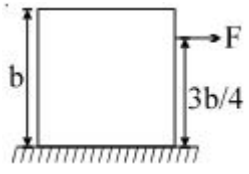
A) Kinetic energy will decrease
B) Moment of inertia will decrease
C) Angular momentum will increase
D) Angular velocity will remain constant

23. A thin uniform straight rod of mass $2\ kg$ and length $1\ m$ is free to rotate about its upper end when at rest. It receives an impulsive blow of $10\ Ns$ at its lowest point, normal to its length as shown in figure. The kinetic energy of rod just after impact is ..... J



A) 75 **B)** 100 **C)** 200 **D)** none

24. A uniform cube of side 'b' and mass M rest on a rough horizontal table.A horizontal force F is applied normal to one of the face at a point, at a height $3b/4$ above the base. What should be the coefficient of friction (μ) between cube and table so that is will tip about an edge before it starts slipping?



A) $\mu > \frac{2}{3}$ **B)** $\mu > \frac{1}{3}$
C) $\mu > \frac{3}{2}$ **D)** none

25. A solid uniform disk of mass m rolls without slipping down a fixed inclined plane with an acceleration a. The frictional force on the disk due to surface of the plane is :

A) $2\,ma$ **B)** $3/2\,ma$
C) ma **D)** $1/2\,ma$

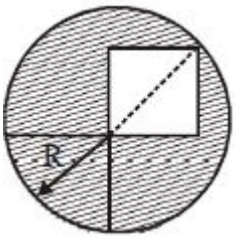
26. Two semicircular rings of linear mass densities λ and 3λ and of radius R each are joining to form a complete ring. The distance of the centre of the mass of complete ring from its geometrical centre is

A) $\frac{2R}{3\pi}$ **B)** $\frac{R}{\pi}$
C) $\frac{2R}{\pi}$ **D)** $\frac{R}{3\pi}$

27. Two spheres of masses $2M$ and M are initially at rest at a distance R apart. Due to mutual force of attraction they approach each other. When they are at separation $R/2$, the acceleration of the centre of mass of sphere would be ..... gm/s^2

A) 0 **B)** 1 **C)** 3 **D)** 12

28. From a circular disc of radius R, a square is cut out with a radius as its diagonal. The center of mass of remainder part is at a distance (from the centre)



A) $\frac{R}{(4\pi-2)}$ **B)** $\frac{R}{2\pi}$
C) $\frac{R}{(\pi-2)}$ **D)** $\frac{R}{(2\pi-2)}$

29. A particle is moving along a straight line with increasing speed. Its angular momentum about a fixed point on this line

A) Goes on increasing
B) Goes on decreasing
C) May be increasing or decreasing depending on direction of motion
D) Remains zero

30. Suppose all the people in the world line up at the equator and all start running at speed v_{rel} relative to surface of earth along equatorial circle. Initial angular velocity of earth $= \omega_0$. Moment of inertia of earth I_E, moment of inertia of all people $= I_P$, radius of earth $= R$:

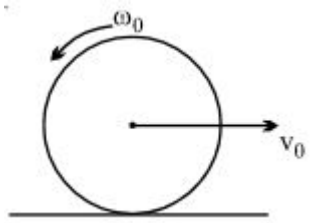
A) There will be no change in angular velocity of rotation of earth.

B) If people run due east change in angular velocity of earth will be $\omega_0 - \frac{I_p v_{rel}}{(I_p+I_E)R}$

C) If people run due west change in angular velocity of earth will be $\omega_0 - \frac{I_p v_{rel}}{(I_p+I_E)R}$

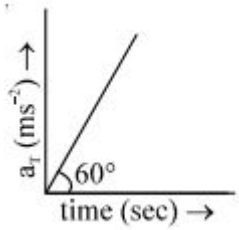
D) If people run due west change in angular velocity of earth will be $\omega_0 - \frac{I_p v_{rel}}{(I_p-I_E)R}$

31. A uniform circular disc placed on a rough horizontal surface has initially a velocity v_0 and an angular velocity ω_0 as shown in the figure. The disc comes to rest after moving some distance in the direction of motion. Then $\frac{v_0}{r\omega_0}$ is



A) $\frac{1}{2}$ **B)** 1 **C)** $\frac{3}{2}$ **D)** 2

32. Tangential acceleration of a particle moving in a circle of radius $1\ m$ varies with time t as (initial velocity of particle is zero). Time after which total acceleration of particle makes and angle of 30^o with radial acceleration is



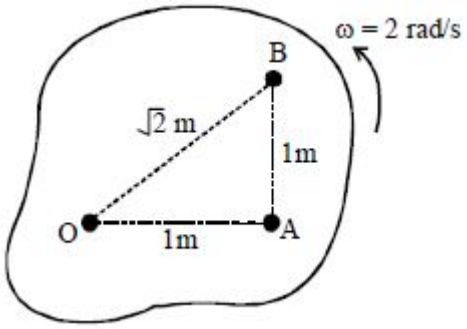
A) $4\ sec$ **B)** $4/3\ sec$

C) $2^{2/3}\ sec$ **D)** $\sqrt{2}$ sec

33. A rope is wound round a hollow cylinder of mass $5\ kg$ and radius $0.5\ m$. ..... rad/s^2 is the angular acceleration of the cylinder if the rope is pulled with a force of $20\ N$?

A) 4 **B)** 5 **C)** 6 **D)** 8

34. A rigid lamina is rotating about an axis passing perpendicular to its plane through point O as shown in figure. The angular velocity of point B w.r.t A is ..... rad/s.



A) 1 **B)** 2 **C)** 3 **D)** 4

35. If a force $10\hat{i} + 15\hat{j} + 25\hat{k}$ acts on a system and gives an acceleration $2\hat{i} + 3\hat{j} - 5\hat{k}$ to the centre of mass of the system, the mass of the system is

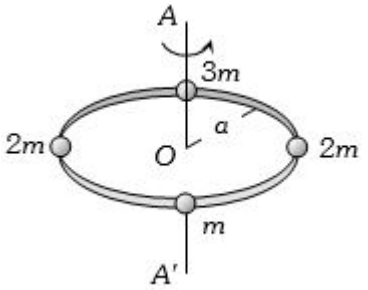
A) $5\ units$

B) $\sqrt{38}\ units$

C) $5\sqrt{38}\ units$

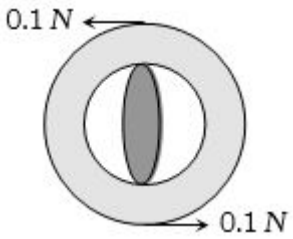
D) given data is not correct

36. Four masses are joined to a light circular frame as shown in the figure. The radius of gyration of this system about an axis passing through the centre of the circular frame and perpendicular to its plane would be



A) $a/\sqrt{2}$ **B)** $a/2$ **C)** a **D)** $2a$

37. Part of the tuning arrangement of a radio consists of a wheel which is acted on by two parallel constant forces as shown in the fig. If the wheel rotates just once, the work done will be about (diameter of the wheel = $0.05\ m$)



A) $0.062\ J$ **B)** $0.031\ J$

C) $0.015\ J$ **D)** $0.057\ J$

38. A body is rolling without slipping on a horizontal plane. If the rotational energy of the body is 40% of the total kinetic energy, then the body might be

A) Cylinder **B)** Hollow sphere

C) Solid cylinder **D)** ring

39. Two objects of masses $200\ gm$ and $500\ gm$ possess velocities $10\hat{i}m/s$ and $3\hat{i} + 5\hat{j}m/s$ respectively. The velocity of their centre of mass in m/s is

A) $5\hat{i} - 25\hat{j}$ **B)** $\frac{5}{7}\hat{i} - 25\hat{j}$

C) $5\hat{i} + \frac{25}{7}\hat{j}$ **D)** $25\hat{i} - \frac{5}{7}\hat{j}$

40. A man spinning in free space changes the shape of his body, $eg.$ by spreading his arms or curling up. By doing this, he can change his

A) moment of inertia
B) rotational kinetic energy
C) angular velocity
D) All of the above

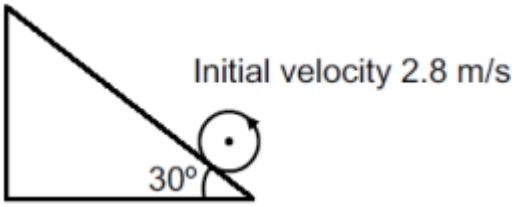
41. On a solid sphere lying on a horizontal surface a force F is applied at a height of $R/2$ from the centre of mass. The initial acceleration of a point at the top of the sphere is (there is no slipping at any point)

A) $\frac{15F}{7M}$ **B)** $\frac{15F}{14M}$
C) $\frac{30F}{7M}$ **D)** $\frac{F}{M}$

42. The angular velocity of a body is $\vec{\omega} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and a torque $\vec{\tau} = \hat{i} + 2\hat{j} + 3\hat{k}$ acts on it. The rotational power will be ..... W

A) 20 **B)** 15 **C)** $\sqrt{17}$ **D)** $\sqrt{14}$

43. A sphere pure rolls on a rough inclined plane with initial velocity $2.8\ m/s$. Find the maximum distance on the inclined plane. (in m)



A) 2.74 **B)** 5.48 **C)** 1.38 **D)** 3.2

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

A) its magnitude changes but the direction remains same
B) both magnitude and direction change
C) only the direction change
D) neither change

45. If a solid sphere of mass $1\ kg$ and radius $0.1\ m$ rolls without slipping at a uniform velocity of $1\ m/s$ along a straight line on a horizontal floor, the kinetic energy is

A) $\frac{7}{5}\ J$ **B)** $\frac{2}{5}\ J$
C) $\frac{7}{10}\ J$ **D)** $1\ J$