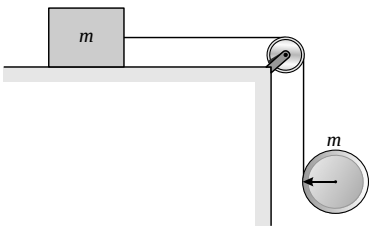
JEE Main Level Practice Test-5

Topic : RIGID BODY DYNAMICS Time: 75Min Marking +4 –1

Section - A : MCQs with Single Option Correct

1. A light thread is wound on a disk of mass m and other end of thread is connected to a block of mass m, which is placed on a rough ground as shown in diagram. Find the minimum value of coefficient of friction for which block remain at rest :



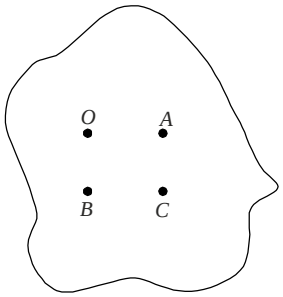
(A) $\frac{1}{3}$

(B) $\frac{1}{4}$

(C) $\frac{1}{2}$

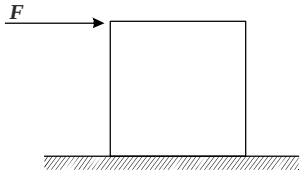
(D) $\frac{1}{5}$

2. O is the centre of mass of a body of mass M as shown in the figure A, B, C are three different point on the body, such that OABC is a rectangle. OB = 8 cm, OC = 10 cm, BC = 6 cm and OA = 10 cm. Which of the following can be written by using parallel axis theorem? I_0 is the moment of inertia about the axis passing through point O and perpendicular to plane of object :



(A) $I_B = I_C + M(BC)^2$ (B) $I_C = I_B + M(BC)^2$ (C) $I_A = I_0 + M(OB)^2$ (D) None of these

3. A force F is applied on the top of a cube as shown in the figure. The coefficient of friction between the cube and ground is μ. If F is gradually, the cube will topple before sliding if :



(A) $\mu > 1$ (B) $\mu < \frac{1}{2}$

(C) $\mu > \frac{1}{2}$ (D) $\mu < 1$

4. A bead is connected with a fixed disc of radius R by an inextensible massless string of length $l = \frac{\pi R}{2}$ in a smooth horizontal plane. If the bead is pushed with a velocity v_0 perpendicular to the string, the bead moves in a horizontal curve, and consequently collapses on the disc after a time t. Then :

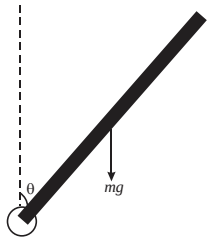
(A) Work done by the string on the bead is mv_0^2

(B) The average speed of the bead is v_0 and its average velocity for time t is $\frac{4v_0}{\pi}$

(C) Tension in the string will increase continuously

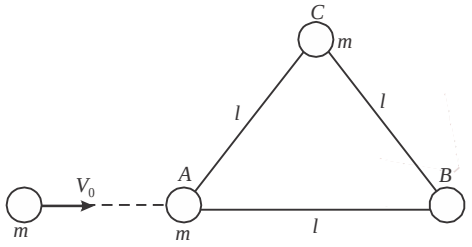
(D) Kinetic energy of the bead increases gradually

5. A uniform rod of length L and mass M is pivoted freely at one end and released as shown. The angular acceleration of the rod and the tangential linear acceleration of the free end when the rod is horizontal are :



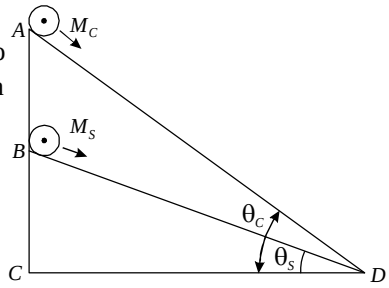
(A) $3g/2L, 3g/2$ (B) $3g/2L, g$ (C) $g/2L, g/2$ (D) $6g/L, 6g$

6. Three (A, B, C) particle each of mass m are connected by three mass-less rod of length l. All three particle lies on smooth horizontal plane. A particle of same mass m moving along one of the rod with velocity v_0 strikes on a particle and stops as shown in diagram. Angular velocity of each particle after collision is :



(A) $\frac{V_0}{\sqrt{3}l}$ (B) $\frac{V_0}{l}$ (C) $\frac{V_0}{2\sqrt{3}l}$ (D) $\frac{V_0}{3\sqrt{3}l}$

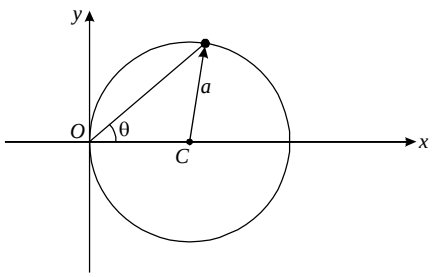
7. A cylinder of mass M_C and sphere of mass M_S are placed at point A and B of two inclines, respectively (See figure). If they roll on the incline without slipping such that their acceleration are the same, then the ratio $\frac{\sin\theta_C}{\sin\theta_S}$ is :



(A) $\sqrt{\frac{8}{7}}$ (B) $\sqrt{\frac{15}{14}}$

(C) $\frac{8}{7}$ (D) $\frac{15}{14}$

8. A particle of mass m is moving in a circular path of radius a, with a constant velocity v as shown in the figure. The centre of circle is marked by 'C'. The angular momentum from the origin O can be written as :



(A) $mva\,(1 + \cos 2\theta)$

(B) $mva\,(1 + \cos\theta)$

(C) $mva\cos 2\theta$

(D) mva

9. From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its center and perpendicular to one of its faces is :

(A) $\frac{MR^2}{32\sqrt{2}\pi}$ (B) $\frac{MR^2}{16\sqrt{2}\pi}$ (C) $\frac{4MR^2}{9\sqrt{3}\pi}$ (D) $\frac{4MR^2}{3\sqrt{3}\pi}$

10. A uniform solid cylindrical roller of mass m is being pulled on a horizontal surface with force F parallel to the surface and applied at its centre. If the acceleration of the cylinder is a and it rolling without slipping then the value of F' is :

(A) ma (B) $\frac{5}{3}ma$ (C) $\frac{3}{2}ma$ (D) $2ma$

11. A particle of mass 2 kg is on a smooth horizontal table and moves in a circular path of radius 0.6 m. The height of the table from the ground is 0.8 m. If the angular speed of the particle is 12 rad s^{-1}, the magnitude of its angular momentum about a point on the ground right under the centre of the circle is :

(A) 14.4 kg m^2 s^{-1} (B) 8.64 kg m^2 s^{-1} (C) 0.16 kg m^2 s^{-1} (D) 11.52 kg m^2 s^{-1}

12. Consider a thin uniform square sheet made of a rigid material. If its side is a mass m and moment of inertia I about one of its diagonals, then :

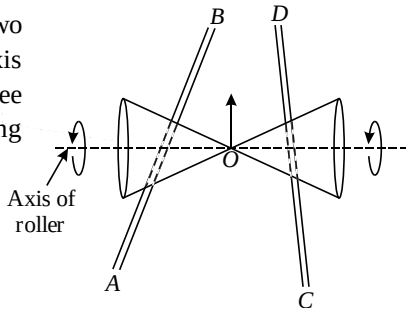
(A) $I > \frac{ma^2}{12}$ (B) $\frac{ma^2}{24} < I < \frac{ma^2}{12}$ (C) $I = \frac{ma^2}{24}$ (D) $I = \frac{ma^2}{12}$

13. A rod is projected such that it is rotating about its c.m. During its flight its flight its angular velocity :

(A) During ascent decreases (B) During decent decreases

(C) During ascent increases (D) Remain same

14. A roller is made by joining together two cones at their vertices O. It is kept on two rails AB and CD, which are placed asymmetrically (see figure), with its axis perpendicular to CD and its centre O at the centre of line joining AB and CD (see figure). It is given a light push so that its starts rolling with its centre O moving parallel to CD in the direction shown. As it moves, the roller will tend to :



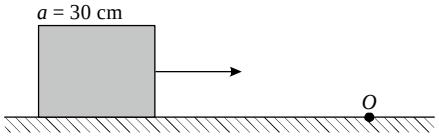
(A) Go straight

(B) Turn left and right alternately

(C) Turn left

(D) Turn right

15. A cubical block of side 30 cm is moving with velocity 2 ms^{-1} on a smooth horizontal surface. The surface has a ridge at a point O as shown in figure. The angular velocity(in rad/s) of the block immediately after it hits the bump, is :

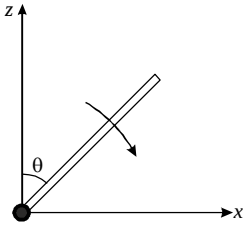


(A) 13.3 (B) 5.0 (C) 9.4 (D) 6.7

16. The moment of inertia of a uniform cylinder of length l and radius R about its perpendicular bisector is I. What is the ratio l/R such that the moment of inertia is minimum ?

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

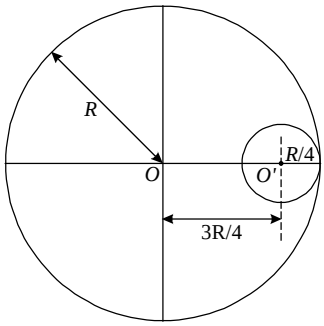
17. A slender uniform rod of mass M and length l is pivoted at one end so that it can rotate in a vertical plane as shown in figure. There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it make an angle θ with the vertical is :



(A) $\frac{3g}{3l}\sin\theta$ (B) $\frac{3g}{3l}\cos\theta$

(C) $\frac{2g}{3l}\cos\theta$ (D) $\frac{3g}{2l}\sin\theta$

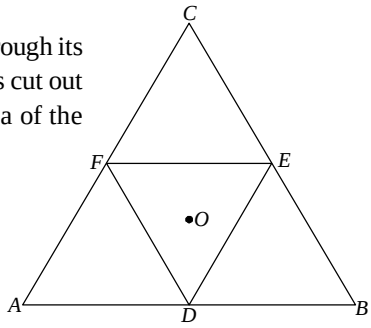
18. A circular hole of radius $R/4$ is made in a thin uniform disc having mass M and radius R, as shown in figure. The moment of inertia of the remaining portion of the disc about an axis passing through the point O and perpendicular to the plane of the disc is :



(A) $\frac{219MR^2}{256}$ (B) $\frac{237MR^2}{512}$

(C) $\frac{19MR^2}{512}$ (D) $\frac{197MR^2}{256}$

19. Moment of inertia of an equilateral triangular lamina ABC, about the axis passing through its centre O and perpendicular to its plane is I_0 as shown in the figure. A cavity DEF is cut out from the lamina, where D, E, F are the mid points of the sides. Moment of inertia of the remaining part of lamina about the same axis is :

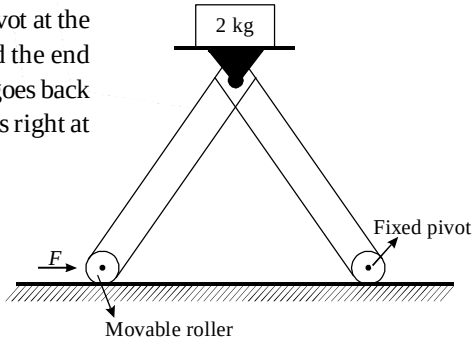


(A) $\frac{7}{8}I_0$ (B) $\frac{15}{16}I_0$

(C) $\frac{3I_0}{4}$ (D) $\frac{31I_0}{32}$

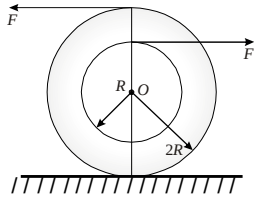
20. The machine as shown in figure has 2 rods of length 1 m connected by a pivot at the top. The end of one rod is connected to the floor by a stationary pivot and the end of the other rod has a roller that rolls along the floor in a slot. As the roller goes back and forth, a 2 kg weight moves up and down. If the roller is moving towards right at a constant speed, the weight moves up with a :

(A) Constant speed
(B) Decreasing speed
(C) Increasing speed
(D) Speed which is 3/4th of that of the roller when the weight is 0.4 m above the ground

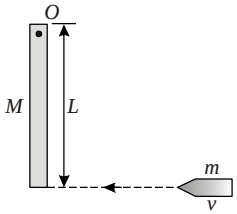


Section- B: INTEGER Answer Type Questions

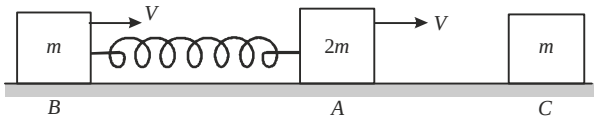
21. In the given figure, $F = 10$ N, $R = 1$ m, mass of the body is 2 kg and moment of inertia of the body about an axis passing through O and perpendicular plane of body is $4\ kg - m^2$. O is the centre of mass of the body. If the ground is smooth, what is total kinetic energy (Joule) of the body after 2 s ?



22. A wooden log of mass M and length L is hinged by a frictionless nail at O. A bullet of mass m strikes with velocity v and sticks to it. The angular velocity of the system immediately after the collision about O is $\frac{PmV}{(M+3m)L}$. Find the value of P.

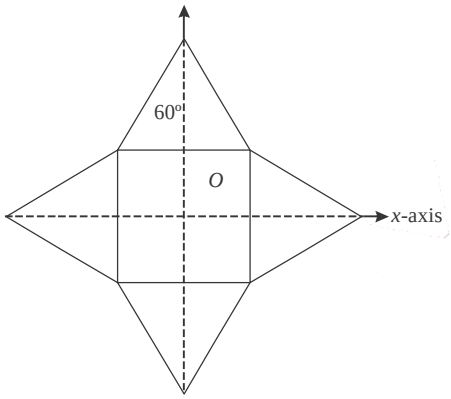


23. Two blocks *A* and *B* of mass 2 *m* and *m* respectively are connected to a massless spring of spring constant *K*. If *A* and *B* moving on the horizontal frictionless surface with velocity *v* to right. If *A* collides with *C* of mass *m* elastically and head on, then the maximum compressions of the spring is $\sqrt{\frac{8m}{nK}}$. Find *n*.

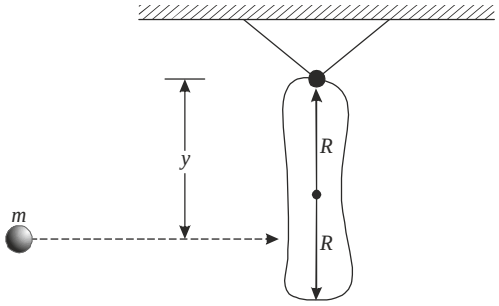


24. A light inextensible thread is wound round a solid cylindrical reel of mass $m = 1.5$ kg and radius 10 cm . The end of the string is held fixed and the reel is allowed to fall so that the thread unwinds. If the axis of the reel remains horizontal, the tension in the thread will be $T = xN$. Find x :

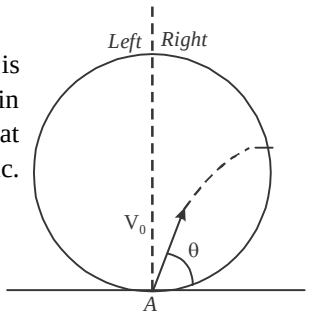
25. Moment of inertia of a uniform symmetric plate as shown in figure about *x*-axis is *I*. Moment of inertia of this plate about an axis passing through centre of plate *O* and perpendicular to the plane of plate is *nI*. Find *n*.



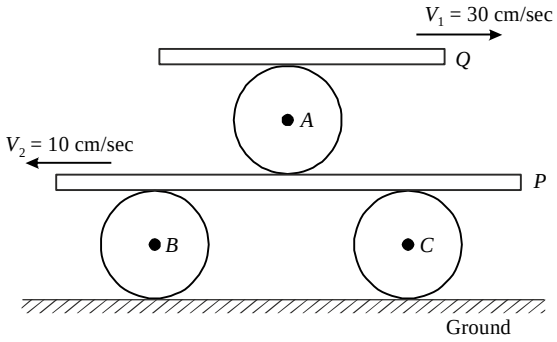
26. A small ball of mass *m* hits a hanging body of length 2*R* at a point where its surface is vertical. The body is hinged at top and free to rotate in vertical plane as shown in figure. Mass of body is *M* and its moment of inertia about the hinge is $3MR^2/2$. If during collision Liner momentum of system (ball + body) is conserved and $y = nR/2$. Find *n*.



27. A hollow sphere of mass *m* and radius *R* is placed on smooth ground. A particle of mass *m* is projected with velocity v_0 and angle θ from lowest point *A* inside the sphere as shown in diagram. If particle strikes the sphere at a point which is on horizontal level of centre and at that moment particle is at highest point. The collision between particle and sphere is elastic. The value of v_0 is $\frac{\sqrt{nRg}}{\sin\theta}$. Find *n*.



28. All three spheres shown in figure are identical having radius 10 cm. There is no slipping at any point of contact. Plank *P* and *Q* are moving in opposite direction with speed 10 and 30 cm/sec. Calculate the height (in cm) of instantaneous axis of rotation of sphere *A* from the ground.



29. A wheel of mass 2 kg and radius 10 cm is rotating about its axis at an angular velocity of 2π rad/s. The force that must be applied tangentially to the wheel to stop it in 5 revolutions is $0.01\,n\pi$ N.

30. A ball of mass 160 g is thrown up at an angle of 60° to the horizontal at a speed of 10 ms^{-1}. The angular momentum of the ball (in kg-m^2/s) at the highest point of the trajectory with respect to the point from which the ball is thrown is approximately *N*. Find *N*. (Take $g = 10\ ms^{-2}$)

Answer Key

Topic : RIGID BODY DYNAMICS — ANSWER KEY

Section - A : MCQs with Single Option Correct

1. (A)	**2.** (B)	**3.** (C)	**4.** (C)
5. (A)	**6.** (C)	**7.** (D)	**8.** (A)
9. (C)	**10.** (C)	**11.** (A)	**12.** (D)
13. (D)	**14.** (C)	**15.** (B)	**16.** (D)
17. (D)	**18.** (B)	**19.** (B)	**20.** (B)

Section- B: INTEGER Answer Type Questions

21. [50]	**22.** [3]	**23.** [27]	**24.** [5]
25. [2]	**26.** [3]	**27.** [2]	**28.** [25]
29. [2]	**30.** [3]		