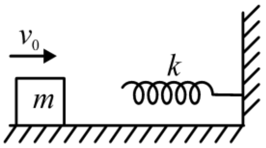
NEET UG (2024)
Physics
Quiz-15

SECTION A

1. A particle moves with the velocity $\vec{v} = \left(5\hat{i} + 2j - k\right) ms^{-1}$ under the influence of a constant force, $\vec{F} = \left(2\hat{i} + 5j - 10k\right) N$. The instantaneous power applied is

(1) 5 W (2) 10 W
(3) 20 W (4) 30 W

2. A block of mass m moving with velocity v_0 on a smooth horizontal surface hits the spring of constant k as shown. The maximum compression in spring is-



(1) $\sqrt{\frac{2m}{k}}.v_0$ (2) $\sqrt{\frac{m}{k}}.v_0$
(3) $\sqrt{\frac{m}{2k}}.v_0$ (4) $\frac{m}{2k}.v_0$

3. A spring with spring constants k when compressed by 1 cm, the potential energy stored is U. If it is further compressed by 3 cm, then change in its potential energy is

(1) 3U (2) 9U
(3) 8 U (4) 15 U

4. When momentum of a body increased by 200% its KE increases by

(1) 200% (2) 300%
(3) 400% (4) 800%

5. In an inelastic collision

(1) Kinetic energy is conserved during the collision
(2) Linear momentum of system is conserved during the collision
(3) Neither momentum nor kinetic energy is conserved during the collision
(4) Both momentum and kinetic energy are conserved during the collision

6. A small ball collides head-on with a massive wall, which is at rest. If the initial speed of ball is 10 m/s and coefficient of restitution is 0.2, then the final speed of ball will be

(1) 4 m/s (2) 1 m/s
(3) 2 m/s (4) Zero

7. A particle A of mass m is moving with velocity v_0 collides elastically with an identical particle B at rest. After collision velocity of particle B will be

(1) v_0 (2) $\frac{v_0}{2}$
(3) $2v_0$ (4) Zero

8. If the coefficient of restitution is 0.6, then collision is

(1) Perfectly elastic collision
(2) Perfectly inelastic collision
(3) Inelastic collision
(4) May be perfectly elastic or inelastic

9. A 1 kg ball moving with speed of 10 m/s collides head on with a 2 kg ball moving in opposite direction with speed of 20 m/s. If collision is perfectly inelastic, the speed of both balls will be

(1) 10 m/s (2) 20 m/s
(3) 15 m/s (4) 5 m/s

10. In a collision, which of the following quantities always remains conserved?

(1) Kinetic energy
(2) Potential energy
(3) Mechanical energy
(4) Linear momentum

11. Four point masses, each weighing 2 kg, are placed at the corners of a square with a side length of 1 m. Determine the ratio of its moment of inertia about a diagonal in the plane to that of a perpendicular axis passing through the center and perpendicular to the plane of the square is

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

12. For which of the following does the center of mass lie outside the body?

(1) A pencil (2) A bangle
(3) A shot put (4) A dice

13. Two persons of masses 50 kg and 60 kg respectively are at the opposite ends of boat. The length of the boat is 4 m and weight 100 kg. The 50 kg man walks up to 60 kg man and sits with him. If the boat is in still water, then the centre of mass of the system shifts by

(1) 0.75 m (2) 1.5 m
(3) Zero (4) 2 m

14. 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

15. 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

16. The moment of inertia, of a solid cylinder of mass M and radius R about an axis, parallel to axis of cylinder and passing through surface is

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

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

17. The torque of a force $\vec{F} = (2\hat{i} + 3\hat{j})$ acting at a point having position $\vec{r} = \hat{i} - 5\hat{j}$, about the origin is

(1) $-2\hat{k}$ (2) $-13\hat{k}$

(3) $2\hat{k}$ (4) $13\hat{k}$

18. A ring and a disc are of same mass and radius. If moment of inertia of ring about an axis through centre and perpendicular to the plane is I, then moment of inertia of the disc about the same axis is

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

(3) $\frac{1}{3}I$ (4) $3I$

19. Mass per unit length of a uniform cross-sectional rod of length L is given by $\lambda = kx$, where k is a constant and x is distance from one end of the rod. The distance of the centre of mass of rod from this end is

(1) $\frac{L}{2}$ (2) $\frac{L}{4}$

(3) $\frac{2L}{3}$ (4) $\frac{L}{3}$

20. A thin circular ring of mass m and radius R is rotating about its axis with a constant angular velocity ω. Two objects each of mass M are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity ω' =

(1) $\frac{\omega(m+2M)}{m}$ (2) $\frac{\omega(m-2M)}{m+2M}$

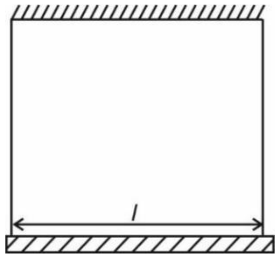
(3) $\frac{\omega m}{(m+M)}$ (4) $\frac{\omega m}{(m+2M)}$

21. A body of a mass m is rotating with angular velocity 10 rad/s. If rotational kinetic energy of body is 100 J, then moment of inertia of the body about the same axis of rotation is

(1) 1 kg m^2 (2) 2 kg m^2

(3) 3 kg m^2 (4) 4 kg m^2

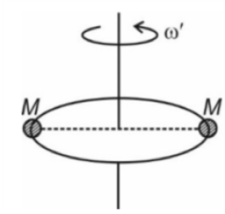
22. A uniform rod is kept suspended in equilibrium from the roof as shown. If the rod has mass m and length l. Then net torque on the rod about its centre is



(1) mgl (2) Zero

(3) $\frac{mgl}{3}$ (4) $2mgl$

23. A disc of mass M and radius R rotates with an angular speed ω. If two-point masses each of mass M are placed gently at a distance R from the centre. Then new angular speed is



(1) $\frac{\omega}{3}$ (2) 5ω

(3) 3ω (4) $\frac{\omega}{5}$

24. If a man standing on the periphery of a stationary disc (free to rotate about its centre) starts walking in the anticlockwise direction along the boundary, then

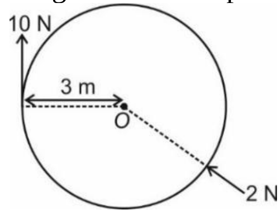
(1) The disc remains stationary

(2) The disc rotates in the clockwise direction

(3) The disc rotates in the anticlockwise direction

(4) The disc rotates in either anticlockwise direction or remain at rest

25. The magnitude of net torque acting on the body shown in the figure about the point O is



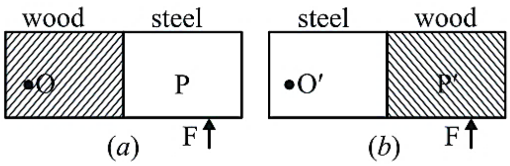
(1) 12 N m (2) 30 N m

(3) 18 N m (4) 42 N m

26. If the angular momentum of a rotating body increases by 3%, keeping its angular velocity constant. Then percentage change in its moment of inertia is

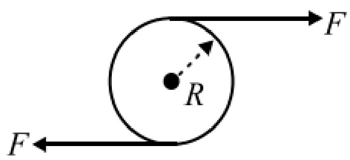
(1) It decreases by 3%
(2) It increases by 3%
(3) It decreases by 6%
(4) It increases by 6%

27. 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):



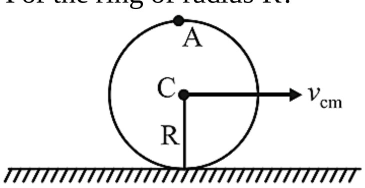
(1) More angular acceleration will be produced in (a)
(2) More angular acceleration will be produced in (b)
(3) Same angular acceleration will be produced in both conditions
(4) Information is incomplete

28. Two equal and opposite forces are applied tangentially to a uniform disc of mass *M* and radius *R* as shown in the figure. If the disc is pivoted at its centre and free to rotate in its plane, the angular acceleration of the disc is



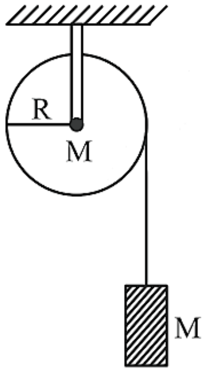
(1) $\frac{F}{MR}$ (2) $\frac{2F}{3MR}$
(3) $\frac{4F}{MR}$ (4) Zero

29. In case of pure rolling, what will be the velocity of point A of the ring of radius R?



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

30. A mass M is supported by a massless string wound around a uniform cylinder of mass M and radius R. On releasing the mass from rest, it will fall with acceleration:



(1) g (2) $\frac{1}{2}g$
(3) $\frac{1}{3}g$ (4) $\frac{2}{3}g$

31. 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) $\sqrt{4gh}$

32. A disc is rolling on an inclined plane without slipping then what fraction of its total kinetic energy will be in form of rotational kinetic energy:

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

33. 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

34. 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

35. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis perpendicular to the plane at an angular velocity ω. Another disc of mass M/3 but same radius is placed gently on the first disc coaxially. The angular velocity of the system now is

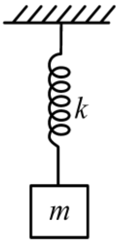
(1) $\frac{4\omega}{3}$ (2) ω
(3) $\frac{3\omega}{4}$ (4) $\frac{3\omega}{8}$

SECTION B

36. A stone of mass 1 kg is tied with a string and it is whirled in a vertical circle of radius 1m. If tension at the highest point is 14 N, then velocity at lowest point will be

(1) 3 m/s (2) 4 m/s
(3) 6 m/s (4) 8 m/s

37. Initially mass m is held such that spring is in relaxed condition. If mass m is suddenly released, maximum elongation in spring will be-

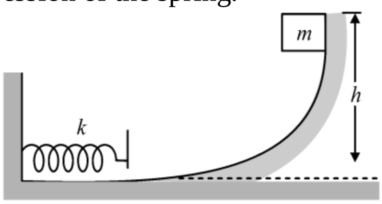


(1) $\frac{mg}{k}$ (2) $\frac{2mg}{k}$
(3) $\frac{mg}{2k}$ (4) $\frac{mg}{4k}$

38. Under the action of a force, a 2 kg body moves such that its position x as a function of time t is given by $x=\frac{t^2}{3}$, where x is in metre and t in second. The work done by the force in first two seconds is

(1) 1600 J (2) 160 J
(3) 16 J (4) $\frac{16}{9}$ J

39. A smooth block of mass m is released from rest from a height *h*. It slides and compresses the spring of stiffness *k*. Find the maximum compression of the spring.



(1) $\sqrt{\frac{2mgh}{k}}$ (2) $\sqrt{\frac{8mgh}{k}}$
(3) $\sqrt{\frac{4mgh}{k}}$ (4) $\sqrt{\frac{2gh}{mk}}$

40. Two balls moving with speed 20 m/s and 10 m/s respectively on a straight road in opposite direction collide head on. If coefficient of restitution is $\frac{1}{2}$, then relative velocity of separation of the ball will be

(1) 20 m/s (2) 10 m/s
(3) 30 m/s (4) 15 m/s

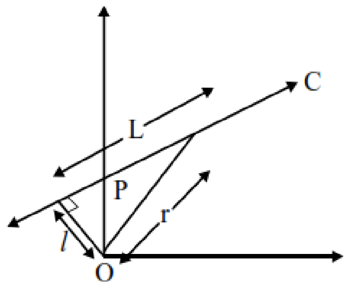
41. A man of mass *M* stands at one end of a plank of length L which lies at rest on a frictionless surface. The man walks on other end of the plank. If mass of the plank is $\frac{M}{3}$, then distance moved by the man relative to ground is

(1) $\frac{3L}{4}$ (2) $\frac{L}{4}$
(3) $\frac{4L}{5}$ (4) $\frac{L}{3}$

42. There is a uniform rectangular lamina made up from a uniform sheet. Mass of lamina is *m* and its length and breadth are 3*l* and 2*l* respectively. Moment of inertia of this lamina about an axis passing through the centre of lamina and perpendicular to its to its plane, will be

(1) $\frac{5ml^2}{12}$ (2) $\frac{21ml^2}{9}$
(3) $\frac{7ml^2}{9}$ (4) $\frac{13ml^2}{12}$

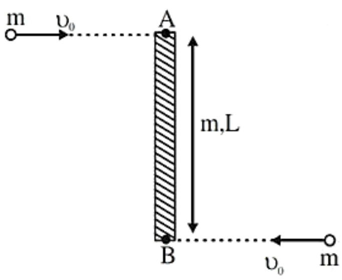
43. A particle of mass m moves along line PC with velocity as shown. What is the angular momentum of the particle about P?



(1) mvL (2) $mv\ell$
(3) mvr (4) zero

Passage (44-45)

A rod AB of mass m length L is placed horizontally on smooth table two identical ball of mass m moving with speed v_0 as shown in diagram strike at end A and B stick to it then:



44. Velocity of COM of system just after collision:

(1) v_0 (2) $\frac{v_0}{3}$
(3) $\frac{2v_0}{3}$ (4) zero

45. Angular velocity about COM:

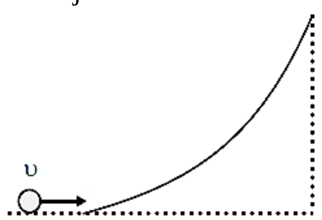
(1) $\frac{12v_0}{L}$ (2) $\frac{12v_0}{7L}$

(3) $\frac{6v_0}{7L}$ (4) zero

46. A sphere cannot roll on:

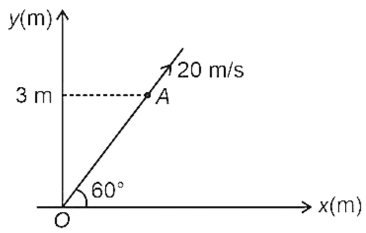
(1) a smooth horizontal surface
(2) a smooth inclined surface
(3) a rough horizontal surface
(4) a rough inclined surface

47. A small object of uniform density rolls up a curved surface with an initial velocity v. It reaches upto a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is



(1) ring (2) solid sphere
(3) hollow sphere (4) disc

48. The angular momentum [in kg m^2 s^{-1}] of a particle of mass 5 kg, moving with a speed of 20 m/s in a straight line (as shown in figure), about the origin is



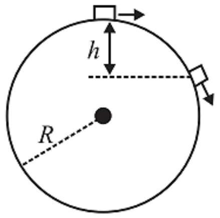
(1) $100\sqrt{2}$ (2) Zero

(3) 300 (4) $\frac{300}{\sqrt{2}}$

49. A stone is rotated in a vertical circle. Speed at bottommost point is $\sqrt{8gR}$, where R is the radius of circle. The ratio of tension at the top and the bottom is:

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

50. A particle originally at rest at the highest point of a smooth vertical circle is slightly displaced. It will leave the circle at a vertical distance *h* below the highest point such that:



(1) $h = R$ (2) $h = \frac{R}{3}$

(3) $h = \frac{R}{2}$ (4) $h = \frac{2R}{3}$

Solution

1. **(4)**

$P = \vec{F}.\vec{V}$

$= \left(2\hat{i} + 5\hat{j} - 10\hat{k}\right).\left(5\hat{i} + 2\hat{j} - \hat{k}\right)$

$= 10 + 10 + 10 = 30W$

[NCERT; Page. No. 128]

2. **(2)**

$E_i = E_f$

$\frac{1}{2}mv_0^2 = \frac{1}{2}kx^2$

$x = \sqrt{\frac{m}{k}}v_0$

[NCERT; Page. No. 123]

3. **(4)**

$U = \frac{1}{2}k(1)^2 = \frac{k}{2}$

$U^1 = \frac{1}{2}k(4)^2 = \frac{1}{2}k(16) = 16U$

$\Delta U = U^1 - U = 16U - U = 15U$

[NCERT; Page. No. 120]

4. **(4)**

$P^1 = 3P$

$K^1 = \frac{(3P)^2}{2m} = \frac{9P^2}{2m}$

$\frac{K^1 - K}{K} \times 100 = \frac{\frac{9P^2}{2m} - \frac{P^2}{2m}}{\frac{P^2}{2m}} \times 100 = 800\%$

[NCERT; Page. No. 117]

5. **(2)**

Linear momentum is conserved for any kind of collision.

[NCERT; Page. No. 129]

6. **(3)**

$v = eu = 0.2 \times 10 = 2$ m/s

[NCERT; Page. No. 129]

7. **(1)**

In perfectly elastic collision velocity of the masses will interchange.

[NCERT; Page. No. 129]

8. **(3)**

For $(0 < e < 1)$ collision is inelastic.

[NCERT; Page. No. 129]

9. **(1)**

By conservation of linear momentum

$P_2 = P_1$

$-10 \times 1 + 20 \times 2 = 3v$

$v = 10$ m/s

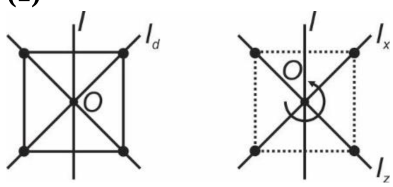
[NCERT; Page. No. 129]

10. **(4)**

In collision, linear momentum is conserved.

[NCERT; Page. No. 129]

11. **(1)**



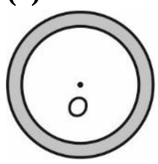
$I_d = 2 \times \left(\frac{1}{\sqrt{2}}\right)^2 + 2 \times \left(\frac{1}{\sqrt{2}}\right)^2 = 2 \text{ kg m}^2$

$I_o = 4 \times 2 \times \left(\frac{1}{\sqrt{2}}\right)^2 = 4 \text{ kg m}^2$

$\frac{I_d}{I_o} = \frac{2}{4} = \frac{1}{2}$

[NCERT; Page. No. 163]

12. **(2)**



Here, centre of mass of bangle is at *O*, hence lie outside the body.

[NCERT; Page. No. 144]

13. **(3)**

Net external force on the man and boat is zero and centre of mass is initially at rest. So centre of mass will not move.

[NCERT; Page. No. 144]

14. **(2)**

$I = I_{disc} + I_{Masses} = \frac{MR^2}{2} + 4mR^2$

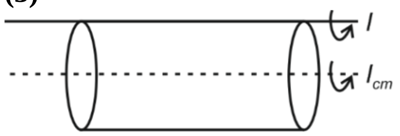
[NCERT; Page. No. 163]

15. **(1)**

The theorem of perpendicular axis is applicable only for 2-D objects.

[NCERT; Page. No. 164]

16. **(3)**



$I = I_{cm} + M.d^2$

$= \dfrac{MR^2}{2} + MR^2$

$= \dfrac{3}{2}MR^2$

[NCERT; Page. No. 164]

17. **(4)**

$$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & j & k \\ 1 & -5 & 0 \\ 2 & 3 & 0 \end{vmatrix} = 3\hat{k} - (-10\hat{k}) = 13\hat{k}$$

[NCERT; Page. No. 154]

18. **(2)**

$$I_R = MR^2, I_D = \frac{MR^2}{2}$$

[NCERT; Page. No. 163]

19. **(3)**

$$x_{CM} = \frac{\int xdm}{\int dm} = \frac{\int_0^L kx^2 dx}{\int_0^L kx\,dx} \quad \therefore x_{CM} = \frac{2L}{3}$$

[NCERT; Page. No. 144]

20. (4)

$Li = Lf$

$I\omega = I_f\,\omega_f$

$mR^2\omega = (m + 2M)R^2\omega_f$

$$\omega_f = \frac{m\omega}{m + +2M}$$

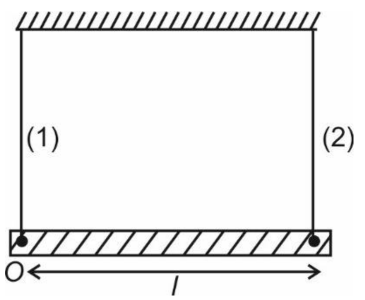
[NCERT; Page. No. 152]

21. **(2)**

$\dfrac{1}{2}I\omega^2 = K \Rightarrow \dfrac{1}{2}I \times 10^2 = 100 \Rightarrow I = 2 \text{ kg m}^2$

[NCERT; Page. No. 163]

22. **(2)**



as: $\tau = I\alpha$ and $\alpha = 0$

$\Rightarrow \tau = 0$

[NCERT; Page. No. 154]

23. **(4)**

As no net external torque acts use law of conservation of angular momentum

$L_i = L_f$

$$L_i = \frac{MR^2}{2} \cdot \omega$$

$$L_f = \left[\frac{MR^2}{2} + M(R)^2 \times 2\right] \cdot \omega'$$

$$= \left[\frac{MR^2}{2} + 2MR^2\right]\omega' = \left[\frac{5}{2}MR^2\right]\omega'$$

$$\Rightarrow \frac{5}{2}MR^2\omega' = \frac{MR^2}{2} \cdot \omega$$

$$\therefore \boxed{\omega' = \frac{\omega}{5}}$$

[NCERT; Page. No. 152]

24. **(2)**

$L_i = L_f$

As $L_i = 0$

$\Rightarrow L_f = 0$

$\therefore m_m \cdot v_m \cdot r + \left(I_d + m_m r^2\right) \cdot \omega = 0$

$$\therefore \omega = \frac{-m_m \cdot v_m \cdot r}{\left(I_d + m_m r^2\right)}$$

$\Rightarrow$ Disc will rotate opposite to the direction of man's motion $\Rightarrow$ Clockwise direction.

[NCERT; Page. No. 167]

25. **(2)**

$\tau = F \cdot r_\perp$ where $r_\perp$ = moment arm

$\tau_{net} = 2 \times 0 + 10 \times 3 = 30$ N m

[NCERT; Page. No. 154]

26. **(2)**

$L = I\omega \Rightarrow L \propto I$

$$\therefore \frac{\Delta L}{L} = \frac{\Delta I}{I}$$

[NCERT; Page. No. 163]

27. **(2)**

The torque about point 0. $\Rightarrow rf$

$rf = I\alpha$

Now I is less in case (b) as COM is closer to point 0.

$\therefore \quad I_B < I_A$

Torque is same for both scales.

$\tau_a = \tau_B$

$I_a\alpha_a = I_B\alpha_B$

$I_B < I_A \Rightarrow \alpha_a < \alpha_B$

[NCERT; Page. No. 154]

28 **(3).**

Net torque about center

= FR + FR = 2FR

$$\alpha = \frac{\text{torque}}{M.I.} = \frac{2FR}{\frac{MR^2}{2}}$$

$$\alpha = \frac{4F}{MR}$$

[NCERT; Page. No. 154]

29. **(4)**

V = ωr (in pure rolling)

$V = V_{cm}$

$V_{net} = 2V_{cm}$

[NCERT; Page. No. 173]

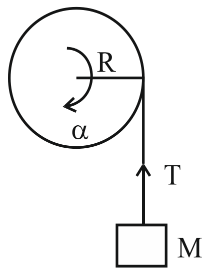
30. **(4)**

τ = Iα

$$TR = \left(\frac{MR^2}{2}\right)\alpha$$

a = αR

$$TR = \frac{MR^2}{2} \times \frac{a}{R}$$



$$T = \frac{Ma}{2} \quad \ldots\text{(i)}$$

Mg–T = Ma

$$Mg = \frac{3Ma}{2} \Rightarrow a = \frac{2g}{3}$$

[NCERT; Page. No. 167]

31. **(3)**

By work–energy Theorem,

$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$$

$$I = \frac{1}{2}mR^2, \qquad V = \omega R$$

$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{V}{R}\right)^2$$

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

[NCERT; Page. No. 148]

32. **(1)**

Rotational Kinetic Energy $= \frac{1}{2}I\omega^2$

$$\frac{1}{2}\left(\frac{1}{2}mr^2\right)\left(\frac{V}{R}\right)^2 = \frac{1}{4}mv^2$$

Total kinetic energy

$$= \frac{1}{2}mv^2 + \frac{1}{4}mv^2 = \frac{3}{4}mv^2$$

$$\frac{KE_{rot}}{KE_{total}} = \frac{1}{3}$$

[NCERT; Page. No. 169]

33. **(1)**

$$KE_{Rotational} = 0.5KE_{Total}$$

$$\frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{1}{2}I\omega^2 + \frac{1}{2}Mv^2\right)$$

$$\frac{1}{4}I\omega^2 = \frac{1}{4}M\omega^2R^2 \Rightarrow I = MR^2 \text{ (Ring)}$$

[NCERT; Page. No. 169]

34. **(3)**

$$\text{KE} = \frac{1}{2}I\omega^2 = \frac{L^{20}}{2I}$$

$KE_1 = KE_2$

$$\frac{L_1^2}{2I_1} = \frac{L_2^2}{2I_2}$$

$$\frac{L_1}{L_3} = \frac{1}{\sqrt{2}}$$

[NCERT; Page. No. 154]

35. **(3)**

$$\frac{MR^2}{2}\omega = \frac{MR^2}{2}\omega_1 + \frac{(M/3)R^2}{2}\omega_1$$

$$\omega_1 = \frac{3\omega}{4}$$

[NCERT; Page. No. 152]

36. **(4)**

$$T + mg = \frac{mv^2}{R} \text{ (at the highest point)}$$

$$\frac{1(v^2)}{1} = 14 + 10 = 24$$

$$v^2 = 24 \Rightarrow v = \sqrt{24}$$

Using mechanical energy conservation

$$\frac{1}{2}(1)u^2 = \frac{1}{2}(1)\left(\sqrt{24}\right)^2 + 1(10)(2)$$

$$u^2 = 64 \Rightarrow u = 8 \text{ m/s}$$

[NCERT; Page. No. 121]

37. (2)

$E_i = E_i$

$\Rightarrow 0 = mgx + \frac{1}{2}kx^2$

$x = \frac{2mg}{k}$

[NCERT; Page. No. 123]

38. (4)

$x = \frac{t^2}{3} \Rightarrow v = \frac{2t}{3}$

$W = \Delta KE. = \frac{1}{2}(2)\left[\left(\frac{4}{3}\right)^2 - 0\right] = \frac{16}{9}$ J

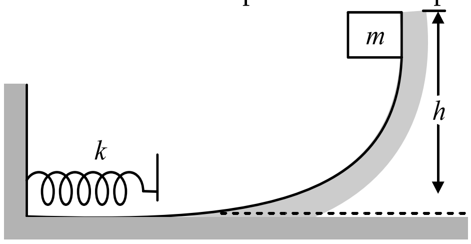
[NCERT; Page. No. 118]

39. (1)

Taking block spring a system. No external force is doing work on system and no non-conservative force is present. The mechanical energy should be conserved.

$\Delta K + \Delta U = 0$

Let x = maximum compression of the spring.



Here $\Delta U = \Delta U_{sp} + \Delta U_{gr}$

$\Delta U_{sp} = \frac{k}{2}x^2$

because the spring is deformed from x = 0 to $x = x$ and $\Delta U_{gr} = -mgh$ because the block falls down through a vertical distance h. Hence,

$\Delta U = \frac{k}{2}x^2 - mgh$

Since, the block will come to rest at the time of maximum compression $\Delta K = 0$. Substituting ΔU and ΔK in the equation

$\Delta U + \Delta K = 0$, We have $\frac{k}{2}x^2 - mgh = 0$

Then $x = \sqrt{\frac{2mgh}{k}}$

[NCERT; Page. No. 123]

40. (4)

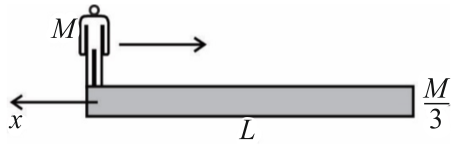
$e = \frac{\text{Relative velocity of separation}}{\text{Relative velocity of approach}}$

$\frac{1}{2} = \frac{\text{Relative velocity of separation}}{30}$

Relative velocity of separation = 15 m/s

[NCERT; Page. No. 129]

41. (2)



$M(L - x) - \frac{Mx}{3} = 0$

(x is distance moved by the plank)

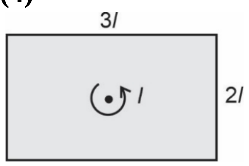
$\Rightarrow x = \frac{3L}{4}$

Distance moved by man w.r.t. ground.

$= L - \frac{3L}{4} = \frac{L}{4}$

[NCERT; Page. No. 149]

42. (4)



$I = m\left[\frac{l^2 + b^2}{12}\right] = m\left[\frac{9I^2 + 4I^2}{12}\right] = \frac{13mI^2}{12}$

[NCERT; Page. No. 164]

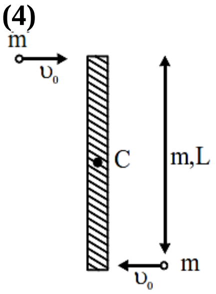
43. (4)

L = $mvr \sin\theta$; r = 0

= 0

[NCERT; Page. No. 154]

44. (4)



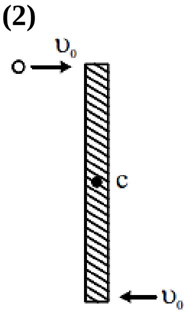
$P_i = P_f$

$mv_0 - mv_0 = 3m\, v_{cm}$

$v_{cm} = 0$

[NCERT; Page. No. 148]

45. (2)



$L_i = mv_0\frac{L}{2} + mv_0\frac{L}{2} = mv_0L$ .... (1)

$L_f = I\omega$

$$= \left[\frac{m\ell^2}{12} + 2 \times m\left(\frac{\ell}{2}\right)^2\right]\omega$$

$$= \left[\frac{m\ell^2}{12} + \frac{m\ell^2}{2}\right]\omega = 7\frac{m\ell^2}{12}\omega \qquad ...(2)$$

$L_i = L_f$

$$mv_0 L = \frac{7m\ell^2}{12}\omega$$

[NCERT; Page. No. 152]

46. **(2)**

Smooth inclined surface will increase speed but not ω

[NCERT; Page. No. 173]

47. **(4)**

$$KE = \left(1 + \frac{K^2}{R^2}\right)\frac{1}{2}mv^2 = mgh$$

$$\Rightarrow \left(1 + \frac{K^2}{R^2}\right)\frac{1}{2}mu = mg\frac{3v^2}{4\,g}$$

$$\Rightarrow \left(1 + \frac{K^2}{R^2}\right) = \frac{3}{2}$$

$$\frac{K^2}{R^2} = \frac{1}{2} = (\text{ Disc})$$

[NCERT; Page. No. 173]

48. **(2)**

$L = mvr_\perp$

At point A, $r_\perp = 0$

$\therefore\ L_A = 0$

[NCERT; Page. No. 154]

49. **(2)**

$$T_{bottom} = mg + \frac{mv^2}{R}$$

$= 9$ mg …(i)

Velocity at top

$$V_{top}^2 = u^2 - 2g(2R) = 4gR$$

$$T_{top} = \frac{mv^2}{R} = mg$$

$$= \frac{m4gR}{R} - mg = 3mg \quad \ldots(ii)$$

$$\frac{T_{top}}{T_{bottom}} = \frac{3mg}{9mg} = 1:3$$

[NCERT; Page. No. 121]

50. **(2)**

By mechanical energy conservation

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

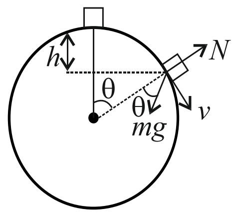
$2mgh = mv^2$ …(i)

Net force towards centre $= \dfrac{mv^2}{R}$

$$mg\cos\theta = \frac{mv^2}{R}$$

$$mg\left(\frac{R-h}{R}\right) = \frac{2mgh}{R}$$

$$h = \frac{R}{3}$$



[NCERT; Page. No. 121]