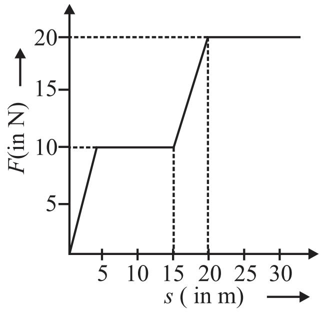
NEET UG (2024)
Physics
Quiz-5

SECTION - A

1. The work done by a force acting on a body is as shown in the graph. The total work done in covering an initial distance of 20 m is:



(1) 225 J (2) 200 J
(3) 400 J (4) 175 J

2. Particles of masses m, 2 m, 3 m, ... nm grams are placed on the same line at distance l, $2l$, $3l$, ..., nl m from a fixed point. The distance of the centre of mass of the particles from the fixed point in meters is

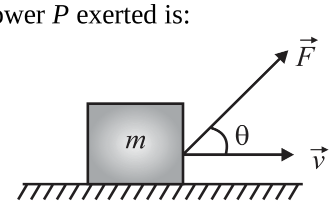
(1) $\frac{(2n+1)l}{3}$ (2) $\frac{(n+1)l}{2}$

(3) $\frac{(2n+1)l}{6}$ (4) $\frac{(n+1)l}{3}$

3. A electric motor creates a tension of 4500 N in a hoisting cable and reels it in at the rate of 2 m/s. What is the power of electric motor?

(1) 15 kW (2) 9 kW
(3) 225 kW (4) 9000 HP

4. A constant force $\vec{F}$ is acting on a body of mass m with constant velocity $\vec{v}$ as shown in the figure. The power P exerted is:



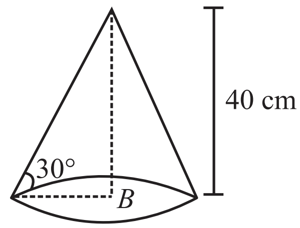
(1) $(F\cos\theta)v$ (2) $\frac{F\cos\theta}{mg}$

(3) $\frac{Fmg\cos\theta}{v}$ (4) $\frac{mg\sin\theta}{F}$

5. In the stable equilibrium position a body has:

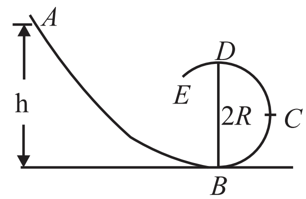
(1) Maximum potential energy
(2) Minimum potential energy
(3) Minimum kinetic energy
(4) Zero kinetic energy

6. A uniform solid cone of height 40 cm is shown in figure. The distance of centre of mass of the cone from point B (Centre of the base) is:



(1) 20 cm (2) 10/3 cm
(3) 20/3 cm (4) 10 cm

7. A frictionless track $ABCDE$ ends in a circular loop of radius R. A body slides down the track from point A which is at a height h = 5 cm. Maximum value of R for the body to successfully complete the loop is:



(1) 5 cm (2) 15/4 cm
(3) 10/3 cm (4) 2 cm

8. A body of mass 5 kg explodes at rest into three fragments with masses in the ratio 1 : 1 : 3. The fragments with equal masses fly in mutually perpendicular directions with speeds of 21 m/s. The velocity of the heaviest fragment will be

(1) 11.5 m/s (2) 14.0 m/s
(3) 7.0 m/s (4) 9.89 m/s

9. A body is dropped from a certain height. When it loses U amount of its energy it acquires a velocity 'v'. The mass of the body is:

(1) $\frac{2U}{v^2}$ (2) $\frac{2v}{U^2}$

(3) $\frac{2v}{U}$ (4) $\frac{U^2}{2v}$

10. A particle of mass m at rest is acted upon by a force F for a time t. Its kinetic energy after an interval t is:

(1) $\frac{F^2t^2}{m}$ (2) $\frac{F^2t^2}{2m}$

(3) $\frac{F^2t^2}{3m}$ (4) $\frac{Ft}{2m}$

11. Two bodies with masses m_1 and m_2 ($m_1 > m_2$) are joined by a string passing over fixed pulley. Assume masses of the pulley and thread negligible. Then the acceleration of the centre of mass

(1) $\left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$ (2) $\left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 g$

(3) $\frac{m_1 g}{m_1 + m_2}$ (4) $\frac{m_2 g}{m_1 + m_2}$

12. A sphere of mass m moving with a constant velocity u hits another stationary sphere of the same mass. If e is the coefficient of restitution, then the ratio of the velocity of two spheres after collision will be

(1) $\frac{1-e}{1+e}$ (2) $\frac{1+e}{1-e}$

(3) $\frac{e+1}{e-1}$ (4) $\frac{e-1}{e+1}$

13. When two bodies collide elastically, then

(1) Kinetic energy of the system alone is conserved

(2) Only momentum is conserved

(3) Both energy and momentum are conserved

(4) Neither energy nor momentum is conserved

14. A body of mass 'M' collides against a wall with a velocity v and retraces its path with the same speed. The change in momentum is (take initial direction of velocity as positive)

(1) Zero (2) $2Mv$

(3) Mv 4) $-2Mv$

15. A gun fires a bullet of mass 50 gm with a velocity of 30 m sec^{-1}. Because of this the gun is pushed back with a velocity of 1 m sec^{-1}. The mass of the gun is

(1) 15 kg (2) 30 kg

(3) 1.5 kg (4) 20 kg

16. A ^{238}U nucleus decays by emitting an alpha particle of speed vms^{-1}. The recoil speed of the residual nucleus is (in ms^{-1})

(1) $-4v/234$ (2) $v/4$

(3) $-4v/238$ (4) $4v/238$

17. A shell of mass m moving with velocity v suddenly breaks into 2 pieces. The part having mass $m/4$ remains stationary. The velocity of the other shell will be

(1) v (2) $2v$

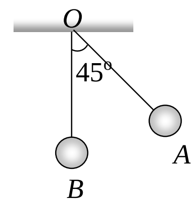
(3) $\frac{3}{4}v$ (4) $\frac{4}{3}v$

18. A system consists of two identical particles. One particle is at rest and other particle has an acceleration a. The centre of mass of the system has an acceleration of

(1) $2a$ (2) $a/2$

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

19. The bob A of a simple pendulum is released when the string makes an angle of 45° with the vertical. It hits another bob B of the same material and same mass kept at rest on the table. If the collision is elastic



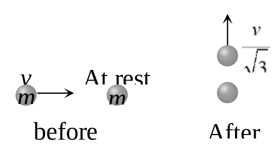
(1) Both A and B rise to the same height

(2) Both A and B come to rest at B

(3) Both A and B move with the same velocity of A

(4) A comes to rest and B moves with the velocity of A

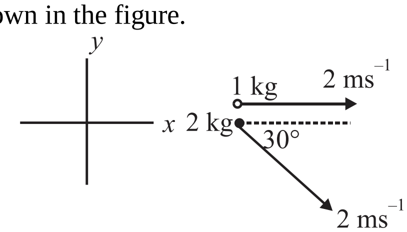
20. A mass 'm' moves with a velocity 'v' and collides inelastically with another identical mass. After collision the Ist mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision



(1) $\frac{2}{\sqrt{3}}v$ (2) $\frac{v}{\sqrt{3}}$

(3) v (4) $\sqrt{3}v$

21. Find the velocity of centre of mass of the system shown in the figure.



(1) $\left(\frac{2+2\sqrt{3}}{3}\right)\hat{i} - \frac{2}{3}\hat{j}$

(2) $4\hat{j}$

(3) $\left(\frac{2-2\sqrt{3}}{3}\right)\hat{i} - \frac{2}{3}\hat{j}$

(4) None of these

22. A bullet of mass a and velocity b is fired into a large block of mass c. The final velocity of the system is

(1) $\frac{c}{a+b}\cdot b$ (2) $\frac{a}{a+c}\cdot b$

(3) $\frac{a+b}{c}.a$ (4) $\frac{a+c}{a}\cdot b$

23. A bullet hits and gets embedded in a solid block resting on a horizontal frictionless table. What is conserved?

(1) Momentum and kinetic energy

(2) Kinetic energy alone

(3) Momentum alone

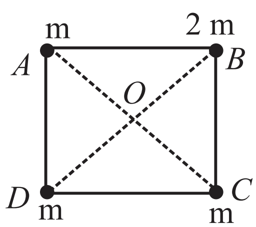
(4) Neither momentum nor kinetic energy

24. An object of mass 3 m splits into three equal fragments. Two fragments have velocities $v\hat{j}$ and $v\hat{i}$. The velocity of the third fragment is:

(1) $(v\hat{j}-v\hat{i})$ (2) $(v\hat{i}-v\hat{j})$

(3) $-(v\hat{i}+v\hat{j})$ (4) $\frac{v(\hat{i}+\hat{j})}{\sqrt{2}}$

25. Centre of mass of the given system of particles will be at



(1) OD (2) OC

(3) OB (4) AO

26. A small disc of radius 2 cm is cut from a disc of radius 6 cm. If the distance between their centers is 3.2 cm, what is the shift in the centre of mass of the disc?

(1) 0.4 cm (2) 2.4 cm

(3) 1.8 cm (4) 1.2 cm

27. Which of the following is not an example of perfectly inelastic collision

(1) A bullet fired into a block if bullet gets embedded into block

(2) Capture of electrons by an atom

(3) A man jumping on to a moving boat

(4) A ball bearing striking another ball bearing

28. A body of mass 40 kg having velocity 4 m/s collides with another body of mass 60 kg having velocity 2 m/s. If the collision is inelastic, then loss in kinetic energy will be

(1) 440 J (2) 392 J

(3) 48 J (4) 144 J

29. 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

(1) $5\hat{i}-25\hat{j}$ (2) $\frac{5}{7}\hat{i}-25\hat{j}$

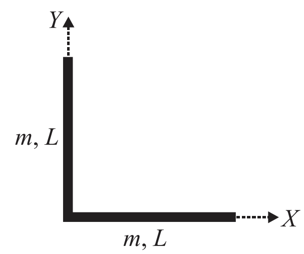
(3) $5\hat{i}+\frac{25}{7}\hat{j}$ (4) $25\hat{i}-\frac{5}{7}\hat{j}$

30. Two rings have their moment of inertia in the ratio of 2:1 and their diameters in the ratio of 4 : 1. The ratio of their respective masses will be

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

(3) 6 : 1 (4) 1 : 8

31. Two rods each of mass m and length L are placed along X and Y axis as shown in figure. Coordinates of the centre of mass of the combination is



(1) $\left(\frac{L}{2},\frac{L}{2}\right)$ (2) $\left(\frac{L}{4},\frac{L}{2}\right)$

(3) $\left(\frac{L}{2},\frac{L}{4}\right)$ (4) $\left(\frac{L}{4},\frac{L}{4}\right)$

32. 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) $\frac{m_1 m_2}{m_1+m_2}l^2$ (2) $\frac{m_1+m_2}{m_1 m_2}l^2$

(3) $(m_1+m_2)l^2$ (4) $\sqrt{m_1 m_2}l^2$

33. The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is

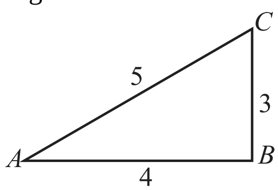
(1) $\frac{1}{2}MR^2$ (2) MR^2

(3) $\frac{7}{2}MR^2$ (4) $\frac{3}{2}MR^2$

34. The centre of mass of a system of particles does not depend on

(1) Position of the particles
(2) Relative distances between the particles
(3) Masses of the particles
(4) Forces acting on the particles

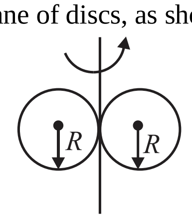
35. The *ABC* is a triangular plate of uniform thickness. The sides are in the ratio shown in the figure. I_{AB}, I_{BC} and I_{CA} are the moments of inertia of the plate about *AB*, *BC* and *CA* respectively. Which one of the following relations is correct?



(1) $I_{AB} + I_{BC} = I_{CA}$
(2) I_{CA} is maximum
(3) $I_{AB} > I_{BC}$
(4) $I_{BC} > I_{AB}$

SECTION – B

36. Moment of inertia of combination of two discs of same mass *M* and same radius *R* kept in contact about the tangent passing through point of contact and in the plane of discs, as shown is

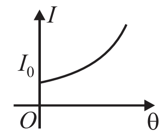


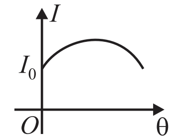
(1) $\frac{MR^2}{4}$ (2) $\frac{5}{4}MR^2$
(3) $\frac{MR^2}{2}$ (4) $\frac{5}{2}MR^2$

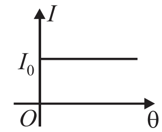
37. The moment of inertia of a uniform semicircular wire of mass *m* and radius *r*, about an axis passing through its centre of mass and perpendicular to its plane is

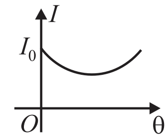
(1) $\frac{mr^2}{2}$ (2) mr^2
(3) $mr^2\left(1-\frac{4}{\pi^2}\right)$ (4) $mr^2\left(1+\frac{4}{\pi^2}\right)$

38. A square plate has a moment of inertia I_0 about an axis lying in its plane, passing through its centre and making an angle θ with one of the sides. Which graph represents the variation of *I* with θ?

(1)


(2)


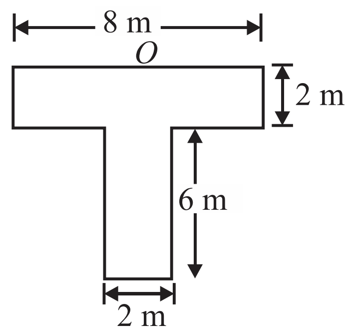
(3)


(4)


39. A person of mass *m* is standing on one end of a plank of mass *M* and length *L* and floating in water. The person moves from one and to another and stops. The displacement of the plank is

(1) $\frac{Lm}{(m+M)}$ (2) $Lm(M + m)$
(3) $L\frac{(m+M)}{m}$ (4) $\frac{LM}{(m+M)}$

40. Find the position of the centre of mass of the T-shaped plate from *O*.



(1) 2.71 m (2) 3.5 m
(3) 2 m (4) 2.50 m

41. Find the centre of mass of a uniform half-disc (*R* is the radius of Disc)

(1) $\frac{4R}{3\pi}$ (2) $\frac{2R}{\pi}$
(3) $\frac{2R}{3\pi}$ (4) $\frac{3R}{4\pi}$

42. The kinetic energy *K* of a particle moving in a straight line depends upon the distance *s* as $K = as^2$ The force acting on the particle is-

(1) 2 *as* (2) 2 *mas*
(3) 2 *a* (4) $\sqrt{as^2}$

43. When a rubber-band is stretched by a distance *x*, it exerts a restoring force of magnitude $F = ax + bx^2$ where *a* and *b* are constants. The work done in stretching the unstretched rubber-band by *L* is :

(1) $aL^2 + bL^3$ (2) $\frac{1}{2}(aL^2 + bL^3)$
(3) $\frac{aL^2}{2} + \frac{bL^3}{3}$ (4) $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

44. A particle is moving in a circular path of radius a under the action of an attractive potential

$U = -\frac{k}{2r^2}$, Its total energy is:

(1) $4a^2$ (2) $2a^2$

(3) Zero (4) $-\frac{3}{2}\frac{k}{a^2}$

45. The average acceleration vector for a particle having a uniform circular motion is-

(1) A constant vector of magnitude $\frac{\upsilon^2}{r}$

(2) A vector of magnitude $\frac{\upsilon^2}{r}$ directed normal to the plane of the given uniform circular motion.

(3) Equal to the instantaneous acceleration vector at the start of the motion.

(4) A null vector.

46. Let a_r and a_t represent radial and tangential acceleration. The motion of a particle may be circular if :

(1) $a_r = 0, a_t = 0$ (2) $a_r = 0, a_t \neq 0$

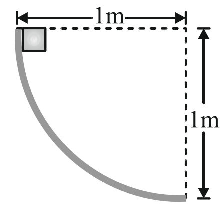
(3) $a_r \neq 0, a_t = 0$ (4) none of these

47. Two objects of masses 300 g and 700 g possess velocities $15\hat{i}$ m/s and $4\hat{i} + 6\hat{j}$ m/s respectively. The velocity of their centre of mass in m/s is

(1) $7\hat{i} + 8\hat{j}$ (2) $7.3\hat{i} + 4.2\hat{j}$

(3) $5\hat{i} + 4\hat{j}$ (4) $2\hat{i} + 6\hat{j}$

48. A body of mass 2 kg slides down a curved track which is quadrant of a circle of radius 1 metre. All the surfaces are frictionless.
If the body starts from rest, its speed at the bottom of the track is



(1) 4.43 m/sec (2) 2 m/sec

(3) 0.5 m/sec (4) 19.6 m/sec

49. Internal forces in a system can change

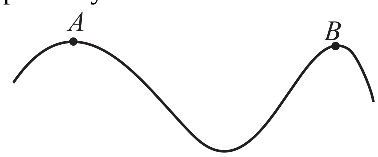
(1) Linear momentum only

(2) Kinetic energy only

(3) Both kinetic energy and linear momentum

(4) Neither the linear momentum nor the kinetic energy of the system.

50. A car moves at a constant speed on a road as shown in figure. The normal force by the road on the car is N_A and N_g when it is at the points A and B respectively.



(1) $N_A = N_B$

(2) $N_A > N_B$

(3) $N_A < N_B$

(4) insufficient

Solution

1. **(2)**

[Pg No. 75, NCERT Topic No. 5.5]

Work done = Area under *F*-*S* graph from x = 0 m to x = 20 m

$$W = \left[\frac{1}{2}\times 5\times 10\right] + [10\times 10] + \left[10\times 5 + \frac{(5\times 10)}{2}\right]$$

W = 25 + 100 + 75 = 200 J

2. **(1)**

[Pg No. 96, NCERT Topic No. 6.2]

Distance of the centre of mass from the fixed point

$$= \frac{ml + (2m)(2l) + ... + (nm)(nl)}{m + 2m + ... + nm}$$

$$= \frac{ml(1 + 2^2 + 3^2 + ... + n^2)}{m(1 + 2 + 3 + ...n)}$$

$$= \left[\left(\frac{n(n+1)(2n+1)}{6}\right)\left(\frac{2}{n(n+1)}\right)\right] l$$

$$= \frac{(2n+1)l}{3}$$

3. **(2)**

[Pg No. 83, NCERT Topic No. 5.10]

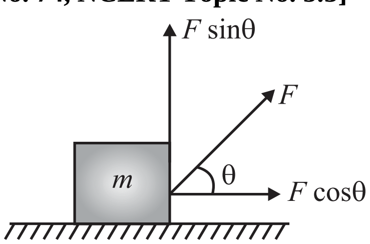
Power = Fv

P = 4500 × 2 = 9000 W

= 9 kW

4. **(1)**

[Pg No. 74, NCERT Topic No. 5.3]



$$\text{Power} = \vec{F}\cdot\vec{v}$$

$$= F\cos\theta\cdot v$$

= (Component of force in the direction of velocity). v

$$\boxed{P = Fv\cos\theta}$$

$$P = (F\cos\theta)v$$

5. **(2)**

[Pg No. 78, NCERT Topic No. 5.8]

In the stable equilibrium, a body has minimum potential energy.

6. **(4)**

[Pg No. 98, NCERT Topic No. 6.2]

$$r_{cm} = \frac{h}{4} = \frac{40}{4} = 10 \text{ cm}$$

7. **(4)**

[Pg No. 78, NCERT Topic No. 5.8]

From the conservation of energy

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

$$v_B = \sqrt{2gh}$$

The condition for completing the loop is given as,

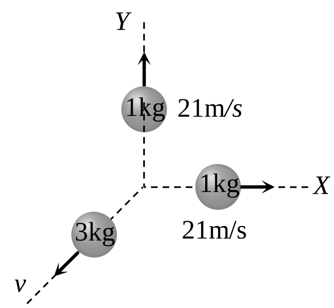
$$v_B = \sqrt{5gR} \Rightarrow \sqrt{2gh} = \sqrt{5gR}$$

$$2h = 5R$$

$$R = \frac{2h}{5} = \frac{2\times 5}{5} = 2 \text{ cm}$$

8. **(4)**

[Pg No. 100, NCERT Topic No. 6.3]



$$P_x = m\times v_x = 1\times 21 = 21 \text{ kg m/s}$$

$$P_y = m\times v_y = 1\times 21 = 21 \text{ kg m/s}$$

$$\therefore \text{ Resultant} = \sqrt{P_x^2 + P_y^2} = 21\sqrt{2} \text{ kg m/s}$$

The momentum of heavier fragment should be numerically equal to resultant of $\vec{P}_x$ and $\vec{P}_y$.

$$3\times v = \sqrt{P_x^2 + P_y^2} = 21\sqrt{2} \therefore v = 7\sqrt{2} = 9.89 \text{ m/s}$$

9. **(1)**

[Pg No. 77, NCERT Topic No. 5.7]

From energy conservation

$$0 + mgh = (mgh - U) + \frac{1}{2}mv^2$$

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

$$U = \frac{1}{2}mv^2 \Rightarrow \boxed{m = \frac{2U}{v^2}}$$

10. **(2)**

[Pg No. 74, NCERT Topic No. 5.4]

$F = ma$

$F = m\frac{v}{t}$

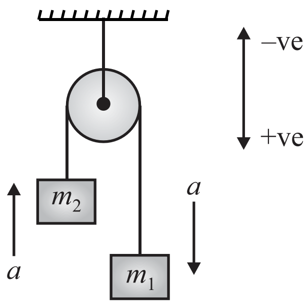
$v = \frac{Ft}{m}$

$K.E. = \frac{1}{2}mv^2$

$= \frac{1}{2}m\frac{F^2t^2}{m^2} = \boxed{\frac{F^2t^2}{2m}}$

11. **(2)**

[Pg No. 99, NCERT Topic No. 6.3]



$a = \frac{\text{Net pulling force}}{\text{Total mass}}$

$= \frac{m_1 g - m_2 g}{m_1 + m_2}$

$= \left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$ .....(i)

Now, $a_{CM} = \frac{m_1 a_1 + m_2 a_2}{m_1 + m_2}$

$a_{CM} = \frac{m_1(+a) + m_2(-a)}{m_1 + m_2}$

$= \left(\frac{m_1 - m_2}{m_1 + m_2}\right)a$

Substituting the value of a from equation (i) we have,

$a_{CM} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 g$

12. **(1)**

[Pg No. 84, NCERT Topic No. 5.11]

13. **(3)**

[Pg No. 85, NCERT Topic No. 5.11.2]

14. **(4)**

[Pg No. 84, NCERT Topic No. 5.11.2]

Change in momentum $= m\vec{v}_2 - m\vec{v}_1$

$= -mv - mv = -2mv$

15. **(3)**

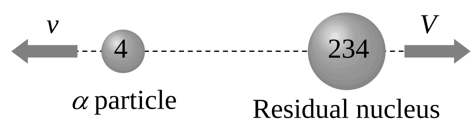
[Pg No. 100, NCERT Topic No. 6.4]

$m_G = \frac{m_B v_B}{v_G} = \frac{50 \times 10^{-3} \times 30}{1} = 1.5\, kg$

16. **(1)**

[Pg No. 100, NCERT Topic No. 6.4]

Initially ^{238}U nucleus was at rest and after decay its part moves in opposite direction.

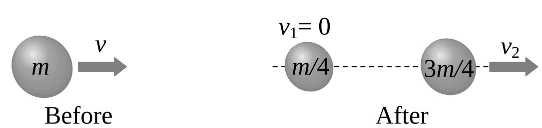


According to conservation of momentum

$4v + 234V = 238 \times 0 \Rightarrow V = -\frac{4v}{234}$

17. **(4)**

[Pg No. 101, NCERT Topic No. 6.4]



According to conservation of momentum

$mv = \left(\frac{m}{4}\right)v_1 + \left(\frac{3m}{4}\right)v_2 \Rightarrow v_2 = \frac{4}{3}v$

18. **(2)**

$\vec{a}_{cm} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1 + m_2} = \frac{0 + ma}{2m} = \frac{a}{2}\left[\because m_1 = m_2 = m\right]$

19. **(4)**

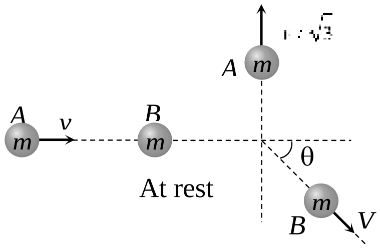
[Pg No. 85, NCERT Topic No. 5.11.2]

Due to the same mass of A and B as well as due to elastic collision velocities of spheres get interchanged after the collision.

20. (1)

[Pg No. 85, NCERT Topic No. 5.11.2]

Let mass A moves with velocity v and collides inelastically with mass B, which is at rest.



According to problem mass A moves in a perpendicular direction and let the mass B moves at angle θ with the horizontal with velocity v.

Initial horizontal momentum of system

(before collision) $= mv$ ....(i)

Final horizontal momentum of system

(after collision) $= mV\cos\theta$ ....(ii)

From the conservation of horizontal linear momentum

$mv = mV\cos\theta \Rightarrow v = V\cos\theta$ ...(iii)

Initial vertical momentum of system (before collision) is zero.

Final vertical momentum of system

$\frac{mv}{\sqrt{3}} - mV\sin\theta$

From the conservation of vertical linear momentum $\frac{mv}{\sqrt{3}} - mV\sin\theta = 0 \Rightarrow \frac{v}{\sqrt{3}} = V\sin\theta$

...(iv)

By solving (iii) and (iv)

$$v^2 + \frac{v^2}{3} = V^2(\sin^2\theta + \cos^2\theta)$$

$$\Rightarrow \frac{4v^2}{3} = V^2 \Rightarrow V = \frac{2}{\sqrt{3}}v.$$

21. (1)

Here, $m_1 = 1$ kg, $m_2 = 2$ kg $\vec{v}_1 = (2\hat{i})$m/s

Taking component of velocity along x and y axes

$$\vec{v}_2 = 2\cos 30^\circ\,\hat{i} - 2\sin 30^\circ\,\hat{j}$$

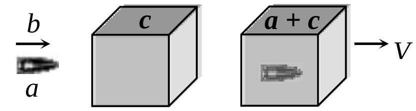
$$\vec{v}_{CM} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$$

$$= \frac{1\times 2\hat{i} + 2(2\cos 30^\circ\,\hat{i} - 2\sin 30^\circ\,\hat{j})}{1+2}$$

$$\vec{v}_{CM} = \frac{2\hat{i} + 2\sqrt{3}\hat{i} - 2\hat{j}}{3} = \left(\frac{2+2\sqrt{3}}{3}\right)\hat{i} - \frac{2}{3}\hat{j}$$

22. (2)

[Pg No. 85, NCERT Topic No. 5.11.3]



Initially bullet moves with velocity b and after collision bullet get embedded in block and both move together with common velocity.

By the conservation of momentum

$$\Rightarrow a \times b + 0 = (a + c)\,V \Rightarrow V = \frac{ab}{a+c}$$

23. (3)

[Pg No. 84, NCERT Topic No. 5.11]

24. (3)

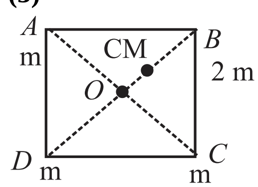
[Pg No. 84, NCERT Topic No. 5.11]

$$0 = m\vec{v}_1 + m\vec{v}_2 + m\vec{v}_3$$

or $\quad 0 = m\left(v\hat{i} + v\hat{j}\right) + m\vec{v}_3$

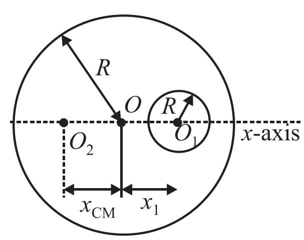
$\therefore \quad \vec{v}_3 = -v\left(\hat{i} + \hat{j}\right).$

25. (3)



If all the masses were same, the centre of mass would have been at O but as the mass at B is 2 m, so the centre of mass of the system will shift towards B. So, centre of mass will be on the line OB.

26. (1)



Let radius of complete disc is R and that of small disc is R_1. Also, let centre of mass now shifts to O_2 at a distance x_{cM} from original centre.

The position of new centre of mass is given by

$x_{CM} = \frac{0 - \sigma\pi R_1^2 x_1}{\sigma\pi R^2 - \sigma\pi R_1^2}$, where, $\sigma =$ mass per unit area Here, $R = 6$ cm, $R_1 = 2$ cm, $x_1 = 3.2$ cm

Hence, $x_{CM} = \frac{-\sigma\times\pi(2)^2\times 3.2}{\sigma\times\pi\times(6)^2 - \sigma\times\pi\times(2)^2}$

$$= -\frac{12.8\pi}{32\pi} = -0.4 \text{ cm}$$

Negative sign indicates the shift is towards left.

27. **(4)**

[Pg No. 84, NCERT Topic No. 5.11]

In case of perfectly inelastic collision, the bodies stick together after impact. In perfectly inelastic collision its not necessary body stick together.

28. **(3)**

[Pg No. 85, NCERT Topic No. 5.11.2]

Loss in kinetic energy

$$= \frac{1}{2}\frac{m_1 m_2 (u_1 - u_2)^2}{m_1 + m_2} = \frac{1}{2}\left(\frac{40 \times 60}{40 + 60}\right)(4-2)^2 = 48\text{J}$$

29. **(3)**

[Pg No. 99, NCERT Topic No. 6.3]

$$\vec{V}_{\text{cm}} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$$

$$= \frac{200 \times 10\hat{i} + 500\ \ 3\hat{i} + 5\hat{j}}{200 + 500} = 5\hat{i} + \frac{25\hat{j}}{7}$$

30. **(4)**

[Pg No. 75, NCERT Topic No. 5.5]

$$I = MR^2$$

$$\frac{I_1}{I_2} = \frac{M_1}{M_2}\left(\frac{R_1}{R_2}\right)^2$$

$$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \left(\frac{R_2}{R_1}\right)^2$$

$$= \frac{2}{1} \times \frac{1}{16} = \frac{1}{8}$$

31. **(4)**

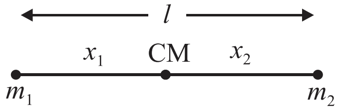
[Pg No. 75, NCERT Topic No. 5.5]

$$X = \frac{m_1x_1 + m_2x_2}{m_1 + m_2} = \frac{L}{4}$$

$$Y = \frac{m_1y_1 + m_2y_2}{m_1 + m_2} = \frac{L}{4}$$

32. **(1)**

[Pg No. 114, NCERT Topic No. 6.9]

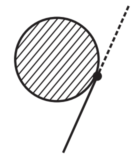


$$x_1 = \frac{m_2 l}{m_1 + m_2} \text{ and } x_2 = \frac{m_1 l}{m_1 + m_2}$$

$$I = m_1x_1^2 + m_2x_2^2 = \frac{m_1m_2}{m_1 + m_2}l^2$$

33. **(4)**

[Pg No. 114, NCERT Topic No. 6.9]



$$I = I_{\text{cm}} + MR^2$$

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

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

34 **(4)**

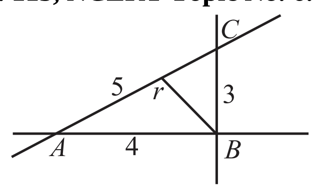
[Pg No. 75, NCERT Topic No. 5.5]

$$x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

So x_{cm} or y_{cm} does not depend upon force acting on the particles.

35. **(4)**

[Pg No. 115, NCERT Topic No. 6.9]



$$I_{AB} = m(3)^2$$

$$I_{BC} = m(4)^2$$

$$I_{CA} = mr^2$$

$$r < 4$$

$$\Rightarrow I_{BC} > I_{AB}$$

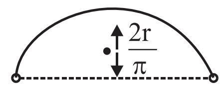
36. **(4)**

[Pg No. 115, NCERT Topic No. 6.9]

$$I = 2\left[\frac{MR^2}{4} + MR^2\right]$$

37. **(3)**

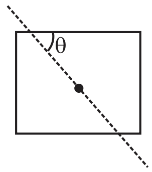
[Pg No. 116, NCERT Topic No. 6.9]



$$mr^2 = I_{cm} + m\left(\frac{2r}{\pi}\right)^2$$

$$I_{cm} = mr^2\left[1 - \frac{4}{\pi^2}\right]$$

38. **(3)**
[Pg No. 116, NCERT Topic No. 6.9]



Using perpendicular axis theorem,

$I_z = I_x + I_y$

$I = 2I'$

$I' = \frac{I}{2} =$ Constant

39. **(1)**
[Pg No. 96, NCERT Topic No. 6.2]

40. **(1)**
Let mass per unit area of the plate be σ.
Mass of horizontal portion $= 8 \times 2a = 16\sigma$
Mass of vertical portion $= 6 \times 2\sigma = 12\sigma$
The centres O_1 and O_2 of these portions lie at distances 1 m and $2 + 3 = 5$ m from the point O.
The CM of the T-shaped plate will lie at distance y from the point O which is given by

$y = \frac{16\sigma \times 1 + 12\sigma \times 5}{16\sigma + 12\sigma} = \frac{76\sigma}{28\sigma} = 2.71$ m

41. **(1)**
[Pg No. 96, NCERT Topic No. 6.2]

42. **(1)**
[Pg No. 41, NCERT Topic No. 3.10]
Kinetic energy $K = as^2$
Force acting on the particle $F = dK/ds$

$F = \frac{d}{dS}(as^2)$

$\Rightarrow F = 2as$

43. **(3)**
[Pg No. 75, NCERT Topic No. 5.5]

$F = ax + bx^2$

$dw = Fdx$

$W = \int_0^L \left(ax + bx^2\right) dx$

$W = \frac{aL^2}{2} + \frac{bL^3}{3}$

44. **(3)**
[Pg No. 77, NCERT Topic No. 5.7]
We know, $F_x = \frac{-dU}{dx}$ where $\vec{x}$ and $\vec{F}$ are in same direction here, radius vector $\vec{r}$ and centripital force $\vec{F}_r$ are in opposite direction,

Hence, $F_r = \frac{dU}{dr}$

$F = \frac{dU}{dr} \Rightarrow F = \frac{k}{r^3} = \frac{mv^2}{r}$

K.E. $= 1/2\, mv^2 = \frac{k}{2r^2}$

T.E. $=$ P.E. $+$ K.E. $= \frac{-K}{2r^2} + \frac{K}{2r^2} = 0$

45. **(4)**
[Pg No. 41, NCERT Topic No. 3.10]
The average acceleration vector will be a null vector, since in one complete round the displacement is null vector which implies that average velocity is also null vector which further implies that average acceleration will also be a null vector for a particle having a uniform circular motion.

46. **(3)**
[Pg No. 41, NCERT Topic No. 3.10]
(1) if $a_r = 0$ and $a_t = 0$, then motion is uniform translatory.
(2) if $a_r = 0$ and $a_t \neq 0$, then the motion is accelerated translatory.
(3) if $a_r \neq 0$ but $a_t = 0$, then the motion is uniform circular.
(4) if $a_r \neq 0$ and $a_t \neq 0$, then the motion is nonuniform circular.

47. **(2)**

$\vec{V}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2} = \frac{300(15\hat{i}) + 700(4\hat{i} + 6\hat{j})}{300 + 700}$

$\vec{V}_{cm} = \frac{4500\hat{i} + 2800\hat{i} + 4200\hat{j}}{1000} = 7.3\hat{i} + 4.2\hat{j}$

(2)

48. **(1)**
[Pg No. 96, NCERT Topic No. 6.2]

By conservation of energy,

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

$\Rightarrow \quad v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 1} = \sqrt{19.6} = 4.43$ m/s

49. **(2)**
[Pg No. 96, NCERT Topic No. 6.2]
According to the law of conservation of momentum, the overall momentum of the system remains unchanged. Internal forces can hence only have an effect on the mechanical energy like KE and PE.

50. **(2)**
[Pg No. 6.3, NCERT Topic No. 4.10]