NEET ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS

CLASS :- 11th **PAPER CODE :- CWT-8**

CHAPTER :- ROTATIONAL MOTION

ANSWER KEY

1.	(C)	**2.**	(B)	**3.**	(C)	**4.**	(B)	**5.**	(C)	**6.**	(B)	**7.**	(B)
8.	(B)	**9.**	(C)	**10.**	(C)	**11.**	(D)	**12.**	(D)	**13.**	(A)	**14.**	(A)
15.	(D)	**16.**	(B)	**17.**	(A)	**18.**	(B)	**19.**	(B)	**20.**	(D)	**21.**	(C)
22.	(D)	**23.**	(A)	**24.**	(C)	**25.**	(A)	**26.**	(C)	**27.**	(D)	**28.**	(C)
29.	(C)	**30.**	(A)	**31.**	(A)	**32.**	(C)	**33.**	(D)	**34.**	(B)	**35.**	(D)
36.	(C)	**37.**	(C)	**38.**	(C)	**39.**	(C)	**40.**	(A)	**41.**	(C)	**42.**	(D)
43.	(C)	**44.**	(C)	**45.**	(C)	**46.**	(D)	**47.**	(D)	**48.**	(A)	**49.**	(D)
50.	(B)												

SOLUTIONS

SECTION-A

1. (C)

Sol. $\frac{d\theta}{dt} = 1.5 + 4t$

$\omega = 9.5$ rad/s

2. (B)

Sol. In pure rolling, mechanical energy remains conserved. Therefore, when heights of inclines are equal, speed of sphere will be same in both the cases. But as acceleration down the plane, $a \propto \sin\theta$ therefore, acceleration and time of descent will be different.

3. (C)

Sol. Linear speed $V = r\omega$

V depends on radius

4. (B)

Sol. $\omega_0 = 3000$ rad/min

$\omega_0 = \frac{3000}{60}$ rad/sec = (50 rad/sec)

t = 10 sec

$\omega_f = 0$

$\omega_f = \omega_0 + \alpha t$

$0 = 50 - \alpha\,(10)$

$\alpha = 5$ rad/sec^2

$0 = \omega_0\, t + \frac{1}{2}\,\alpha + 2$

$0 = (50)\,(10) + \frac{1}{2}\,(-10)\,(10)^2$

500 – 250 = 250 rad

5. (C)

Sol. $I_x + I_y = I_z$

z axes is perpendicular to plane of body.

6. (B)

7. (B)

Sol. Sphere is rotating about a diameter

so, $a = \alpha R$

but, R is zero for particles on the diameter.

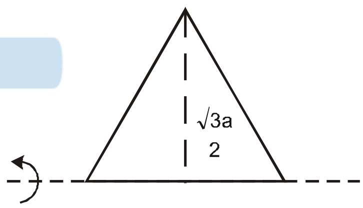
8. (B)

Sol. $\theta = \omega t + \frac{1}{2}\alpha t^2 = 10$ rad

9. (C)

Sol. $I = m\left(\frac{\sqrt{3}a}{2}\right)^2$

$I = \frac{3ma^2}{4}$



10. (C)

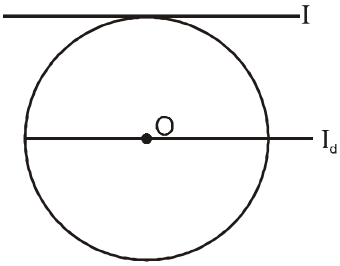
Sol. The horizontal shift of end x will be double the shift of centre of spool. Hence centre travels by $\frac{S}{2}$.

11. (D)

Sol. Moment of inertia of a disc about its diameter is

$I_d = \frac{1}{4}MR^2$

Now, according to perpendicular axis theorem moment of inertia of disc about a tangent passing through rim and in the plane of disc is



$I = I_d + MR^2$

$= \frac{1}{4}MR^2 + MR^2$

$= \frac{5}{4}MR^2$

12. (D)

Sol. $I = \frac{MR^2}{2} + 2\left[\frac{3}{2}MR^2\right] = \frac{7}{2}MR^2$

13. (A)

Sol. $mgh = \frac{1}{2}mV^2 + \frac{1}{2}I\omega^2$

$mgh = \frac{1}{2}mV^2 + \frac{1}{2}\frac{mR^2}{2}\left(\frac{V}{R}\right)^2$

$mgh = \frac{1}{2}mV^2 + \frac{1}{4}mV^2$

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

14. (A)

15. (D)

Sol. For disc, $I = \frac{1}{2}ma^2$ For ring, $I = ma^2$

For square of side 2a

$= \frac{M}{12}[(2a)^2 + (2a)^2] = \frac{2}{3}Ma^2$

For square of rod of length 2a

$I = 4\left[M\frac{(2a)^2}{12} + Ma^2\right] = \frac{16}{3}Ma^2$

Hence, moment of inertia is maximum for square of four rods.

16. (B)

Sol. Moment of inertia of solid sphere about an axis passing through its centre of gravity.

$r = \frac{2}{5}mr^2$

Where m = mass of sphere

R = radius of sphere

From theorem of parallel axis, moment of inertia about its tangential axis

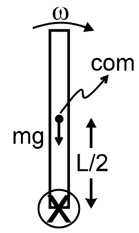
$I = I' + mR^2 = \frac{2}{5}MR^2 + MR^2 = \frac{7}{5}MR^2$

17. (A)

Sol. The moment of inertia in rotational motion is equivalent to mass as in linear motion.

18. (B)

Sol. For the circular motion of com :



$mg = m\left(\frac{L}{2}\right)\omega^2 \Rightarrow \omega = \sqrt{\frac{2g}{L}}$

19. (B)

Sol. mg sin θ component is always down the plane whether it is rolling up or rolling down. Therefore, for no slipping, sense of angular acceleration should also be same in both the cases. Therefore, force of friction f always act upwards.

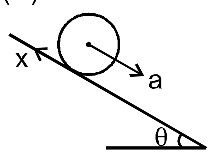
20. (D)

Sol. $\tau = \frac{\Delta L}{\Delta t} = \frac{2}{5} = 0.4\ N-m$

21. (C)

Sol. Direction of Angular momentum is along the direction of angular velocity, which is an axial vector.

22. (D)



Sol. Torque about COM

$f.R = I \cdot \alpha$ $(a = \alpha R)$

$F.R = \frac{mR^2}{2}a = \left(\frac{mR^2}{2} \cdot R\right)$

$\Rightarrow \left(f = \frac{ma}{2}\right)$

23. (A)

Sol. Moment of inertia depends on distribution of mass about axis of rotation. Density of iron is more than that of aluminium, therefore for moment of inertia to be maximum, the iron should be far away from the axis. Thus, aluminium should beat interior and iron surrounds it.

24. (C)

Sol. If a body has mass M and radius of gyration is K, then $I = MK^2$

Moment of inertia of a disc and circular ring about a tangential axis in their planes are respectively.

$I_d = \frac{5}{4}M_dR^2 \quad \Rightarrow \quad I_r = \frac{3}{2}M_rR^2$

but $\quad I = MK^2 \quad \Rightarrow \quad K = \sqrt{\frac{I}{M}}$

$\therefore \quad \frac{K_d}{K_r} = \sqrt{\frac{I_d}{I_r} \times \frac{M_r}{M_d}} \quad$ or

$\frac{I_d}{I_r} = \sqrt{\frac{(5/4)M_dR^2}{(3/2)M_rR^2} \times \frac{M_r}{M_d}} = \sqrt{\frac{5}{6}}$

$\therefore \quad I_d : I_r = \sqrt{5} : \sqrt{6}$

25. (A)

Sol. $\ell = 3$ kg m^2, $\tau = 6$ Nm, t = 20 sec

From $\tau = I\alpha$

Angular accleration $\alpha = \frac{\tau}{I} = \frac{6}{3} = 2$ rad/sec^2

$\therefore$ Angular displacement

$= \omega_0 t + \frac{1}{2}\alpha t^2$

$= 0 \times 20 + \frac{1}{2}(B)(20)^2$

= 400 radian

26. (C)

Sol. $\vec{F} = 2\hat{i} + 3\hat{j} - \hat{k}$ at point (2,–3,1)

torque about point (0, 0, 2)

$\vec{r} = \left(2\hat{i} - 3\hat{j} + \hat{k}\right) - 2\hat{k}$

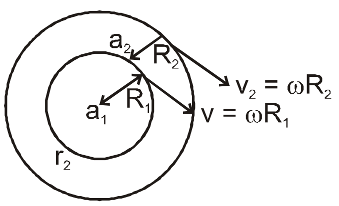
$\vec{\tau} = \vec{r} \times \vec{F} = (2\hat{i} - 3\hat{j} - \hat{k}) \times (2\hat{i} + 3\hat{j} - \hat{k})$

$\vec{\tau} = (6\hat{i} + 12\hat{k}) \Rightarrow \left|\vec{\tau}\right| = (6\sqrt{5})$

27. (D)

Sol. $ma_1 = \frac{mv_1^2}{R_1}$ .... (i)

and $ma_2 = \frac{mv_2^2}{R_2}$ .... (ii)



and $\frac{F_1}{F_2} = \frac{ma_1}{ma_2}$

$= \frac{R_2}{mR_2^2\omega^2} \quad \therefore \quad \frac{F_1}{F_2} = \frac{R_1}{R_2}$

28. (C)

Sol. $F = 4\hat{i} - 10\hat{j}$

$\vec{r} = (-5\hat{i} - 3\hat{j})$

$\tau = \vec{r} \times \vec{F}$

$= (-5\hat{i} - 3\hat{j}) \times (4\hat{i} - 10\hat{j})$

$= 50\hat{k} + 12\hat{k} = 62\hat{k}$

29. (C)

Sol. torque of a couple always remains constant about any point

30. (A)

Sol. $\tau = I\alpha$

$30 = 2 \times \alpha$

$\Rightarrow \quad \alpha = 15$ rad/sec^2

From equation of angular motion

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

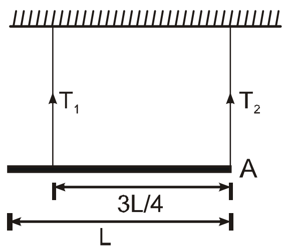
$= 0 + \frac{1}{2} \times 15 \times 10 \times 10 = 750$ rad

31. (A)

Sol. a = (g tan θ) so net force along the indined plane is zero so it will continue in pure rolling with constant angular velocity.

32. (C)

Sol. $t_A = 0$



$T_1 \times \frac{3L}{4} - mg\frac{L}{2} = 0$ ....(A)

$T_1 = \frac{2mg}{3}$

$T_1 + T_2 = mg$ ....(B)

$T_2 = \frac{mg}{3}$

$\frac{T_1}{T_2} = \frac{2}{1}$ **Ans.**

33. (D)

Sol. As the inclined plane is smooth, the sphere can never roll rather it will just slip down.

Hence, the angular momentum remains conserved about any point on a line parallel to the inclined plane and passing through the centre of the ball.

34. (B)

Sol. $KE = \frac{1}{2} I\omega^2$

$1500 = (1.2)\ \omega^2$

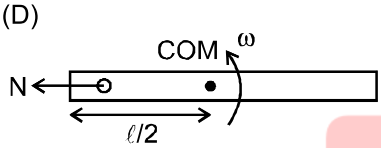
$\omega = \sqrt{\frac{3000}{1.2}}$

$\omega_f - \omega_i = \alpha t$

$\sqrt{\frac{3000}{1.2}} = 25\ t$

$t = 2\ s$

35. (D)

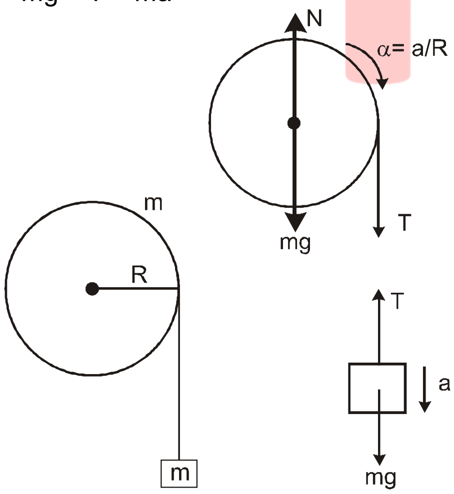


Sol. $N = \left(m\omega^2 \frac{\ell}{2}\right)$

SECTION-B

36. (C)

Sol. $mg - T = ma$



$TR = \frac{mR^2\alpha}{2}$

$T = \frac{mR\alpha}{2} = \frac{ma}{2}$

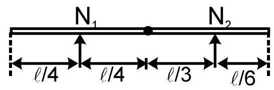
$mg - \frac{ma}{2} = ma$

$\frac{3ma}{2} = mg$

$a = \frac{2g}{3}$ **Ans.**

37. (C)

Sol.



For rotational equilibrium

$N_1 \times \frac{\ell}{4} = N_2 \times \frac{\ell}{6}$

$N_1 : N_2 = 4 : 3$

38. (C)

Sol. $\frac{E_A}{E_B} = \frac{\frac{1}{2}I_A\omega_A^2}{\frac{1}{2}I_B\omega_B^2} = \frac{L_A^2}{I_A}\ \frac{I_B}{L_B^2} \Rightarrow \quad \frac{L_A}{L_B} = 5$

39. (C)

Sol. Beam is not at rotational equilibrium, so force exerted by the rod (beam) decrease

40. (A)

Sol. $KE = \frac{1}{2}\ mv^2\ (1 + 1)$

$= mv^2$

$= 0.4 \times 0.1^2$

$= 4 \times 10^{-3}$.

41. (C)

Sol. By applying two force in opposite directions.

42. (D)

Sol. $KE_R = \frac{1}{2}I\omega^2$

$L = I\omega$

$KE_R = \frac{L^2}{2I}$.

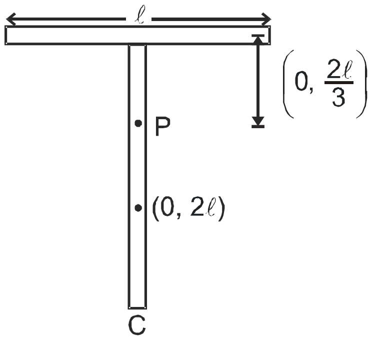
43. (C)

Sol. $\vec{\tau} = \frac{d\vec{L}}{dt} = \frac{4A_0 - A_0}{4} = \left(\frac{3A_0}{4}\right)$

44. (C)

Sol. For pure translatory motion, net torque about centre of mass should be zero. Thus $\vec{F}$ is applied at centre of mass of system.

$$P = \frac{0 \times \ell + \ell.2\ell}{\ell + 2\ell} = \frac{2\ell^2}{3\ell} = \frac{2\ell}{3}$$



$\therefore \quad PC = \left(\ell - \frac{2\ell}{3} + \ell\right)$

$= \frac{4\ell}{3}$

45. (C)

Sol. Given : $I = 2kg - m^2$, $\omega_0 = \frac{60}{60} \times 2\pi$ rad/s,

$\omega = 0$, t = 60s

The torque required to stop the wheel's rotation is

$$\tau = I\alpha = I\left(\frac{\omega_0 - \omega}{t}\right)$$

$$\tau = \frac{2 \times 2\pi \times 60}{60 \times 60} = \frac{\pi}{15} \text{ N-m}$$

46. (D)

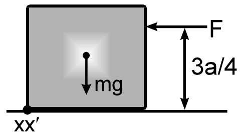
Sol. Since the angular speed and angular acceleration of each moving point onthe rod is same, acceleration of each moving point on the rod is in same direction, that is, parallel. Hence statement-1 is false.

47. (D)

Sol. As the inclined plane is smooth, the sphere can never roll rather it will just slip down.

Hence, the angular momentum remains conserved about any point on a line parallel to the inclined plane and passing through the centre of the ball.

48. (A)



Sol. For topling about edge xx′ __________

$F_{min.} \frac{3a}{4} = mg \frac{a}{2}$

$F_{min.} = \frac{2mg}{3}$.

49. (D)

Sol. For translational equilibrium $\sigma\vec{F} = 0$

For rotational equilibrium $\sigma\vec{\tau} = 0$

torque is required to produce angular accelerations

50. (B)

Sol. From conservation of angular momentum ($I\omega$ = constant), angular velocity will remain half. As,

$K = \frac{1}{2} I\omega^2$

The rotational kinetic energy will become half. Hence, the correct option is (B).