JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 11th **PAPER CODE :- CWT-8**
CHAPTER :- ROTATIONAL MOTION

ANSWER KEY

1.	(A)	**2.**	(B)	**3.**	(D)	**4.**	(B)	**5.**	(B)	**6.**	(A)	**7.**	(C)
8.	(D)	**9.**	(A)	**10.**	(A)	**11.**	(C)	**12.**	(D)	**13.**	(A)	**14.**	(B)
15.	(B)	**16.**	(D)	**17.**	(D)	**18.**	(B)	**19.**	(D)	**20.**	(D)	**21.**	20
22.	8	**23.**	250	**24.**	62	**25.**	3	**26.**	64	**27.**	7	**28.**	6
29.	20N	**30.**	8cm										

SOLUTIONS

1. (A)

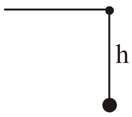
Sol. $I_1\omega_1 = I_2\omega_2$

$$\frac{2}{5}mR^2\frac{2\pi}{24} = \frac{2}{6}m(rR)^2\frac{2\pi}{T'}$$

$T' = 24\eta^2$

2. (B)

Sol.



Velocity at B = $\sqrt{2gh}$

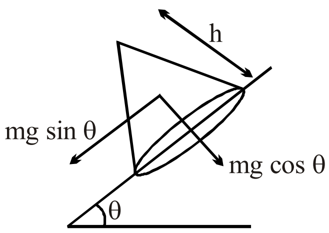
$\therefore$ angular momentum = m × $\sqrt{2gh}$ × b

3. (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.

4. (B)

Sol. $mg\sin\theta\,\frac{h}{4} = mg\cos\theta \times r$



$\Rightarrow \tan\theta = \frac{4r}{h}$

$\mu = \tan\theta$

$4r = \mu h$

5. (B)

Sol. $KE = \frac{1}{2}\frac{MR^2}{2}\left(\frac{V}{R}\right)^2 = \frac{Mv^2}{4}$

6. (A)

Sol. Net force will be towards right & net torque anticlockwise.

7. (C)

Sol. Remainingmass further apart from axis hence radius of gyration increases.

8. (D)

Sol. $I = \frac{1}{4}MR^2$

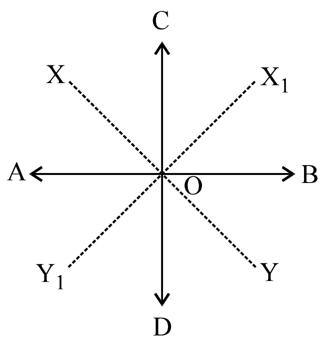
$I_{rim} = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2 = 6I$

9. (A)

Sol. $I_0 = I_{AB} + I_{CD} = \frac{ML^2}{6}$

⊥r Axis Theorem

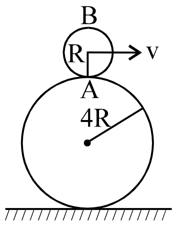
$I_0 = I_{XY} + I_{X'Y'}\ (I_{XY} + I_{X'Y'})$



$I_{XY} = \frac{I_0}{2} = \frac{ML^2}{12}$ Ans.

10. (A)

Sol.



$\vec{a}_A = \vec{a}_{A/cm} + \vec{a}_{cm}$

$\vec{a}_{cm} = \frac{v^2}{5R}\downarrow$

$\vec{a}_{A/cm} = R\omega^2 = \frac{v^2}{R}\uparrow$

$\vec{a}_A = \left(\frac{v^2}{R} - \frac{v^2}{5R}\right)\uparrow = \frac{4v^2}{5R}\uparrow$

11. (C)

Sol. $a_s = \frac{g\sin\theta}{1+\frac{I}{mR^2}} = \frac{g\sin\theta}{7}$

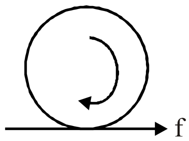
$a_c = \frac{2}{3} g \sin\theta$

12. (D)

Sol. Points on the disc, which are present on the circle of radius R & having center at point of contact will have speed $v = R\omega$.

13. (A)

Sol.



14. (B)

Sol. $40 \times 2 = 10\,\alpha$ .... (1)

$\theta = \frac{1}{2}\alpha t^2 = 36\,\omega$

$l = r\theta = 72$ m

15. (B)

Sol. $R\theta = h$

$\Rightarrow \theta = h/R$

16. (D)

Sol. $T \times R = f \times R$

$2f = mg\sin\theta$

$2\mu\, mg\cos\theta = mg\sin\theta$

$\mu = \frac{1}{2}\tan 30° = \frac{1}{2\sqrt{3}}$

17. (D)

Sol. $\vec{F}_{ext} = 0$ and $\vec{\tau}_{ext} = 0$

$\Rightarrow$ $\vec{P}$ = conserved and $\vec{L}$ = conserved

$\Rightarrow$ KE = conserved

But, $I_i \neq I_f$

Hence, $\omega_i \neq \omega_f$

18. (B)

Sol. Rotation energy = $\frac{1}{2}I\omega^2$ $I = mK^2$

linear energy = $\frac{1}{2}mv^2$ K = gyration radius

Total energy = $\frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$ $v = \omega R$

Frictional of its total energy associated with rotation.

$= \frac{\frac{1}{2}I\omega^2}{\frac{1}{2}mv^2 + \frac{1}{2}mv^2} = \frac{mK^2\omega^2}{mK^2\omega^2 + m\omega^2R^2}$

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

19. (D)

Sol. For rotational equation

$T_AX_A = T_BX_B$

X_A & X_B from Mg.

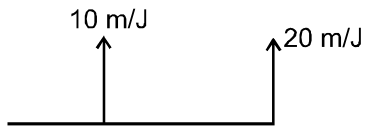
If $X_A > X_B$; $T_B > T_A$.

20. (D)

Sol. By definitiion of instantaneouscentre.

21. 20

Sol.



$20 = V_{cm} + wR$

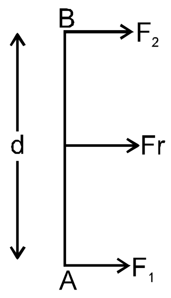
$20 = 10 + \omega\left(\frac{\ell}{2}\right)$

$10 = \frac{\omega}{2}$

(ω = 20 rad / sec)

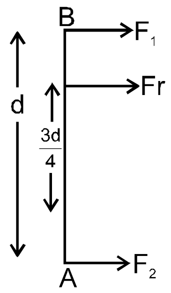
22. 8

Sol.



Torque about point A

$\tau_A = Fr\left(\frac{d}{2}\right) + F_2(d)$



$\tau'_A = Fr\left(\frac{3d}{4}\right) + F_1(d)$

$(F_1 + F_2)\frac{d}{2} + F_2 d = (F_1 + F_2)\left(\frac{3d}{4}\right) + F_1 d$

$\frac{F_1 + F_2}{2} + F_2 = \left(\frac{3}{4}F_1 + \frac{3}{4}F_2 + F_1\right)$

$\frac{F_1}{2} - \frac{3}{4}F_1 - F_1 = \left(\frac{3}{4}F_1 + F_2 - \frac{F_2}{2}\right)$

$\left(\frac{-F_1}{4} - F_1\right) = \left(\frac{-F_2}{4} - \frac{F_2}{2}\right)$

$\frac{5F_1}{4} = \frac{3F_2}{4}$

$5F_1 = 3F_2$

$\frac{F_1}{F_2} = \left(\frac{3}{5}\right).$

23. 250

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

24. 62

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

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

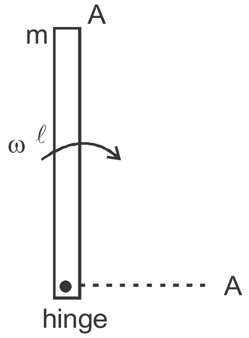
$\tau = \vec{r} \times \vec{F}$

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

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

25. 3

Sol.



using energy conservation

$mg\frac{\ell}{2} = \frac{1}{2}I\omega^2$

$mg\frac{\ell}{2} = \frac{1}{2}\cdot\frac{m\ell}{3}\omega^2$

$\ell = 1m \qquad \omega = \sqrt{\frac{3g}{\ell}}$

$V_A = \omega\ell = \sqrt{3g} = \left(\sqrt{3g}\right)$

26. 64

Sol. Mass of disc (X), $mx = \pi R^2 t\rho$

Where ρ = density of material of disc

$\therefore \qquad I_X = \frac{1}{2}m_X R^2 = \frac{1}{2}R^2 t\rho R^2$

$I_X = \frac{1}{2}\pi\rho R^4$ ....(i)

Again mass of disc (Y)

$m_y = \pi = (4R)^2\frac{t}{4}\rho = 4\pi R^2 t\rho$

and $I_Y = \frac{1}{2}m_Y(4R^2) = \frac{1}{2}4\pi R^2 t\rho .16R^2$

$\Rightarrow \qquad I_Y = 32\pi t\rho R^4$ ......(ii)

$\therefore \qquad \frac{I_Y}{I_X} = \frac{32\pi t\rho R^4}{\frac{1}{2}\pi\rho t R^4}$

$\Rightarrow \qquad = 64$

$\therefore \qquad I_Y = 64\, I_x$

27. 7

Sol. Final kinetic energy of both discs is same

$$\left[\frac{3}{2}\right]\frac{1}{2}m(3)^2 + mg\,(30) = \frac{3}{2}\frac{1}{2}mv_2^2 + mg(27)$$

$$\frac{3}{4}.\,9 + 300 = \frac{3}{4}v_2^2 + 270 \quad ;$$

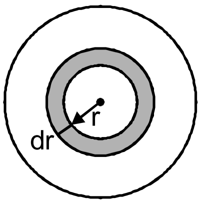
$$\frac{27}{4} + 30 = \frac{3}{4}v_2^2$$

$$\Rightarrow \quad v_2^2 = 9 + 40 \Rightarrow v_2 = 7$$

28. 6

Sol. Consider a shell of radius r and thickness dr

$$dI = \frac{2}{3}(\rho.4\pi r^2 dr)r^2$$



$$I = \int dI$$

$$\frac{I_B}{I_A} = \frac{\int_o^R \frac{2}{3}k\frac{r^5}{R^5}.4\pi r^2 dr \quad r^2}{\int_o^R \frac{2}{3}k\frac{r}{R}4\pi r^2 dr \quad r^2} = \frac{6}{10}$$

29. 20N

Sol. $mg\frac{R}{2} - fR = \tau = mR^2\alpha$ ...... (1)

$f = mac$ .... (2)

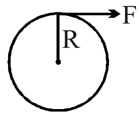
$a_c = R\alpha$ .... (3)

from (1) $a = \frac{g}{4R}$; $a_c = \frac{g}{4}$

$$f = \frac{mg}{4} = \frac{8\times10}{4} = 20\text{ N}$$

30. 8cm

Sol. $F \times R = \frac{2}{5}MR^2\alpha$



$$\alpha = \frac{5F}{2MR} \quad \Rightarrow \quad 2\pi = \frac{1}{2}\alpha t^2$$

$$\Rightarrow \quad t^2 = \frac{4\pi}{\alpha} \qquad \text{also } a_{cm} = \frac{F}{M}$$

$$S = \frac{1}{2}a_{cm}\,t^2 = \frac{1}{2}\left(\frac{F}{M}\right)\frac{4\pi}{\alpha} = \frac{1}{2}\left(\frac{F}{M}\right)\times$$

$$\frac{4\pi}{\left(\frac{5F}{2MR}\right)} = \frac{4\pi R}{5}$$

$$= \frac{4\times22}{35}\lambda\frac{35}{11} = 8\text{ cm}$$