Physicsaholics

DPP – 4

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Q 1. A fly wheel rotating about a fixed axis has a kinetic energy of 360J. When its angular speed is 30rad/s. The moment of inertia of the wheel about the axis of rotation is
(a) 0.6 kg-m^2 (b) 0.15 kg-m^2
(c) 0.8 kg-m^2 (d) 0.75 kg-m^2

Q 2. A wheel is rotating with an angular speed 20 rad/s. It is stopped to rest by applying constant torque in 4s. If the moment of inertia of the wheel about is axis is 0.20 kg-m^2, then the magnitude of work done by the torque in two seconds will be :
(a) 10 J (b) 20 J
(c) 30 J (d) 40 J

Q 3. Moment of inertia of a ring is 3 kg-m^2. It is rotated for 20 s from its rest position by a torque of 6 N−m. Calculate the work done
(a) 36 J (b) 800 J
(c) 1500 J (d) 2400 J

Q 4. A flywheel is in the form of a uniform circular disc of radius 1 m and mass 2 kg. The work which must be done on it to increase its frequency of rotation from 5 rev/s to 10 rev/s is approximately
(a) 150 J (b) 300 J
(c) 1500 J (d) 3000 J

Q 5. Energy of 1000 J is spent to increase the angular speed of a wheel from 20rad/s to 30rad/s. Calculate the moment of inertia of the wheel.
(a) 4 kg-m^2 (b) 400 kg-m^2
(c) 80 kg-m^2 (d) 300 kg-m^2

Q 6. If the angular momentum of a body increases by 50%, its kinetic energy of rotation increases by
(a) 50 % (b) 25 %
(c) 125 % (d) 100 %

Q 7. A flywheel of moment of inertia 5.0 kg m^2 is rotated at a speed of 60 rad/s. Because of the friction at the axle, it comes to rest in 5.0 minutes. Find the average torque of the friction and the magnitude of angular momentum of the wheel 1 minute before it stops rotating
(a) 1 N-m, 60 (b) 2 N-m, 40
(c) 3 N-m, 20 (d) 4 N-m, 30

Q 8. A rigid body rotates with an angular momentum L. If its kinetic energy is halved, the angular momentum becomes

(a) L (b) L/2

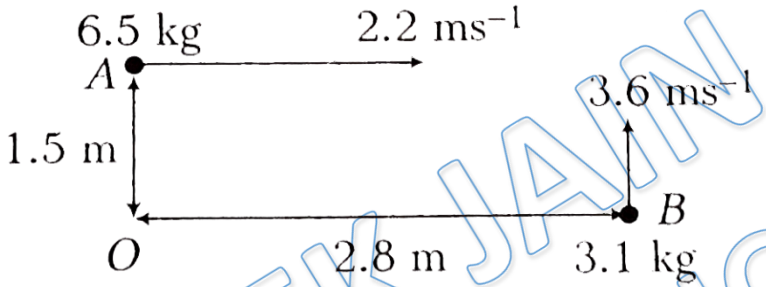
(c) 2L (d) $L/\sqrt{2}$

Q 9. A flywheel of moment of inertia 7.5 kg-m^2 is rotating at 240 revolution per minute; calculate its K.E

(a) 2218 J (b) 2368 J

(c) 1278 J (d) 3288 J

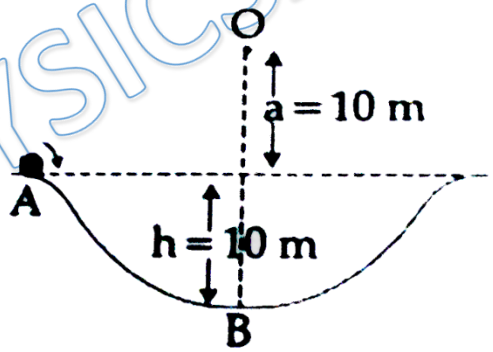
Q 10. Two particle A and B are moving as shown in the figure. Their total angular momentum (in kg-m^2/s) about the point O is



(a) 9.8 (b) zero

(c) 52.7 (d) 37.9

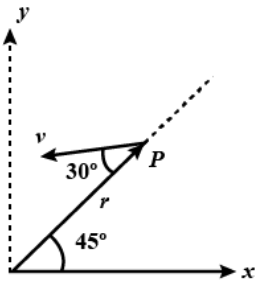
Q 11. A particle of mass 20g is released with an initial velocity 5m/s along the curve from the point A, as shown in the figure. The point A is at height h from point B. The particle slides along the frictionless surface. When the particle reaches point B, its angular momentum about O will be : (Take g=10m/s^2).



(a) 2 kg-m^2/s (b) 8 kg-m^2/s

(c) 6 kg-m^2/s (d) 3 kg-m^2/s

Q 12. A particle P with a mass 2.0 kg has position vector r = 3.0 m and velocity v = 4.0 m/s as shown. It is accelerated by the force = 2.0 N. All these vectors lie in a common plane. The angular momentum vector about origin is



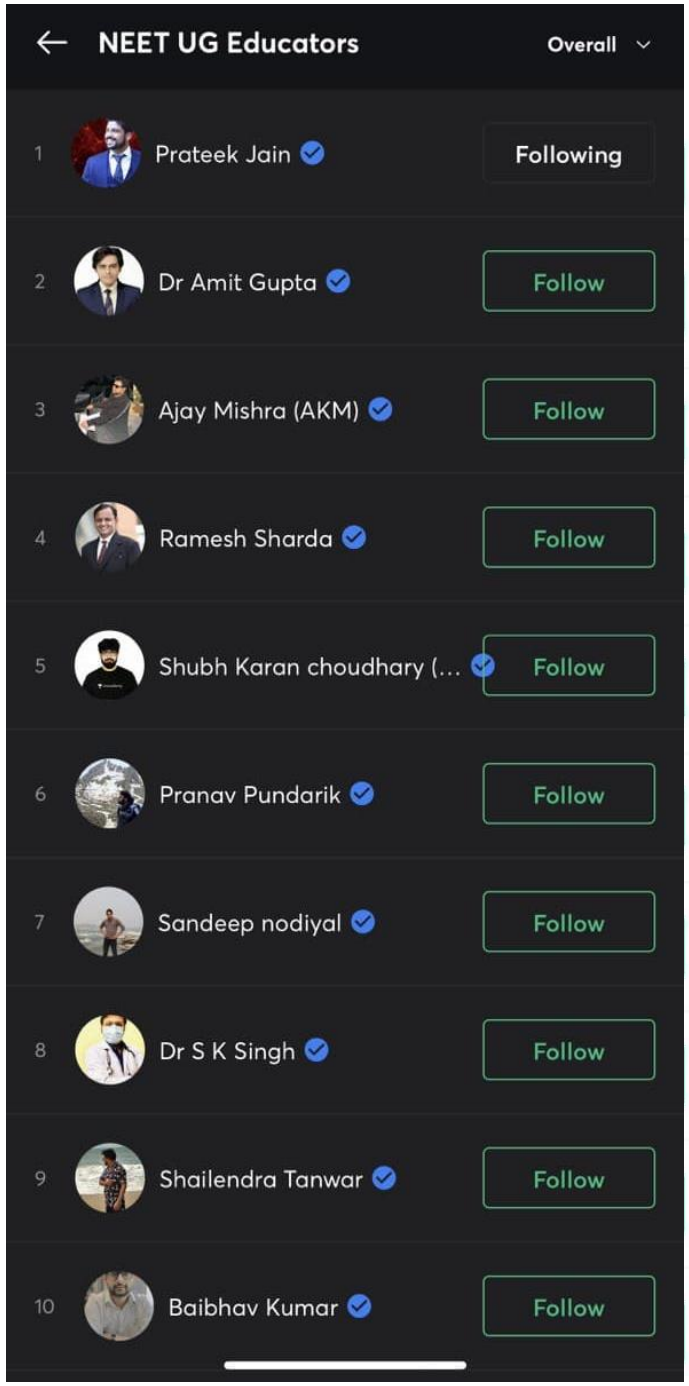
(a) 12 kg-m^2/s out of the plane of the figure
(b) 12 kg-m^2/s into of the plane of the figure
(c) Zero
(d) 24 kg-m^2/s into of the plane of the figure

Q 13. Find angular momentum (in kg-m^2/s) of particle of mass 0.01 kg, position vector $\vec{r}$ =(10$\hat{\imath}$ + 6$\hat{\jmath}$) meter and moving with a velocity 5 $\hat{\imath}$ m/s About the origin

(a) 3 $\hat{\imath}$ (b) $-0.3\ \hat{k}$
(c) $-20\ \hat{k}$ (d) $-3\ \hat{k}$

Answer Key

Q.1 c	**Q.2 c**	**Q.3 d**	**Q.4 c**	**Q.5 a**
Q.6 c	**Q.7 a**	**Q.8 d**	**Q.9 b**	**Q.10 a**
Q.11 c	**Q.12 a**	**Q.13 b**		



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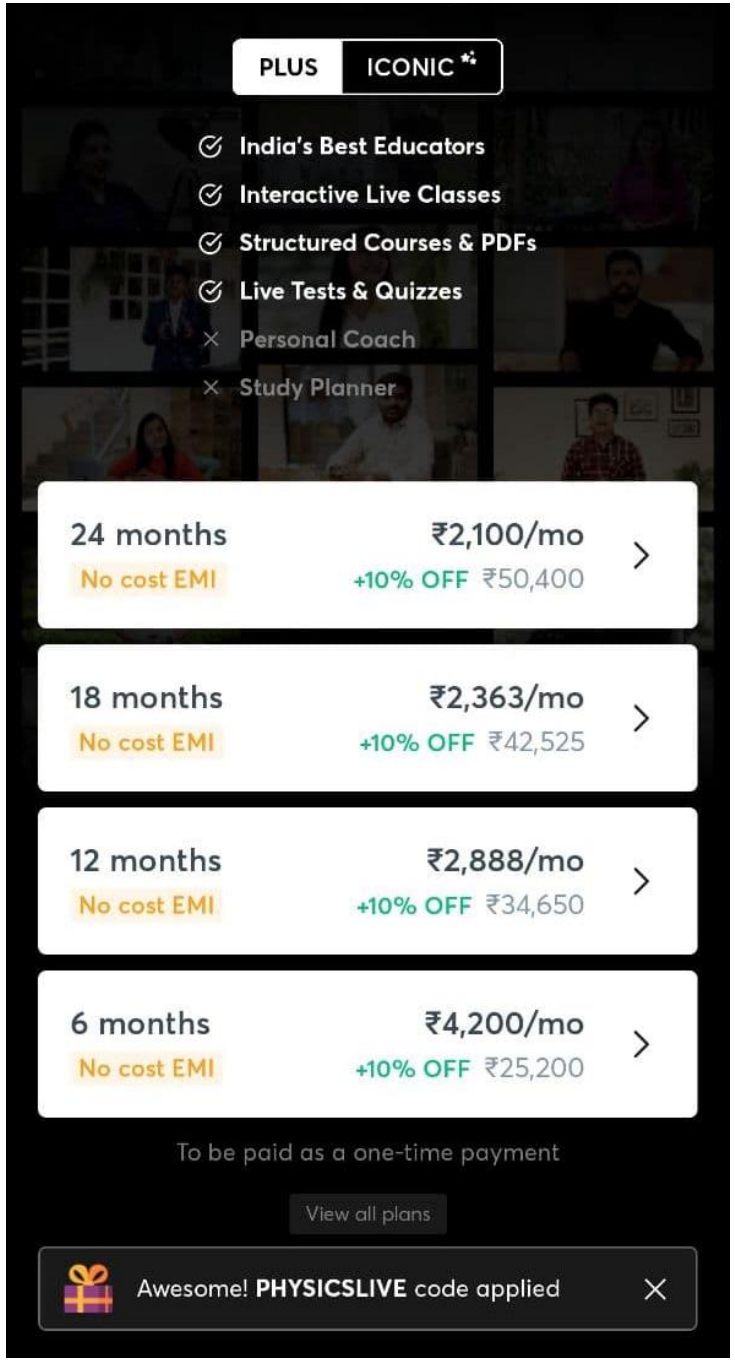


Written Solution

DPP- 4 Rotation: Rotational Kinetic Energy & Angular Momentum

By Physicsaholics Team

Solution: 1

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

$$360 = \frac{1}{2} I (30)^2$$

$$I = \frac{720}{900}$$

$$I = \frac{8}{10}$$

$$I = 0.8 \text{ kg-m}^2 \quad \text{Ans.}$$

Ans. c

Solution: 2

$\omega = 20$ rad/s

$\omega = \omega_0 + \alpha t$

$0 = 20 + \alpha(4)$

$\boxed{\alpha = -5 \text{ rad/s}^2}$

at $t = 2$ sec

$\omega = \omega_0 + \alpha t$

$\omega = 20 - 5(2)$

$\boxed{\omega = 10 \text{ rad/s}}$

W.D. = change in K.E.

$W.D. = \frac{1}{2} I (\omega_f^2 - \omega_i^2)$

$= \frac{1}{2} I (10^2 - 20^2)$

$= \frac{1}{2} \times 0.20 \times (-300)$

$\boxed{W.D. = -30 \text{ J}}$ Ans-

Ans. c

Solution: 3

$\tau = I\alpha$

$6 = 3 \times \alpha$

$\boxed{\alpha = 2 \text{ rad/s}^2}$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2}(2)(20)^2$

$\boxed{\theta = 400 \text{ rad}}$

$\omega = 2 \times \theta$

$= 6 \times 400$

$\boxed{\omega = 2400 \text{ J}}$ kg

Ans. d

Solution: 4

$$I = \frac{mr^2}{2} = \frac{2 \times (1)^2}{2}$$

$$\boxed{I = 1 \text{ kg-m}^2}$$

$f_1 = 5$ rev/s $\Rightarrow \omega_1 = 5 \times 2\pi = 10\pi$ rad/s

$f_2 = 10$ rev/s $\Rightarrow \omega_2 = 10 \times 2\pi = 20\pi$ rad/s

$$W.D. = \Delta KE = \frac{1}{2} I (\omega_2^2 - \omega_1^2)$$

$$WD = \frac{1}{2} \times 1 \times (20\pi)^2 - (10\pi)^2 = \frac{1}{2}(400\pi^2 - 100\pi^2)$$

$$WD = 150\pi^2 \simeq 150 \times 10$$

$$\boxed{WD \simeq 1500 \text{ J}}$$ Ans.

Ans. c

Solution: 5

$$W.D = \frac{1}{2} I \left((30)^2 - (20)^2\right)$$

$$1000 = \frac{1}{2} I (900 - 400)$$

$$1000 = \frac{I}{2} (500)$$

$$I = 4\ kg\text{-}m^2 \quad \text{Ans.}$$

Ans. a

Solution: 6

$$KE = \frac{1}{2} I\omega^2 = \frac{L^2}{2I} \quad -(1)$$

and $L = I\omega$

if $L_2 = 1.5L$

then; $KE_2 = \frac{(1.5L)^2}{2I}$ $-(2)$

$$\frac{(1)}{(2)} \Rightarrow \frac{KE}{KE_2} = \frac{L^2/2I}{(1.5L)^2/2I} = \frac{1}{(1.5)^2} = \frac{1}{2.25} = \frac{100}{225}$$

$$KE_2 = \frac{225}{100} KE = \frac{9}{4} KE$$

$$\%\,KE = \frac{\frac{9}{4}KE - KE}{KE} \times 100 = \frac{5}{4} \times 100 = 125\% \uparrow \text{ Ans}$$

Ans. c

Solution: 7

5 min = 300 sec

1 min = 60 sec

$I = 5\ kg\text{-}m^2$

$\omega_0 = 60\ rad/s$

$\omega = \omega_0 + \alpha t$

$0 = 60 + \alpha(300)$

$\boxed{\alpha = -\frac{1}{5}\ rad/s^2}$

$\tau = I\alpha$

$\tau = 5 \times \frac{1}{5}$

$\boxed{\tau = 1\ N\text{-}m}$

at $t = 240\ s$ or 4 mnt

$\omega = \omega_0 + \alpha t$

$\omega = 60 - \frac{1}{5} \times 240 = 60 - 48$

$\omega = 12$

$L = I\omega$

$L = 5 \times 12$

$\boxed{L = 60\ kg\text{-}m^2\text{-}rad/s}$

Ans. a

Solution: 8

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

$$KE_2 = \frac{KE}{2}$$

$$KE_2 = \frac{L_2^2}{2I} \quad \text{---(2)}$$

$$\frac{(1)}{(2)} \Rightarrow \frac{KE}{KE/2} = \frac{L^2/2I}{L_2^2/2I}$$

$$2 = \left(\frac{L}{L_2}\right)^2$$

$$\boxed{L_2 = \frac{L}{\sqrt{2}}} \quad \text{Ans.}$$

Ans. d

Solution: 9

$I = 7.5\ kg\text{-}m^2 \qquad f = 240\ rev/min$

$\omega = 240 \times \frac{2\pi}{60}$

$\omega = 8\pi\ rad/s$

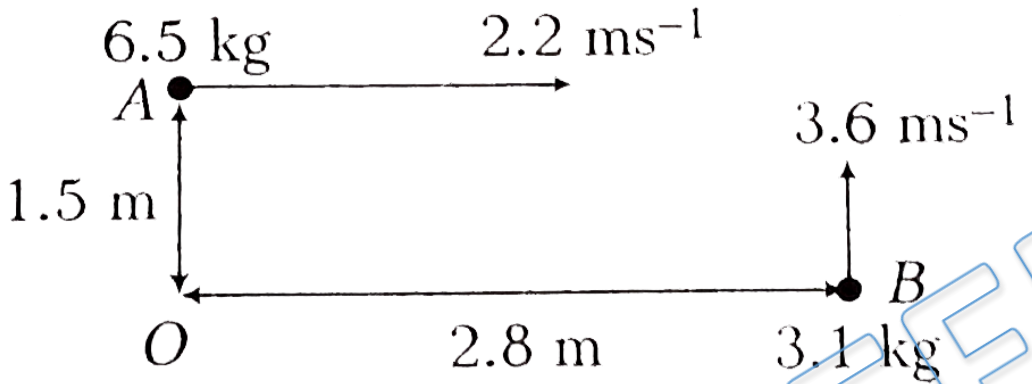
$KE = \frac{1}{2} I \omega^2 = \frac{1}{2} \times (7.5) \times (8\pi)^2$

$KE = \frac{7.5}{2} \times 64 \times \pi^2 = \frac{7.5 \times 64 \times \pi^2}{2}$

$\boxed{KE = 2368\ J}$ Ans.

Ans. b

Solution: 10



$\vec{L} = \vec{L}_A + \vec{L}_B$

$L = (6.5 \times 2.2 \times 1.5) - (3.1 \times 2.8 \times 3.6)$

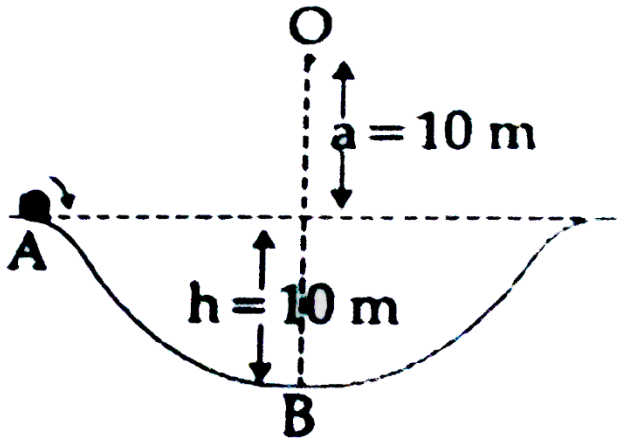
$L = 21.45 - 31.25$

$L = -9.80$

$L = 9.80$ kg-m²/s (up the plane) Ans.

Ans. a

Solution: 11



$K.E_i + P.E_i = K.E_f + P.E_f$

$\frac{1}{2}m(5)^2 + mg(10) = \frac{1}{2}mv^2 + 0$

$\frac{25}{2} + 100 = \frac{v^2}{2}$

$v^2 = 225$

$\boxed{v = 15 \text{ m/s}}$

$L = mvr$

$r = a + h = 10 + 10 = 20\text{ m}$

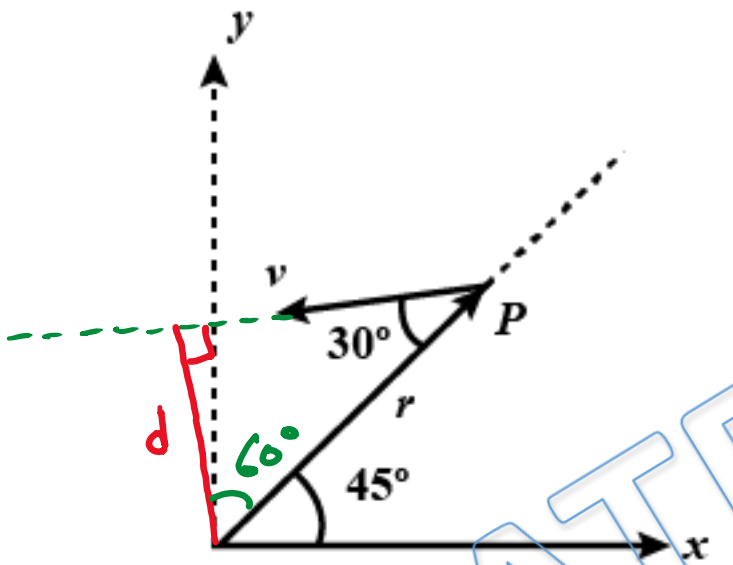
$L = (20\times10^{-3}) \times 15 \times 20$

$L = 400 \times 15 \times 10^{-3}$

$\boxed{L = 6 \text{ kg-m}^2/\text{s}}$ Ans

Ans. c

Solution: 12



$L = mvd$

$L = 2 \times 4 \times 1.5$

$L = 12 \text{ kg-m}^2/\text{s}$ (out the plane)

$d = r\cos 60°$

$d = 3 \times \frac{1}{2}$

$d = 1.5 \text{ m}$

Ans. a

Solution: 13

$$\vec{L} = m(\vec{r} \times \vec{v})$$

$$\vec{L} = 0.01\left[(10\hat{i} + 6\hat{j}) \times (5\hat{i})\right]$$

$$\vec{L} = 0.01\left[-30\hat{k}\right]$$

$$\boxed{\vec{L} = -0.3\hat{k}} \quad \text{Ans.}$$

Ans. b

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