Physicsaholics

DPP – 3

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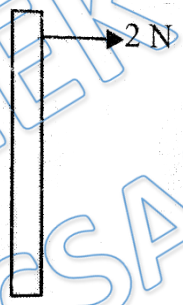
Q 1. The moment of inertia of a body is 2.5 kg-m^2. Calculate the torque required to produce an angular acceleration of 18 rad/s^2 in the body

(a) 45 N-m (b) 56 N-m
(c) 13 N-m (d) 27 N-m

Q 2. A flywheel of moment of inertia 5.0 kg−m^2 is rotated at a speed of 10rad/s because of the friction at the axis it comes to rest in 10s. Find the average torque of the friction.

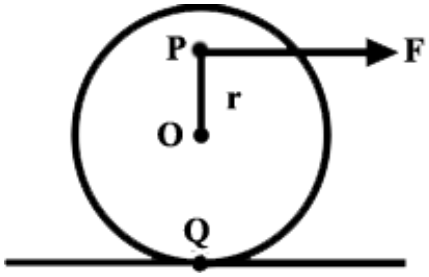
(a) 1 N-m (b) 3 N-m
(c) 2 N-m (d) 5 N-m

Q 3. Find acceleration a and angular acceleration α. If F = 2N, m = 1kg and l = 2m.



(a) 2 m/s^2, 6 rad/s^2 (b) 6 m/s^2, 2 rad/s^2
(c) 4 m/s^2, 4 rad/s^2 (d) 3 m/s^2, 5 rad/s^2

Q 4. A uniform disc of mass m, radius R is placed on a smooth horizontal surface. If we apply a horizontal force F at P as shown in the figure. If F = 4N, m = 1kg, R = 1m and r = $\frac{1}{2}$ m then, find the angular acceleration of the disc (in rad/s^2)



(a) 2 (b) 4
(c) 40 (d) 27

Q 5. A string is wrapped around a cylinder of mass M and radius R. The string is pulled vertically upwards to prevent the center of mass from falling as the cylinder unwinds the string, The tension in the string is

(a) $\frac{2Mg}{3}$ (b) $\frac{Mg}{2}$
(c) Mg (d) $\frac{Mg}{6}$

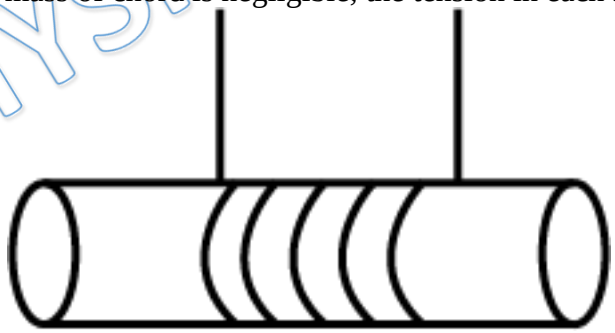
Q 6. Torques of equal magnitude are applied to a hollow cylinder and a solid sphere, both having the same mass and radius. The cylinder is free to rotate about its standard axis of symmetry, and the sphere is free to rotate about an axis passing through its center.
(a) The angular velocity at a certain time will be greater for solid sphere
(b) The angular velocity at a certain time will be greater for Hollow cylinder
(c) The angular velocity at a certain time will be equal for both
(d) None of these

Q 7. A torque of 2 newton-m produces an angular acceleration of 2 rad/sec^2 a body. If its radius of gyration is 2m, its mass will be
(a) 2 kg (b) 4 kg
(c) 1/2 kg (d) 1/4 kg

Q 8. A flywheel of moment of inertia 3×10^2 kgm^2 is rotating with uniform angular speed of 4.6 rad/s. If a torque of 6.9×10^2 Nm retards the wheel, then the time in which the wheel comes to rest is
(a) 1.5 s (b) 2 s
(c) 0.5 s (d) 1 s

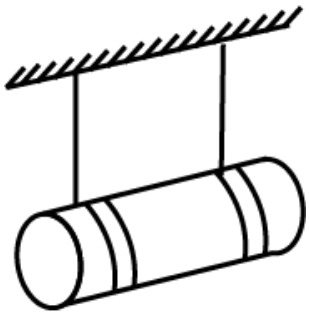
Q 9. A flywheel of moment of inertia 0.4 Kg/m^2 and radius 0.2m is free to rotate about a central axis. If a string is wrapped around it and it is pulled with a force of 10N then its angular velocity after 4s of start will be
(a) 5 rad/s (b) 20 rad/s
(c) 10 rad/s (d) 0.8 rad/s

Q 10. A solid cylinder of mass M and radius R starts falling under gravity at t = 0 as shown in the figure. If the mass of chord is negligible, the tension in each string is?



(a) $\frac{Mg}{2}$ (b) Mg
(c) $\frac{Mg}{3}$ (d) $\frac{Mg}{6}$

Q 11. A solid cylinder of mass M and radius R starts falling freely under gravity at t = 0 as show in the figure. The tension in each string at any given time t is T. The instantaneous power developed by the gravitational force at time t is P. The linear acceleration of the cylinder is a. Then which of the following is incorrect:



(a) $T = \frac{Mg}{6}$ (b) $a = \frac{2g}{3}$

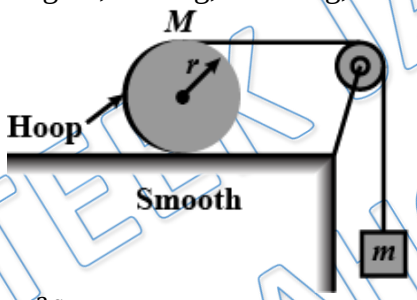
(c) $P = \frac{2}{3}Mg^2t$ (d) angular acc. $= \frac{7g}{19R}$

Q 12. A torque of 2.0×10^{-4} Nm is applied to produce an angular acceleration of 4 rad/s^2 in a rotating body. What is the moment of inertia of the body ?

(a) 2×10^{-5} kg-m^2 (b) 5×10^{-5} kg-m^2

(c) 2×10^{-4} kg-m^2 (d) 5×10^{-4} kg-m^2

Q 13. For the system shown in figure, M=1kg, m=0.2kg, r=0.2m. Calculate tension in string

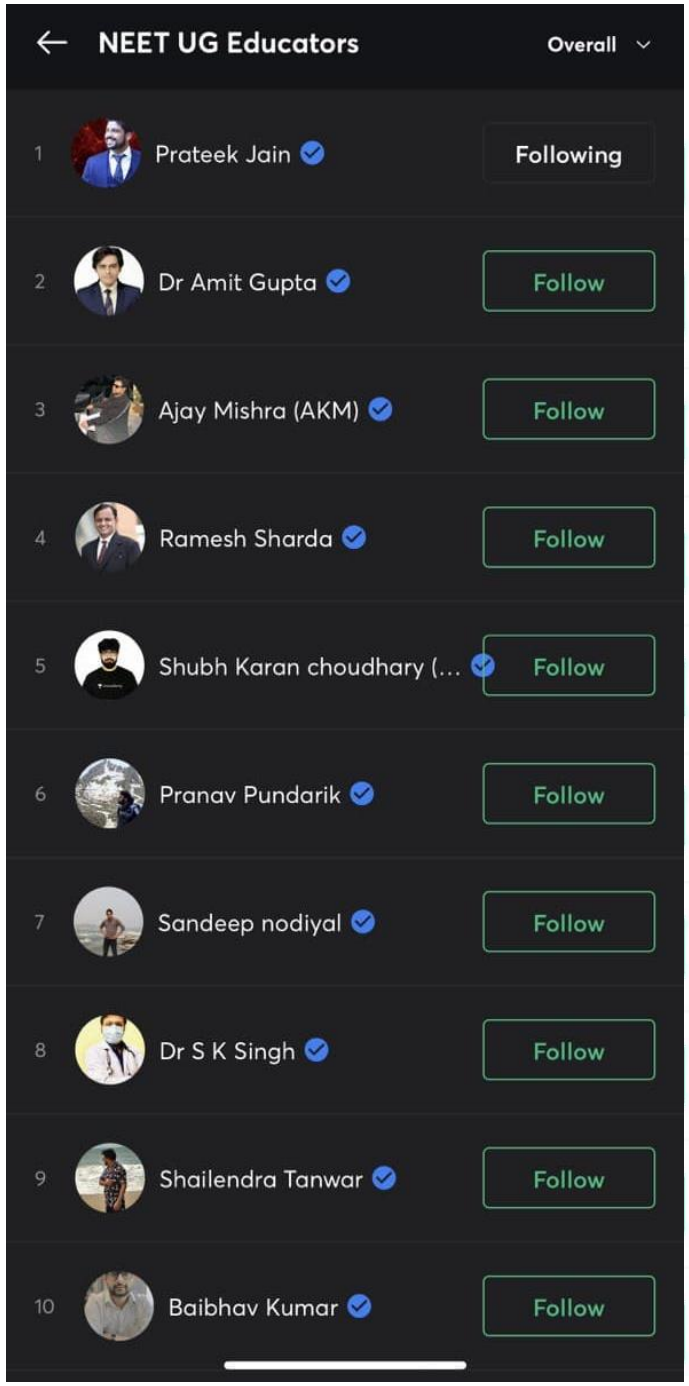


(a) $\frac{g}{7}$ (b) $\frac{2g}{3}$

(c) $\frac{3g}{2}$ (d) $\frac{11g}{12}$

Answer Key

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



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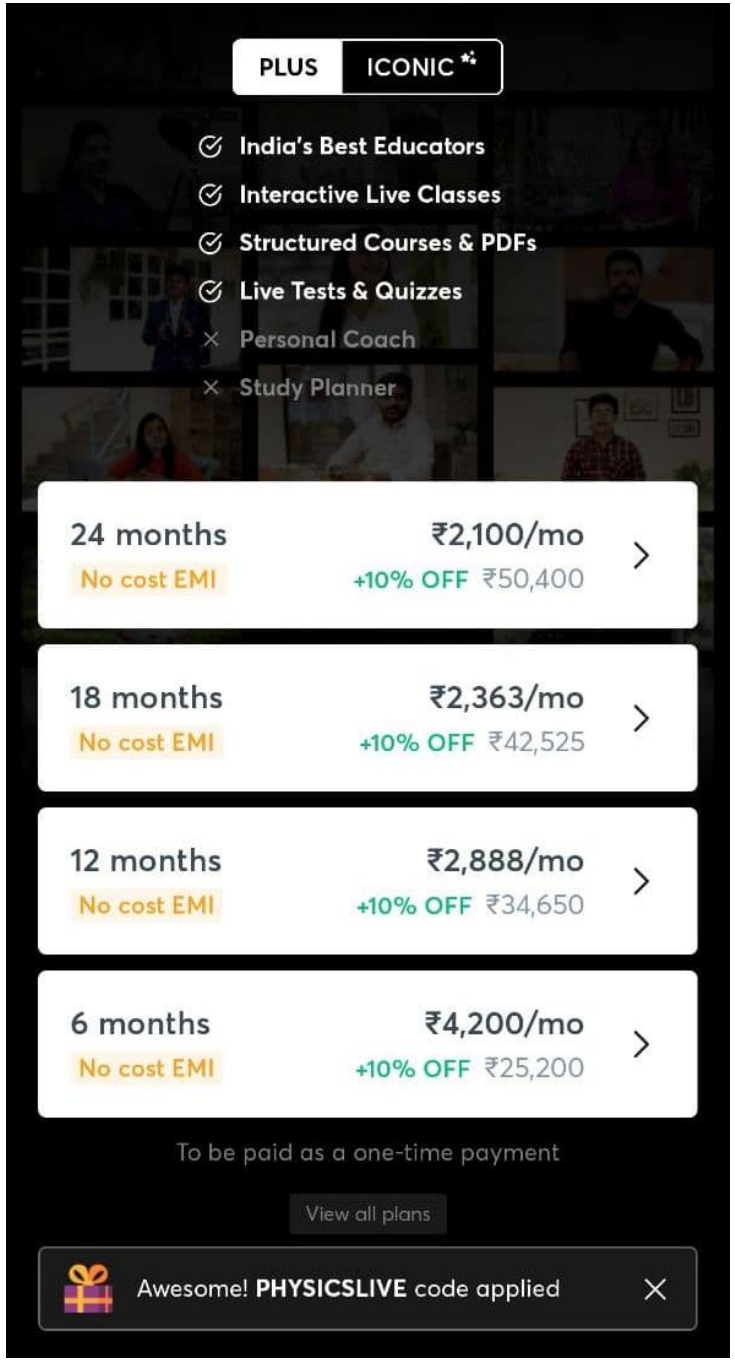


Written Solution

DPP- 3 Rotation: Relation between Torque & Moment of inertia

By Physicsaholics Team

Solution: 1

$I = 2.5 \text{ kg-m}^2$

$\alpha = 18 \text{ rad/s}^2$

$\tau = I\alpha$

$\tau = 2.5 \times 18$

$\boxed{\tau = 45 \text{ N-m}}$ Ans

Ans (a)

Solution: 2

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

$\omega = 10\ rad/s$

$\omega = \omega_0 + \alpha t$

$0 = 10 + \alpha(10)$

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

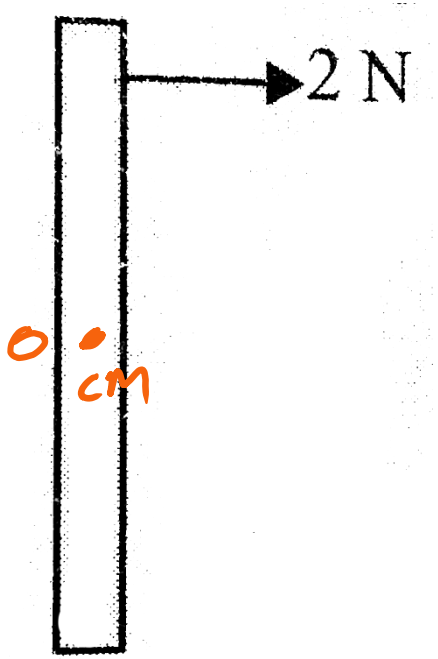
$\tau = I\alpha$

$\tau = 5 \times 1$

$\boxed{\tau = 5\ N\text{-}m}$ Ans.

Ans (d)

Solution: 3



$\tau_o = 2 \times \left(\frac{2}{2}\right) = 2$ N-m

$\tau = I\alpha$; $I = \frac{md^2}{12}$

$2 = \frac{1 \times (2)^2}{12} \alpha$

$\alpha = 6$ rad/s^2 Ans

$a_{cm} = \frac{F}{m} = \frac{2}{1}$

$a_{cm} = 2$ m/s^2 Ans

Ans. a

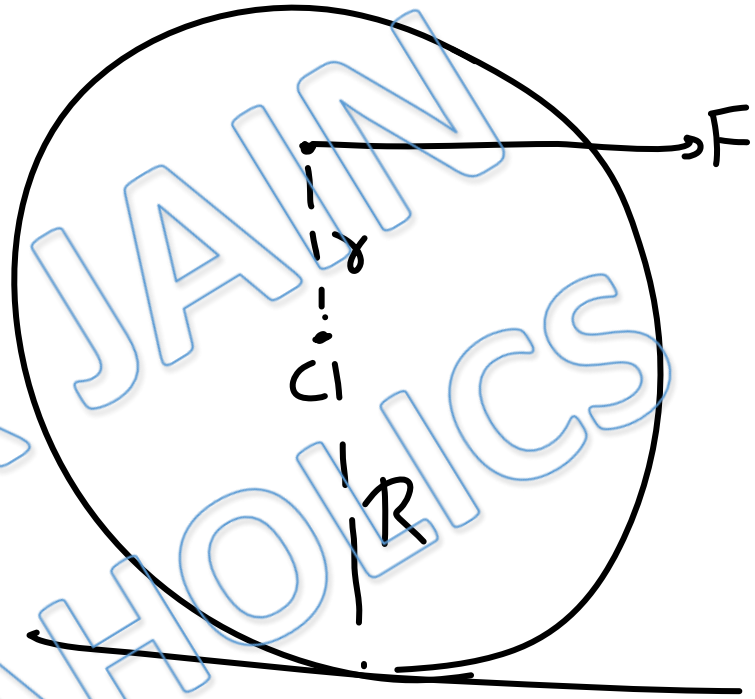
Solution : 4

$$I_{CM} = \frac{mR^2}{2} = \frac{1 \times 1^2}{2} = 1/2$$

$$\tau_{CM} = F\gamma = 4 \times \frac{1}{2}$$

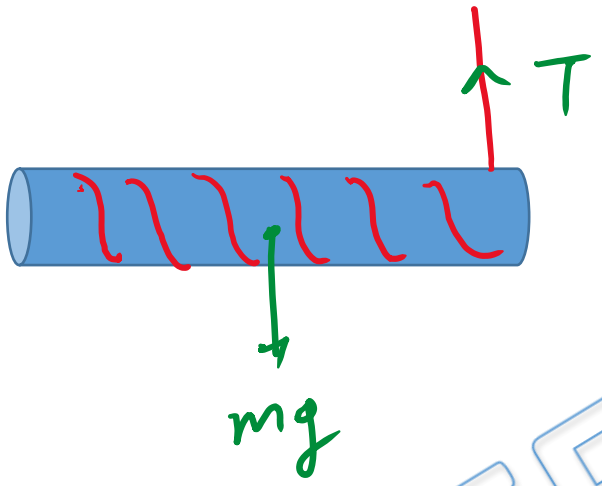
$$\tau_{CM} = I_{CM}\alpha$$

$$\alpha = 4 \text{ rad/sec}^2$$



Ans (b)

Solution: 5



if COM is not moving

then; $F_{ext} = 0$

so; $\boxed{T = mg}$ Ans

Ans. c

Solution: 6

Hollow cylinder

$I_c = mr^2$

$\tau = I\alpha$

Solid sphere

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

$\Rightarrow \alpha_s > \alpha_c$

& $\omega = \omega_0 + \alpha t$

as $\alpha_s > \alpha_c$

so ; in same time

$\boxed{\omega_s > \omega_c}$

$\Rightarrow$ $\because \tau$ = same on both

so; $(\tau)_c = (\tau)_s$

$\Rightarrow I_c\alpha_c = I_s\alpha_s$

$mr^2\,\alpha_c = \frac{2}{5}mr^2\alpha_s$

$\boxed{\frac{\alpha_c}{\alpha_s} = \frac{2}{5}}$ $\Rightarrow \alpha_s > \alpha_c$

Ans. a

Solution: 7

$$\tau = I\alpha$$

$$\tau = mK^2\alpha$$

$$2 = m \times 2^2 \times 2$$

$$m = 1/4\ kg$$

Ans. d

Solution: 8

$I = 3 \times 10^2 \text{ kg-m}^2$

$\tau = 6.9 \times 10^2 \text{ N-m}$

$\omega = 4.6 \text{ rad/s}$

$\tau = I\alpha$

$\alpha = \frac{\tau}{I} = \frac{6.9 \times 10^2}{3 \times 10^2}$

$\alpha = 2.3 \text{ rad/s}^2$

α is retarding

so, $\boxed{\alpha = -2.3 \text{ rad/s}^2}$

$\omega = \omega_0 + \alpha t$

$0 = 4.6 + (-2.3)\, t$

$\boxed{t = 2 \text{ sec}}$ Ans

Ans. b

Solution: 9

$r = 0.2\,m$

$\tau = r \times F$

$\tau = 0.2 \times 10$

$\therefore \tau = 2\ N\text{-}m$

$\tau = I\alpha$

$2 = 0.4\alpha$

$\alpha = 5\ rad/s^2$

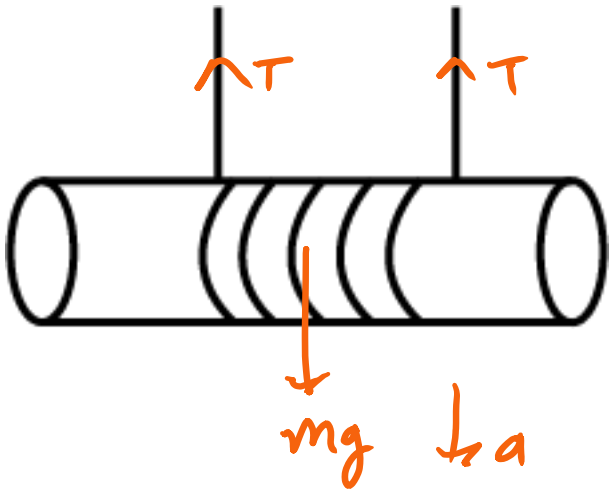
$\omega = \omega_0 + \alpha t$

$\omega = 0 + 5 \times 4$

$\omega = 20\ rad/s$ Ans.

Ans. b

Solution: 10



$mg - 2T = ma$

$a = \alpha R$

$\tau = (2T) \times R = I\alpha$

$2T \times R = \frac{MR^2}{2}\alpha$

$\boxed{\alpha = \frac{4T}{MR}}$

$a = \alpha R = \frac{4T}{MR} \times R = \frac{4T}{M}$

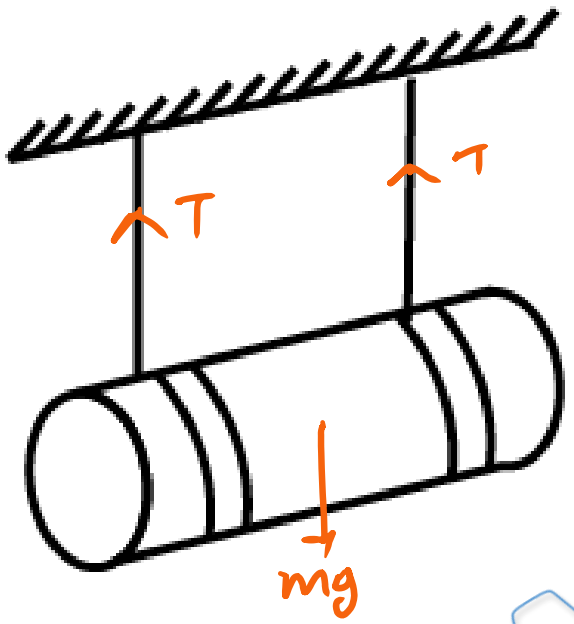
$mg - 2T = M\left(\frac{4T}{M}\right)$

$mg = 6T$

$\boxed{T = \frac{mg}{6}}$ Ans.

Ans. d

Solution: 11



$mg - 2T = ma$

$\tau = 2TR = I\alpha$

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

$\boxed{\alpha = \frac{4T}{mR}}$

$a = \alpha R = \frac{4T}{mR} \times R = \frac{4T}{m}$

$mg - 2T = m\left(\frac{4T}{m}\right) = 4T$

$\boxed{T = \frac{mg}{6}}$; $\alpha = \frac{4\left(\frac{mg}{6}\right)}{mR} = \frac{4g}{6R}$

$\Rightarrow \boxed{\alpha = \frac{4g}{6R}}$

$a = \alpha R$

$a = \frac{4g}{6R} \times R = \frac{4g}{6} = \frac{2g}{3}$

$\boxed{a = \frac{2g}{3}}$

at $t = t$

$\omega = \omega_0 + \alpha t$

$\omega = \frac{4g}{6R}t = \frac{2gt}{3R}$

$\Rightarrow v = R\omega = \frac{2gt}{3}$

$P = Fv = mg\left(\frac{2gt}{3}\right)$

$\boxed{P = \frac{2}{3}mg^2t}$ Ans.

Ans. d

Solution: 12

$\tau = 2 \times 10^{-4}$ Nm

$\alpha = 4$ rad/s^2

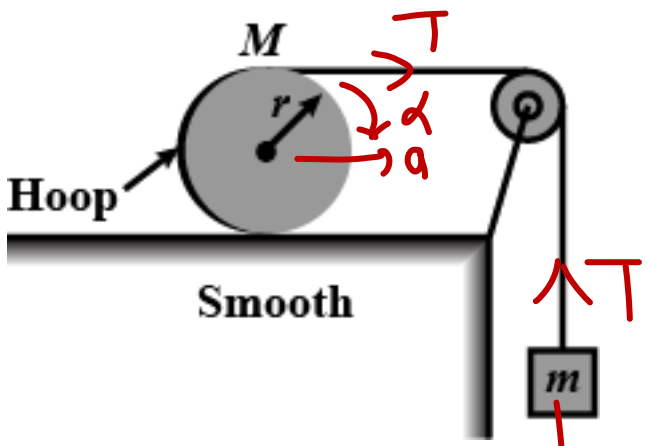
$\tau = I \alpha$

$2 \times 10^{-4} = I(4)$

$I = 5 \times 10^{-5}$ kg-m^2 Ans.

Ans. b

Solution: 13



$M = 1\,kg$, $m = 0.2\,kg$, $r = 0.2\,m$

$mg - T = ma_0$ — (I)

$T = Ma$ — (II)

$a_0 = a + \alpha r$

$\tau_{cm} = I_{cm}\alpha \Rightarrow Tr = Mr^2\alpha$

$r\alpha = T/M$ — (III)

$g - \frac{T}{m} = \frac{T}{M} + \frac{T}{M} = \frac{2T}{M}$

$\Rightarrow g = T\left(\frac{1}{0.2} + \frac{2}{1}\right) = 7T$

$\Rightarrow T = g/7$

Ans. a

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