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DPP – 6B (Rotation)

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Q 1. When different regular bodies roll down along an inclined plane from rest, then acceleration will be maximum for a body whose -
(a) radius of gyration is least
(b) mass is least
(c) surface area is maximum
(d) moment of inertia is maximum

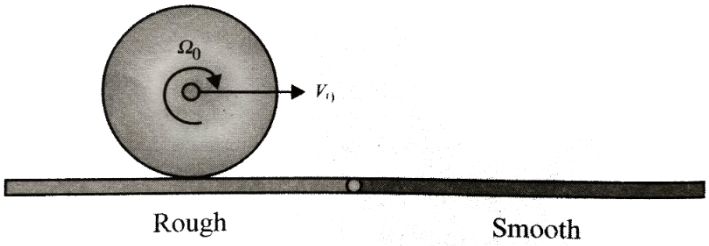
Q 2. A solid iron sphere A rolls down an inclined plane, while another hollow sphere B with the same mass and external radius also rolls down the inclined plane from same point. If V_A and V_B are their velocities at the bottom of the inclined plane, then
(a) $V_A > V_B$
(b) $V_A = V_B$
(c) $V_A < V_B$
(d) $V_A > = < V_B$

Q 3. When different regular bodies slide down along an rough inclined plane from rest, acceleration
(a) Will be maximum for ring
(b) Will be minimum for ring
(c) Will be maximum for solid sphere
(d) will be same for all

Q 4. A motorcycle is accelerating on a level road , direction of friction on
(a) rear wheel is in forward direction
(b) rear wheel is in backword direction
(c) Front wheel is in forward direction
(d) Front wheel is zero

Q 5. A disc is projected on rough horizontal surface with velocity v. find velocity of its centre when it starts rolling ?
(a) v
(b) v/2
(c) v/3
(d) 2v/3

Q 6. A rolling body of mass m and radius R is rolling on a rough surface without any pulling force as shown in figure. What happens when it enters on a smooth surface?

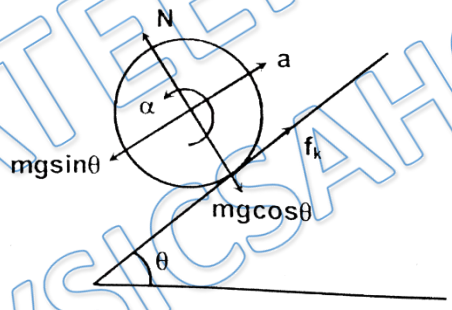


(a) Will move with half of initial angular speed
(b) Will move with double the initial angular speed
(c) Will continue rolling with the same angular speed
(d) cannot say anything

Q 7. What is the minimum coefficient of friction for a solid sphere to roll without slipping on an inclined plane of inclination θ?

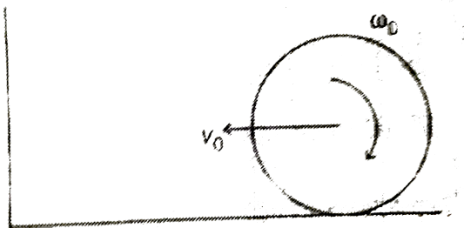
(a) $\frac{2}{7}\tan\theta$ (b) $\frac{1}{3}g\tan\theta$
(c) $\frac{1}{2}\tan\theta$ (d) $\frac{2}{5}\tan\theta$

Q 8. A uniform solid sphere of mass m and radius 'R' is imparted an initial velocity v_o and angular $\omega_0 = \frac{2v_o}{R}$ and then placed on a rough inclined plane of inclination 'theta' and coefficient of friction μ = 2tanθ as shown. The time after which the sphere will start rolling without slipping is



(a) $\frac{v_o}{2g\sin\theta}$ (b) $\frac{v_o}{4g\sin\theta}$
(c) $\frac{v_o}{6g\sin\theta}$ (d) $\frac{v_o}{8g\sin\theta}$

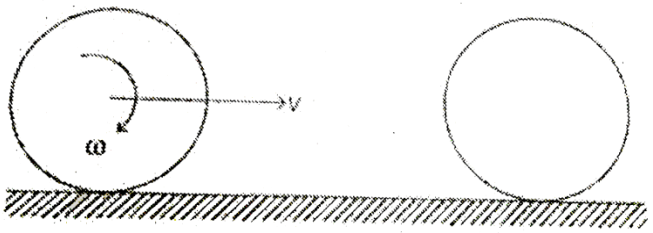
Q 9. A solid sphere has linear velocity v_0 = 4 m/s and angular velocity ω_0 = 9 rad/s as shown. Ground on which it is moving , is smooth . It collides elastically with a rough wall of coefficient of friction μ . Radius of the sphere is 1m and mass is 2 kg. If the sphere after colliding with the wall rolls without slipping on opposite direction, then coefficient of friction μ is



(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$

(c) $\frac{3}{4}$ (d) $\frac{1}{4}$

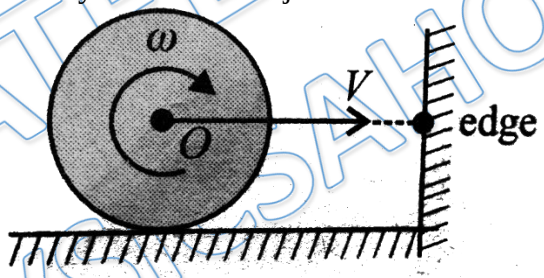
Q 10. A solid sphere is rolling without slipping on rough ground as shown in figure. If collides elastically with an identical another sphere at rest. There is no friction between the two spheres . Radius of each sphere is R and mass is m. Linear velocity of first sphere after it again starts rolling without slipping is



(a) $\frac{v}{7}$ (b) $\frac{2v}{7}$

(c) $\frac{7v}{2}$ (d) $\frac{3v}{4}$

Q 11. A uniform solid sphere of radius r is rolling on a smooth horizontal surface with velocity v and angular velocity ω (v = ωr). The sphere collides with a sharp edge on the wall as shown in figure. The coefficient of friction between the sphere and the edge μ=1/5. Just after the collision the angular velocity of the sphere becomes equal to zero. The linear velocity of the surface just after the collision is equal to



(a) v (b) $\frac{v}{5}$

(c) $\frac{3v}{5}$ (d) $\frac{v}{6}$

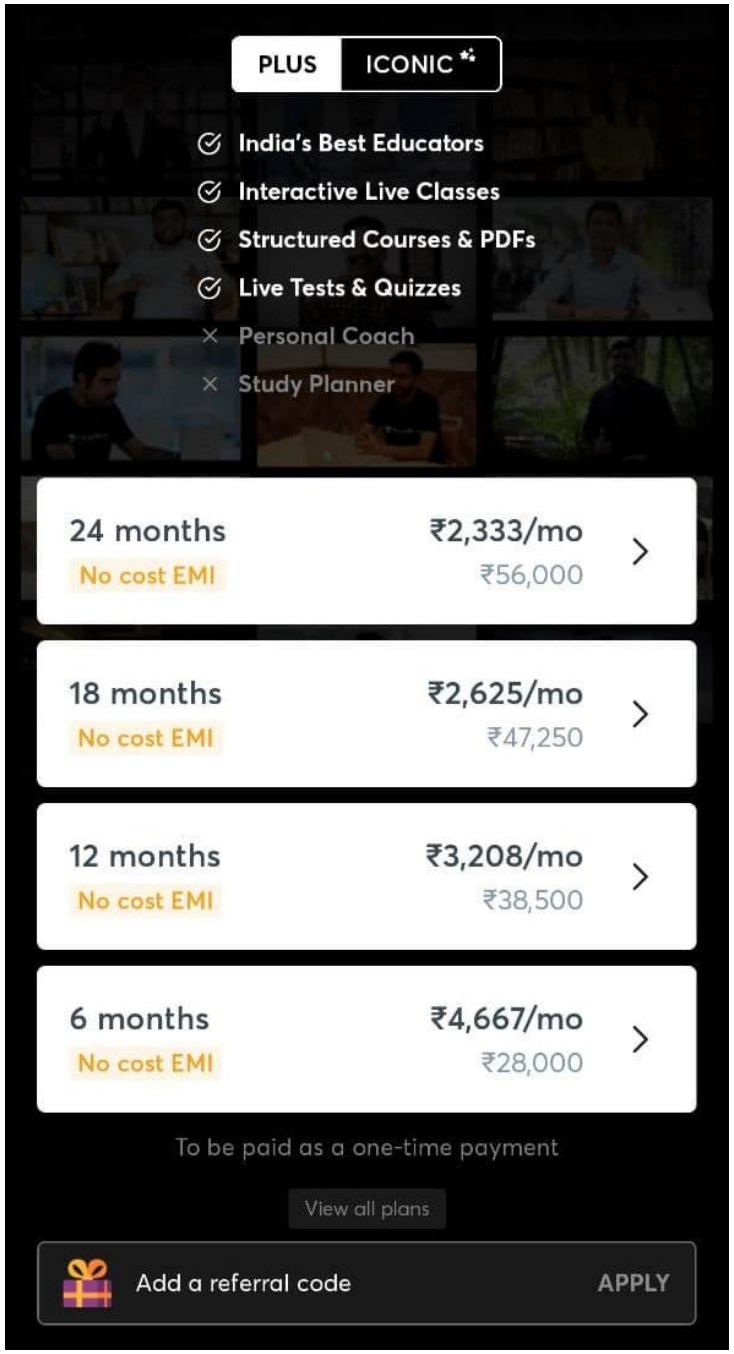
Q 12. A cylinder rolls down an inclined, plane of inclination 30°, the acceleration of cylinder is

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

(c) $\frac{g}{2}$ (d) $\frac{g}{6}$

Answer Key

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



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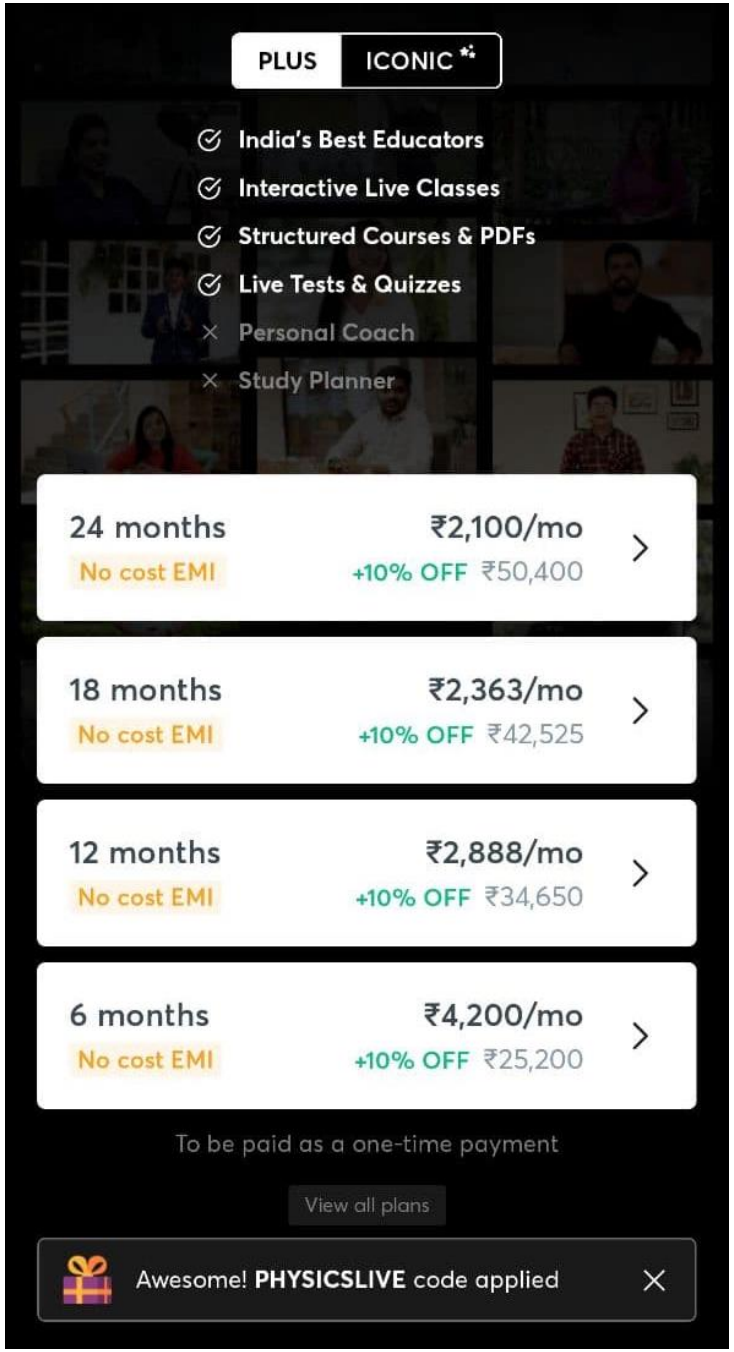


Written Solution

DPP- 6 B Rotation: dynamics of Rolling Motion

By Physicsaholics Team

Q.1) When different regular bodies roll down along an inclined plane from rest, then acceleration will be maximum for a body whose -

(a) radius of gyration is least

(b) mass is least

(c) surface area is maximum

(d) moment of inertia is maximum

$$a = \frac{g \sin\theta}{1 + \frac{I}{mR^2}}$$

$$a = \frac{g \sin\theta}{1 + \frac{k^2}{R^2}}$$

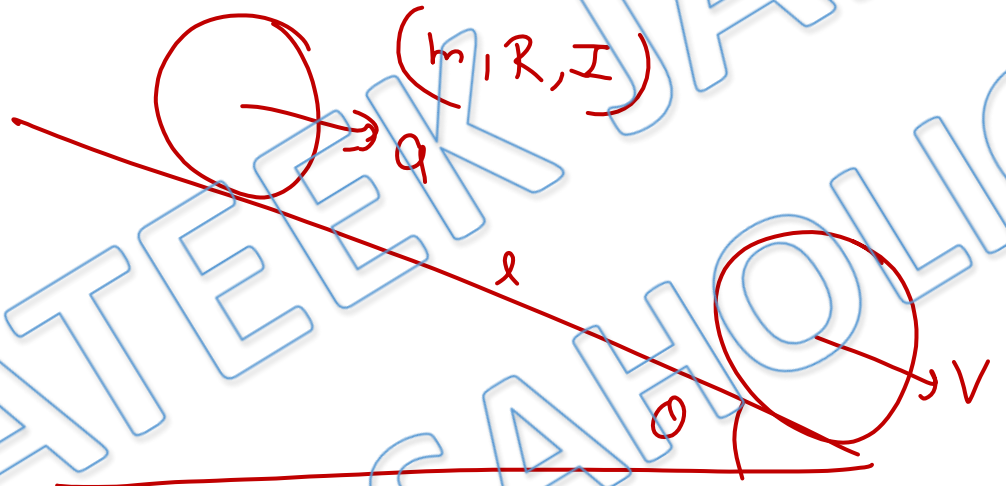
Q.2) A solid iron sphere A rolls down an inclined plane, while another hollow sphere B with the same mass and external radius also rolls down the inclined plane from same point. If V_A and V_B are their velocities at the bottom of the inclined plane, then

(a) $V_A > V_B$

(b) $V_A = V_B$

(c) $V_A < V_B$

(d) $V_A >= < V_B$



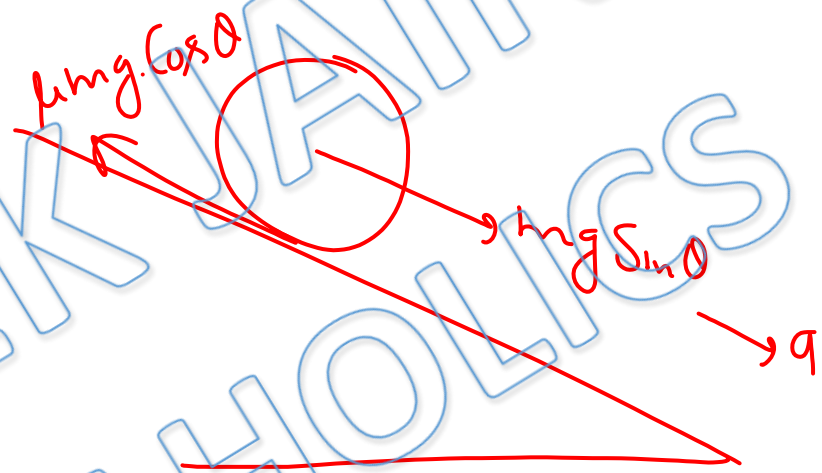
$$V = \sqrt{2gl}$$

$$a = \frac{g\sin\theta}{1 + \frac{I}{mR^2}}$$

$$a_{solid} > a_{hollow}$$

$$V_{solid} > V_{hollow}$$

Q.3) When different regular bodies slide down along an rough inclined plane from rest, acceleration



(a) Will be maximum for ring

(b) Will be minimum for ring

(c) Will be maximum for solid sphere

(d) will be same for all

$a = g(\sin\theta - \mu\cos\theta)$

↳ Same for all

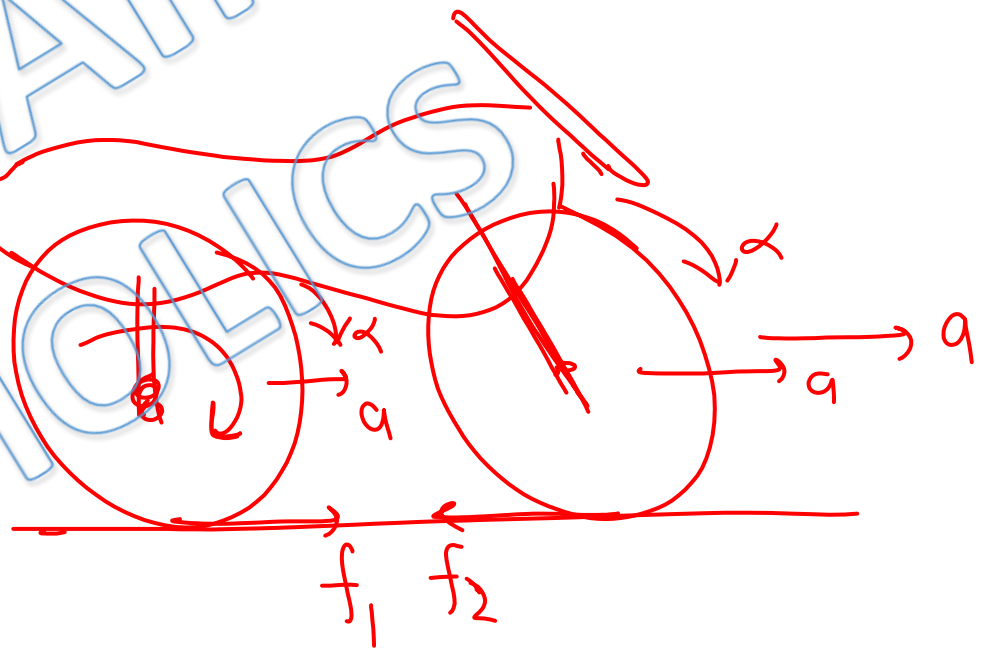
Q.4) A motorcycle is accelerating on a level road , direction of friction on

(a) rear wheel is in forward direction

(b) rear wheel is in backword direction

(c) Front wheel is in forward direction

(d) Front wheel is zero



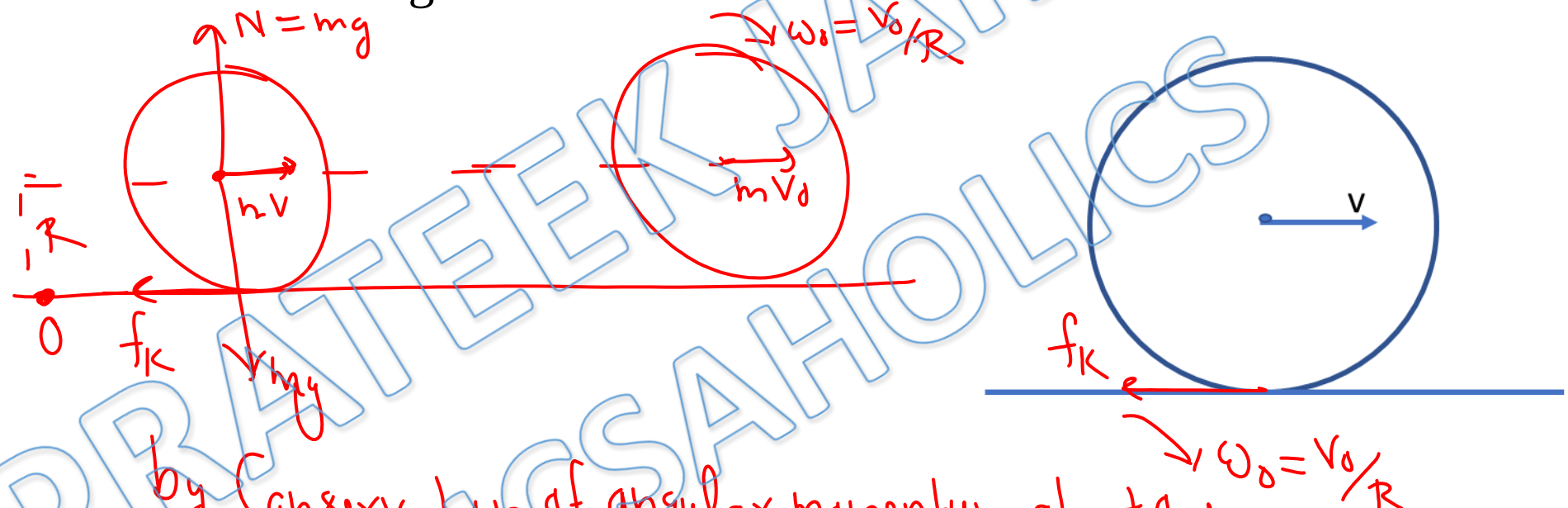
Q.5) A disc is projected on rough horizontal surface with velocity v. find velocity of its centre when it starts rolling ?

(a) v

(b) v/2

(c) v/3

(d) ~~2v/3~~



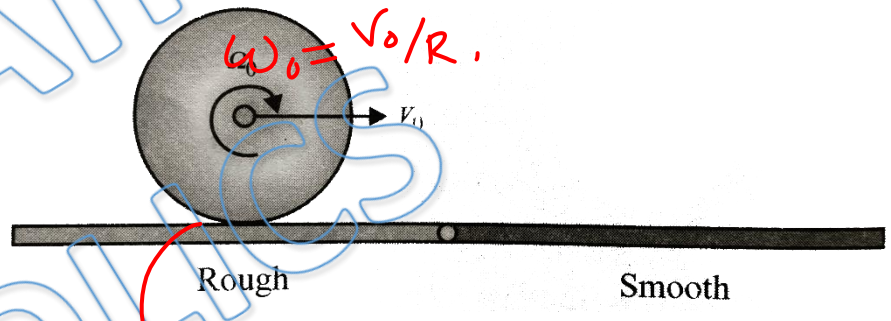
by conservation of angular momentum about O →

$$mvR = mV_0R + \frac{mR^2}{2}\left(\frac{V_0}{R}\right)$$

$$mvR = \frac{3}{2}mV_0R$$

$$V_0 = \frac{2v}{3}$$

Q.6) A rolling body of mass m and radius R is rolling on a rough surface without any pulling force as shown in figure. What happens when it enters on a smooth surface?



(a) Will move with half of initial angular speed

(b) Will move with double the initial angular speed

(c) Will continue rolling with the same angular speed

(d) cannot say anything

$f_r = 0$

Q.7) What is the minimum coefficient of friction for a solid sphere to roll without slipping on an inclined plane of inclination θ?

(a) $\frac{2}{7}\tan\theta$

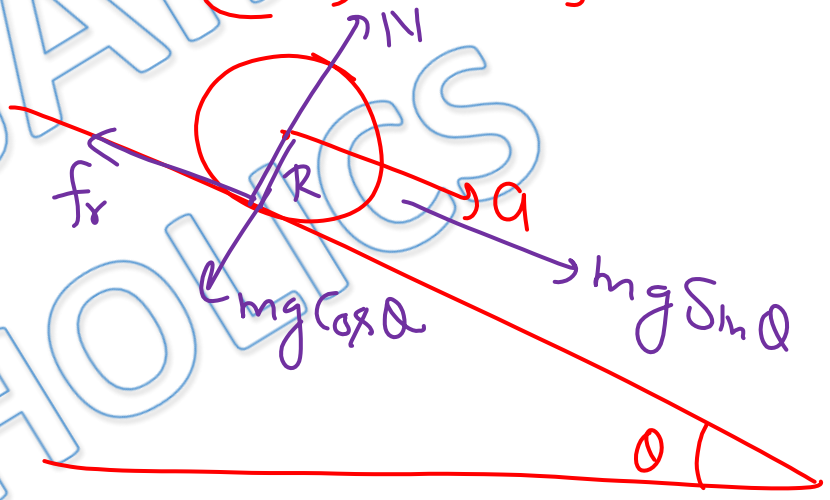
(b) $\frac{1}{3}g\tan\theta$

(c) $\frac{1}{2}\tan\theta$

(d) $\frac{2}{5}\tan\theta$

$$a = \frac{g\sin\theta}{1+\frac{I}{mR^2}} = \frac{g\sin\theta}{1+\frac{2}{5}} = \frac{5g\sin\theta}{7}$$

(m, R) $I = \frac{2}{5}mR^2$



$$mg\sin\theta - f_r = ma$$

$$f_r = mg\sin\theta - \frac{5}{7}mg\sin\theta$$

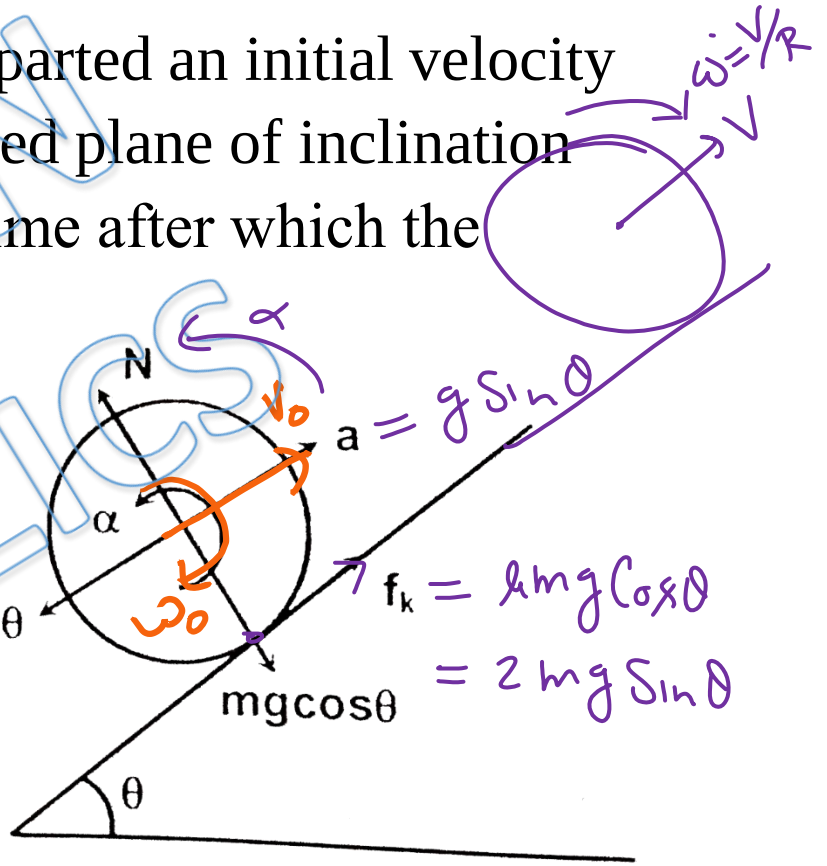
$$f_r = \frac{2}{7}mg\sin\theta \leq \mu mg\cos\theta$$

$$\mu \geq \frac{2\tan\theta}{7}$$

Q.8) A uniform solid sphere of mass m and radius 'R' is imparted an initial velocity v_o and angular $\omega_0 = \frac{2v_o}{R}$ and then placed on a rough inclined plane of inclination 'theta' and coefficient of friction $\mu = 2\tan\theta$ as shown. The time after which the sphere will start rolling without slipping is

(a) $\frac{v_o}{2g\sin\theta}$ (b) $\frac{v_o}{4g\sin\theta}$

(c) $\frac{v_o}{6g\sin\theta}$ (d) $\frac{v_o}{8g\sin\theta}$



$\omega_0 R = 2v_0$

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

$2\mu mgR\sin\theta = \frac{2}{5}\mu mR^2\alpha$

$\alpha = \frac{5g\sin\theta}{R}$

$a = \frac{f_k - mg\sin\theta}{m} = \frac{\mu g\sin\theta}{\mu}$

at $t = t$

$v = v_0 + g\sin\theta\, t$ --(I)

$\omega = \omega_0 - \frac{5g\sin\theta}{R}t$ --(II)

$\omega R = \omega_0 R - 5g\sin\theta\, t$

$v = \omega R \Rightarrow v_0 + g\sin\theta\, t = \omega_0 R - 5g\sin\theta\, t$

$6g\sin\theta\, t = v_0$

Q.9) A solid sphere has linear velocity v_0 = 4 m/s and angular velocity ω_0 = 9 rad/s as shown. Ground on which it is moving , is smooth . It collides elastically with a rough wall of coefficient of friction μ . Radius of the sphere is 1m and mass is 2 kg. If the sphere after colliding with the wall rolls without slipping on opposite direction, then coefficient of friction μ is

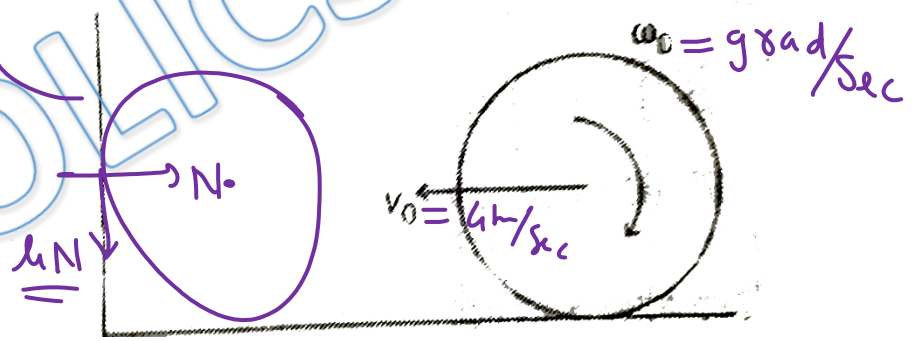
(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$

(c) $\frac{3}{4}$ ~~(d) $\frac{1}{4}$~~

by impulse momentum theorem →

$N\Delta t = (+8) - (-8)$

$N\Delta t = 16$ — (1)

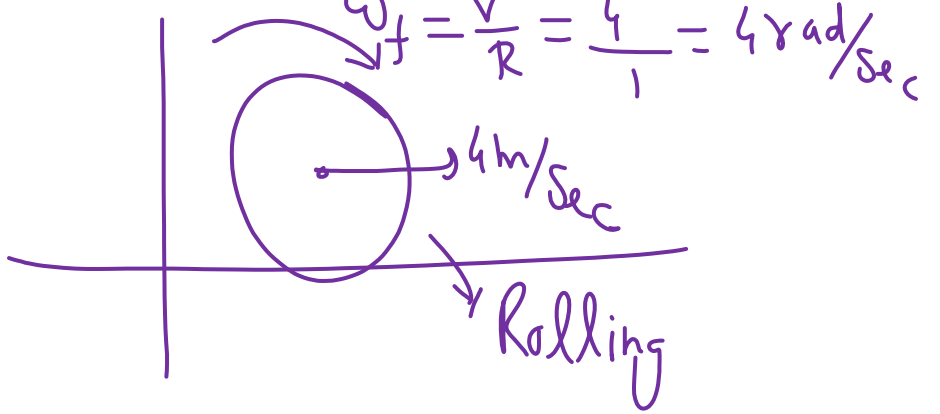


by angular impulse - angular momentum theorem →

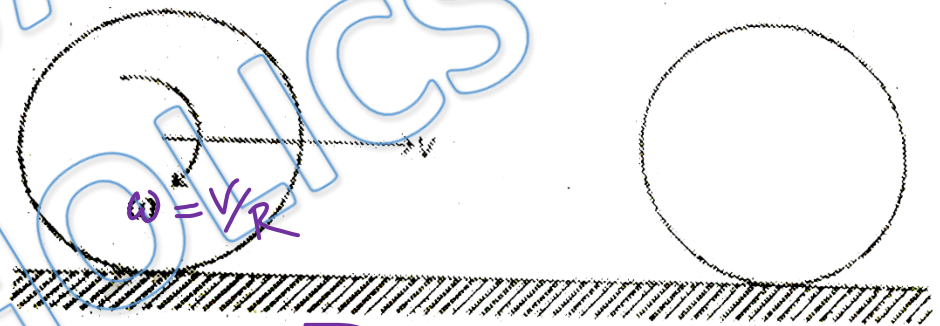
$-\mu N\Delta t = \frac{2}{5}\times 2(1)^2(4-9)$

$-16\mu = \frac{4}{5}\times(-5)$

$\mu = 1/4$



Q.10) A solid sphere is rolling without slipping on rough ground as shown in figure. If collides elastically with an identical another sphere at rest. There is no friction between the two spheres . Radius of each sphere is R and mass is m. Linear velocity of first sphere after it again starts rolling without slipping is



(a) $\frac{v}{7}$

(b) $\frac{2v}{7}$

(c) $\frac{7v}{2}$

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

first sphere after collision

by Conservation of A M about O →

$$\frac{2}{5}mR^2\omega = mV_0R + \frac{2}{5}mR^2\omega_f = \frac{7}{5}mV_0R$$

$$V_0 = \frac{2}{7}R\omega = \frac{2}{7}V$$

Q.11) A uniform solid sphere of radius r is rolling on a smooth horizontal surface with velocity v and angular velocity ω (v = ωr). The sphere collides with a sharp edge on the wall as shown in figure. The coefficient of friction between the sphere and the edge μ=1/5. Just after the collision the angular velocity of the sphere becomes equal to zero. The linear velocity of the surface just after the collision is equal to

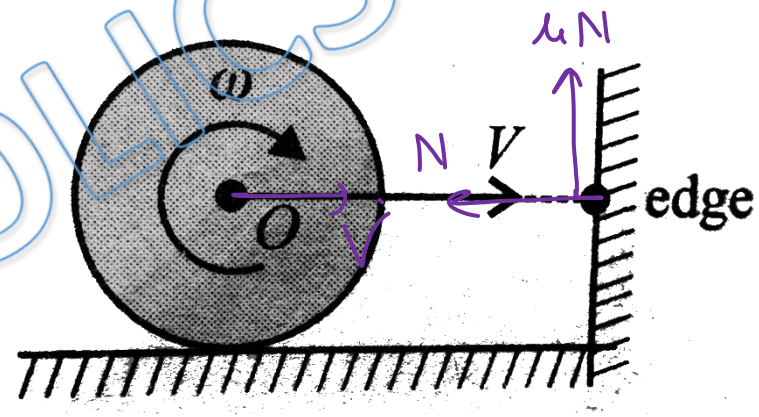
$N\Delta t = mv_0 - (-mv)$

(a) v

(b) $\frac{v}{5}$

(c) $\frac{3v}{5}$

(d) $\frac{v}{6}$



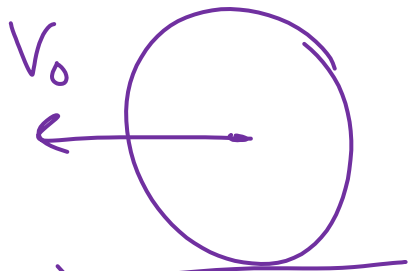
by AI - AM theorem

$N\Delta t = mv_0 + mv$ ---(I)

$\mu N\Delta t R = \frac{2}{5}mR^2\omega$ ---(II)

$\mu m(v_0+v) = \frac{2}{5}mRv$

$\frac{1}{5}(v_0+v) = \frac{2}{5}v$



$v_0 = v$

Q.12) A cylinder rolls down an inclined, plane of inclination 30°, the acceleration of cylinder is

(a) $\frac{g}{3}$

(b) g

(c) $\frac{g}{2}$

(d) $\frac{g}{6}$

$$a = \frac{g \sin\theta}{1 + \frac{I}{mR^2}}$$

$$= \frac{g \times 1/2}{1 + \frac{mR^2}{2mR^2}}$$

$$= g/3$$

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