DPP – 8

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/37

Video Solution on YouTube:- https://youtu.be/VkqGHJ8gU3E

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/49

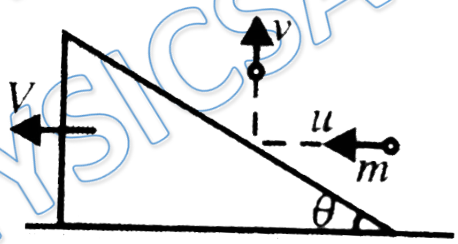
Q 1. A smooth sphere is moving on a horizontal surface with velocity vector $2\hat{i} + 2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ vector and the coefficient of restitution between the sphere and the wall is e = $\frac{1}{2}$. The velocity vector of the sphere after it hits the wall is:

(a) $\hat{i} - \hat{j}$ (b) $-\hat{i} + 2\hat{j}$
(c) $-\hat{i} - \hat{j}$ (d) $2\hat{i} - \hat{j}$

Q 2. A sphere has a elastic oblique collision with another identical sphere which is initially at rest. The angle between their velocities after the collision is

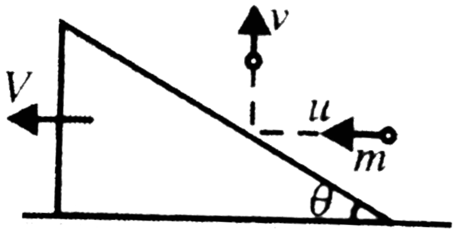
(a) 30° (b) 45°
(c) 60° (d) 90°

Q 3. A ball of mass m moving horizontally with velocity u hits a wedge of mass M. The wedge is situated on a smooth horizontal source. If after striking with wedge the ball starts moving in vertical direction and the wedge starts moving in horizontal plane. Calculate the velocity of wedge V



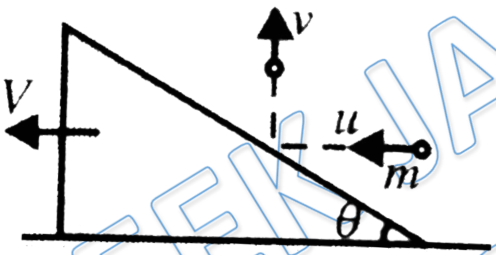
(a) $\frac{mu}{M}$ (b) $\frac{mu(\sin\theta - 1)}{M\sin\theta}$
(c) $\frac{mu(\cos\theta - 1)}{M\sin\theta}$ (d) $\frac{mu(\sin 2\theta - 1)}{M\cos\theta}$

Q 4. A ball of mass m moving horizontally with velocity u hits a wedge of mass M. The wedge is situated on a smooth horizontal source. If after striking with wedge the ball starts moving in vertical direction and the wedge starts moving in horizontal plane. The impulse imparted by the ball on the wedge



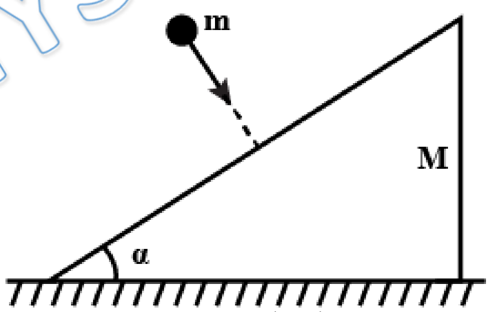
(a) $\frac{mu}{\sin\theta}$ (b) $\frac{mu}{\cos\theta}$
(c) $mu\sin\theta$ (d) $\frac{mu}{\cot\theta}$

Q 5. A ball of mass m moving horizontally with velocity u hits a wedge of mass M. The wedge is situated on a smooth horizontal source. If after striking with wedge the ball starts moving in vertical direction and the wedge starts moving in horizontal plane. The coefficient of restitution e = ?



(a) $\frac{m}{M}\cot^2\theta$ (b) $\frac{m}{M}\tan^2\theta$
(c) $\frac{m}{M}+\cot^2\theta$ (d) $\frac{m}{M}-\cot^2\theta$

Q 6. A ball of mass m collides with a stationary wedge of mass M, perpendicular to its inclined face, inclined at an angle as shown in the figure. If the coefficient of restitution between the wedge and ball is e, calculate the velocity off wedge just after collision.

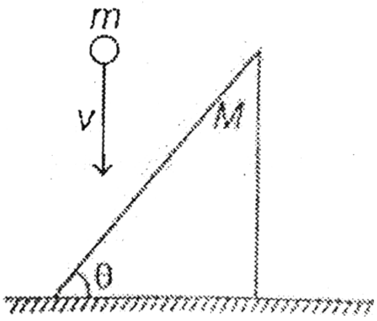


(a) $\frac{mu\sin\alpha\,(e+2)}{M+m\sin^2\alpha}$ (b) $\frac{mu\sin\alpha\,(e+1)}{M+m\sin^2\alpha}$
(c) $\frac{mu\sin\alpha\,(e+1)}{2M+m\sin^2\alpha}$ (d) $\frac{mu\sin\alpha(e+2)}{M+2m\sin^2\alpha}$

Q 7. In a collision between two solid spheres, velocity of separation along the line of impact (assume no external forces act on the system of two spheres during impact)
(a) cannot be greater than velocity of approach
(b) cannot be less than velocity of approach

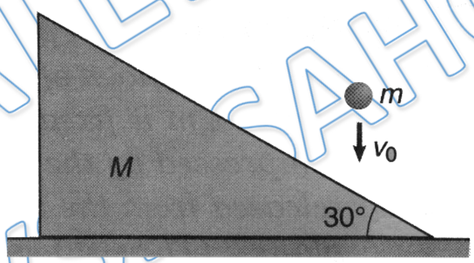
(c) cannot be equal to velocity of approach
(d) none of these

Q 8. A ball of mass m moving vertically down , collides with inclined surface of the wedge . After the collision , wedge starts moving in horizontal direction with velocity v_o. If all the surfaces are smooth then impulse applied by wedge on the ball during collision is given by



(a) $mv_0 \sin\theta$ (b) $mv_0 \cos\theta$
(c) $\frac{mv_0}{\sin\theta}$ (d) $\frac{mv_0}{\cos\theta}$

Q 9. A ball of mass m = 1kg falling vertically with a velocity v_o = 2m/s strikes a wedge of mass M = 2kg kept on a smooth, horizontal surface as shown in figure. If impulse between ball and wedge during collision is J. Find impulse on wedges from ground during impact.



(a) $\frac{1}{2}$ J (b) $\frac{\sqrt{3}}{2}$ J
(c) $\frac{1}{\sqrt{3}}$ J (d) $\frac{2}{\sqrt{3}}$ J

Q 10. A sphere of mass m_1 = 2kg collides with a sphere of mass m_2 = 3kg which is at rest. Mass m_1 will move at right angles to the line, joining centers at the time of collision, if the coefficient of restitution is
(a) $\frac{4}{9}$ (b) $\frac{1}{2}$
(c) $\frac{2}{3}$ (d) $\sqrt{2/3}$

Q 11. Sand is being dropped on a conveyer belt at the rate of M kg/s. The force(in newton) necessary to keep the belt moving with a constant velocity of v m/s will be
(a) $\frac{\text{Mv}}{2}$ (b) zero
(c) Mv (d) 2Mv

Q 12. Sand drops from a stationary hopper at the rate of 5 kg/s on to a conveyor belt moving with a constant speed of 2m/s. What is the power delivered by the motor to keep the belt moving ?

(a) 5 W (b) 10 W
(c) 20 W (d) 2.5 W

Q 13. The force on a rocket moving with a velocity 300 m/s with respect to ejected gas is 210N. The rate of consumption of fuel of rocket is

(a) 0.7 kg/s (b) 1.4 kg/s
(c) 0.07 kg/s (d) 10.7 kg/s

Q 14. A rocket of mass 20kg has 180kg fuel. The exhaust velocity of the fuel (w.r.t. rocket) is 1.6km/s. Calculate the minimum rate of consumption of fuel so that the rocket may rise from the ground: (take g = 10 m/s^2)

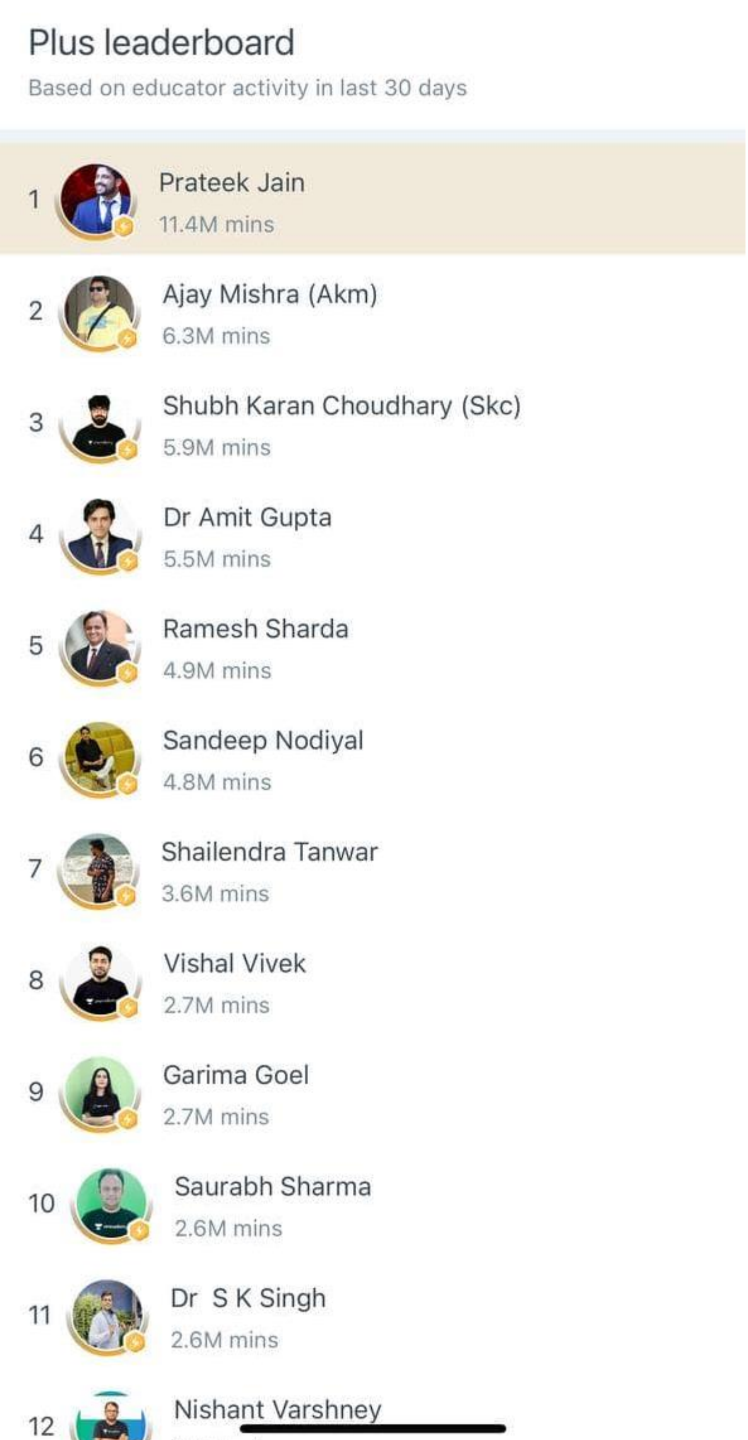
(a) 1.2 kg/s (b) 0.25 kg/s
(c) 2.5 kg/s (d) 1.25 kg/s

Q 15. A rocket is set for a vertical firing . If the exhaust speed (w.r.t. rocket) is 2000 m/s, find the rate of fuel consumption for initial vertical upward acceleration of 30 m/s^2. [Take total mass of rocket = 6000 kg & g = 10 m/s^2]

(a) 120 kg/s (b) 240 kg/s
(c) 90 kg/s (d) 150 kg/s

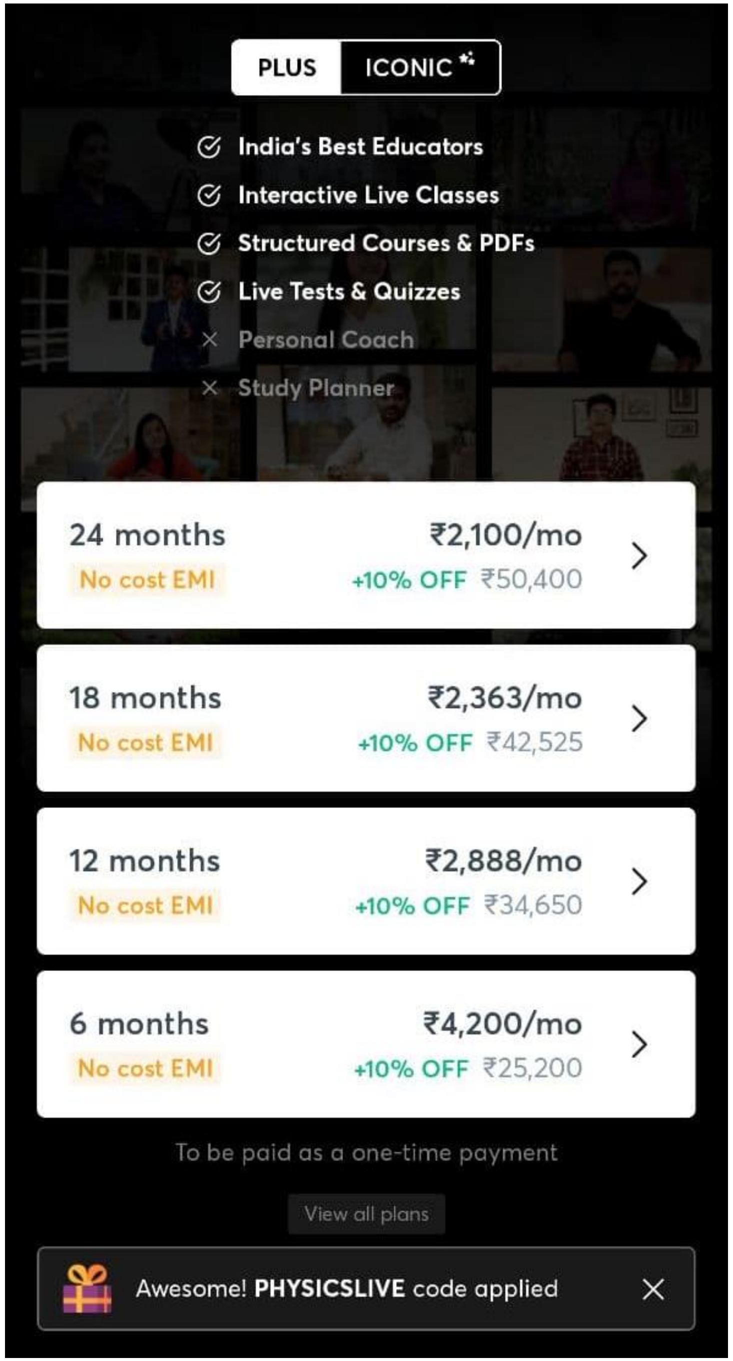
Answer Key

Q.1 b	Q.2 d	Q.3 a	Q.4 a	Q.5 c
Q.6 b	Q.7 a	Q.8 c	Q.9 b	Q.10 c
Q.11 c	Q.12 c	Q.13 a	Q.14 d	Q.15 a



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS and learn from India's Top Faculties.

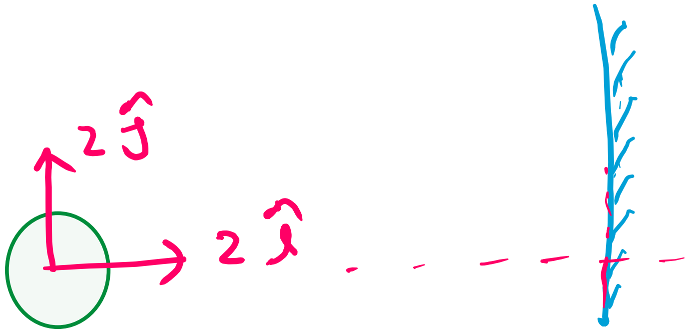


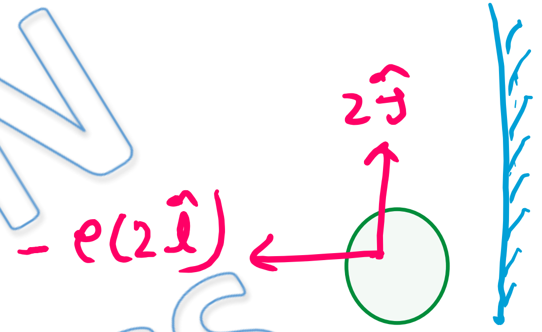
Written Solution

DPP-8 COM: Oblique Collision & Variable Mass System

By Physicsaholics Team

Solution: 1





$$\vec{V}_i = 2\hat{i} + 2\hat{j}$$

$$\vec{V}_f = -e(2\hat{i}) + 2\hat{j}$$

$$\vec{V}_f = -\left(\frac{1}{2}\right)(2\hat{i}) + 2\hat{j}$$

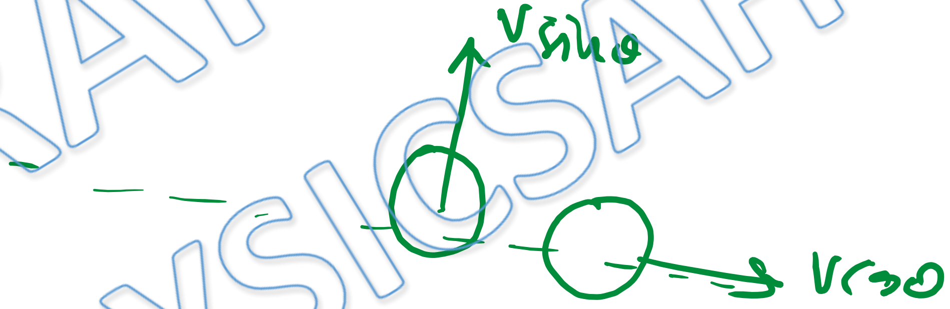
$$\boxed{\vec{V}_f = -\hat{i} + 2\hat{j}}$$ Ans.

Ans. b

Solution: 2

In oblique collision,

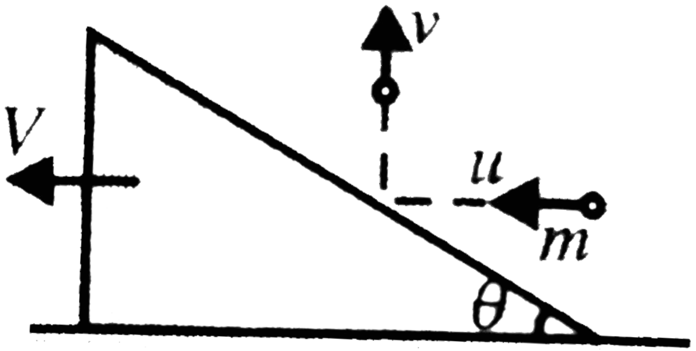
For elastic collision



Spheres will move at 90°.

Ans. d

Solution: 3



in horizontal direction

$F_{ext} = 0$

so, momentum is conserved

in x-dirn

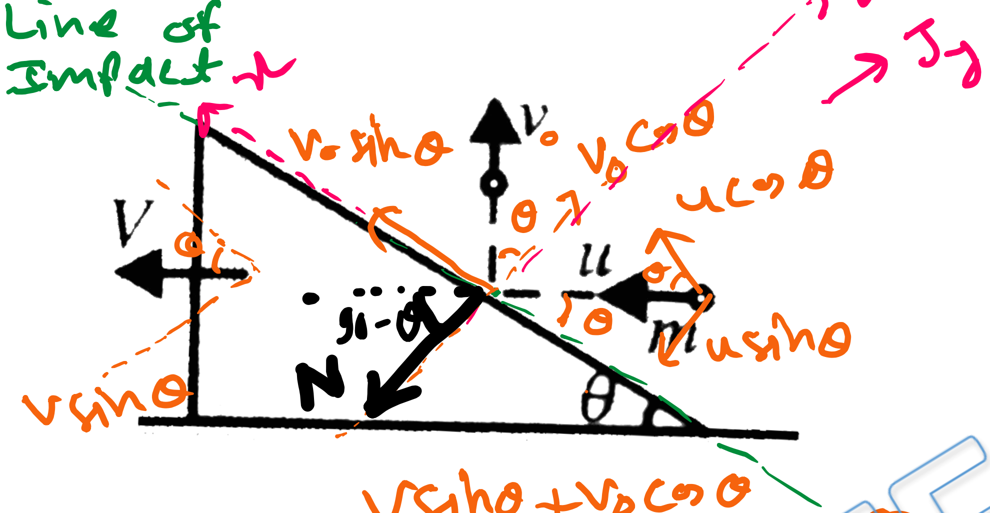
so, $mu + M(0) = m(0) + M(V)$

$mu = MV$

$$V = \frac{mu}{M}$$ Ans

Ans. a

Solution: 4



$$e = \frac{v\sin\theta + v_0\cos\theta}{u\sin\theta} \quad \text{— (1)}$$

& $u\cos\theta = v_0\sin\theta$

$\Rightarrow v_0 = u\cot\theta$ — (2)

$J_x = 0$ [$\because$ || to line of impact]

$J_y = ?$

For ball in y-dirn.

$-mu\sin\theta + J_y = m v_0\cos\theta$

$\Rightarrow -mu\sin\theta + J_y = m(u\cot\theta)\cos\theta$

$J_y = mu\sin\theta + mu\frac{\cos^2\theta}{\sin\theta}$

$= mu\left(\frac{\sin^2\theta + \cos^2\theta}{\sin\theta}\right)$

$$\boxed{J_y = \frac{mu}{\sin\theta}}$$

$$\boxed{J = \frac{mu}{\sin\theta}}$$ Ans

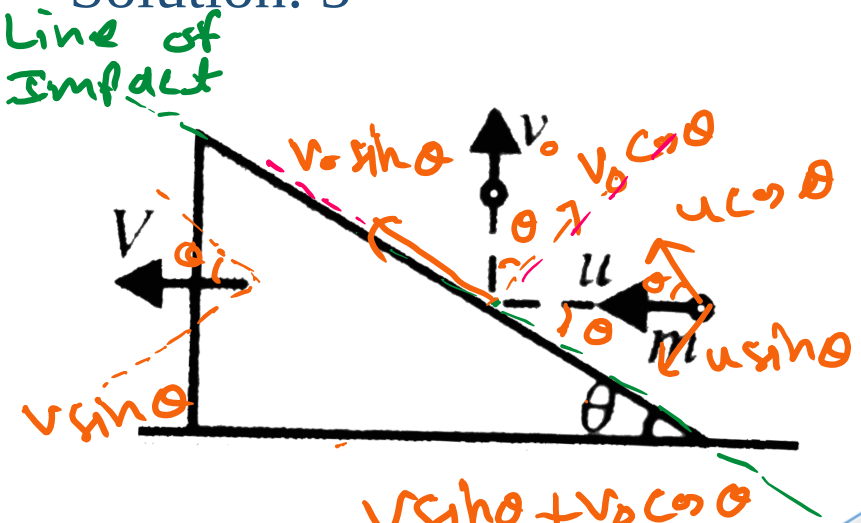
OR Impulse by ball on wedge $= N\Delta t$

$N\Delta t\cos(90-\theta) = MV = mu$

$N\Delta t = \frac{mu}{\sin\theta}$

Ans. a

Solution: 5



$$e = \frac{V\sin\theta + V_0\cos\theta}{u\sin\theta} \quad \text{—(1)}$$

& $u\cos\theta = V_0\sin\theta$

$\Rightarrow V_0 = u\cot\theta$ —(2)

& from momentum conservation in $-x$ dirn.

$mu = MV$

$\Rightarrow V = \frac{mu}{M}$ —(3)

So, $e = \frac{V\sin\theta + V_0\cos\theta}{u\sin\theta}$

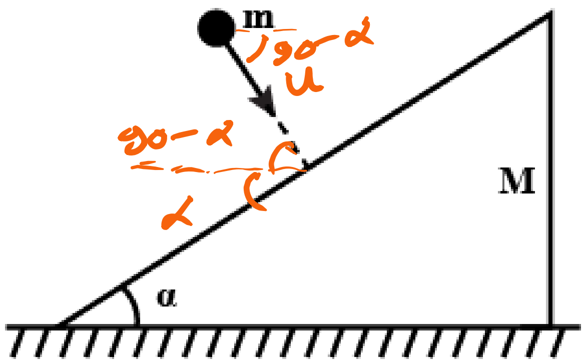
$e = \frac{V}{u} + \frac{V_0}{u}\cot\theta$

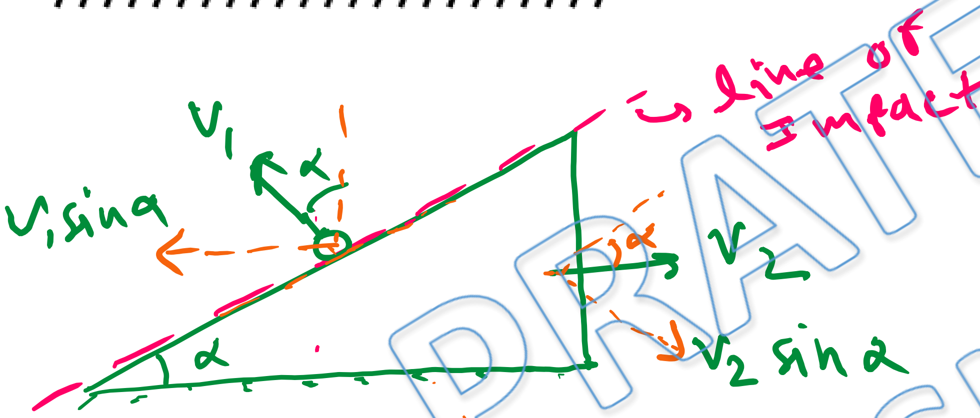
$e = \frac{m}{M} + \frac{u\cot\theta}{u}\cot\theta$

$$e = \frac{m}{M} + \cot^2\theta$$ Ans.

Ans. c

Solution: 6





Let, Impulse imparted between ball & wedge = J

$$e = \frac{\text{vel. of separation}}{\text{vel. of approach}} = \frac{v_1 + v_2 \sin\alpha}{u}$$

$$v_1 + v_2 \sin\alpha = eu$$

$$\boxed{v_2 = \frac{eu - v_1}{\sin\alpha}} \quad \text{or} \quad \boxed{v_1 = eu - v_2 \sin\alpha}$$

Momentum conservation in x-direction

$$mu\sin\alpha = Mv_2 - mv_1 \sin\alpha$$

$$mu\sin\alpha = Mv_2 - m(eu - v_2\sin\alpha)\sin\alpha$$

$$mu\sin\alpha = Mv_2 + mv_2\sin^2\alpha - emu\sin\alpha$$

$$v_2 = \frac{mu\sin\alpha(1+e)}{M + m\sin^2\alpha}$$

$$\Rightarrow \boxed{v_2 = \frac{mu\sin\alpha(1+e)}{M + m\sin^2\alpha}} \quad \text{Ans.}$$

Ans. b

Solution: 7

$$\because \quad e = \frac{\text{Vel. of separation}}{\text{Vel. of approach}}$$

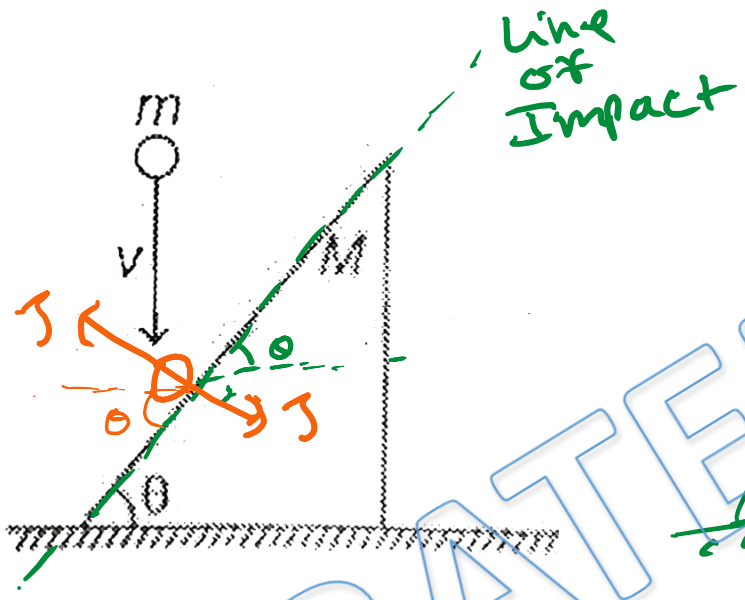
$$\Rightarrow \quad 0 \le e \le 1 \quad [\text{for collision between two solid bodies}]$$

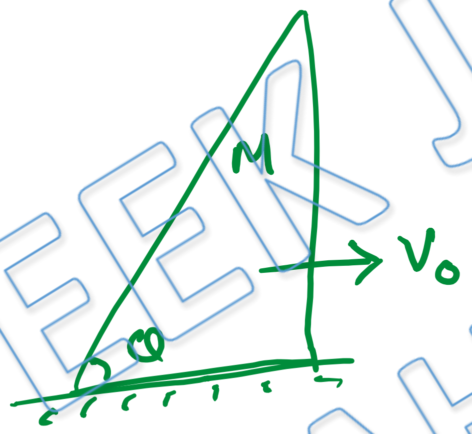
$$0 \le \frac{\text{Vel. of separation}}{\text{Vel. of approach}} \le 1$$

$$\Rightarrow \quad \boxed{0 \le \text{Velocity of separation} \le \text{Vel. of approach}}$$

Ans. a

Solution: 8





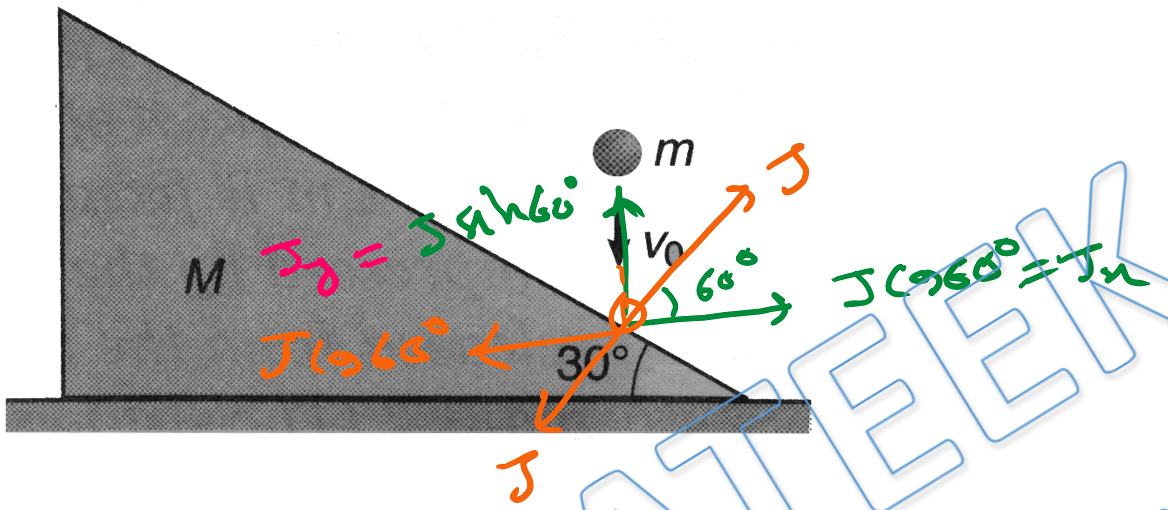
for wedge; (J = Impulse)

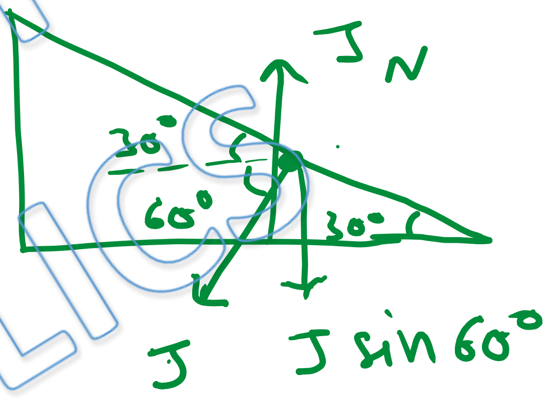
$J \sin\theta = M V_0$

$$J = \frac{M V_0}{\sin\theta}$$

Ans. c

Solution: 9





J_N = impulse due to ground in y dirn for wedge

$\Delta p = 0$

$\therefore \Rightarrow 0 = J\sin 60° - J_N$

$J_N = J\sin 60°$

$$J_N = \frac{\sqrt{3}J}{2}$$

Ans. b

Solution: 10

along x-axis

$P_i = P_f$

$m_1 v\cos\theta = m_2 V_2$

$2(v\cos\theta) = 3V_2$

$$\boxed{V_2 = \frac{2}{3}v\cos\theta}$$

$e = \dfrac{V_2}{v\cos\theta}$

$\Rightarrow e = \dfrac{\frac{2}{3}v\cos\theta}{v\cos\theta}$

$$\boxed{e = \frac{2}{3}}$$ Ans.

Ans. c

Solution: 11

$$P = mv$$

$$F = \frac{dP}{dt} = \frac{dm}{dt} v \quad [\because v = \text{constant}]$$

$$\because \frac{dm}{dt} = M \text{ kg/s}$$

So; $\boxed{F = Mv}$ Ans

Ans. c

Solution: 12

Force require to move with constant velocity

$F = v\frac{dm}{dt}$

$F = mv$

Power $= F \cdot v$

$= mv \cdot v$

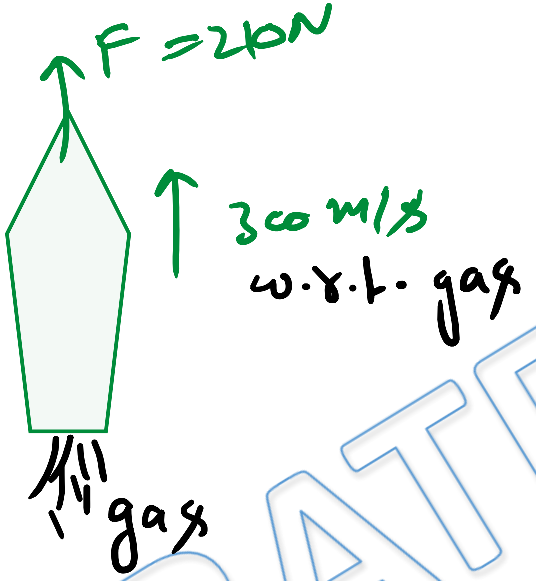
$P = mv^2$

$\Rightarrow P = 5 \times (2)^2$

$P = 20$ watt Ans.

Ans. c

Solution: 13



$$F = v\frac{dm}{dt}$$

$$210 = (300)\frac{dm}{dt}$$

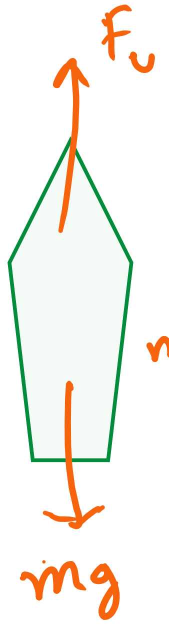
$$\frac{dm}{dt} = \frac{210}{300}$$

$$\boxed{\frac{dm}{dt} = 0.7\ kg/s}$$ Ans

.

Ans. a

Solution: 14



to lift the rocket

$F_{min} = F_u = mg$

$F_u = v\dfrac{dm}{dt}$

$m = (20 + 180)$

$m = 200\ kg$

$mg = v\dfrac{dm}{dt}$

$200 \times 10 = (1.6 \times 1000)\dfrac{dm}{dt}$

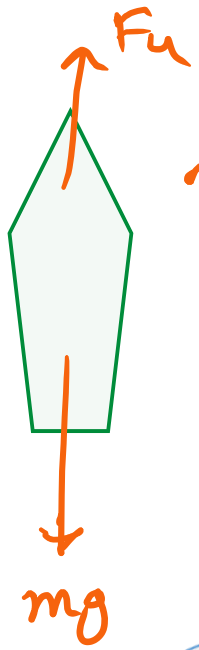
$2000 = 1600\dfrac{dm}{dt}$

$\boxed{\dfrac{dm}{dt} = \dfrac{5}{4}\ kg/s}$ Ans

(d) $\boxed{\dfrac{dm}{dt} = 1.25\ kg/s}$ Ans

Ans. d

Solution: 15



$\uparrow a = 30\, m/s^2$

$F_u - mg = ma$

$F_u = m(a+g) = 6000\,(30+10) = 6000 \times 40$

$= 24 \times 10^4$ kg

$F_u = V_{rel} \dfrac{dm}{dt}$

$24 \times 10^4 = 2000 \times \dfrac{dm}{dt}$

$$\boxed{\dfrac{dm}{dt} = 120\ kg/s}$$ Ans

Ans. a

For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/37

Video Solution on YouTube:- https://youtu.be/VkqGHJ8gU3E

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/49

SUBSCRIBE

@Physicsaholics

@Physicsaholics_prateek

@NEET_Physics
@IITJEE_Physics

physicsaholics.com

Unacademy

CLICK

Chalo Niklo