COLLISIONS TUTORIAL

Pg 39 — 7, 13

Pg 40-45 — 4, 7, 8, 14, 15, 16, 18, 26, 29, 32
35, 40, 41, 44, 46, 47, 48

Pg 47-48 — Comp 1, Comp 2

Pg 39

7)

$27\ km/hr. = \frac{27 \times 5}{18} = 7.5$

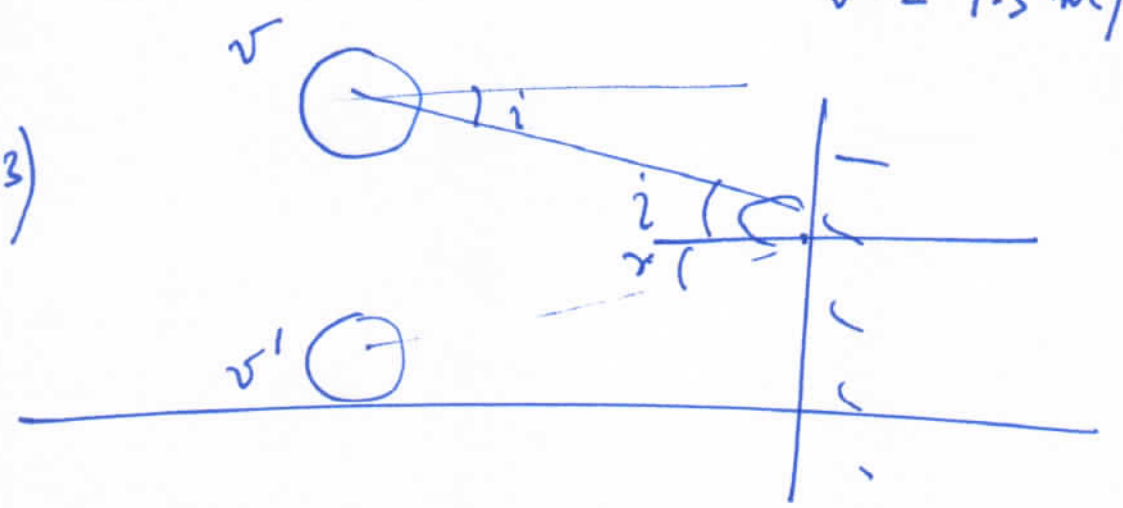
$300 \times 7.5 + 25 \times 7.5$

Δt

$(25-m)v' + 300v' + mv'$

$v' = 7.5\ m/s.$

(13)



i, r, e ?

$mv\cos i$

$\frac{v'\cos r}{v\cos i} = e.$

$v'\sin r = v \sin i$

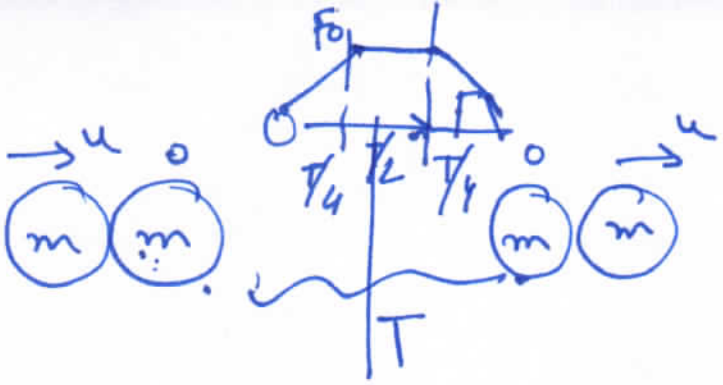
$v' = \frac{v \sin i}{\sin r}$

$v' = \frac{ev\cos i}{\cos r}$

$v\frac{\sin i}{\sin r} = ev\frac{\cos i}{\cos r} \Rightarrow e = \frac{\tan i}{\tan r}$

P, 46-45

4)



$mu - m(0) = mu.$

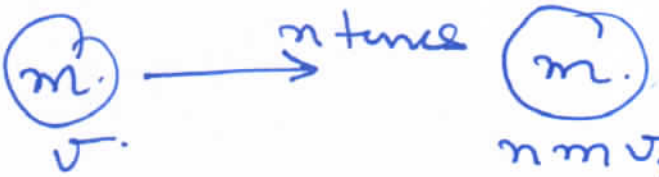
Impulse on body = Change in its momentum.

$$\frac{1}{2}F_0 T/4 + F_0 \times T/2 + \frac{1}{2}F_0 \times T/4 = mu$$

$$\frac{3F_0T}{4} = mu.$$

$$F_0 = \frac{4mu}{3T}$$ (C)

7)



$\Rightarrow v_f = nv_i.$

$\frac{1}{2}mv_f^2 = \frac{1}{2}mn^2v_i^2$

$= n^2 K.E_i$

(D)

8)

$$K.E = \frac{1}{2}mv^2$$

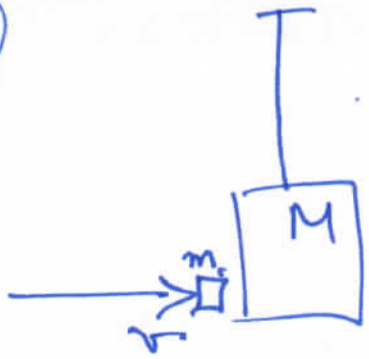
$$\Delta K.E = \frac{1}{2}m \cdot 2v\Delta v.$$

$$\frac{\Delta K.E}{K.E} = 2\frac{\Delta v}{v}\frac{m}{m} = 2\frac{\Delta p}{p}$$

$$\frac{\Delta p}{p} \times 100\% = \frac{1}{2}\frac{\Delta K.E}{K.E} \times 100\%$$

$= 0.05\%$

(14)



$$mv + M\times 0 = (M+m)v'$$

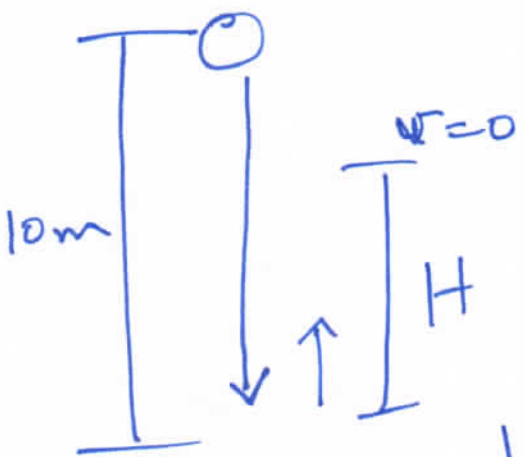
$$v' = \frac{mv}{M+m}$$

$$\frac{1}{2}(M+m)v'^2 = \frac{1}{2}(M+m)\left(\frac{mv}{M+m}\right)^2$$

$$= \frac{1}{2}\frac{m^2v^2}{M+m}$$

(D)

(15)



$$v = \sqrt{2gh}.$$

$$= \sqrt{2\times 10\times 10} = 10\sqrt{2}$$

$$\frac{1}{2}mv'^2 = \frac{60}{100}\cdot\frac{1}{2}mv^2$$

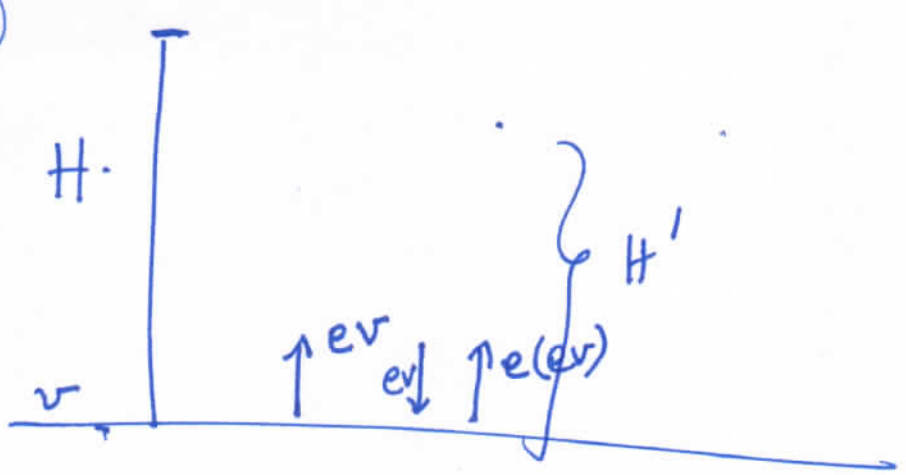
$$v' = \sqrt{\frac{3}{5}}\,v = 10\sqrt{\frac{6}{5}}$$

$$v^2 - v'^2 = 2(-g)H.$$

$$0^2 - 100\times\frac{6}{5} = -2\times 10\times H \qquad H = 6\,m.$$

(D)

(16)



$\frac{v'}{v} = e$

$v' = ve$

$v = \sqrt{2gH}$

$v^2 = 2gH$ $\quad v_f^2 - v_i^2 = 2aH'$

$0 - (e^2 v)^2 = 2(-g)H'$

$e^4 v^2 = 2gH' \Rightarrow H' = \frac{e^4 v^2}{2g}$

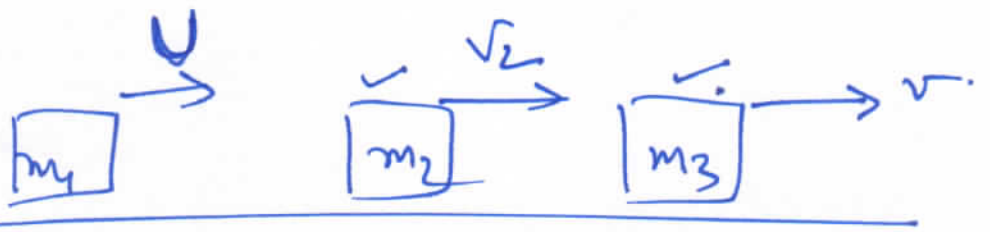
$\Rightarrow H' = e^4 \frac{2gH}{2g}$

$= e^4 H$

(18)

velocities exchange.

(26)



$v_2 = \frac{m_2 - m_1}{m_1 + m_2} u_2 + \frac{2m_1}{m_1 + m_2} u_1$

$v_2 = 0 + \frac{2m_1}{m_1 + m_2} U$

$$v_2 = 0 + \frac{2m_2}{m_2+m_3}\left(\frac{2m_1}{m_1+m_2}\right)U$$

$$= \frac{4m_1m_2}{(m_1+m_2)(m_2+m_3)}U \quad (A)$$

29) $(M+m)\times 0 = -mv + Mv'$

$$v' = \frac{mv}{M} \uparrow \qquad H = v't$$

$$= \frac{mv}{M} \times \frac{h}{v}$$

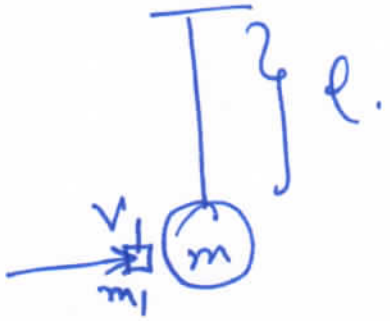
$$h = vt \Rightarrow \frac{h}{v} = t \qquad = \frac{mh}{M}$$

H above ground.

$$H + h = \frac{(m+M)h}{M}$$

(D)

32)

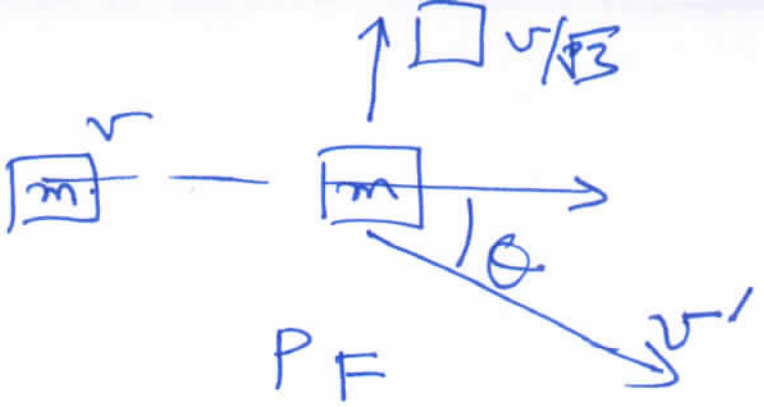


$$m_1v_1 + m\times 0 = m\times v + m_1\frac{v_1}{3}$$

$$\frac{2m_1v_1}{3} = mv \Rightarrow v = \frac{2m_1}{3m}v_1$$

$$v = \sqrt{5gl} = \frac{2m_1}{3m}v_1 \Rightarrow v_1 = \frac{3m}{2m_1}\sqrt{5gl} \quad (B)$$

35)



P_H P_I P_F

$$mv = mv'\cos\theta$$

P_I P_F

$$P_I\ \theta = \frac{mv}{\sqrt{3}} - mv'\sin\theta$$

$$mv = \sqrt{3}mv'\sin\theta$$

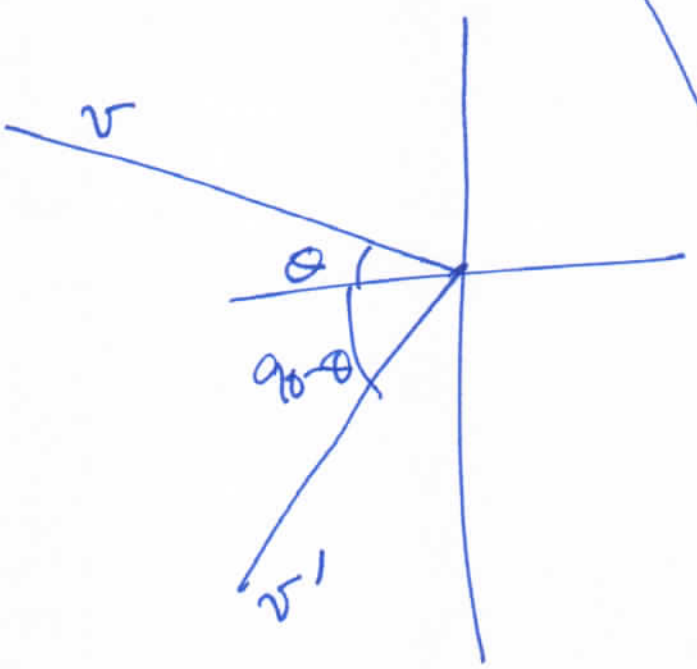
$$mv = mv'\cos\theta$$

$$\tan\theta = \frac{1}{\sqrt{3}} \qquad \theta = 30^\circ$$

$$v' = \frac{v}{\cos\theta} = \frac{v}{\cos 30^\circ} = \frac{v}{\sqrt{3}/2} = \frac{2v}{\sqrt{3}}$$

(A)

(40) $e = 1/3$



$$v \sin\theta = v' \sin(90-\theta)$$

$$v \sin\theta = v' \cos\theta$$

$$v' = v \tan\theta .$$

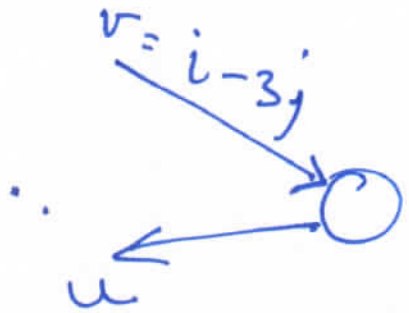
$$\frac{v' \cos(90-\theta)}{v \cos\theta} = e$$

$$\frac{v' \sin\theta}{v \cos\theta} = e$$

$$\frac{v \tan\theta \cdot \tan\theta}{v} = e \Rightarrow \theta = \tan^{-1}\sqrt{e}$$

$$= 30^\circ$$

41



$\Delta p \cdot x = I$

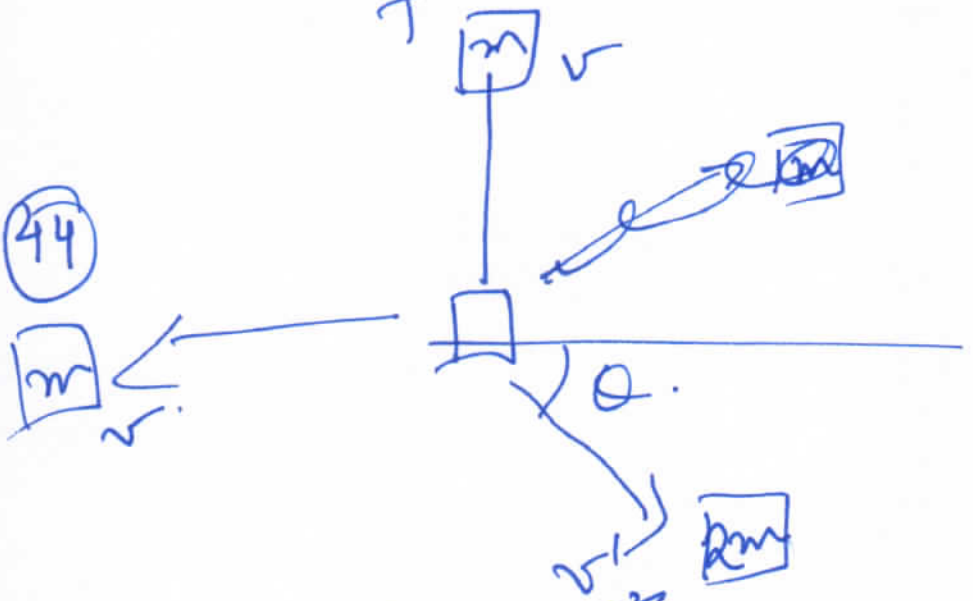
$mu - m(+1) = -2m.$

$mu = -m$

$u = -1.$

$v_f = -i - 3j$ (C)

44



$p_i = 0$

$-mv + 2mv'\cos\theta = 0$

$mv - 2mv'\sin\theta = 0.$

$v' = v/\sqrt{2}$

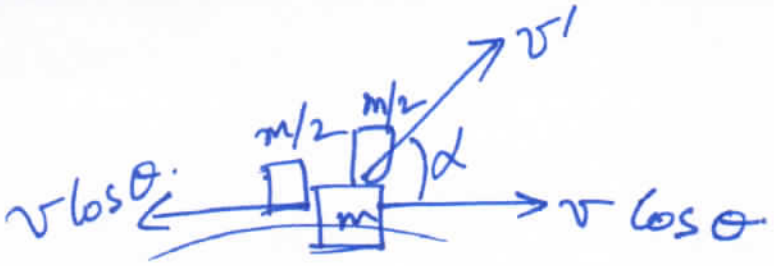
$\theta = 45^\circ$

$\frac{1}{2}mv^2 \times 2 + \frac{1}{2} \times 2m(v/\sqrt{2})^2$

$= mv^2 + 2mv^2/2$

$= 3\frac{mv^2}{2}$

(46)



$P_{//}$

I

$$mv\cos\theta = \frac{m}{2}v'\cos\alpha + \frac{m}{2}(-v\cos\theta)$$

$$\frac{3mv}{2}\cos\theta = \frac{m}{2}v'\cos 0^\circ$$

$P_\perp$

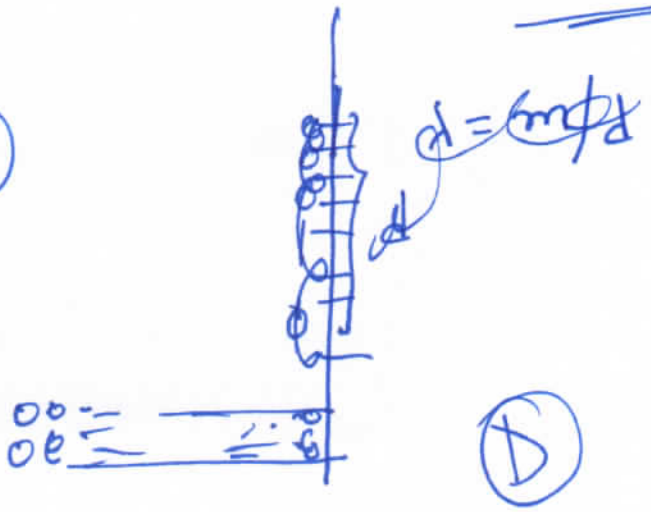
$$\Rightarrow v' = 3v\cos\theta \quad (A)$$

I.

$$= 0 = \frac{m}{2}v'\sin\alpha$$

$$\longrightarrow \alpha = 0^\circ$$

(48)



(D)

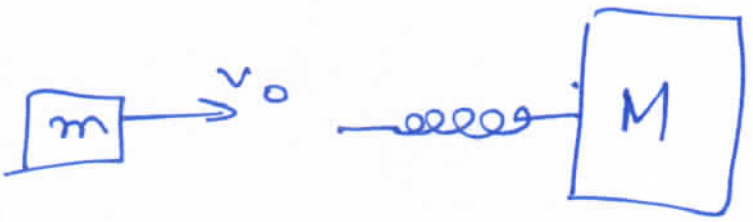
$$\Delta p_1 = \lambda(v_0 - (-v)) = \lambda(v_0 + v)$$

$$\Delta p_{\Delta t} = v_0 \Delta t \lambda (v_0 + v)$$

$$\Rightarrow F\Delta t = v_0 \Delta t \lambda (v_0 + v)$$

Pg 47

Comp 1



$$V_{CM} = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

$$= \frac{m v_0 + M \dot{x}_0}{m + M}$$

$$= \frac{m v_0}{m + M} \quad (A)$$

$$V_{m\,rel\,CM} = v_0 - V_{CM}$$

$$= v_0 - \frac{m v_0}{M + m}$$

$$= \frac{M v_0}{M + m}. \quad (B)$$

At max compression

$$mv_0 + M \times 0 = m \times v' + M \times v'$$

$$v' = \frac{mv_0}{(M+m)}$$

$$\frac{1}{2} m v_0^2 = \frac{1}{2} k x^2 + \frac{1}{2} m (v')^2 + \frac{1}{2} M \left(\frac{mv_0}{M} \right)^2$$

$$\frac{1}{2} m v_0^2 = \frac{1}{2} k x^2 + \frac{1}{2} \frac{m^2 v_0^2}{M} + \frac{1}{2} (m+M) v'^2$$

$$m v_0^2 \left(1 - \frac{m}{M}\right) = k x^2$$

$$x = v_0 \sqrt{\frac{m(M-m)}{Mk}}$$

$$k x^2 = m v_0^2 - (M+m) \left(\frac{m v_0}{M+m} \right)^2$$

$$= m v_0^2 - \frac{m^2 v_0^2}{M+m}$$

$$\Rightarrow x_{MAX} = v_0 \sqrt{\frac{1}{k} \frac{Mm}{M+m}} = m v_0^2 \left(1 - \frac{m}{M+m}\right) = \frac{Mm v_0^2}{M+m}$$