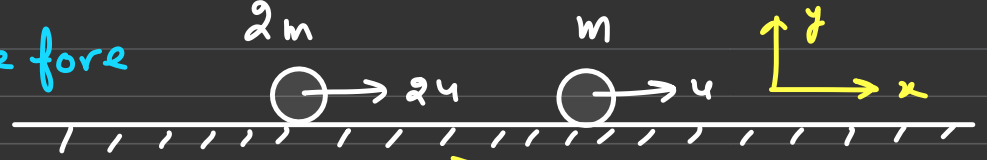
E&M5


VMC
Vidyamandir
Classes
SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

e)

a) ① before



$I = \int F\,dt$

② during

③ After

In this Q. we can L. of C. of L.M

$$2m \times 2u + m u = 2m v_1 + m v_2 \quad -(1)$$

$$5u = 2v_1 + v_2$$

$(KE)_i = (KE)_f$

$$\frac{1}{2}\,2m\,(2u)^2 + \frac{1}{2}\,m\,(u)^2 = \frac{1}{2}\,2m\,(v_1^2) + \frac{1}{2}\,m\,(v_2^2) \quad -(11)$$

$\frac{1}{2}(2m)(2u)^2 + \frac{1}{2}m(u)^2 = \frac{1}{2}(2m)(v_1^2) + \frac{1}{2}m(v_2^2)$

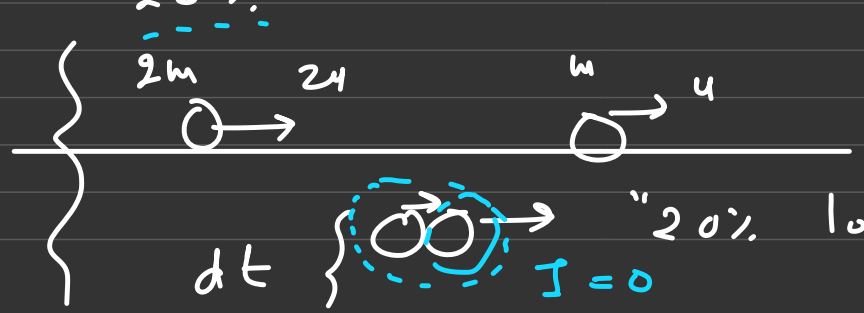
$4.5u^2 = v_1^2 + \frac{1}{2}v_2^2$ — (11)

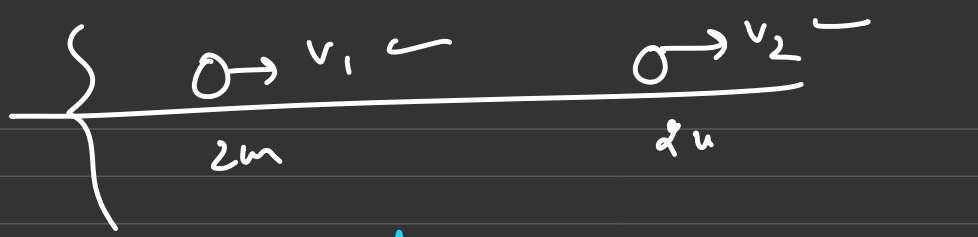
$v_2 =$ quadratic $\{\alpha, \beta\}$

Homework

– "Sep" wala –

b) find final velocities if % loss in KE is 20%





L. of c. of m

$$2m \times 2u + m \times u = 2m v_1 + m v_2 \quad \text{(i)}$$

L. of c. of E

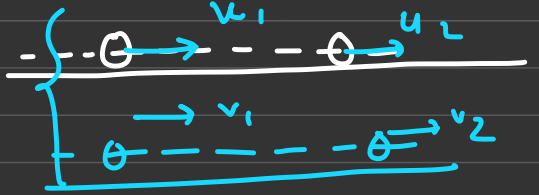
$$= \frac{80}{100} \times \left\{ \frac{1}{2} 2m (2u)^2 + \frac{1}{2} m (u)^2 \right\} = \frac{1}{2} 2m (v_1^2) + \frac{1}{2} m (v_2^2) \quad \text{(ii)}$$

Collision:

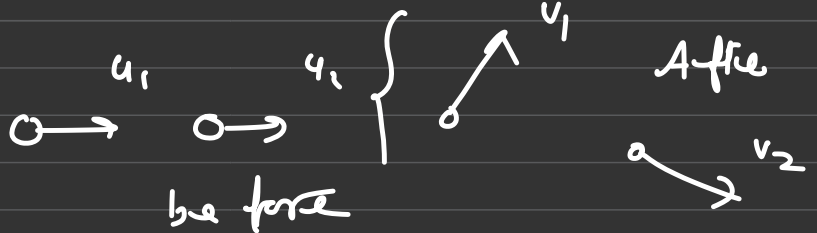
on the basis of line of impact

(1) Head on Head

motion of object must be along line of impact



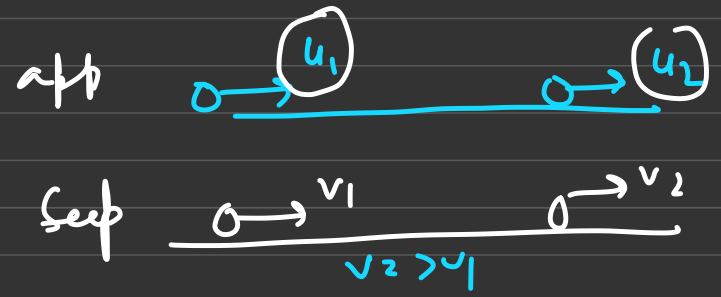
(2) oblique : motion of object before and after collision must not be along line of impact



Collision: "On the basis of KE energy loss"

① Elastic Collision: (1) No loss of KE
(2) L.o.f.C.o.f m
(3) $V_{sep} = e V_{app}$

$u_1 > u_2$



$u_1 - u_2 = V_{app}$

$v_2 - v_1 = V_{sep}$

e = Coefficient of Restitution

$e = 1$ "No-loss in KE"

Elastic collision

(2) Inelastic collision : (1) Some loss in KE

" e = 1/2 Ka bilkul ~~(2)~~ (2) C of C of L. m

ye matlab nahi hai ki 50% loss hai "

(3) $V_{sep} = e V_{app}$

$0 < e < 1$

(NOT all)

(3) Perfectly inelastic collision

(1) max in loss in KE

(2) C of C of C. M

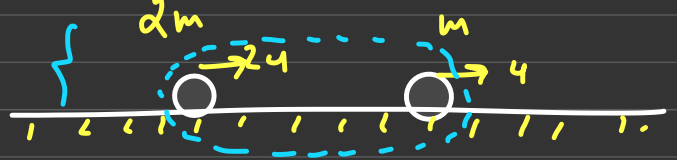
(3) $V_{sep} = e V_{app}$

$e = 0$

$V_{sep} = 0$

Q)

a)



"e = 1" No loss in KC
Head on Head

find final velocities?

$0 \rightarrow v_1$ $0 \rightarrow v_2$

$2m \times 2u + m \times u = 2m \times v_1 + m v_2$

$5u = 2v_1 + v_2$ — (I)

$\Rightarrow$ $V_{sep} = eV_{app}$

$2v_2 - 2v_1 = 2 \times u$ — (II)

$3v_2 = 7u \longrightarrow v_2 = (7u/3)$

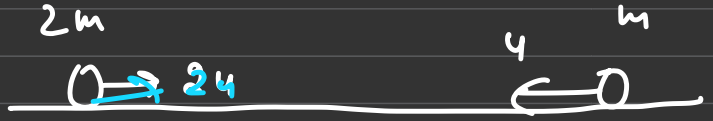
$$v_1 = \frac{5u - \frac{7u}{3}}{2} = \frac{8u}{3\times 2}$$

$$v_1 = \left(\frac{4u}{3}\right) \Leftarrow$$

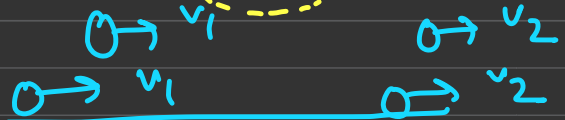
if $e = 1/2$ find % loss in KE

=

b)



if $e = \frac{1}{2}$ then find velocities After collision ?



(assumption)

$4mu - mu = 2mv_1 + mv_2$

$$3u = 2v_1 + v_2 \quad \text{—(1)}$$

$V_{sep} = e\, V_{app}$

$$2v_2 - 2v_1 = \frac{1}{2}(3u) \quad \text{—— (II)}$$

$$3v_2 = 6u$$

$$v_2 = 2u$$

$$2v_1 = 3u - 2u$$

$$v_1 = \left(\frac{u}{2}\right)$$

% loss in KE $= \left\{ \frac{(KE)_i - (KE)_f}{(KE)_i} \right\} \times 100$

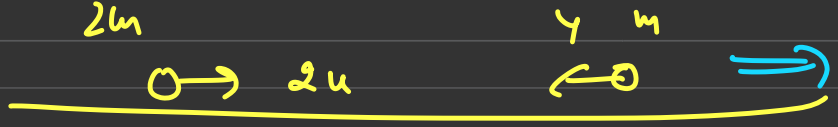
$$(KE)_i = \frac{1}{2}\, 2m\, (2u)^2 + \frac{1}{2}\, m\, (u)^2 = 4.5mu^2$$

$$(KE)_f = \frac{1}{2} 2m\, (u/2)^2 + \frac{1}{2}\, m\, (2u)^2 = 2.25mu^2$$

$$\left(\frac{4.5mu^2 - 2.25mu^2}{4.5mu^2}\right) \times 100$$

$$= \frac{2.25}{4.5} mu^2 \times 100 = 50\%$$

c) $e = 0$



$\Rightarrow v_1, v_2$

$v_1 = v_2$

then find % loss in KE = ?

$u_{rel} = 0$

$e = 0 \Rightarrow$ move together

(1) c. of c. of M

$3mu = 2mv_1 + mv_2$ (1)

(2) $u_{rel} = v_1 = v_2$

$3mu = 2mv_1 + mv_1$

$3mv_1 = 3mu$

$v_1 = u$

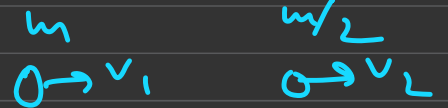
$$\begin{cases} (KE)_i = 4.5mu^2 \\ (KE)_f = \frac{1}{2}3m(u)^2 = 1.5mu^2 \end{cases}$$

$$\%\ \text{loss} = \left(\frac{4.5\,mu^2 - 1.5\,mu^2}{4.5\,mu^2}\right) \times 100$$

$$\frac{3}{4.5} \times 100 = \frac{2}{3} \times 100$$

$$= 67.7\%$$

9)



if % loss in KE = 5%
then find then e = ?

$$mu + \frac{mu}{4} = mv_1 + \frac{m}{2}v_2 \quad (1)$$

$$0.95\left(\frac{1}{2}m(u)^2 + \frac{1}{2}\,m/2\,(u/2)^2\right) = \frac{1}{2}mv_1^2 + \frac{1}{2}m/2\,(v_2)^2$$

$$\begin{matrix} v_1 \\ v_2 \end{matrix} = \begin{pmatrix} \alpha & \beta \\ \alpha' & \beta' \end{pmatrix}$$

we will get V_{sep} from here

$V_{sep} = e \times V_{applied}$

$\frac{1}{2} = e$

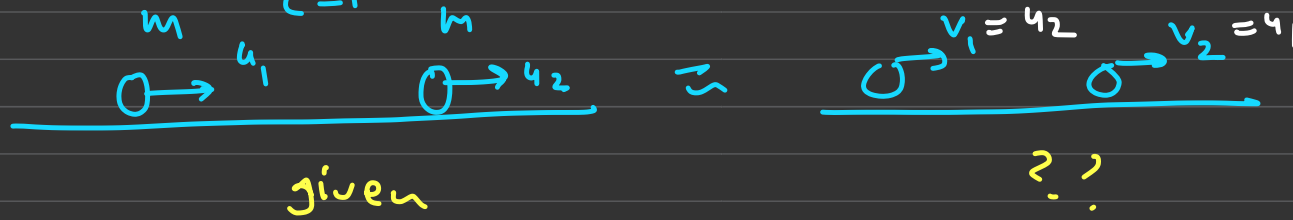
$V_{applied} = V_2$

we will get 'e'

complete the sol:

Special cases in Head on Head collision:

① $e = 1$



$$m \times u_1 + m u_2 = m v_1 + m v_2 \quad \text{— (I)}$$

$$v_2 - v_1 = 1 \times (u_1 - u_2) \quad \text{— (II)}$$

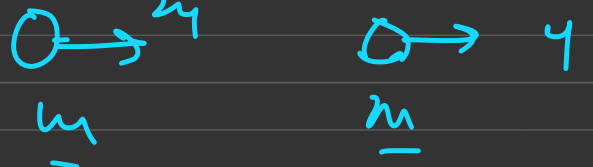
$$u_1 + u_2 = v_1 + v_2$$
$$u_1 - u_2 = -v_1 + v_2$$

$$v_1 = u_2$$

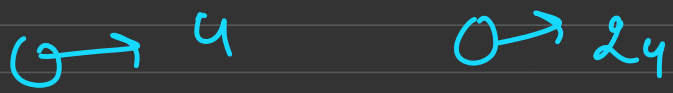
$$2v_2 = 2u_1$$
$$v_2 = u_1$$

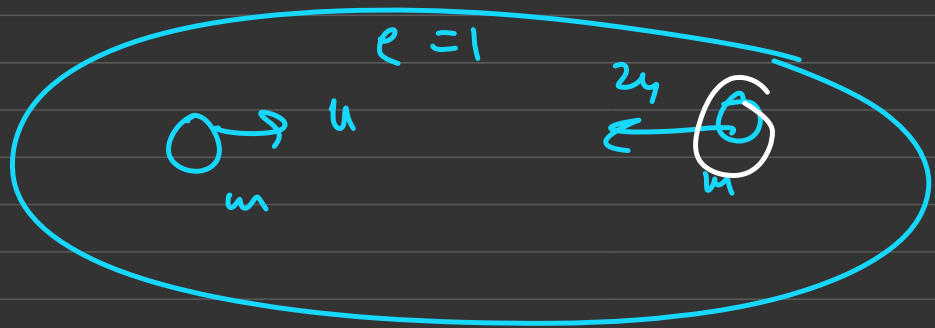
two if identical bodies of same mass colliding Head on Head elastically then they exchange their velocity

e = 1 (Head on collision)

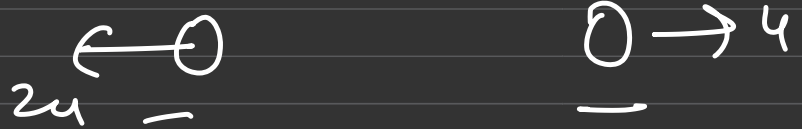
① 

Af collision



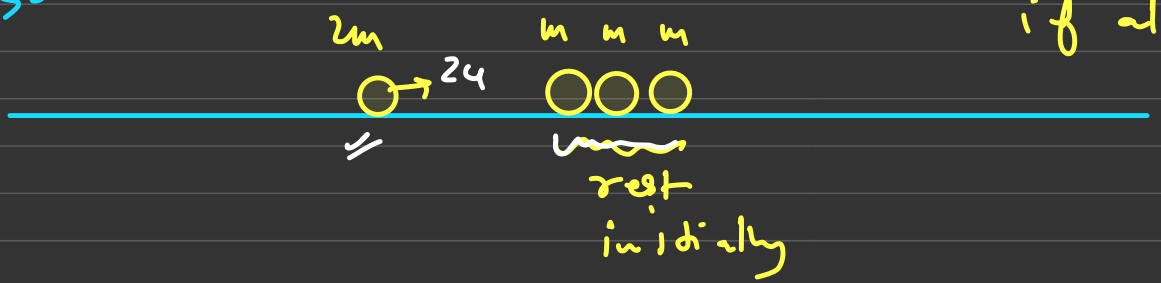
② 

// After collision



9) Problem Solving

$t = 0$



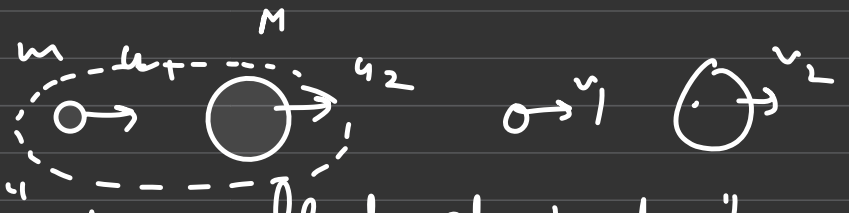
if all possible collision are elastic

then find - a) total no. of collision

b) find velocities of all masses

Special case 2:

$M \gg m$



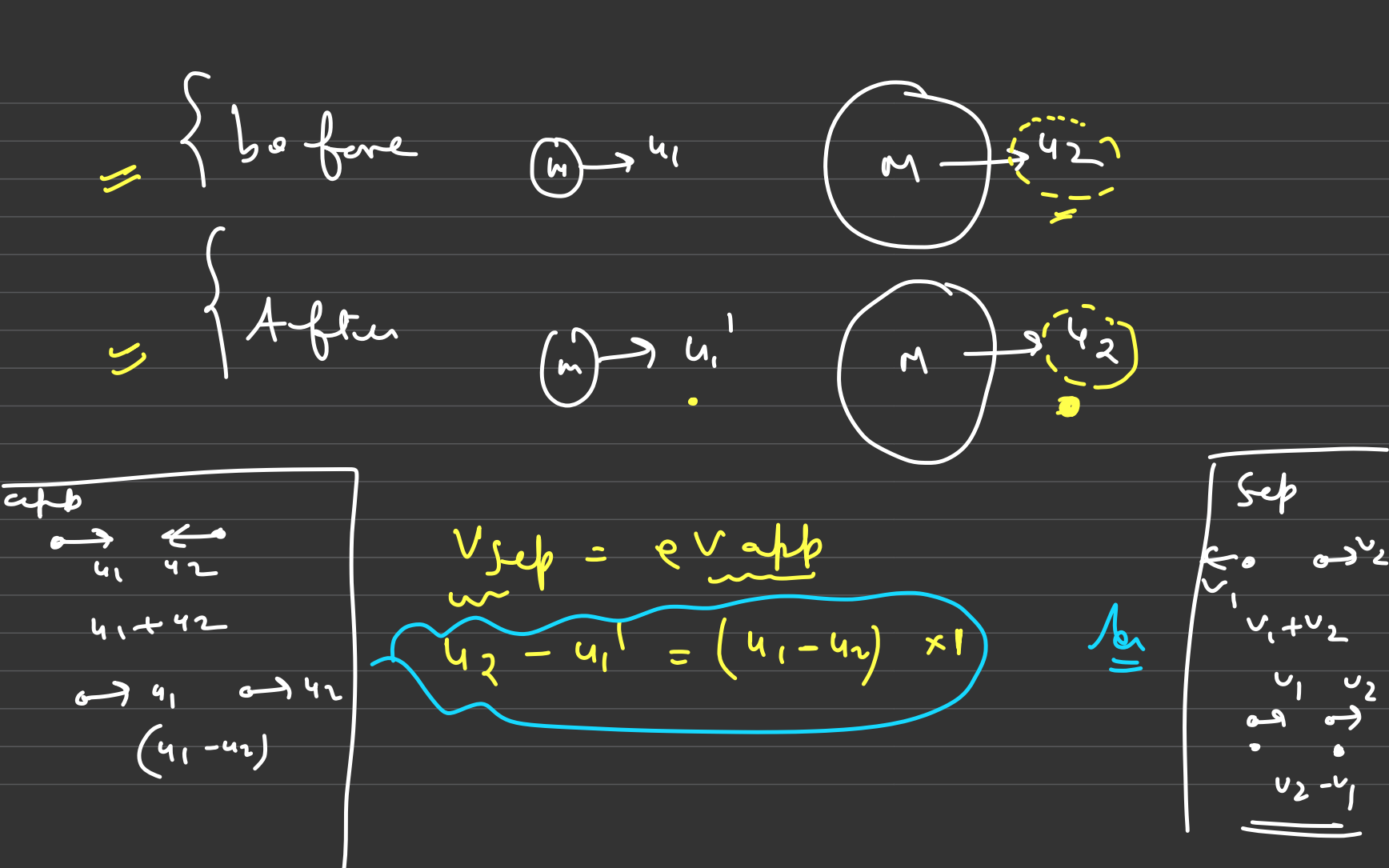
$$\begin{cases} m u_1 + M u_2 = m v_1 + M v_2 \\ m(v_1 - u_1) = M(u_2 - v_2) \end{cases}$$

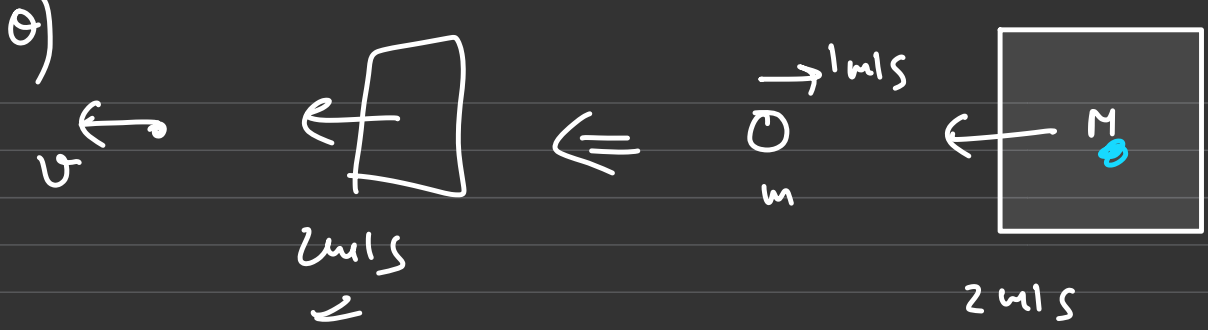
$$u_2 - v_2 = \frac{m}{M}(v_1 - u_1) \approx 0$$

Approximation

if $M \gg m$ $\quad u_2 - v_2 = 0$

$v_2 = u_2$ $\quad v_2 = u_2$


Before
m → u1
M → u2
After
m → u1'
M → u2
a+b
u1 u2
u1+u2
u1 u2
(u1-u2)
V sep = e V a+b
u2 - u1' = (u1-u2) x1
sep
v2
v1
v1+v2
v1 v2
v2-v1



then find velocities of objects after collision if collision is elastic?

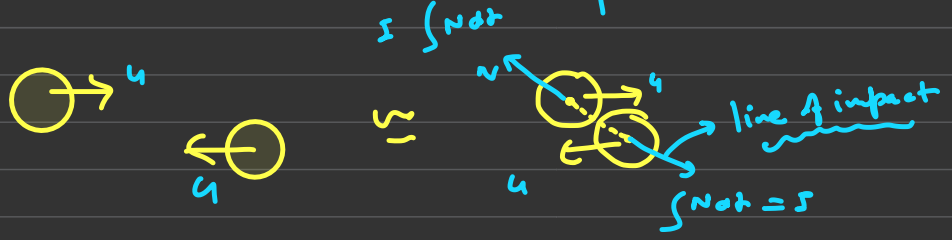
$$\Rightarrow \quad V_{sep} = e\,V_{app}$$

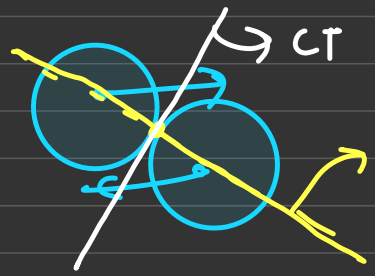
$$(V - 2) = 1 \times (3)$$

$$V = 5\ m/s$$

Oblique Collision

{ " Velocity After Collision must not be along line of impact "

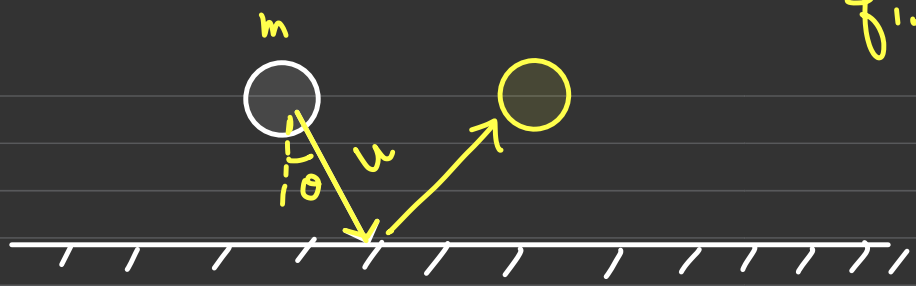




C.N ≡ Common Normal

CT = Common Tayant

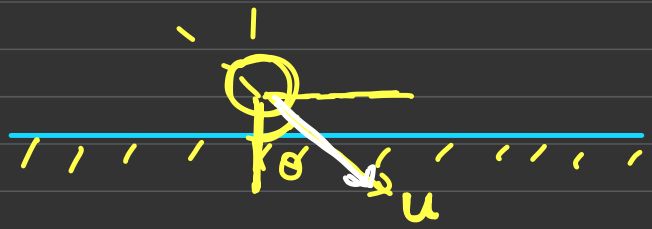
Q)



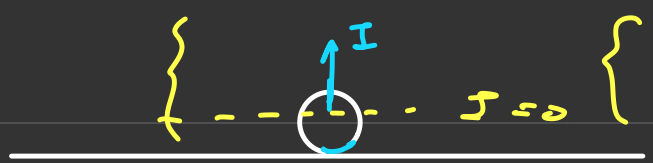
find speed After collision

'e' → inelastic

Steps: ① Draw initial velocity diagram (just before collision)

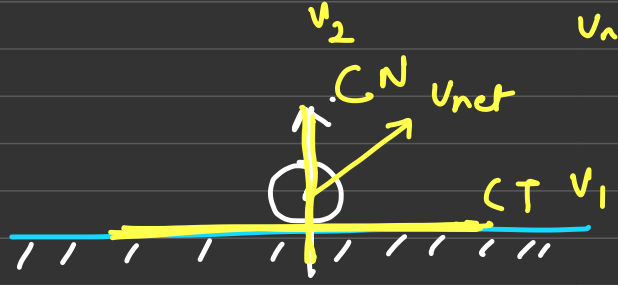


② Draw impulse diagram during collision



(3) Draw final velocity diagram (just after collision)

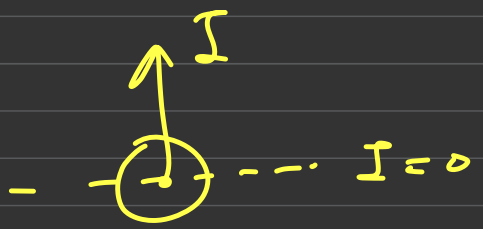
$v_{net} = \sqrt{v_1^2 + v_2^2}$

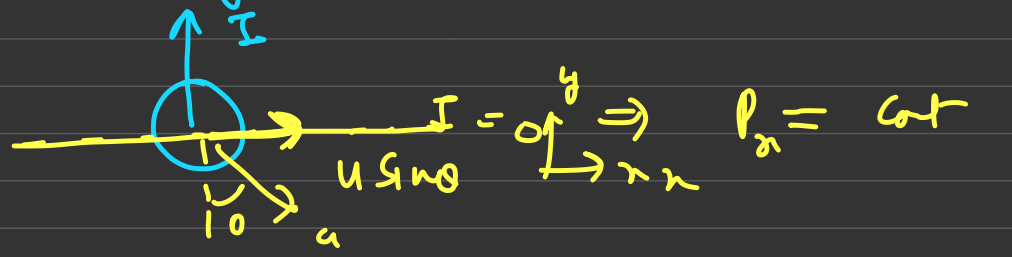


④ $V_{sep} = e\, V_{app}$ "along Common Normal"

$$v_2 = e\, u \cos\theta \quad \text{— (1)}$$

⑤ if Impulse along any axis = 0
then we can simply apply
law of conservation of momentum
along that axis





$\Rightarrow P_x = \text{Const}$

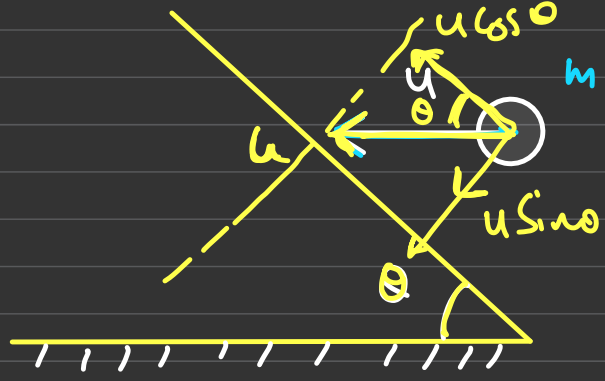
$m u \sin\theta = m v_1$

$$v_1 = u \sin\omega$$

$$\begin{cases} v_1 = u \sin\omega \\ v_2 = eu \cos\omega \end{cases}$$

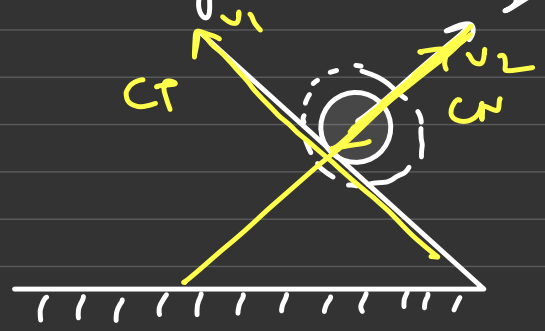
$$v_{red} = \sqrt{u^2 \sin^2\omega + e^2 u^2 \cos^2\omega}$$

find speed of ball after collision?



(I) Initial velocity Diagram

(II) Impulse diagram



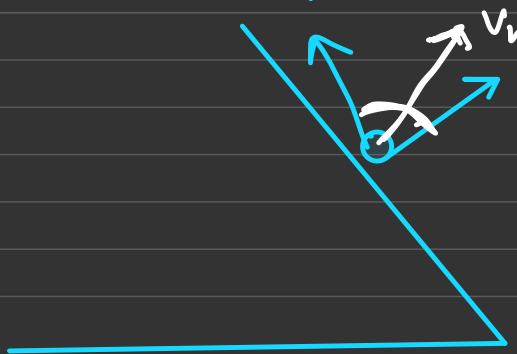
(iii) ✓

(iv) Apply $v_{sep} = e v_{app}$

$$v_2 = e u \sin\theta \quad \text{—(i)}$$

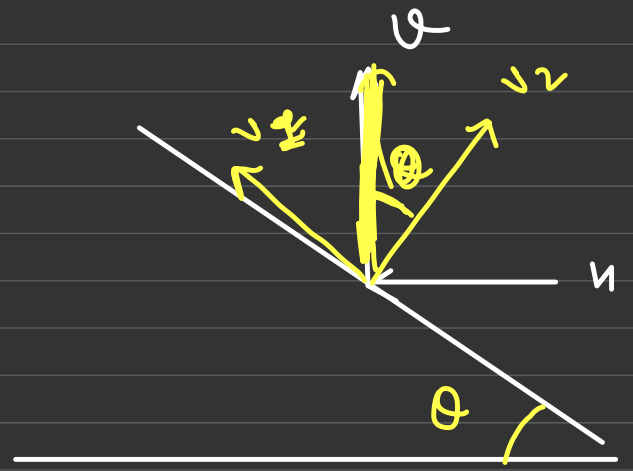
(v) $m u \cos\theta = m v_1$ —(ii)

$v_1 = u\cos\theta$ $v_1 = u\cos\theta$



Extra Qums in Smp Q :

find 'e' for which v_{net} is vertically upwards



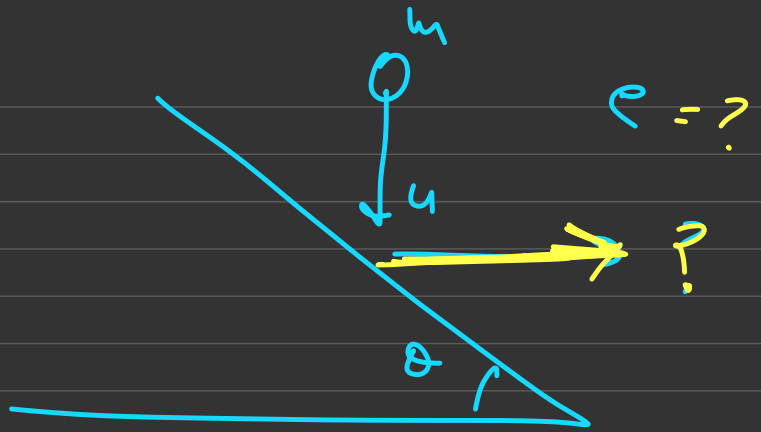
Ans

$$\tan\theta = \frac{v_1}{v_2} = \frac{u\cos\theta}{e\,u\sin\theta}$$

$$\tan^2\theta = \frac{1}{e}$$

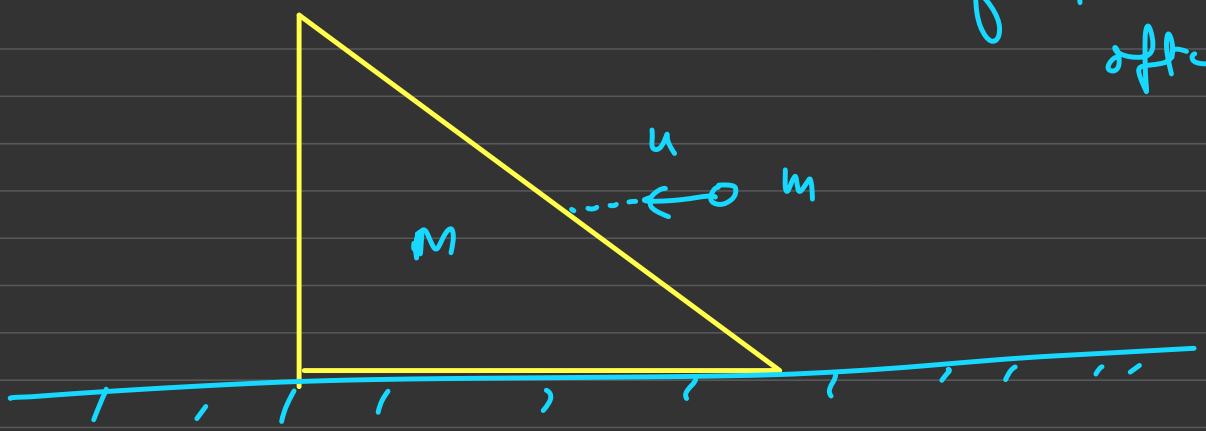
$$e = \cot^2\theta$$

01)



find value of e for after collision ball go over horizontal?

Q2)



find velocity after collision?

Level 1 !

Till DTS # 4

Level 2.

Com topic

Poe Cons