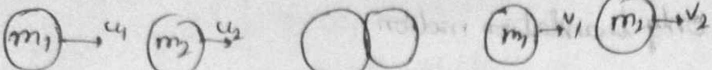
COLLISION

→ L·C·L·M is valid for any type of collision.



L·C·L·M $\quad m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

KE $\quad \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

coeff of restitution $e = \frac{v_2 - v_1}{u_2 - u_1}$

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1+m_2}\right)$

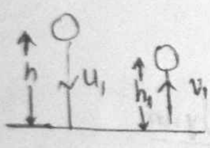
$v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \left(\frac{2m_1}{m_1+m_2}\right)$

e

- $e = 1$ elastic collision → KE conserved
- $0 < e < 1$ $(KE)_i - (KE)_f$ → KE is loss
- $e = 0$ (perfect inelastic collision) $(KE)_i - (KE)_f$ → KE is loss is max.

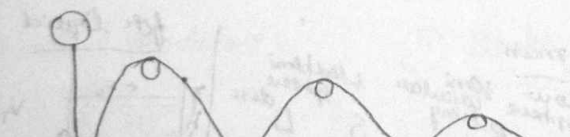
→ (i) Fraction of K.E retained $= \left(\frac{M_1 - M_2}{M_1 + M_2}\right)^2$

(ii) Fraction of K.E transferred $= \frac{4M_1M_2}{(M_1+M_2)^2}$

(iii) 

$\boxed{v_1 = eu_1}$ $\quad \boxed{h_n = e^{2n}h}$

(iv) distance travelled by the ball to rest.



$d = h\left(\frac{1+e^2}{1-e^2}\right)$

$t = \sqrt{\frac{2h}{g}}\left(\frac{1+e}{1-e}\right)$

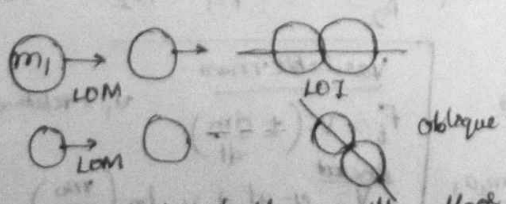
$\Delta p = mv_0\left(\frac{1+e}{1-e}\right)$

% Loss in energy $= 1 - e^2 \times 100\%$

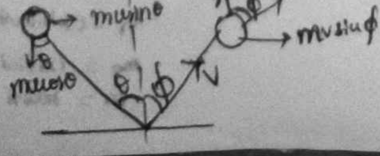
Avg speed $= \dfrac{h\left(\frac{1+e^2}{1-e^2}\right)}{\sqrt{\frac{2h}{g}}\left(\frac{1+e}{1-e}\right)}$ $\qquad \langle v \rangle = \dfrac{h}{\sqrt{\frac{2h}{g}}\left(\frac{1+e}{1-e}\right)}$

→ Understanding head on collision & oblique collision

LOI – line of impact
LOM – line of motion.



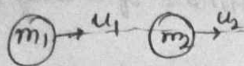
→ Collision of ball with floor obliquely:



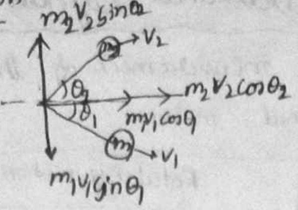
$V = u\sqrt{\sin^2\theta + e^2\cos^2\theta}$

$\tan\phi = \frac{\tan\theta}{e}$

→ Oblique (or) 2D collision



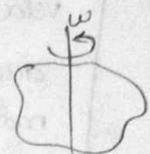
LOM



L.C.L.M (vector) $\quad m_1 u_1 + m_2 u_2 = m_1 v_1 \cos\theta_1 + m_2 v_2 \cos\theta_2$

KE (scalar) $\quad \frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$

Angular momentum (L)



→ $L = m(r \times v) = mvr\sin\theta$, for pure rotation $L = I\omega$

→ for both rotational & translational $\quad L_{total} = I_c \omega + mvr_\perp$

→ angular momentum (conservation) $\quad I_1 \omega_1 = I_2 \omega_2$

→ $v = r\omega$

acceleration of particle P with two components a_n & a_t as it is rotating in a circle.

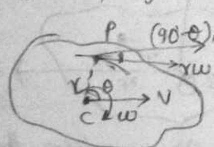
$$a_n = r\omega^2 = v^2/r \quad \text{(towards circle)}$$

$$a_t = r\alpha = r \cdot \frac{d\omega}{dt} \quad \text{(tangential)}$$

$$a = \sqrt{a_n^2 + a_t^2}$$

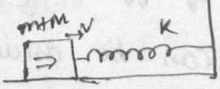
$$\int d\theta = \int \omega dt, \quad \int d\omega = \int \alpha dt, \quad \int \omega d\omega = \int \alpha d\theta$$

→



$$v_p = \sqrt{v^2 + (r\omega)^2 + 2(v)(r\omega)\cos(90-\theta)}$$

→

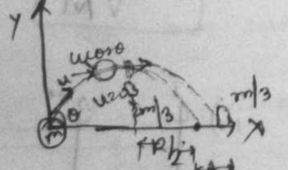


$mu = (m+M)v$

loss in KE = Gain in PE

$\frac{1}{2}(m+M)\left(\frac{mu}{M+m}\right)^2 = \frac{1}{2}kx^2$

→ concept of explosion



$\frac{2m}{3} \times \frac{R}{2} = \frac{m}{3} d$

$d = R$

$A = d + R = 2R = \frac{2 \times u^2 \sin 2\theta}{g}$

→ When angular momentum is constant τ is zero.