Collisions/ Impact :-

1. Perfectly elastic Collisions ($e = 1$)
2. Perfectly inelastic Collisions ($e = 0$)
3. Partially elastic ($0 < e < 1$)

Perfectly elastic Collisions :-

when the initial kinetic energy before Collision is equal to the final k.e. after Collision Such a collision known as perfectly elastic Collision

$u_1 > u_2$ $\qquad\qquad$ $V_2 > V_1$

linear Moment Cost.

$$m_1 u_1 + m_2 u_2 = m_2 V_2 + m_1 V_1 \qquad (1)$$

K.E. equal

$$\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 V_1^2 + \frac{1}{2} m_2 u_2^2 \qquad (2)$$

From (1) & (2)

$$\boxed{u_1 - u_2 = V_2 - V_1}$$

Vel. of approach = Vel. of Separation

In case of perfectly plastic Collision

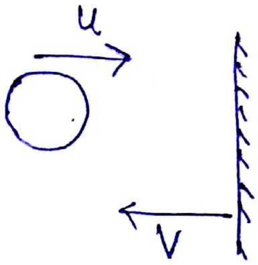
Special Case 1 Velocity are interchange if mass equal

if $m_1 = m_2$; $e = 1$

$$\vec{u}_1 = \vec{v}_2$$

$$\vec{u}_2 = \vec{v}_1$$

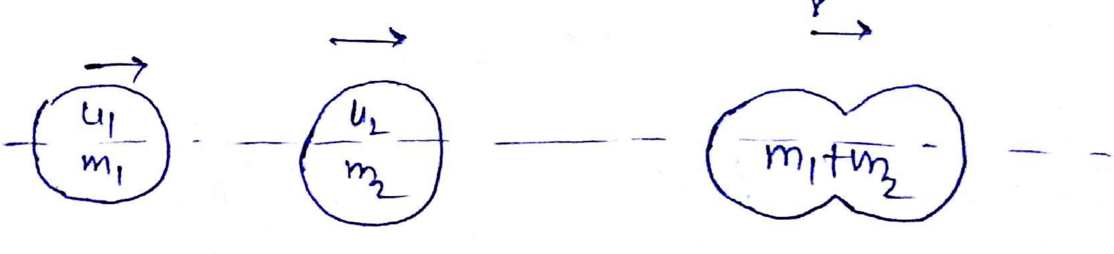
Case 2



$$\vec{u} = -\vec{V}$$

Perfectly Inelastic Collision (e = 0) →

If two perfectly inelastic bodies moving along the same line Collide they stick to each other.

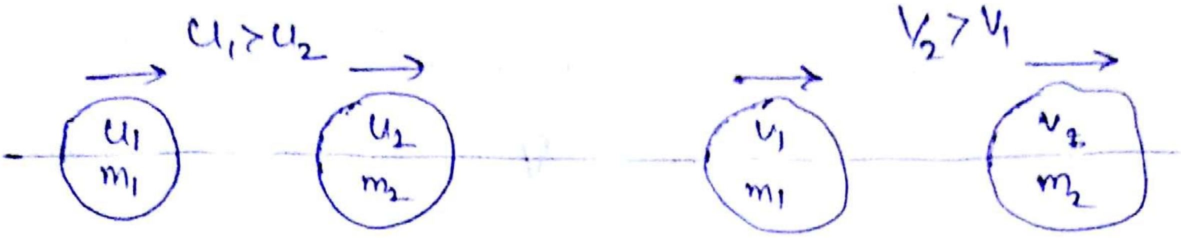


$$m_1 u_1 + m_2 u_2 = (m_1 + m_2) V$$

$$(K.E.)_{Loss} = (K.E.)_i - (K.E.)_f$$

$$(K.E)_{loss.} = \frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 - \frac{1}{2}(m_1+m_2) V^2$$

Partially Elastic ($0 < e < 1$)



$$m_1u_1 + m_2u_2 = m_1v_1 + m_2V_2$$

Vel. of sep = e(Vel. of appo)

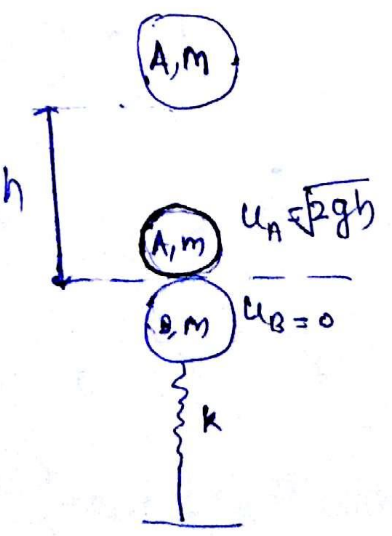
$$V_2 - V_1 = e(u_1 - u_2)$$

e - Coeff. of restitution

$$e = \frac{\text{Vel. of sep.}}{\text{Vel. of appo}}$$

1) Perfectly elastic $e = 1$
2) Perfectly inelastic / plastic $e = 0$ [∵ Vel. of sep = 0]

Question
4.1
pg. 84
Gate book

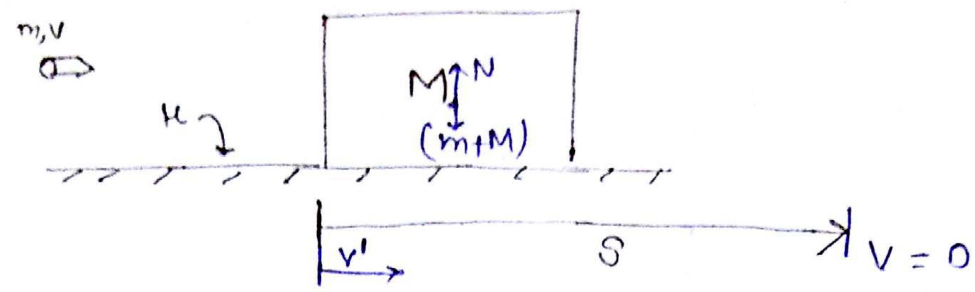


$u_A = V_B$

$u_B = V_A$

Velocity of A immediately after impact = 0

Q.4.3
P.g.84



find $v = ?$

(M+m) $P =$ Constant

$$mv + 0 = (M+m)v' \quad \text{--- (1)}$$

$$f_k = \mu N = \mu(M+m)g$$

(M+m) total work done

$$TWD = \Delta(K.E.)$$

$$W_k = -f_k S = 0 - \frac{1}{2}(M+m)v'^2$$

$$\mu(M+m)gS = \frac{1}{2}(M+m)v'^2$$

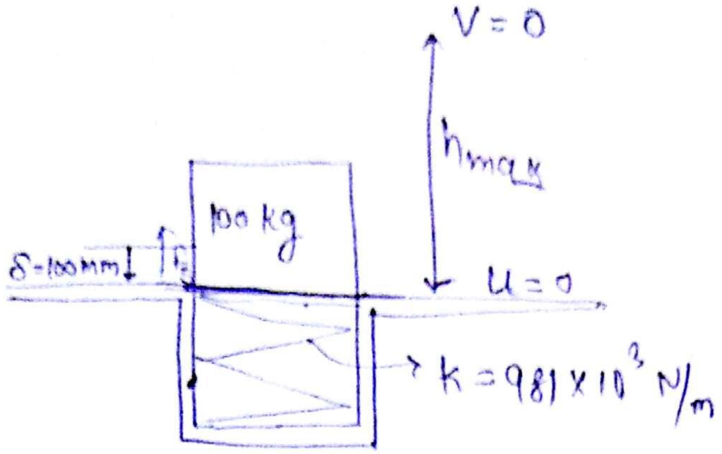
$$v' = \sqrt{2\mu g s} \quad \text{--- (2)}$$

From (1) & (2)

$$mv = (M+m)\sqrt{2\mu g s}$$

$$v = \frac{M+m}{m}\sqrt{2\mu g s}$$

Q. 4.4



TWD = Δ(K.E.)

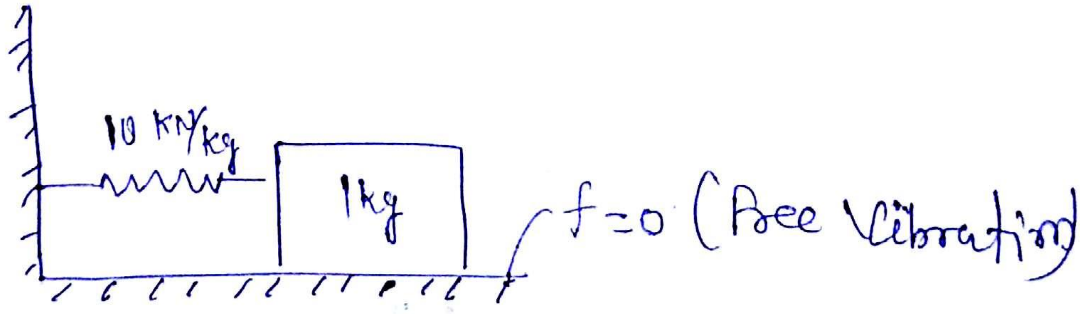
$\frac{1}{2} k \delta_i^2 - mgh = 0 + 0$

$h = \frac{k \delta_i^2}{2mg} = \frac{981 \times 10^3 \times 100 \times 100}{2 \times 100 \times 9.81 \times 1000 \times 1000}$

$h = 5$ m

$h = 5000$ mm

Q. 4.10
Pg. 85



$F_{impulsive} = 5 \times 10^3$ N $\quad t = 10^{-4}$ s

Solⁿ

impulse = Ft = $5 \times 10^3 \times 10^{-4}$

Impulse = 0.5 N-S

change in Momentum = 0.5 N-s

$\Delta p = P_f - P_i = 0.5$

$$\Delta P = P_f - P_i = mV_f$$

$$\frac{0.5}{1} = V_f \Rightarrow$$

$$V_f = 0.5 \ m/s$$

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$$

$$1 \times 0.5^2 = 10 \times 10^3 x^2$$

$$x = A = 5 \ mm$$

$$A = 5mm$$