DPP – 03

SOLUTION

1. net mass of car and gun $= Mgc$ and momentum is Pgc

momentum conservation $\Rightarrow P_{gc} = P_{\text{bullet.}}$.

$m_{gc}v_{gc} = m_{\text{bullet}} \cdot V_{\text{bullet}}$

$(50-1)\text{Vgc1} = 1 \times 100$ (When first shell is fired)

$v_{gc1} = 2.04 \text{ m/s}$

when the second shell is fired

$(49-1)v_{gc2} = 1 \times 100$

$v_{gc2} = 2.08 \text{ m/s}$

So net recoiling velocity of car and gun system.

is $\Rightarrow 2.04 + 2.08 \quad (\text{ie } v_{gc1} + v_{gc2})$

$= 4.12 \text{ m/s}$

$\approx 4 \text{ m/s}$ (nearest integer)

2. mass of bullet $(\mathrm{m}_b) = 20\text{gm} = 0.02 \text{ kg}$

mass of wooden block $(m_w) = 5 \text{ kg}$.

Momentum conservation

$0.02 \times 400 = 0.02 \times 200 + 5v_w \Rightarrow v_w = 0.8 \text{ m/s}$.

Retardation of block (wooden)

$v^2 = u^2 + 2as \Rightarrow 0 = (0.8)^2 + 2a \times 0.2$

$a = 1.6 \text{ m/sec}^2$

$$\because a = \mu g \Rightarrow \mu = \frac{a}{g} = \frac{1.6}{10} = \frac{8}{50}$$

$$a = \frac{8}{50}$$

So $\lambda = 8$

3. mass of boy $(m_b) = 60 \text{ kg}$.

mass of plot from $(M_p) = 40 \text{ kg}$.

mass of stone $(m_s) = 1 \text{ kg}$

$u = 10 \text{ m/s}$ velocity of stone.

$$\text{Range of stone } x_{\text{stone}} = \frac{u^2 \sin 2\theta}{g} = \frac{(10)^2 \sin 9^\circ}{10}$$

$x_{\text{stone}} = 10 \text{ cm} = x_s$.

$$\frac{m_s \times x_s + (m_b + m_p)\text{xp}}{m_s + m_b} = 0$$

$1 \times 10 + 100\text{xp} = 0$

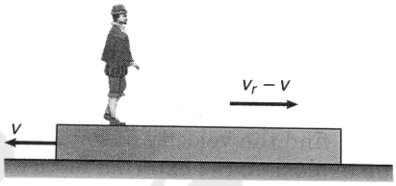
$x_p = -10$ cm

-ve shows opposite side displacement

So $\quad 2\alpha = 10$

$\alpha = 5$

4. Absolute velocity of man i.e., velocity of man w.rt. ground is $v_r - v$ where v is the recoil velocity of platform. Taking the platform and the man as a system, net external force on the system in horizontal direction is zero. The linear momentum of the system remains constant. Initially both the man and the platform were at rest.



Hence, $0 = m_1(v_r - v) - m_2 v$

$\Rightarrow \ v = \frac{m_1 v_r}{m_1 + m_2}$

5. When the smaller block reaches A, then both the blocks will have same horizontal velocity. Applying Law of Conservation of Linear Momentum (along axis perpendicular to gravity), we get

$mv = (m + M)v_x$

$\Rightarrow v_x = \frac{mv}{m+M}$

6. Applying Law of Conservation of Linear Momentum and Mechanical Energy we get,

$mv = MV \qquad .....(1)$

and $mgR = \frac{1}{2}mv^2 + \frac{1}{2}MV^2 \qquad .....(2)$

Solving (1) and (2), we get velocity of cube to be

$$v = \sqrt{\frac{2MgR}{M + m}}$$

7. from momentum conservation

$m_1 v_1 = m_2 v_2$

$500 \times 10 = (500 + 50)V_2$

$V_2 = \frac{100}{11}$ m/sec

8. $P_i = MV$

After explosion

$P_f = mV + m'V'$

$P_f = 0 + (M - m)V'$

$P_i = P_f$ (momentum conservation)

$MV = (M - m)V'$

$V' = \frac{MV}{(M-m)}$

9. When m leaves M, both would be moving at same speed horizontally, so we have

$\mathrm{mu} = (\mathrm{m} + \mathrm{M})\mathrm{v}$

$\Rightarrow \mathrm{v} = \frac{\mathrm{mu}}{\mathrm{m+M}}$

The mass m will also have a vertical speed $\mathrm{v_y}$ due to which it rises to a maximum height H. Applying the Work Energy Theorem, we get

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

$$\Rightarrow \mathrm{u}^2 - 2\mathrm{gH} = \frac{\mathrm{mu}^2}{\mathrm{m} + \mathrm{M}}$$

$$\Rightarrow 2\mathrm{gH} = \mathrm{u}^2 - \frac{\mathrm{mu}^2}{\mathrm{m} + \mathrm{M}} = \frac{\mathrm{Mu}^2}{\mathrm{m} + \mathrm{M}}$$

$\Rightarrow \mathrm{H} = \frac{\mathrm{Mu}^2}{2\mathrm{g(M+m)}}$