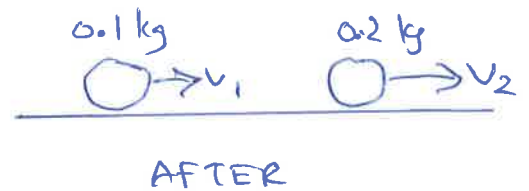
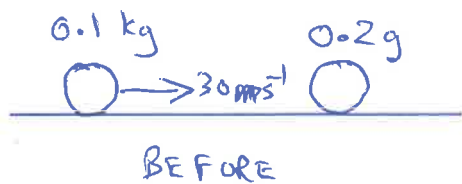


①



①

CONSERVATION OF MOMENTUM:

MOMENTUM BEFORE COLLISION = MOMENTUM AFTER COLLISION

$$(0.1)(30) = 0.1v_1 + 0.2v_2$$

$$3 = 0.1v_1 + 0.2v_2$$

O.K. to leave as it is but easier to manipulate if we multiply by 10 throughout.

$$30 = v_1 + 2v_2 \quad \text{————— (1)}$$

CONSERVATION OF ENERGY:

K.E. BEFORE COLLISION = K.E. AFTER COLLISION

$$\frac{1}{2}(0.1)(30)^2 = \frac{1}{2}(0.1)v_1^2 + \frac{1}{2}(0.2)v_2^2$$

$$90 = 0.1v_1^2 + 0.2v_2^2$$

AGAIN PROBABLY BETTER TO MULTIPLY THROUGHOUT BY 10:

$$900 = v_1^2 + 2v_2^2 \quad \text{————— (2)}$$

From (1): $v_1 = 30 - 2v_2$ ————— (3)

Substitute for v_1 into (2)

(2)

$$900 = (30 - 2v_2)^2 + 2v_2^2$$

$$900 = 900 - 60v_2 - 60v_2 + 4v_2^2 + 2v_2^2$$

Collect similar terms:

$$6v_2^2 - 120v_2 = 0$$

There is a v_2 common in both terms to L.H.S,

Take it outside bracket:

$$v_2 (6v_2 - 120) = 0$$

As in previous exercises either

$$\underline{v_2 = 0 \text{ ms}^{-1}}$$

From (3) $\underline{v_1 = 30 \text{ ms}^{-1}}$

or $6v_2 - 120 = 0$

$$6v_2 = 120$$

$$\underline{v_2 = 20 \text{ ms}^{-1}}$$

From (3) $\underline{v_1 = -10 \text{ ms}^{-1}}$

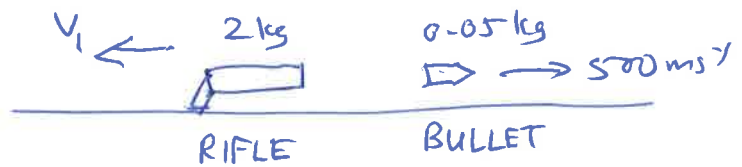
This solution is
more plausible

(3)

(2)

BEFORE : ZERO MOMENTUM

AFTER :



Remember signs:

$$0 = -2v_1 + (0.05)(500)$$

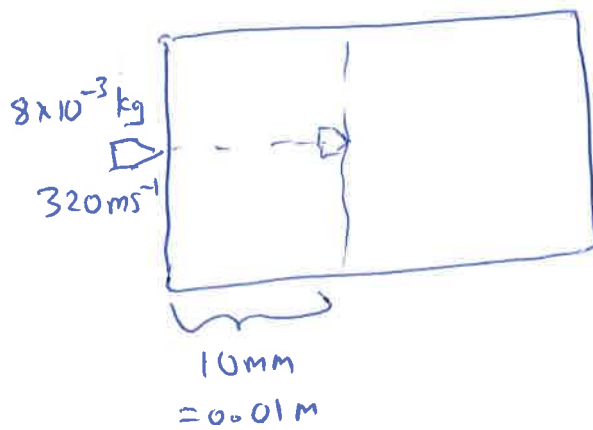
$$2v_1 = (0.05)(500)$$

$$\underline{v_1 = 12.5 \text{ ms}^{-1}}$$

IF YOU HAD PUT v_1 GOING IN OPPOSITE DIRECTION IN FIGURE THEN v_1 WOULD BE -12.5 ms^{-1} INDICATING THE CORRECT DIRECTION SO IT DOESN'T MATTER WHAT DIRECTION YOU ASSUME IN FIGURE.

$$\begin{aligned} \text{K.E. OF BULLET} &= \frac{1}{2}(0.05)(500)^2 \\ &= \underline{6250 \text{ J}} \end{aligned}$$

(3)



Again, just balance energy,

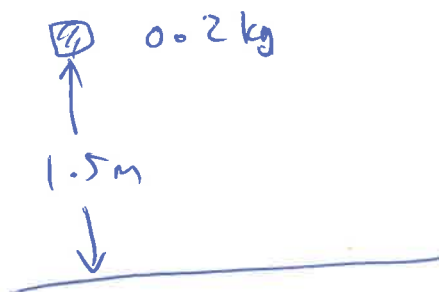
$$\text{K.E. OF BULLET} = \text{WORK DONE BY RESISTIVE FORCE TO STOP BULLET}$$

$$\frac{1}{2} (8 \times 10^{-3}) (320)^2 = F \times 0.01$$

Just rearrange to find F

$$\underline{F = 40,960 \text{ N}}$$

(4)



P.E. is totally converted to K.E. when it reaches ground.

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

(take $g = 10 \text{ ms}^{-2}$)

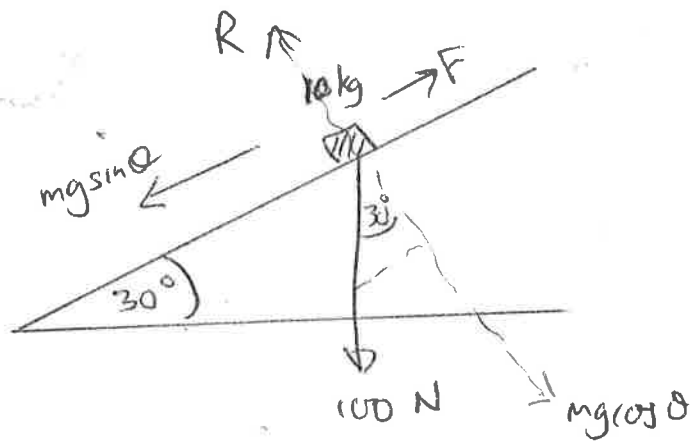
$$v^2 = 2gh = 2 \times 10 \times 1.5$$

$$v^2 = 30$$

$$\underline{v = 5.5 \text{ ms}^{-1} \text{ to 1 d.p.}}$$

(4)

(5)



Take $g = 10 \text{ ms}^{-2}$

(a) Consider forces $\perp$ to plane.
No motion $\therefore$ zero net force

$$\therefore R = mg \cos 30^\circ$$

$$R = (10)(10)(0.866)$$

$$R = 86.6 \text{ N}$$

But Friction Force $F = \mu R$ and $\mu = 0.7$

$$\therefore F = (0.7)(86.6)$$

$$F = 60.62 \text{ N} \quad \text{to 2 d.p.}$$

(b) Consider forces $\parallel$ to plane

$$mg \sin \theta = (10)(10)(0.5) \\ = 50 \text{ N}$$

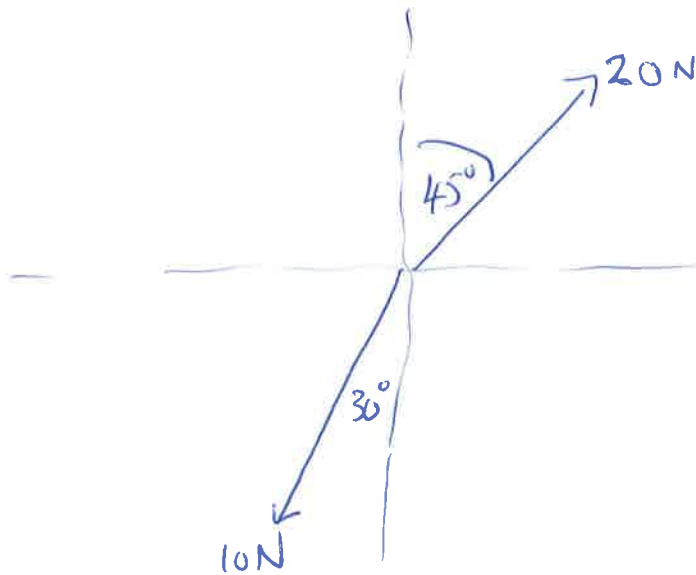
But Frictional force F is 60.62 N in opposite direction.

$\therefore$ Body does not slide down plane since $mg \sin \theta$ does not overcome Frictional force.

(c) Acceleration $\therefore$ is zero.

6.

⑥



Resolve forces in Horizontal direction :

$$F_H = 20 \cos 45^\circ - 10 \cos 60^\circ$$

$$F_H = 14.14 - 5$$

$$\underline{F_H = 9.14 \text{ N}}$$

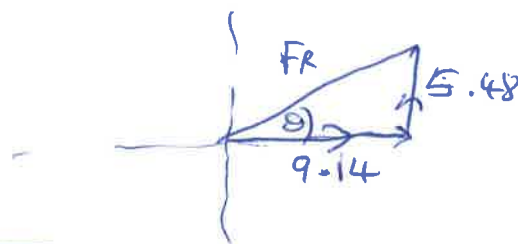
Resolve forces in Vertical Direction

$$F_V = 20 \cos 45^\circ - 10 \cos 30^\circ$$

$$F_V = 14.14 - 8.66$$

$$\underline{F_V = 5.48 \text{ N}}$$

Draw diagram



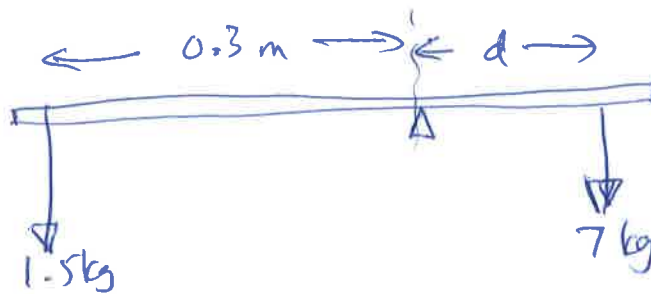
$$F_R = \sqrt{9.14^2 + 5.48^2}$$

$$\theta = \tan^{-1} \left(\frac{5.48}{9.14} \right)$$

$$\underline{F_R = 10.66 \text{ N to 2 D.}}$$

$$\underline{\theta = 30.95^\circ \text{ to 2 D}}$$

⑦



⑦

For beam to remain in equilibrium:

(clockwise Moment of Forces = Anticlockwise Moment)

(Remember, Moment = Force $\times$ Perpendicular distance)

$$7g \times d = 1.5g \times 0.3$$

(Assume $g = 10 \text{ m/s}^2$ but it cancels out anyway)

$$d = \frac{1.5 \times 0.3}{7}$$

$$\underline{d = 0.064 \text{ m}} \quad \text{to 3 d.p.}$$

8

8

$$(a) \quad \text{Stress} = \frac{\text{Force}}{\text{Area}} = \frac{10 \times 10^{\text{N}}}{0.1 \times 10^{-4} \text{ m}^2}$$

$$(0.1 \text{ cm}^2 = 0.1 \times 10^{-4} \text{ m}^2)$$

$$\therefore \text{Stress} = \frac{100}{0.1 \times 10^{-4}} = 10^7 \text{ Pa}$$

(b) From Hooke's Law:

$$\text{Stress} = E \times \text{Strain}$$

let e = extension

$$\text{Stress} = E \times \frac{e}{l}$$

where l original length

$$\therefore 10^7 = \frac{50 \times 10^9 \times e}{1}$$

$$\therefore \underline{e = 2 \times 10^{-4} \text{ m}}$$