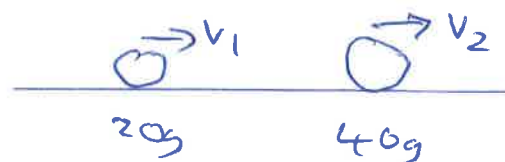
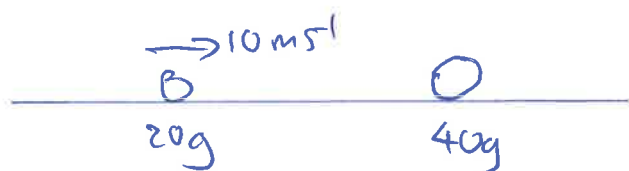


(4)

BEFORE

AFTER

(1)



From Conservation of Momentum:

Momentum before collision = Momentum after collision

$$20 \times 10 = 20v_1 + 40v_2$$

$$200 = 20v_1 + 40v_2$$

$$\underline{10 = v_1 + 2v_2} \quad \text{--- (1)}$$

From Conservation of Energy:

K.E. Before collision = K.E. After collision

$$\frac{1}{2}(20)(10)^2 = \frac{1}{2}(20)v_1^2 + \frac{1}{2}(40)v_2^2$$

$$1000 = 10v_1^2 + 20v_2^2$$

$$\underline{100 = v_1^2 + 2v_2^2} \quad \text{--- (2)}$$

$$\text{From (1)} \quad v_1 = 10 - 2v_2 \quad \text{--- (3)}$$

Substitute for v_1 into (2) to find v_2 :

$$100 = (10 - 2v_2)^2 + 2v_2^2$$

$$100 = 100 - 40v_2 + 4v_2^2 + 2v_2^2$$

Collect similar terms & rearrange:

$$6v_2^2 - 40v_2 = 0$$

$$6v_2^2 - 40v_2 = 0 \quad (2)$$

$$v_2(6v_2 - 40) = 0$$

This is of the form $A \times B = 0$

$\therefore$ either $A = 0$ or $B = 0$

$\therefore$ either $v_2 = 0$

$$\text{or } 6v_2 - 40 = 0 \quad \text{i.e. } v_2 = \frac{40}{6}$$

From these two values for v_2 , find v_1 from (3)

If $v_2 = 0$ then $v_1 = 10 \text{ ms}^{-1}$

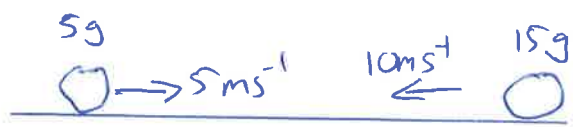
$$\text{If } v_2 = \frac{40}{6} \quad \text{then } v_1 = 10 - \frac{2 \times 40}{6}$$

$$\text{i.e. if } v_2 = 6.7 \text{ ms}^{-1} \quad \text{then } v_1 = -3.3 \text{ ms}^{-1}$$

this second solution is the more plausible.

5.

③



Conservation of Momentum:

$$5 \times 5 - 10 \times 15 = 5v_1 + 15v_2$$

$$-125 = 5v_1 + 15v_2$$

$$\underline{-25 = v_1 + 15v_2} \quad \text{--- (1)}$$

Conservation of Energy:

$$\frac{1}{2} 5 (5)^2 + \frac{1}{2} 15 (10)^2 = \frac{1}{2} 5 v_1^2 + \frac{1}{2} 15 v_2^2$$

(Cancel $\frac{1}{2}$ in each term on both sides)

$$125 + 1500 = 5v_1^2 + 15v_2^2$$

$$1625 = 5v_1^2 + 15v_2^2$$

$$\underline{325 = v_1^2 + 3v_2^2} \quad \text{--- (2)}$$

From (1) : $v_1 = -25 - 15v_2$ Substitute into (2)

$$325 = (-25 - 15v_2)^2 + 3v_2^2$$

$$325 = 625 + 750v_2 + 225v_2^2 + 3v_2^2$$

Collect terms

$$0 = 300 + 750v_2 + 228v_2^2$$

$$\text{i.e. } 228v_2^2 + 750v_2 + 300 = 0$$

Quadratic formula:

$$v_2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

(4)

$$a = 228$$

$$b = 750$$

$$c = 300$$

$$v_2 = \frac{-750 \pm \sqrt{(750)^2 - 4(228)(300)}}{2 \times 228}$$

$$v_2 = \frac{-750 \pm \sqrt{288900}}{456}$$

$$v_2 = \frac{-750 \pm 537.5}{456}$$

$$\therefore v_2 = \frac{-212.5}{456} = -0.47 \text{ or } v_2 = \frac{-1287.5}{456} = -2.8$$

from (3):

$$\therefore v_1 = -17.95 \text{ ms}^{-1} \text{ or } v_1 = 17 \text{ ms}^{-1}$$

First pair are more plausible.