

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise A, Question 21

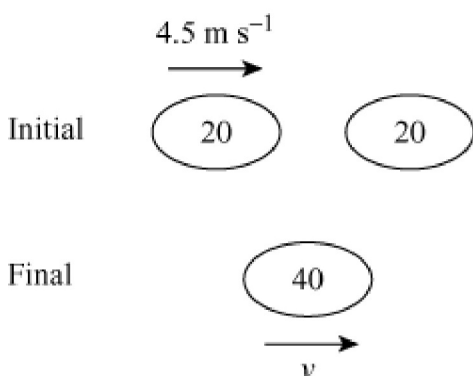
Question:

Three supermarket trolleys, each of mass 20 kg, are placed on a straight line. As these trolleys move they are not subject to any resistance to motion. The first one is set in motion so that it moves at a speed of 4.5 m s^{-1} towards the second trolley. It then collides with the second trolley. After this collision the two trolleys continue to move together along the straight line at constant speed until they collide with the third trolley. After this collision all three trolleys move together along the straight line.

- (a) Show that the speed of the two moving trolleys after the first collision is 2.25 m s^{-1} .
- (b) Find the speed of the trolleys after the second collision.
- (c) After the second collision the combined trolleys are subject to a single, horizontal resistance force of magnitude 30 N.
- (i) Calculate the acceleration of the trolleys while this force acts.
- (ii) Find the distance that the trolleys move after the second collision, before they come to rest. [A]

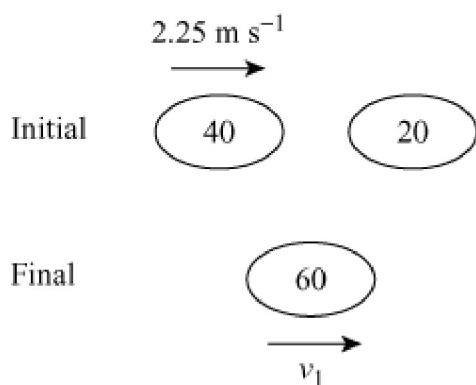
Solution:

- (a) First collision



$$\begin{aligned} \text{Using conservation of momentum } 20 \times 4.5 &= 40v \\ v &= 2.25 \text{ m s}^{-1} \\ \therefore \text{ Speed of the two moving trolleys is } &2.25 \text{ m s}^{-1} \end{aligned}$$

- (b) Second collision;



Using conservation of momentum $40 \times 2.25 = 60v_1$

$$v_1 = 1.5 \text{ m s}^{-1}$$

\therefore Speed of the trolleys is 1.5 m s^{-1}

For the combined trolleys, using $F = ma$,

$$\begin{aligned} -30 &= 60a \\ \text{(c) (i)} \quad a &= -\frac{1}{2} \end{aligned}$$

\therefore Acceleration is -0.5 m s^{-2}

Using $v^2 = u^2 + 2as$ to find the distance,

$$\begin{aligned} \text{(ii) } 0 &= (1.5)^2 - 2 \times 0.5 \times s \\ s &= 2.25 \text{ m} \end{aligned}$$

\therefore Distance is 2.25 m.