Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

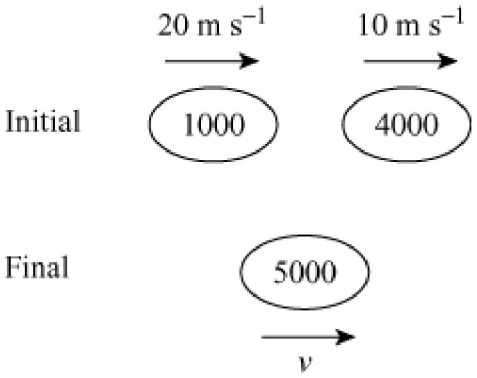
8 Momentum

Exercise Test yourself, Question 1

Question:

A car, of mass 1000 kg, is travelling at 20 m s^{-1}, when it drives into a truck, of mass 4000 kg, which was moving at 10 m s^{-1} in the same direction. After the collision the two vehicles move together. Find the speed of the vehicles after the collision.

Solution:



Using conservation of momentum

$$1000 \times 20 + 4000 \times 10 = 5000v$$
$$v = 12$$

$\therefore$ Speed is 12 m s^{-1}.

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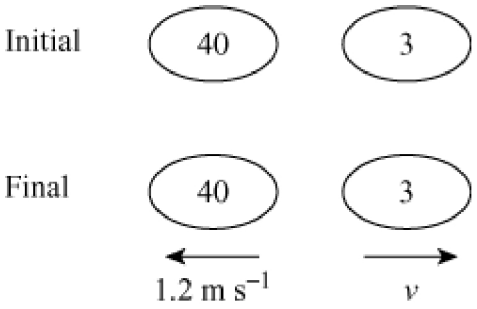
Exercise Test yourself, Question 2

Question:

A child of mass 40 kg stands on a skate board, of mass 3 kg. Initially both are at rest. The boy jumps off so that he travels horizontally at 1.2 m s^{-1}. Find the speed of the skateboard.

Solution:



Using conservation of momentum

$0 = 1.2 \times 40 - 3v$

$v = 16$

$\therefore$ Speed is 16 m s^{-1}.

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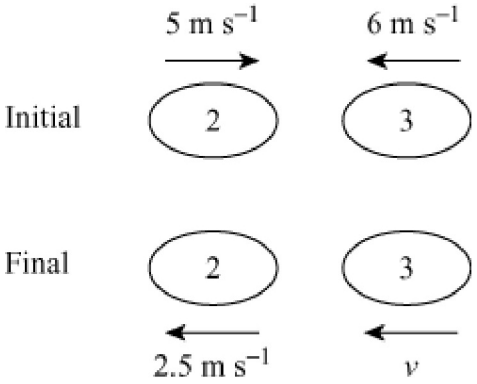
Exercise Test yourself, Question 3

Question:

Two particles are travelling towards each other when they collide. One has mass 2 kg and was travelling at 5 m s^{-1} before the collision and the other has mass 3 kg and a velocity of 6 m s^{-1} before the collision. The 2 kg mass reverses direction and moves at 2.5 m s^{-1} after the collision. Describe how the 3 kg mass moves after the collision.

Solution:



Using conservation of momentum (with speeds to the left as positive)

$$3 \times 6 - 2 \times 5 = 2 \times 2.5 + 3v$$
$$8 = 5 + 3v$$
$$v = 1$$

$\therefore$ The 3 kg mass moves with speed 1 m s^{-1} in the same direction as before the collision.

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Exercise Test yourself, Question 4

Question:

Two particles, A and B, have velocities $\begin{bmatrix} 4 \\ 7 \end{bmatrix}$ m s^{-1} and $\begin{bmatrix} -2 \\ 6 \end{bmatrix}$ m s^{-1}, respectively, when they collide. The mass of A is 4 kg and the mass of B is 6 kg.

(a) If the particles coalesce, find their velocity after the collision.

(b) If the velocity of B is $\begin{bmatrix} 0.5 \\ 4 \end{bmatrix}$ m s^{-1} after the collision, find the velocity of A.

Solution:

(a) Using conservation of momentum

$$4\begin{bmatrix} 4 \\ 7 \end{bmatrix} + 6\begin{bmatrix} -2 \\ 6 \end{bmatrix} = 10\text{v}$$

$$\begin{bmatrix} 4 \\ 64 \end{bmatrix} = 10\text{v}$$

$$\text{v} = \begin{bmatrix} 0.4 \\ 6.4 \end{bmatrix} \text{ m s}^{-1}$$

(b) Using conservation of momentum

$$4\begin{bmatrix} 4 \\ 7 \end{bmatrix} + 6\begin{bmatrix} -2 \\ 6 \end{bmatrix} = 4\text{v} + 6\begin{bmatrix} 0.5 \\ 4 \end{bmatrix}$$

$$\begin{bmatrix} 4 \\ 64 \end{bmatrix} = 4\text{v} + \begin{bmatrix} 3 \\ 24 \end{bmatrix}$$

$$4\text{v} = \begin{bmatrix} 1 \\ 40 \end{bmatrix}$$

$$\therefore \text{v} = \begin{bmatrix} 0.25 \\ 10 \end{bmatrix} \text{ m s}^{-1}$$

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Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise Test yourself, Question 5

Question:

The mass of particle A is 3 kg and it moves with velocity $\begin{bmatrix} 2 \\ \frac{2}{3} \end{bmatrix}$ m s^{-1}. The mass of particle B is m kg and it moves with velocity $\begin{bmatrix} k \\ \frac{k}{11} \end{bmatrix}$ m s^{-1}. The two particles collide and coalesce. After the collision they move with velocity $\begin{bmatrix} 2 \\ \frac{2}{8} \end{bmatrix}$ m s^{-1}.

(a) Find m.

(b) Find k.

Solution:

(a) Using conservation of momentum

$$3\begin{bmatrix} 2 \\ \frac{2}{3} \end{bmatrix} + m\begin{bmatrix} k \\ \frac{k}{11} \end{bmatrix} = (3+m)\begin{bmatrix} 2 \\ \frac{2}{8} \end{bmatrix}$$

$$\begin{bmatrix} 6+mk \\ \frac{6+mk}{9+11m} \end{bmatrix} = \begin{bmatrix} 6+2m \\ \frac{6+2m}{24+8m} \end{bmatrix} \quad [1]$$

Considering **j** components

$$\begin{aligned} 9+11m &= 24+8m \\ 3m &= 15 \\ m &= 5 \end{aligned}$$

(b) Considering **i** components of [1]

$$\begin{aligned} 6+mk &= 6+2m \\ m=5 \quad \Rightarrow \quad 6+5k &= 16 \\ k &= 2 \end{aligned}$$