Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise A, Question 14

Question:

Two cars are initially 36 m apart travelling in the same direction along a straight, horizontal road. The car in front is initially travelling at 10 m s^{-1}, but decelerating at 2 m s^{-2}. The other car travels at a constant 15 m s^{-1}.

(a) Model the cars as particles. By finding the distance travelled by each car after t seconds, show that the distance between the two cars is $36 - 5t - t^2$ metres. Find when they would collide if neither car takes avoiding action.

(b) Would it be necessary to revise your answers to (a) if the cars were not modelled as particles? Give reasons to support your answer.

The mass of the front car is 1500 kg and the mass of the other car is 1000 kg.

(c) The cars do collide and after the collision the two cars move together. Find the speed of the cars just after the collision. [A]

Solution:

(a) Using $s = ut + \frac{1}{2}at^2$,

distance the car in front travels is $10t - \frac{1}{2} \times 2t^2$

$= 10t - t^2$

distance the other car travels is $15t$

$\therefore$ Distance the cars are apart is $36 + (10t - t^2) - (15t)$

$= 36 - 5t - t^2$ metres

Cars would collide when this distance is zero;

$36 - 5t - t^2 = 0$

$t^2 + 5t - 36 = 0$

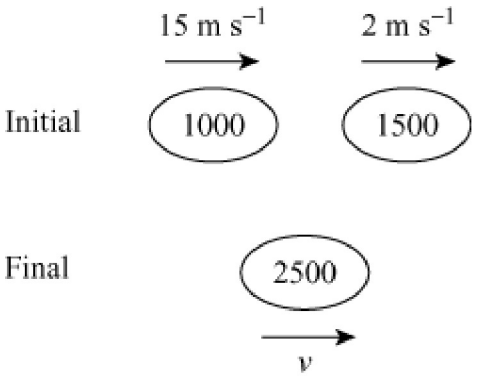
$(t + 9)(t - 4) = 0$

$\therefore$ Time is 4 seconds ($t = -9$ is not required)

(b) No; the cars were 36 metres apart which is much larger than the size of a car.

(c) Just before the collision (i.e. when $t = 4$),
the first car, using $v = u + at$, has speed $10 - 2 \times 4 = 2$ m s^{-1},
The second car still has speed 15 m s^{-1}

At the collision;



Using conservation of momentum

$15 \times 1000 + 2 \times 1500 = 2500v$

$v = 7.2 \text{ m s}^{-1}$

$\therefore$ speed of the cars is 7.2 m s^{-1}.