

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise A, Question 20

Question:

After a collision, a car and a van, of combined mass 3000 kg, slide together along a straight horizontal road. The coefficient of friction between the road and the tyres of the vehicles as they slide is 0.7.

(a) Model the car and the van as a single particle.

(i) Show that the magnitude of the frictional force acting is 20 580 N.

(ii) Find the acceleration of the car and van after the collision.

(iii) The car and the van slide together for a distance of 5 m before coming to rest. Using the result from (a)

(ii), show that just after the collision the car and van were moving at 8.28 m s^{-1} , to three significant figures.

(b) The mass of the car is 1200 kg and the mass of the van is 1800 kg. Before the collision, the van was stationary. Find the speed of the car just before the collision. [A]

Solution:

(a) (i) For the combined car and van, the normal reaction is $3000g \text{ N}$;

$$\begin{aligned} \text{using } F &= \mu R, \\ \text{frictional force} &= 0.7 \times 3000g \\ &= 20\,580 \text{ N} \end{aligned}$$

(ii) For the combined car and van,

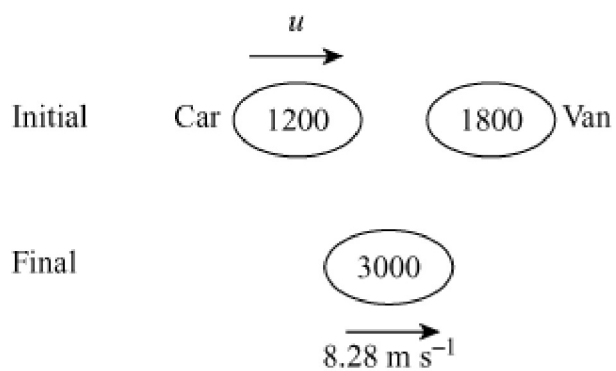
$$\begin{aligned} \text{using } F &= ma, \\ -20580 &= 3000a \\ a &= -6.86 \text{ m s}^{-2} \end{aligned}$$

(iii) For the combined car and van,

$$\begin{aligned} v^2 &= u^2 + 2as \text{ gives} \\ 0 &= u^2 - 2 \times 6.86 \times 5 \\ u &= \sqrt{2 \times 6.86 \times 5} \\ &= 8.282 \text{ m s}^{-1} \end{aligned}$$

\therefore car and van were moving at 8.28 m s^{-1}

(b) At the collision of the car and the van;



using conservation of momentum;

$$1200u = 3000 \times 8.28$$

$$\therefore u = 20.706 \text{ m s}^{-1}$$

Speed of the car before the collision is 20.7 m s^{-1} .