Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise A, Question 22

Question:

A test is carried out on a rocket, of mass 200 kg, which is fired horizontally at a speed of 50 m s^{-1}. The rocket experiences a constant air resistance force of 1568 N. It travels a distance of 108 m before it hits a stationary tank, of mass 4800 kg. Assume that the rocket always travels horizontally.

(a) Find the speed of the rocket when it has travelled a distance of 108 m.
When the rocket hits the tank it becomes lodged in it.

(b) Find the speed of the tank and the rocket just after the collision.
The tank then slides until it comes to rest. The coefficient of friction between the tank and the ground is 0.6.
Neglect any air resistance when considering the motion of the tank and rocket together.

(c) Find the distance that the tank slides. [A]

Solution:

(a) For the rocket moving horizontally before hitting the tank;

$F = ma$ gives $-1568 = 200a$

$a = -7.84$ m s^{-1}

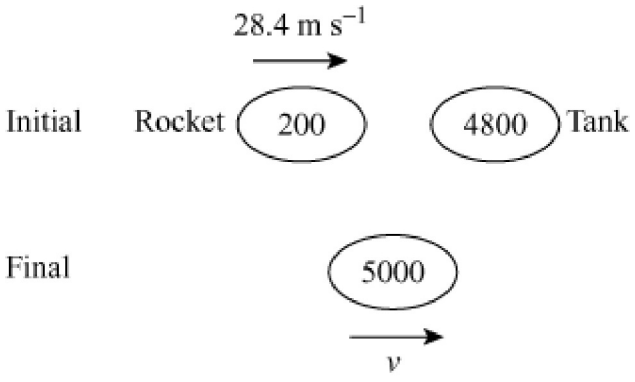
To find the speed, using $v^2 = u^2 + 2as$,

$v^2 = 50^2 - 2 \times 7.84 \times 108$

$v = 28.4$ m s^{-1}

$\therefore$ Speed of the rocket is 28.4 m s^{-1}

(b) For the collision of rocket and tank;



Using conservation of momentum

$200 \times 28.4 = 5000v$

$v = 1.136$ m s^{-1}

$\therefore$ Speed of the tank and the rocket is 1.136 m s^{-1}

(c) When the tank is sliding, the normal reaction between the tank (and rocket) and the ground is $5000g$ N

$$\therefore F = \mu R$$

$$\Rightarrow \text{ frictional force is } 0.6 \times 5000g = 3000g \text{ N}$$

$$F = ma \Rightarrow -3000g = 5000a$$

$$\therefore a = -5.88 \text{ m } s^{-2}$$

To find the distance which the tank slides,

$$v^2 = u^2 + 2as$$

$$\Rightarrow 0 = 1.136^2 - 2 \times 5.88 \times s$$

$$s = \frac{1.136^2}{2 \times 5.88}$$

$$= 0.1097 \text{ m}$$

$\therefore$ Distance is 0.110 m.