

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

8 Momentum

Exercise A, Question 18

Question:

A bullet, of mass 50 grams, is fired from a gun, of mass 5 kg. The bullet hits a wooden block, of mass 3 kg, that is initially at rest on a rough, horizontal surface. The bullet becomes embedded in the block. The combined block and bullet slide 0.5 m before coming to rest. The coefficient of friction between the block and the surface is 0.8. Assume that the bullet always travels horizontally.

(a) Show that the speed of the bullet before it hits the block is 170.8 m s^{-1} .

(b) Find the speed at which the gun recoils after firing. [A]

Solution:

(a) Using $F = \mu R$ where R is equivalent to the weight of the block and the bullet; i.e. $R = 3.05g \text{ N}$

$$\begin{aligned} \text{Frictional force} &= 0.8 \times 3.05g \\ &= 23.912 \text{ N} \end{aligned}$$

To find the deceleration of the block,

$$\text{Using } F = ma \text{ gives } -23.912 = 3.05a$$

$$\therefore a = -7.84 \text{ m s}^{-2}$$

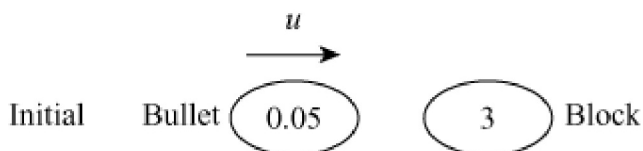
$$\text{Using } v^2 = u^2 + 2as \text{ while the block (and bullet) is sliding}$$

$$0 = u^2 - 2 \times 7.84 \times 0.5$$

$$u = 2.8$$

\therefore Speed of block and bullet after impact is 2.8 m s^{-1}

At impact of bullet with block;



Using conservation of momentum

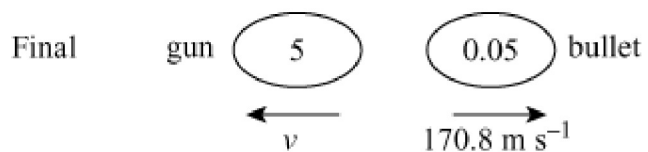
$$0.05u = 3.05 \times 2.8$$

$$u = 170.8$$

Speed of bullet is 170.8 m s^{-1}

(b) When bullet leaves the gun;

Initial (all at rest)



Using conservation of momentum

$$5v = 0.05 \times 170.8$$

Speed of recoil is 1.708 m s^{-1} .