Solution

Given, mass of the bullet (m) = 10g (or 0.01 kg)

Initial velocity of the bullet (u) = 150 m/s

Terminal velocity of the bullet (v) = 0 m/s

Time period (t) = 0.03 s

To find the distance of penetration, the acceleration of the bullet must be calculated.

As per the first motion equation, $v = u + at$

Therefore, $a = \frac{v-u}{t} = \frac{0-150}{0.03}\ ms^{-2}$

Acceleration of the bullet after striking the wooden block is -5000 ms^{-2}.

Now, from the motion equation: $(v^2 - u^2) = 2as$, the distance of penetration (s) can be calculated as follows:

s = $\frac{v^2-u^2}{2a} = \frac{0^2-(150)^2}{2(-5000)}$ meters = 2.25 meters

As per the second law of motion, F = ma

Therefore, force exerted by the wooden block on the bullet (F) = 0.01kg * (-5000 ms^{-2})

= -50 N

This implies that the wooden block exerts a force of magnitude 50 N on the bullet in the direction that is opposite to the trajectory of the bullet.

15. An object of mass 1 kg travelling in a straight line with a velocity of 10 m s^{-1} collides with, and sticks to, a stationary wooden block of mass 5 kg. Then they both move off together in the same straight line. Calculate the total momentum just before the impact and just after the impact. Also, calculate the velocity of the combined object.

Solution

Given, mass of the object (m_1) = 1kg

Mass of the block (m_2) = 5kg

Initial velocity of the object (u_1) = 10 m/s

Initial velocity of the block (u_2) = 0

Mass of the resulting object = $m_1 + m_2$ = 6kg

Velocity of the resulting object (v) = ?

Total momentum before the collision = $m_1u_1 + m_2u_2$ = (1kg)(10m/s) + 0 = 10 kg.m.s^{-1}

As per the law of conservation of momentum, the total momentum before the collision is equal to the total momentum post the collision. Therefore, the total momentum post the collision is also 10 kg.m.s^{-1}