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A bullet is fired out of a gun with a velocity of 300 m/s, with respect to ground. If the bullet has a mass of 0.06 kg and the gun has a mass of 1.5 kg, what percentage of the total kinetic energy (of the bullet and gun) does the bullet have?

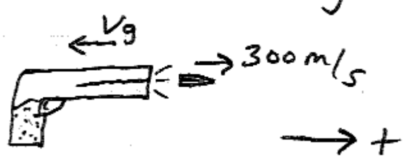
Solution:

Use conservation of linear momentum equation.

The initial velocity of the bullet and gun is zero. So,

$$0 = 0.06 \times 300 - 1.5 v_g$$

, where v_g is the gun velocity after firing, with respect to ground



Solving, $V_g = 12\ m/s$

The kinetic energy of the bullet is

$$KE_b = \frac{1}{2}(0.06)(300)^2 = 2700\ J$$

The kinetic energy of the gun is

$$KE_g = \frac{1}{2}(1.5)(12)^2 = 108\ J$$

The percentage of total kinetic energy that the bullet has is:

$$\eta_b = \frac{2700}{2700+108}$$

$$= \underline{96.15\%}$$

Even though the bullet and gun experience the same magnitude of impulse, the bullet acquires much more of the kinetic energy

The bullet, as a result, can do a lot more damage if it hits something then the gun can (moving back at 12 m/s). In fact, the greater the mass of the gun, relative to the bullet, the greater the proportion of kinetic energy that the bullet has (after firing). To see this let's solve this problem again without using numbers.

Conservation of linear momentum:

$$0 = m_b v_b - m_g v_g$$

$$m_b v_b = m_g v_g \quad (1)$$

where m_b is the mass of the bullet, m_g is the mass of the gun, and v_b is the velocity of the bullet

Kinetic Energy ratio:

$$\eta_b = \frac{\frac{1}{2} m_b v_b^2}{\frac{1}{2} m_b v_b^2 + \frac{1}{2} m_g v_g^2}$$

$$\eta_b = \frac{1}{1 + \frac{m_g v_g^2}{m_b v_b^2}}$$

$$\eta_b = \frac{1}{1 + \frac{m_b}{m_g}}$$

(after substituting equation (1))

As $\frac{m_b}{m_g} \rightarrow 0$ $\eta_b \rightarrow 100\%$