Answer on Question #60685 – Physics – Mechanics – Relativity

An unconstrained rifle of mass 5.00kg fires a 50.0g bullet at a speed of 300.0m/s with respect to the ground.
a) What is the initial momentum of the rifle-bullet system?
b) What is the recoil velocity of the rifle?

Solution.

a) Momentum is defined as the product of mass and velocity. For a particle of mass m and velocity v, the momentum p is mv. It is a vector quantity. At the initial moment (before a shot) the rifle and a bullet were in rest. Hence velocity of the rifle-bullet system equal zero. Therefore initial momentum equal zero.

b) If a system does not interact with its environment in any way, then certain mechanical properties of the system cannot change. They are sometimes called "constants of the motion". These quantities are said to be "conserved" and the conservation laws which result can be considered to be the most fundamental principles of mechanics. If the system is an isolated system, then the momentum of the system is a constant of the motion and subject to the principle of conservation of momentum. Our system rifle-bullet is an isolated system. The principle of conservation of momentum say that: The vector sum of the moment a $m\vec{v}$ of all the objects of a system cannot be changed by interactions within the system. Using the principle of conservation of momentum to system rifle-bullet write

$$M\vec{v_1} + m\vec{v_2} = \vec{0}$$

where M – mass rifle, m – mass bullet, $\vec{v_1}$ – recoil velocity, $\vec{v_2}$ – bullet velocity after shot. Obviously the recoil velocity and the velocity of a bullet in opposite directions. Hence (choosing the positive direction the direction of the bullet velocity)

$$-Mv_1 + mv_2 = 0$$

Therefore $v_1 = \frac{mv_2}{M} = \frac{0.05kg \cdot 300m/s}{5kg} = 3m/s$.

Answer: a) Initial momentum equal zero b) $v_1 = 3m/s$.