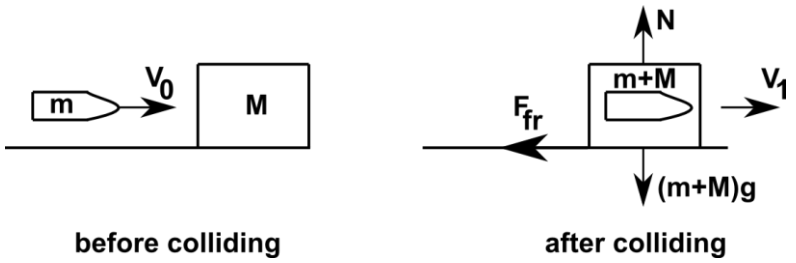
Answer on Question 49509, Physics, Mechanics | Kinematics | Dynamics

Question:

A wooden block with mass $M = 3kg$ is lying on a horizontal table. It is hit by a bullet with mass $m = 5g$ which moves horizontally. The bullet remains in the block after colliding with it. The block moves on the table a distance $d = 25cm$. The coefficient of kinetic friction $\mu_k = 0.2$. Find the starting speed of the bullet.

Solution:



By the law of conservation of momentum we have:

$$mv_0 + 0 = (m+M)v_1.$$

From this equation we can obtain velocity of the wooden block after colliding:

$$v_1 = \frac{mv_0}{m+M}.$$

Let's use the law of conservation of energy. Kinetic energy of the wooden block with the bullet is equal to the work done by the friction force when block moves on the horizontal table a distance $d = 0.25m$:

$$\frac{1}{2}(m+M)v_1^2 = F_{fr}d,$$

$$F_{fr} = \mu_k N = \mu_k (m+M)g.$$

Substituting v_1 and F_{fr} into equation for law of conservation of energy and solve it for v_0 we obtain:

$$v_0 = \frac{m+M}{m}\sqrt{2\mu_k gd} = \frac{0.005kg + 3kg}{0.005kg} \cdot \sqrt{2 \cdot 0.2 \cdot 9.8\frac{m}{s^2} \cdot 0.25m} = 595\frac{m}{s}.$$

Answer:

Starting speed of the bullet is $v_0 = 595\frac{m}{s}$.