Answer on Question#49637 - Physics - Other

A bullet mass $m = 0.1\ \text{kg}$ is fired vertically through a hole into a $M = 5\ \text{kg}$ block resting on a table. If the velocity of the bullet is $v = 400\ \text{m/s}$ and the bullet sticks in the block, how high will the block and bullet combination rise above the table top?

Solution:

According to the momentum conservation law, the momentum of the block and bullet combination (when the bullet just stuck) equals the momentum of the bullet just before the collision. So the momentum this combination just after collision has the following value

$$p = m \cdot v$$

The kinetic energy of the combination (when the bullet just stuck):

$$E_k = \frac{p^2}{2(m+M)}$$

According to the law of conservation of energy the block and bullet combination will reach the highest point when its kinetic energy becomes potential. It can be written as follows

$$(m+M) \cdot g \cdot h = \frac{p^2}{2(m+M)}$$

where $(m+M) \cdot g \cdot h$ is the potential energy of the block and bullet combination ($g = 9.8 \frac{m}{s^2}$ is the gravitation constant and h is the maximum hight).

Expressing h from this equation we obtain

$$h = \frac{p^2}{2(m+M)^2 g} = \frac{(m \cdot v)^2}{2(m+M)^2 g} = \frac{(0.1\ \text{kg} \cdot 400\ \text{m/s})^2}{2(0.1\ \text{kg} + 5\ \text{kg})^2 9.8 \frac{m}{s^2}} \approx 3.14\ \text{m}$$

Answer: $h = \frac{(m \cdot v)^2}{2(m+M)^2 g} \approx 3.14\ \text{m}.$