Answer on Question #44306 – Physics - Mechanics | Kinematics | Dynamics

The initial velocity u of a bullet in penetrating a distance 's' through a target is reduced by u/n. how far will the bullet proceed through the target before coming to rest?

Solution:

$u - initial\ velocity\ of\ the\ bullet;$
$S - first\ traveled\ distance;$
$\frac{u}{n} - final\ velocity\ after\ travelling\ first\ distance;$
$D - traveled\ distance\ before\ coming\ to\ rest;$
$a - deceleration\ of\ the\ bullet;$
$t_1 - time\ of\ travelling\ distance\ S;$
$t_2 - time\ of\ travelling\ distance\ D;$

Equation of motio of the bullet for the travelled distance S:

$$S = ut_1 - \frac{at_1{}^2}{2} \quad (1)$$

Rate equation for the bullet:

$$\frac{u}{n} = u - at_1$$

$$a = \left(\frac{u}{t_1} - \frac{u}{nt_1}\right) = \frac{u}{t_1}\left(1 - \frac{1}{n}\right) \quad (2)$$

$(2) in (1)$:

$$S = ut_1 - \frac{u}{t_1}\left(1 - \frac{1}{n}\right) \cdot \frac{t_1{}^2}{2}$$

$$S = ut_1 - \frac{u}{2}\left(1 - \frac{1}{n}\right) t_1$$

$$t_1 = \frac{S}{u - \frac{u}{2}\left(1 - \frac{1}{n}\right)} = \frac{S}{\frac{u}{2} + \frac{u}{2} \cdot \frac{1}{n}} = \frac{2S}{u(n+1)} \quad (3)$$

$(3) in (2)$:

$$a = \frac{u}{\frac{2S}{u(n+1)}}\left(1 - \frac{1}{n}\right) = \frac{u^2(n+1)}{2S}\left(1 - \frac{1}{n}\right) = \frac{u^2(n+1)}{2S} \cdot \left(\frac{n-1}{n}\right) =$$

$$= \frac{u^2(n+1)}{2S} \cdot \left(\frac{n-1}{n}\right) = \frac{u^2(n^2-1)}{2nS} \quad (4)$$

Rate equation for the bullet (final velocity of the bullet is zero):

$$0 = u - at_2$$

$$t_2 = \frac{u}{a} \quad (5)$$

Equation of motion of the bullet for the travelled distance D:

$$D = ut_2 - \frac{at_2{}^2}{2} \quad (6)$$

$(5) in (6)$:

$$D = u \cdot \frac{u}{a} - \frac{a\left(\frac{u}{a}\right)^2}{2} = \frac{u^2}{2a} \quad (7)$$

$$(4) in (7):$$

$$D = \frac{u^2}{2 \cdot \frac{u^2(n^2-1)}{2nS}} = \frac{u^2 nS}{u^2(n^2-1)} = \frac{nS}{n^2-1}$$

Answer: Distance that bullet proceed through the target before coming to rest is equal to $\frac{nS}{n^2-1}$