Answer on Question #81866 - Physics - Mechanics – Relativity

A gun barrel of mass 600kg has a recoil spring of stiffness 294 kn/m. if the barrel recoils 1.3m on firing determine i) The initial recoil velocity of barrel ii) The critical damping coefficient of dashpot which is engaged at the end of recoil stroke. Iii) Time required for the barrel to return at the end of recoil stroke.

Solution

1) Calculate the natural frequency:

$$\omega = \sqrt{\frac{k}{m}} = 22.14\ \mathrm{s}^{-1}.$$

Energy of firing will transform to energy of spring, which then will be transformed to kinetic energy:

$$\frac{mv^2}{2} = \frac{kx^2}{2} \Rightarrow v = x\sqrt{\frac{k}{m}} = 1.3 \cdot \sqrt{\frac{294 \cdot 10^3}{600}} = 28.78\ \mathrm{m/s}.$$

2) The damping factor at critical damping is 1. Thus, the critical damping coefficient will be

$$c = 2m \cdot DF \cdot \omega = 2m \cdot DF \cdot \sqrt{\frac{k}{m}} = 2 \cdot 600 \cdot 1 \cdot \sqrt{\frac{294 \cdot 10^3}{600}} = 2.656 \cdot 10^4\ \mathrm{kg/s}.$$

3) We set the time when the barrel reaches the position $x = 1.22$ to be $t = 0$. Write the expression for the motion of barrel at critical damping:

$$x(t) = (C_1 + C_2 t)e^{-\omega t},$$

here C_1 and C_2 can be obtained from the initial conditions at $t = 0$:

$$\begin{cases} x = 1.3 \\ v = 0 \end{cases}$$

thus $C_1 = 1.3\ \mathrm{m}$ and $C_2 = -28.78\ \mathrm{m/s}$.

The barrel will return to the end of recoil stroke:

$$0.001 = (1.3 - 28.78t)e^{-22.14t},$$

$$t = 0.045$$

Answer

$28.78\ \mathrm{m/s}, 2.656 \cdot 10^4\ \mathrm{kg/s}, 0.045\ \mathrm{s}$