1. A 200 g mass is attached to a spring of spring constant k. The spring is compressed 15 cm from its equilibrium value. When released the mass reaches a speed 5 m/s. What is the spring constant (N/m)?

Solution

m = 200 g = 0.2 kg; Δx = 15 cm = 0.15 m; v = 5 m/s; k - ?

The law of conservation of energy:

$$\frac{k(\Delta x)^2}{2} = \frac{mv^2}{2};$$

$$k = \frac{mv^2}{(\Delta x)^2} \approx \boldsymbol{220\ N/m}$$

Answer: k ≈ 220 N/m.

2. A 34-g bullet traveling at 120 m/s embeds itself in a wooden block on a smooth surface. The block then slides toward a spring and collides with it. The block compresses the spring (k = 100 N/m) a maximum of 1.25 cm. Calculate the mass of the block of wood.

Solution

m = 34 g = 0.034 kg; v = 120 m/s; k = 100 N/m; Δx = 1.25 cm = 0.0125 m; M - ?

The law of conservation of momentum:

$$mv = (m+M)v_1;\ \rightarrow\quad v_1 = \frac{mv}{m+M}.$$

The law of conservation of energy:

$$\frac{(m+M)v_1^2}{2} = \frac{k(\Delta x)^2}{2};\ \rightarrow\ \frac{(mv)^2}{m+M} = k(\Delta x)^2$$

$$M = \frac{(mv)^2}{k(\Delta x)^2} - m = \boldsymbol{1\ 065\ kg}$$

Answer: M = 1 065 kg.

3. If a force of 3000 N is exerted upon a 60 kg mass for 3 second, how much impulse does the mass experience?

Solution

From the definition:

$$J = F * \Delta t = 3\ 000 * 3 = \boldsymbol{9\ 000\ N * s}$$

Answer: J = 9 000 N*s.