Answer on Question#39598 – Physics – Mechanics

A solid cylinder of mass 3 kg is rolling on a horizontal surface with velocity 4 m/s. It collides with a horizontal spring of force constant 200 N/m. What will be the maximum compression produced in spring?

Solution:

Here we should apply conservation of mechanical energy .

Kinetic energy of rolling body initially is equal to potential energy of the spring:

$$E_k = E_p \quad (1)$$

Potential energy of the spring (Δx- maximum compression of the spring):

$$E_p = \frac{k\Delta x^2}{2}$$

Kinetic energy of rolling body = Translational KE + Rotational KE:

$$E_k = \frac{mv^2}{2} + \frac{J\omega^2}{2} \quad (2)$$

Moment of inertia of solid cylinder:

$$J = \frac{mR^2}{2} \quad (3)$$

Angular velocity of the cylinder:

$$\omega = \frac{v}{R} \quad (4)$$

$$(4)\text{and}(3)\text{in}(2):$$

$$E_k = \frac{mv^2}{2} + \frac{mR^2}{2}\frac{\left(\frac{v}{R}\right)^2}{2} = \frac{mv^2}{2} + \frac{mv^2}{4} = \frac{3mv^2}{4} \quad (5)$$

$$(5)\text{to}(1)$$

$$\frac{k\Delta x^2}{2} = \frac{3mv^2}{4}$$

$$\Delta x = \sqrt{\frac{3mv^2}{2k}} = \sqrt{\frac{3 \cdot 3\text{kg} \cdot \left(4\frac{\text{m}}{\text{s}}\right)^2}{2 \cdot 200\frac{\text{N}}{\text{m}}}} = 0.6\ \text{m}$$

Answer: the maximum compression produced in spring will be $0.6\ \text{m}$.