A spring system with k = 2500 n/m is compressed for 0.5 m to be used in launching a 2 kg ball and make it roll horizontally on the ground where μ = 0.2 between the ball and the ground. The spring is stretched for 0.1 m when the ball is detached from the spring. For how many meters will the ball roll before coming to a stop?

Solution.

$$k = 2500\frac{N}{m}$$

$$x_1 = 0.5m$$

$$x_2 = 0.1m$$

$$m = 2kg$$

$$\mu = 0.2$$

The kinetic energy of the ball goes on the work of the force of friction

$$E_p = E_k - A_{fr}$$

$$\frac{k{x_1}^2}{2} = \frac{mv^2}{2} - F_{fr} \cdot S$$

On the other side, elastic force minus the friction force equals mass multiplied by acceleration for Newton's second law:

$$F_{el} - F_{fr} = ma$$

$$N - mg = 0$$

$$F_{fr} = N \cdot \mu = mg\mu$$

$$kx_2 - mg\mu = ma$$

We can express the acceleration, which is equal:

$$a = \frac{kx_2 - mg\mu}{m}$$

And the formula of distance is:

$$S = \frac{v^2}{2a}$$

From which we express the speed

$$v^2 = 2Sa$$

And substituting into equation

$$\frac{kx_1{}^2}{2} = \frac{m2Sa}{2} - F_{fr} \cdot S$$

Simplify

$$\frac{kx_1{}^2}{2} = mSa - mg\mu \cdot S$$

$$\frac{kx_1{}^2}{2} = mS\frac{kx_2 - mg\mu}{m} - mg\mu \cdot S$$

The distance is

$$S = \frac{kx_1{}^2}{2(2kx_2 - 4\mu mg)} = \frac{2500 \cdot 0.25}{2 \cdot 2500 \cdot 0.1 - 4 \cdot 0.2 \cdot 2 \cdot 10} = 1.3m$$

Answer: 1.3m