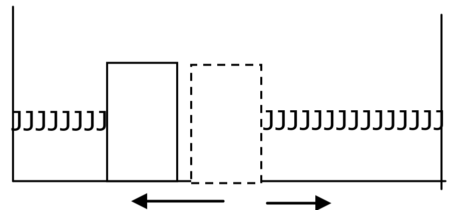
Q- Consider two ideal springs. the spring on the left (constant = 50 N/m) has its left end attached to a fixed wall while its right end is free to move. The spring on the right (constant = 72 N/m) has its right end attached to a fixed wall while its left end is free to move. A block of mass m = 2 kg is pressed up against the right end of the left spring causing it to compress by D = 1.8m. The block is then released from rest causing the left spring to push it to the right and after the block leaves the left spring, it slides towards the left and causes the right spring to compress. Determine the maximum amount the right spring will compress when a) assuming no friction between table and block and b) assuming the coefficient of kinetic friction between the table and the block = 0.3.

Answer:



a) The work done to push the spring will be stored in it in form of elastic potential energy and is equal to

$$\tfrac{1}{2} K_1x_1^2 = 0.5*50*1.8^2 = 81 \text{ J}$$

This energy will be given as kinetic energy and then stored in the second spring as elastic potential energy of the second spring when the compression in it is maximum

Hence if the maximum compression is x^2 (at rest at that instant) we have

$$\tfrac{1}{2} K_2x_2^2 = 81$$

Or $\quad 0.5*72*x_2^2 = 81$

Gives $\quad x_2 = 1.5$ m

b) If there is friction between the block and the floor some energy will be lost to do work against friction and hence the compression in the second spring will be less.

The energy equation is then written as loss of elastic potential energy is equal to the work done against friction

$$\tfrac{1}{2} K_1x_1^2 - \tfrac{1}{2} K_2x_2^2 = F*(x_1 + x_2)$$

The total distance moved by the block will be $(x_1 + x_2)$

As the friction force $F = \mu N = \mu mg = 0.3*2*9.8 = 5.88$ N

Above equation gives

$$81 - 36x_2^2 = 5.88*(1.8 + x_2)$$

Or $\quad - 36x_2^2 - 5.88*x_2 + 81 - 5.88*1.8 = 0$

Or $\quad 36x_2^2 + 5.88*x_2 - 70.4 = 0$

using the farmula for quadratic equation we have

$$\{ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \}$$

$$x_2 = \frac{-5.88 \pm \sqrt{5.88^2 - 4*36*(-70.4)}}{2*36} = \frac{-5.88 \pm 100.86}{72} = 1.32 \text{ m}$$

Considering only positive sign, Negative will give x_2 negative, which is irrelevant.