

Question #58178, Physics / Classical Mechanics

The spring-flex exercise system consists of a spring with one end fixed and a handle on the other end. The idea is that you exercise your muscles by stretching the spring from its natural length, which is 31 cm. If a 190 Newton force is required to keep the spring stretched to a length of 44 cm, how much work is required to stretch it from 51 cm to 67 cm?

Solution:

According to Hooke's Law:

$$F = kX ;$$

where k is the spring stiffness; X is spring deformation.

One can obtain stiffness value:

$$k = \frac{F}{X} ;$$

$$k = \frac{190}{0.44} = 431.82 \text{ N/m}$$

The equation of force required to stretch the spring:

$$F(x) = 431.82x$$

To find the work required, one needs to integrate the function in the given interval:

$$W = \int_{0.51}^{0.67} 431.82x = 215.91x^2 \Big|_{0.51}^{0.67} = 215.91 \times (0.67)^2 - 215.91 \times (0.51)^2 = 40.76 \text{ J}$$

Answer: 40.76 J