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A force of 10 N will stretch a rubber band 5 cm (0.05 m). Assuming that Hooke's law applies, how far will a 14-N force stretch the rubber band? How much work does it take to stretch the rubber band this far?

Hooke's law states that $F = kx$. Use this to determine the force constant k for the rubber band.

Substitute the given values and solve for k. Be sure to use the compatible units of newtons and meters.

$$\begin{aligned} F &= kx \\ 10 &= k(0.05) \\ 200 &= k \end{aligned}$$

The force equation for this rubber band is $F = 200x$.

To determine how far a 14-N force will stretch the rubber band, substitute 14 for F and solve for x.

$$\begin{aligned} F &= 200x \\ 14 &= 200x \\ 0.07 &= x \end{aligned}$$

A 14-N force will stretch the rubber band 0.07 m or 7 cm.

The work done by a variable force F(x) directed along the x-axis from $x = a$ to $x = b$ is given by the following definite integral.

$$W = \int_a^b F(x)\,dx$$

Picture the rubber band laid out along the x-axis with its movable end at the origin. When the rubber band is stretched, the end moves from $x = 0$ m to $x = 0.07$ m.

To determine the work done to stretch the rubber band, first substitute 0 for a, 0.07 for b, and 200x for F(x). Then integrate.

$$\begin{aligned} \int_a^b F(x)\,dx &= \int_0^{0.07} 200x\,dx \\ &= 100x^2\Big]_0^{0.07} \end{aligned}$$

Now evaluate the definite integral.

$$\begin{aligned} 100x^2\Big]_0^{0.07} &= 100(0.07)^2 - 100(0)^2 \\ &= 0.49 \text{ J} \end{aligned}$$

It takes 0.49 joules of work to stretch the rubber band 0.07 meters.