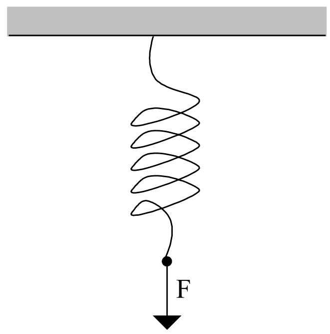
## Chapter 6 Problem 21 †




**Given**
$k = 200\ N/m$

**Solution**
a) Find the work done to stretch the spring 10 $cm$.

According to the diagram, as the spring is stretched downward, the spring exerts a force in the upward direction. The relationship is as follows.

$$\vec{F_s} = -k\Delta x\hat{j}$$

By Newton's $3^{rd}$ law the person doing the work must be exerting an equal and opposite force on the spring. Therefore, this force is

$$\vec{F_p} = k\Delta x\hat{j}$$

We find the work that the person did on the spring by using the definition of work.

$$W = \int_0^x F dx = \int_0^x kx dx = \tfrac{1}{2}kx^2\Big|_0^x = \tfrac{1}{2}kx^2$$

The integral definition of work is used because the spring force is constantly changing magnitude. Therefore, to stretch the spring 10 $cm$

$$W = \tfrac{1}{2}(200\ N/m)(0.10\ m)^2 = 1.0\ J$$

b) Find the work to go from 10 $cm$ to 20 $cm$.

The work to go from 0 $cm$ to 20 $cm$ is

$$W = \tfrac{1}{2}(200\ N/m)(0.20\ m)^2 = 4.0\ J$$

The difference of energy between 10 $cm$ and 20 $cm$ is

$$\Delta W = W_f - W_i = 4.0\ J - 1.0\ J = 3.0\ J$$

†Problem from Essential University Physics, Wolfson