Springy Springs:

A force of 4.9 N is applied to a block attached to the free end of a spring, stretching the spring from its relaxed length by 12 mm.

(a) What is the spring constant of the spring?

The stretched spring pulls with a force of -4.9 N for a length of x=12mm. Thus

$$k = -\frac{F}{x} = -\frac{-4.9N}{12 \times 10^{-3}m} = 408N/m$$

(b) What force does the spring exert if it is stretched by 17 mm?

We have

$$F = -kx = -(408N/m)(17 \times 10^{-3}m) = -6.9N$$

(c) The spring is stretched by 17 mm from its relaxed length. **How much work does the spring force do on the block?**

Since the spring is initially relaxed:

$$W = -\frac{1}{2}kx^2 = -\frac{1}{2}(408N/m)(17 \times 10^{-3}m)^2 = -5.9 \times 10^{-2}J = -59mJ$$

(d) The same spring is initially stretched by 17 mm. Then it is allowed to return slowly to its relaxed state and is then compressed by 12 mm. **How much work does the spring do during the total displacement of the block?**

For this situation we have $x_i = +17mm$ (stretching) and $x_f = 12mm$ (compressing). Thus

$$W = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2 = \frac{1}{2}k(x_i^2 - x_f^2) = 0.03J = 30mJ$$

In this case, the spring did more positive work (in moving from its initial stretched state to its relaxed state) than negative work (moving farther from its relaxed state to its final compression state). Thus the net work is positive.