Task. A force $F_1 = 80\ N$ extends a natural length $L = 8\ m$ by $\Delta L_1 = 0.4\ m$. What will be the length of the spring when the applied force is $F_2 = 100\ N$?

Solution. By Hooke's law the force F needed to extend a spring ΔL is proportional to ΔL:

$$F = k\,\Delta L,$$

where k is a constant called *stiffness* of a spring.

In the first case

$$\Delta L_1 = 0.4\ m, \qquad F_1 = 80\,N,$$

whence

$$F_1 = k\,\Delta L_1,$$

and so

$$k = \frac{F_1}{\Delta L_1} = \frac{80}{0.4} = 200\ N/m.$$

Now apply the force $F_2 = 100\ N$ and let ΔL_2 be the extension of the length in this case. Then similarly,

$$F_2 = k\Delta L_2,$$

whence

$$\Delta L_2 = \frac{F_2}{k} = \frac{100}{200} = 0.5\ m.$$

Hence the length of the spring in the second case will be

$$L_2 = L + \Delta L_2 = 8 + 0.5 = 8.5\ m.$$

Answer. $8.5\ m$.