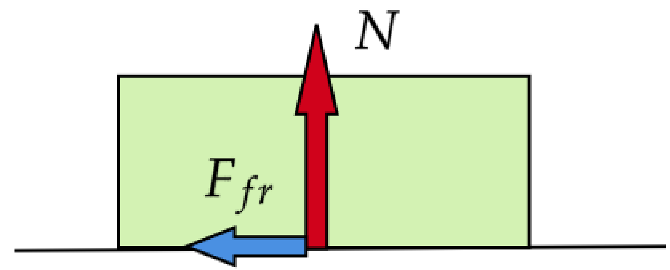
Kinetic friction. Elastic Force.

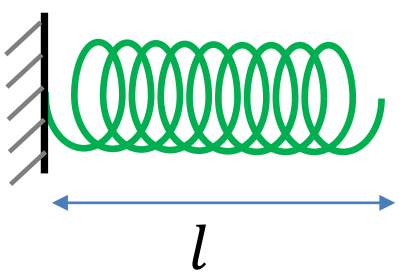
Kinetic friction:

$$F_{fr} = \mu \cdot N$$



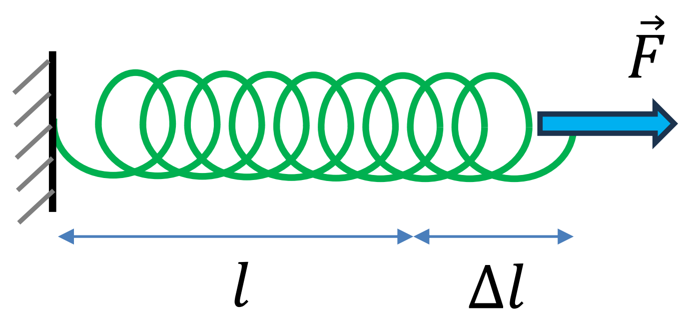
Hooke's law:

$$F = k \cdot \Delta l$$



Spring constant:

$$k \rightarrow \frac{N}{cm}, \frac{N}{m}$$



Homework 11

Problem 1.
An advanced version of a robot from previous homework should also be able to drag boxes with acceleration $2\ \frac{m}{s^2}$. What force should the robot apply to a $10\ kg$ box if the friction coefficient between the box and the floor is $\mu = 0.5$?

Problem 2.
A spring scale (on the right, also called a dynamometer) is calibrated in Newtons. You measure the distance between a $2\ N$ and a $5\ N$ marks and find that it is $6\ cm$. What is the spring constant of the spring in this dynamometer? What is the distance between a $0\ N$ and a $5\ N$ marks?

Problem 3.
Amazon continues improving its robots. Now, the robot should drag the same box by a spring attached to it. The friction coefficient is $\mu = 0.5$, and the spring constant is $20\ \frac{N}{cm}$. What is the deformation of the spring if the robot drags the box with horizontal acceleration $3\ \frac{m}{s^2}$?

Problem 4* (bonus problem).
On the next page!

Homework 11

Problem 4* (bonus problem).
In systems with several springs, a notion of an effective spring constant is useful. Suppose we can replace several springs with one spring and get the same total deformation under the same force. The spring constant of this one spring is called the effective spring constant of a system. Find the effective spring constant for the "series" (left figure) and "parallel" (right figure) connection of two springs with spring constants $k_1 = 5\ \frac{N}{cm}$ and $k_2 = 10\ \frac{N}{cm}$.