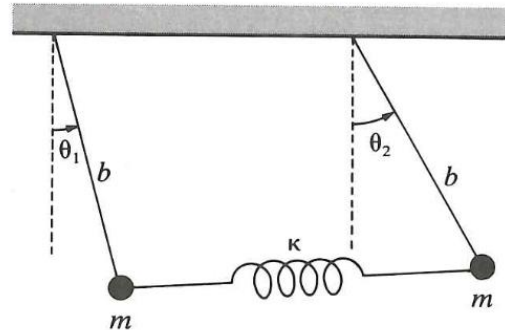


## Classical Mechanics TFY 4345 – Exercise 9

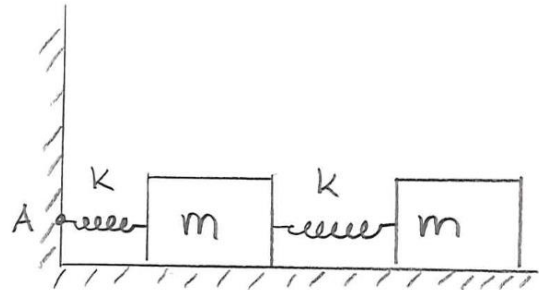
### 1. Coupled pendula.

Start by writing up the kinetic and potential energies in generalized coordinates. Determine the eigenfrequencies and describe the normal mode motion for two pendula of equal lengths  $b$  and equal masses  $m$  connected by a spring of force constant  $k$ . The spring is unstretched in equilibrium position. Assume small oscillations.



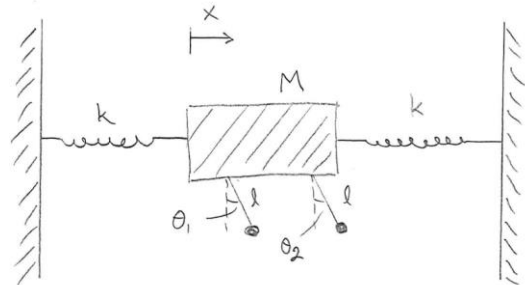
### 2. Two coupled oscillators.

Evaluate the eigenfrequencies of the following system. Determine also the associated eigenfrequencies and describe the vibrational modes qualitatively. The masses glide frictionless on the surface, and the other spring is attached to the fixed point A.



### 3. Oscillating body with two attached pendula.

Evaluate the eigenfrequencies of the following system. You will need three generalized coordinates. Assume small oscillations.



### 4. Double pendulum.

Consider the double pendulum, with  $m_1 = m_2 = m$  and  $l_1 = l_2 = l$ . Evaluate the eigenfrequencies and eigenvectors based on the theory of coupled oscillations (small oscillations).

