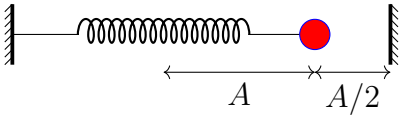
Total marks: 30

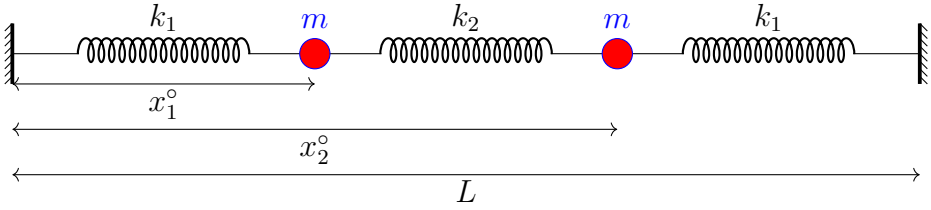
1. Consider a spring-mass oscillator of time period $T$ as shown in the figure below. There is a wall $A/2$ distance to the right from the equilibrium position of the oscillator. [4]




The oscillator is given an initial displacement $A$ towards the left and released from the rest. Considering all collisions to be elastic, what is the time period of the oscillator?

2. For an oscillator we found $\omega = \pm\omega_\circ$. If it started with $x(0) = A$ and $\dot{x}(0) = \frac{\omega_\circ A}{2}$ then find $x(t)$. [4]
Can you solve the problem using only $Ae^{i\omega_\circ t}$? Why not?

3. Consider the spring-mass system shown in the figure below: [15]




   (a) Find the equilibrium positions ($x_1^\circ$ and $x_2^\circ$). Assuming the equilibrium length of the spring $a_\circ$ to be $\frac{L}{10}$ . [4]

   (b) Assuming unequal masses $m_1$ and $m_2$ and $k_1 = k_2 = k$, find the longitudinal normal mode frequencies. [6]

   (c) For longitudinal modes, assuming equal masses $m_1 = m_2$ (you may start from the known solutions), find the $x_1(t)$ and $x_2(t)$ for motion starting from the rest with an initial displacement $x_1(0) = A$ and $x_2(0) = \frac{A}{2}$. [5]

4. Find the normal modes (frequencies and ratios of amplitude) for the transverse oscillation of the following system: [7]