University of Alabama
Department of Physics and Astronomy

PH 105 LeClair Summer 2015

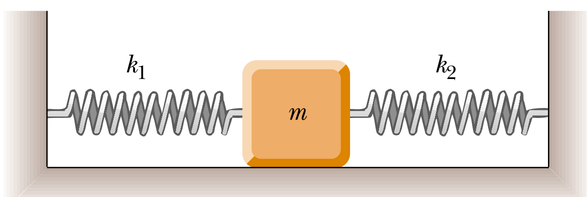
Week 4 Homework

Instructions:

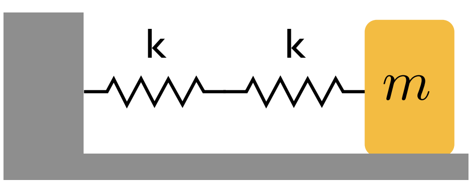
1. There are problems assigned for each day of class.
2. The following class, you will turn in the one problem the instructor requests.
3. Only the chosen problem for the day is graded.
4. Please follow the homework template provided.
5. You may collaborate, but everyone must turn in their own work.

Problems for 16 June (due 17 June)

1. A block of mass m is connected to two springs of force constants k_1 and k_2 as shown below. The block moves on a frictionless table after it is displaced from equilibrium and released. Determine the period of simple harmonic motion. (Hint: what is the total force on the block if it is displaced by an amount x?

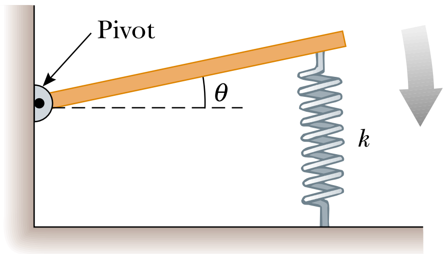


2. A mass m is connected to two springs in series as shown below. What is the period of simple harmonic motion if the mass is displaced from equilibrium. *Hint: what must be true of the displacement of each spring if the total displacement is Δx?*



Problems for 17 June (due 18 June)

3. A horizontal plank of mass m and length L is pivoted at one end. The plank's other end is supported by a spring of force constant k. The moment of inertia of the plank about the pivot is $I = \frac{1}{3}mL^2$. The plank is displaced by a small angle θ from horizontal equilibrium and released. Find the angular frequency ω of simple harmonic motion. (Hint: consider the torques about the pivot point.)



4. *Energetics of diatomic systems* An approximate expression for the potential energy of two ions as a function of their separation is

$$\mathsf{PE} = -\frac{\mathsf{k}e^2}{\mathsf{r}} + \frac{\mathsf{b}}{\mathsf{r}^9} \tag{1}$$

The first term is the Coulomb interaction representing the electrical attraction of the two ions, while the second term is introduced to account for the repulsive effect of the two ions at small distances. **(a)** Find b as a function of the equilibrium spacing r_o. (What must be true at equilibrium?) **(b)** For KCl, with an equilibrium spacing of $\mathsf{r}_\mathsf{o} = 0.279\,\mathrm{nm}$, calculate the frequency of small oscillations about $\mathsf{r} = \mathsf{r}_\mathsf{o}$. *Hint: do a Taylor expansion of the potential energy to make it look like a harmonic oscillator for small* $\mathsf{r} = \mathsf{r}_\mathsf{o}$*.*