University of Alabama
Department of Physics and Astronomy

PH 105 LeClair Summer 2012

Problem Set 11

Instructions:

1. Answer all questions below. All questions have equal weight.
2. Due Fri 22 June 2012 at the start of lecture, or electronically by midnight.
3. You may collaborate, but everyone must turn in their own work.

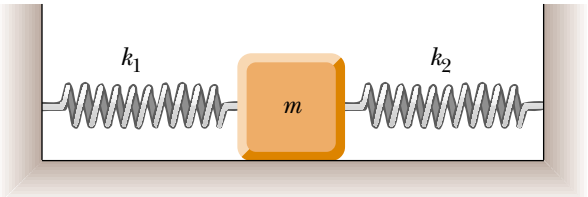
1. An aircraft door closes by pushing it inside the airplane first. We will assume $P = 0$ outside the aircraft, and $P = 0.9\,\text{atm}$ inside during flight. If the sealing surface of the door is 5 cm wide all around the door, and the door's outer dimensions are 2 m by 0.7 m, what is the total force required to open the door while in flight?

2. Viscosity of most fluids can be represented by an extra "drag" force on a body moving in a liquid. For a body of spherical shape, the drag force is reasonably well approximated by $F_{\text{drag}} = 6\pi\eta R v$, where v is the velocity of the body and η is a parameter of the fluid. The presence of viscosity leads to a "terminal velocity" of a body falling in a fluid (*e.g.,* a person falling in air).

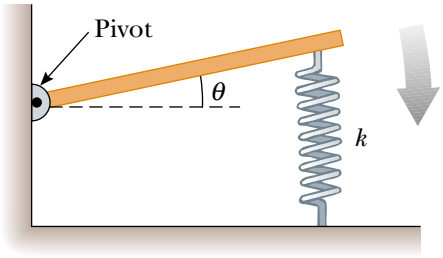
Consider a sphere of radius R and density ρ_s falling through a fluid of density ρ and viscosity parameter η. Find an expression for the terminal velocity of the sphere.

3. A pendulum is formed by pivoting a long thin rod of mass M and length L about a point on the rod. If the pivot is a distance x from the rod's center, for what x is the period of the pendulum minimum? The moment of inertia for a thin rod about its center of mass is $I = \frac{1}{12}ML^2$.

4. 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?



5. 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.)


Pivot
θ
k