1. Review problems 8 and 9 of Assignment 0.

2. Taylor: Problem 5.27.

3. Consider an underdamped harmonic oscillator.
   (a) Find an expression for the energy of an underdamped harmonic oscillator as a function of time and then, by calculating its derivative, an expression for the rate of energy loss due to dissipation.
   (b) Make an approximate plot of the latter expression assuming the damping parameter $\beta$ equal about 0.1 of the natural frequency $\omega_0$. Interpret the minima and maxima appearing on the plot.
   (c) For a small $\beta$, calculate the average rate at which the oscillator loses energy, i.e., the time average of the energy loss in one cycle. In this limit, one can assume that the exponential factor in the solution is approximately constant over one cycle.

4. A grandfather’s clock has a pendulum of length $l$ with a bob of mass $m$. A mass $M$ falls a distance $h$ in time $d$ to keep the amplitude of oscillations constant at $\theta_m$. Find the damping constant $\beta$ of the pendulum.
   
   **Hints:** Assume the pendulum is a (slightly) damped, driven harmonic oscillator, described by the equation:
   
   $$\ddot{\theta} + 2\beta\dot{\theta} + \omega_0^2\theta = A \cos(\omega t)$$
   
   where $\omega_0^2 = g/l$. The solution to this equation is
   
   $$\theta(t) = A e^{-\beta t} \cos(\sqrt{\omega_0^2 - \beta^2} t - \delta_1) + D \cos(\omega t - \delta),$$
   
   where $A$ and $\delta_1$ are adjustable constants and $D$ and $\delta$ are expressible in terms of the parameters from Eq. (1). Do not derive this equation. Assume that the clock is in the transient state all the time and that the amplitude of the motion can be approximated as the value at the point where $\cos(\sqrt{\omega_0^2 - \beta^2} t - \delta_1) = 1$.

5. Taylor: Problem 5.43. Interpret “a couple of centimeters” as 2 cm.

6. Taylor: Problem 5.44. The constants listed in the problem are defined by Eqs. (5.57), (5.64), and (5.77) in the text.