

## Physics 263: Problem Set #6

These problems are officially due at the end of the day on Friday, May 8, but since that is the day of the midterm, I encourage you to do it by Thursday afternoon. Also note we'll have class on Thursday May 7.

1. Morin 11.60 (Passing trains) p. 563
2. Morin 12.29 (Decay in to photons) p. 617
3. Morin 4.19 (Removing a spring) p. 123
4. Morin 4.28 (Ratio of maxima) p. 125
5. Morin 4.30 (No damping force) p. 126
6. Damped oscillators are often characterized by the dimensionless “quality factor”  $Q \equiv \frac{\tilde{\omega}}{2\gamma}$  where  $\tilde{\omega} \equiv \sqrt{\omega^2 - \gamma^2} \approx \omega$  for light damping (i.e. large  $Q$ ). In the *absence* of damping, the oscillator coordinate obeys  $x(t) = x_0 \sin(\omega t)$ , and the maximum displacement occurs exactly half-way between zero-crossing, i.e. a quarter of the way through the motion at a phase angle of  $\omega t = \pi/2$ . Show that in the presence of (light) damping, the maximum occurs at phase angle  $\phi \approx \pi/2 - \frac{1}{2Q}$ . (This observation is useful when using an oscilloscope, which is good at finding zero-crossings and peaks.)
7. Show that for a lightly damped oscillator the energy lost each cycle is a fraction  $2\pi/Q$  of the total energy stored in the oscillator.
8. (BONUS) Morin 4.22 (Projectile on a spring)
9. Shankar, problem 5.4.3 pg. 103.
10. Shankar, problem 5.4.4 pg. 103.
11. Shankar, problem 5.4.5 pg. 103.