Physics 25 Problem Set 1

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due Monday, April 10

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

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1. One way to look at the phase shift of the current in Equation 12 on page 300 of the text is to solve for the 'phase' $\phi = -\omega t$ such that $I(t) = 0$ and t is as near to zero as possible. Plugging into Equation 12 results in the solution mentioned in the text, that $\phi = \arctan(\alpha/\omega)$. Let's look at this a slightly different way; take:

   $$V(t) = \mathrm{Re}(Ae^{-\alpha t + i\omega t})$$

   but then forget about taking the real part. You can work everything and take the real part at the end, so usually in physics we just say:

   $$V(t) = Ae^{-\alpha t + i\omega t},$$

   which gives us a complex-valued $V(t)$ to develop some feeling for; that is the purpose of this problem.

   (a) Start from the equation above for a complex-valued $V(t)$ and evaluate the resulting complex-valued $I(t)$.

   (b) Make a plot in the complex plane of $I(0)$ when there is no damping, meaning $\alpha = 0$.

   (c) Add the value of $I(0)$ on the same plot of the complex plane when there is light damping, meaning $0 < \alpha/\omega = R/(2L\omega) << 1$.

   (d) What is the angle between the two complex numbers plotted?

   (e) Make a fresh plot in the complex plain that depicts $I(t)$ for values of t running from 0 to a large value.

   (f) For light damping, relate the phase shift ϕ to the quality factor Q.

2. Purcell 8.2

3. Purcell 8.3

4. Purcell 8.7

5. Purcell 8.10
