Homework #9 (100 points) - Show all work on the following problems:

(Grading rubric: Solid attempt = 50% credit, Correct approach but errors = 75% credit, Correct original solution = 100% credit, Copy of online solutions = 0% credit)

Problem 1 (25 points): Calculate the electric and magnetic fields of an oscillating magnetic dipole without assuming $r >> c/\omega$. I*n other words, use both terms of the magnetic vector potential in Eq. 11.33 to compute the fields. The results should look familiar if you compare to HW 5 Problem 3.*

Problem 2 (25 points): Calculate the power radiated from an insulating circular ring of radius b that lies in the x-y plane, centered at the origin, assuming that it has a charge density $\lambda = \lambda_0 sin\phi$ and that it rotates with an angular velocity ω about the z-axis

Problem 3 (25 points): Drop an electron from rest in normal earth's gravity. As it falls, it gains kinetic energy from the gravitational potential energy. However, it also loses a small amount of energy to radiation. What fraction of the electron's gravitational potential energy loss goes into radiation in the first centimeter of free-fall? *Hint: Not much.*

Problem 4 (25 points): In the Bohr model for hydrogen, the electron in its ground state follows a circular orbit with a radius a_0 (the Bohr radius = 5×10^{-11} m) around the proton. Assuming a circular orbit with an initial radius a_0, use the Larmor formula to calculate the energy loss due to radiation as the electron's orbit spirals in toward the nucleus (you can assume each orbit is circular, but with a decreasing radius). Integrate to find the "classical" lifetime of the hydrogen atom under radiative losses. *Hint: It's pretty short!*

Note: The resolution to this seeming paradox lies in quantum mechanics. Since the electron energy levels are quantized, the H atom can only radiate energy in discrete quanta, and it cannot radiate from the ground state at all.