Homework #9 (10 points) - Show all work on the following problems:

Problem 1 (2.5 points): By approximating a capacitor as an electric dipole, calculate the total energy lost to radiation from a capacitor as it discharges through a resistor, as a fraction of the initial energy stored in the capacitor. Assume a parallel-plate capacitor with capacitance *C*, plate separation *d*, and initial charge $+Q_0$ on one plate and $-Q_0$ on the other, so that the initial stored energy is $Q_0^2/(2C)$. Assume this capacitor discharges through a resistor with resistance *R*, so that $Q(t) = Q_0 e^{-t/RC}$. *Hint: The radiative losses are very small.*

Problem 2 (2.5 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 (2.5 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 (2.5 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.