Phys 321 – E & M II – Test 3 – Dec. 2, 2005

1.(25 pts) Given that $V(\vec{r},t) = 0$ and $\vec{A}(\vec{r},t) = -\dfrac{qt\,\hat{r}}{4\pi\varepsilon_0 r^2}$.

a) Find the electric and magnetic fields.

b) Use the gauge transformation $\lambda = -\dfrac{qt}{4\pi\varepsilon_0 r}$ to transform the potentials. What are the new potentials?

c) Find the charge and current distributions, corresponding to either set of potentials.

2.(25 pts) Suppose a point charge q is constrained to move along the x axis. Determine the electric and magnetic fields at points on the axis to the ***right*** of the charge.

3. (25 pts.) A proton of charge q and mass m is accelerated from rest through a distance D in a uniform electric field $\boldsymbol{E}$.

a) Determine the acceleration of the charge and the total power radiated by the charge.

b) What is the kinetic energy gained by the proton?

b) What fraction of the kinetic energy gained is lost by radiation?

4.(25 pts) A particle of mass m and charge q is attached to a spring with force constant κ, hanging from the ceiling. It is pulled down a distance A below equilibrium and released, at time $t = 0$.

a) Determine the equation of motion of the charge?

b) Use the Larmor formula to determine the total time-averaged power radiated.

c) The amplitude A of the oscillation will gradually decrease because of the radiation. Determine the amplitude as a function of time. What is the relaxation time, *i.e.*, when the amplitude has been reduced to A/e ? Assume the fraction of energy lost in one cycle is very small.