Physics 303 Final Exam

Please return by: January 29, 2008

Problem 1

A point charge q is moving according to the law

$$\vec{r}(t) = \vec{r_0} + at\vec{i} + bt^2\vec{j} + ct^3\vec{k}$$

where a, b, c and $\vec{r_0}$ are some given constants. Find the electric and magnetic fields at the origin of the coordinate system as the functions of time.

Problem 2

Find the solutions of the Maxwells equations in the Loretz gauge:

$$\begin{aligned} \partial_k F^{ik} &= \frac{4\pi}{c} j^i \\ \partial_i A^i &= 0 \\ i, k &= 0, 1, 2 \\ A^i \equiv (\phi, A_x, A_y); j^i &\equiv (c\rho, j_x, j_y) \end{aligned} \tag{1}$$

for the two-dimensional electrodynamics (i.e. the electrodynamics in the 2 + 1 Minkowski space), describing the analogue of the electromagnetic radiation in two dimensions. **Hint:** Follow the same logic we used to derive the retarding potentials in the usual (3-dimensional) case, i.e. find the spherically symmetric solutions in the vacuum first, then consider a point-like time-dependent infinitezimal charge in an infinitely small volume element and finally write the solution for the arbitrary charge distribution. It may be helpful to use the Fourier transformation for the time variable. Recall the asymptotic properties of the Bessel's functions and the form of the Green's functions in two dimensions.

Problem 3

Consider an ideal gaz of N identical charged particles inside a tank of a volume V, at the initial temperature T. Electromagnetic interaction and collisions between the particles can be neglected, however, there are the radiation losses due to collisions with the walls of the tank. Estimate the time in which the temperature would fall by one half due to the radiation.