Problem Set 1
Electrodynamics
Spring, '05
Due: April 8, 2005

Problem 1: Find the Green's function for the wave equation associated with the following two contours for the time integral:

Can you give a physical interpretation to this Green's function? (In terms of waves, what do these look like?)

Problem 2: Jackson 6.1. Explain these results in terms of a 3D world.

Problem 3: Jackson 6.8. Would your result change if the sphere were a conductor? If so, how?

Problem 4: A point charge q oscillates around the origin. Its position is given by $z(t) = z_0 \sin \omega t$. Find:

a. The charge density ρ and the current density $\vec{J}$ of the system;
b. The electric and magnetic fields along the z and x axes (assume that q where q is the distance from the observer to the origin); and
c. The total power radiated as a function of time. Compare this last number to the Lamour formula that gives

$$P = \frac{2}{3}\frac{q^2}{4\pi\varepsilon_0}\frac{a^2}{c^3}$$

where a is the acceleration of the charge.

Qualifying Exam Problems:

Do not use Mathematica on these problems.

Question 3B – Spring, '86

A circular loop of wire is held in a fixed position, with the plane of the loop parallel to the surface of the earth. A small bar magnet is falling downward along the axis of the loop. The magnetic moment of the bar magnet is parallel to the axis of the loop. The distance from the magnet to the loop is quite large compared to the radius of the loop. Show that the rate of Joule heating in the loop is equal to the rate at which work is done on the falling magnet by a force directed opposite to that of gravity.

Hint: Although isolated magnetic moments have been demonstrated to exist, it is permissible to regard a magnetic dipole as being composed of two suitably large magnetic monopoles of equal but opposite sign and separated by a suitably small distance, with the force on a single magnetic monopole Q_m in a magnetic field $\vec{B}$ being equal to $Q_m\vec{B}$.