PHY3323: ELECTROMAGNETISM I

Problem set 3, (due Sep. 17, 2008)

PROBLEM 1

(a) Compute the line integral of

$$\vec{v} = (r^2 \cos^2\theta)\hat{r} - (2r\cos\theta\sin\theta)\hat{\theta} + 3r\sin\theta\hat{\phi}$$

around the path shown in Griffiths' Fig. 1.50 (the points in the figure are labeled by their Cartesian coordinates).

(b) Recalculate the result using the Stokes' theorem.

Hint: use spherical or cylindrical coordinates.

PROBLEM 2

Calculate the total charge of a spherical shell with an inner radius a and an outer radius b. The volume charge density (the charge per unit volume) of the shell is given by the following function:

$$\rho(r,\theta,\phi) = \rho_0 \frac{r}{b}\cos^2(\theta)$$

where ρ_0 is a positive constant.

PROBLEM 3

Evaluate the integral:

$$\int_{-\infty}^{a} x^2\delta(x-b)dx$$

where a, and b could be any two numbers.

PROBLEM 4

(a) Write an expression for the mass density $\rho(\vec{r})$ of a point particle with a mass m at a position $\vec{r'}$. How much is the volume integral of ρ over the entire space?

(b) What is the mass density of a system of two point particles with mass m each. One of the particle is at the origin of the coordinate system and the other one is at $\vec{a}$. How much is the integral of the density over the entire space?

(c) What is the mass density of a uniform infinitesimally small spherical shell of radius R and total mass M, centered at the origin. Show that the integral over the entire space is equal to M.