PHYSICS 110A – HOMEWORK SET 1

Due Friday 1/15/10. Ten points per problem. Selected answers are provided.

Reading: Griffiths, Chapter 1.

1.) Consider a two-dimensional vector $\vec{v} = (x, y)$. If this vector is rotated by an angle θ (counterclockwise), it will develop a new representation $\vec{v}' = (x', y')$. In general, the components of $\vec{v}'$ can be determined by contracting a two-by-two matrix $R_2(\theta)$ with the components of $\vec{v}$, i.e., $\vec{v}' = R_2(\theta) \cdot \vec{v}$.

Derive the form of the two-by-two matrix $R_2(\theta)$, explicitly in terms of θ. How would $R_2(\theta)$ be different if instead of rotating the vector conterclockwise by θ, the *coordinate system* were rotated counterclockwise by θ? Demonstrate that your answers work by considering an initial vector $\vec{v} = (1, 0)$, and rotations of 45°.

2.) Problem 1.5 (do it only for the x component of the result).

3.) Problem 1.7. ($\hat{r} = 2/3\hat{x} - 2/3\hat{y} + 1/3\hat{z}$)

4.) Problem 1.12. (3 mi N, 2 mi W; 720 ft; 311 ft/mile NW)

5.) Problem 1.13

6.) Problem 1.20; but just do product rule (i), to get a feel for where these identities come from.

7.) Problem 1.26.

8.) Problem 1.33.

9.) Using geometrical argmuents, derive the expressions for the volume element $d\tau$ in cartesian (obvious!), cylindrical, and spherical coordinates.

10.) Problem 1.46.

11.) Problem 1.53.

12.) Problem 1.60; part (a) only.

13.) Problem 1.61. Answer a) by doing the integration explicitly, rather than simply by using the result of c) in a clever way. Also, remember that your answer to a) should be a vector!

14.) Use the divergence theorem and the law of superposition to prove Gauss's Law for a general charge distribution $\rho(\vec{r})$.