E&M Problem Set 1
Due Tuesday, January 22 at 4PM

SPECIAL NOTE: I could not find a symbol that exactly matches the book's script r for the separation vector. Instead I am using the following notation: $\vec{\mathfrak{r}} = \vec{r} - \vec{r}'$, $\mathfrak{r} = |\vec{\mathfrak{r}}|$ and $\hat{\mathfrak{r}} = \vec{\mathfrak{r}}/\mathfrak{r}$.

1. **Griffiths Problem 1.9:** (Chapter 1, Problem 9) Find the tranformation matrix R that describes a rotation by 120° about an axis from the origin through the point (1,1,1). The rotation is clockwise as you look down the axis toward the origin.

2. **Griffiths Problem 1.13:** Let $\vec{\mathfrak{r}}$ be the separation vector from a fixed point (x', y', z') to the point (x, y, z), and let $\mathfrak{r}$ be its length. Show that

   (a) $\vec{\nabla}(\mathfrak{r}^2) = 2\vec{\mathfrak{r}}$

   (b) $\vec{\nabla}(\frac{1}{\mathfrak{r}}) = -\frac{\hat{\mathfrak{r}}}{\mathfrak{r}^2}$

   (c) What is the *general* formula for $\vec{\nabla}(\mathfrak{r}^n)$?

3. **Griffiths Problem 1.16:** Sketch the vector function $\vec{v} = \frac{\hat{r}}{r^2}$ and compute its divergence. The answer may surprise you...can you explain it?

4. **Griffiths Problem 1.26:** Prove the divergence of a curl is always zero. *Check* it for function $\vec{v}_a = x^2\hat{x} + 3xz^2\hat{y} - 2xz\hat{z}$ (from Problem 1.15).

5. **Griffiths Problem 1.37:** Express the unit vectors $\hat{r}, \hat{\theta}, \hat{\phi}$ in terms of $\hat{x}, \hat{y}, \hat{z}$ (that is, derive Eqn. 1.64). Check your answers several ways (does $\hat{r} \cdot \hat{r} = 1$, $\hat{\theta} \cdot \hat{\phi} = 0$, $\hat{r} \times \hat{\theta} = \hat{\phi}$ ...). Also work out the inverse formulas, giving $\hat{x}, \hat{y}, \hat{z}$ in terms of $\hat{r}, \hat{\theta}, \hat{\phi}$.