1. Read Griffiths sections 5-1 and 5-2. Did you read all the pages?

2. In Cartesian coordinates, the displacement vector $\vec{r}$ can be written in terms of the unit vectors as $x\hat{e_x} + y\hat{e_y} + z\hat{e_z}$. Express the displacement vector in

   (a) spherical polar coordiates and unit vectors

   (b) cylindrical polar coordiates and unit vectors

3. Give a numerical answer or simplify as much as possible:

   (a) $\vec{\nabla} \cdot \vec{r}$ (divergence of the displacement vector).

   (b) $\vec{\nabla} \times \vec{r}$ (curl of the displacement vector).

   (c) $\vec{\nabla}|\vec{r}|$ (gradient of the length of the displacement vector).

   (d) $\nabla^2|\vec{r}|$ (Laplacian of the length of the displacement vector).

   (e) $\vec{\nabla} \times \hat{\theta}$ (curl of the polar angle unit vector in spherical polar coordinates).

4. Show that the Laplacian in spherical polar coordinates (equation 4.13) of Griffiths can also be written as

$$\nabla^2 = \frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} + \frac{\cot(\theta)}{r^2}\frac{\partial}{\partial \theta} + \frac{1}{r^2}\frac{\partial^2}{\partial \theta^2} + \frac{1}{r^2 \sin^2(\theta)}\frac{\partial^2}{\partial \phi^2}$$

5. Show by explicit integration that the spherical harmonics $Y_0^0$ and $Y_2^0$ are orthogonal. Show your work.

# Bonus:

1. Griffiths 4.4