

E&M Problem Set 2

Due Tuesday, January 29 at 4PM

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

1. Griffiths Problem 1.38:

- (a) Check the divergence theorem for the function $\vec{v}_1 = r^2 \hat{\mathbf{r}}$, using as your volume the sphere of radius R , centered at the origin.
- (b) Do the same for $\vec{v}_2 = \frac{1}{r^2} \hat{\mathbf{r}}$. (If the answer surprises you, look back at Problem 1.16.)

2. Griffiths Problem 1.44: Evaluate the following integrals:

- (a) $\int_{-2}^2 (2x + 3) \delta(3x) dx$
- (b) $\int_0^2 (x^3 + 3x + 2) \delta(1 - x) dx$
- (c) $\int_{-1}^1 9x^2 \delta(3x + 1) dx$
- (d) $\int_{-\infty}^a \delta(x - b) dx$

3. Griffiths Problem 1.49:

- (a) Let $\vec{F}_1 = x^2 \hat{\mathbf{z}}$ and $\vec{F}_2 = x \hat{\mathbf{x}} + y \hat{\mathbf{y}} + z \hat{\mathbf{z}}$. Calculate the divergence and curl of \vec{F}_1 and \vec{F}_2 . Which one can be written as the gradient of a scalar? Find a scalar potential that does the job. Which one can be written as the curl of a vector? Find a suitable vector potential.
- (b) Show that $\vec{F}_3 = yz \hat{\mathbf{x}} + zx \hat{\mathbf{y}} + xy \hat{\mathbf{z}}$ can be written both as the gradient of a scalar and the curl of a vector. Find the scalar and vector potentials of this function.

4. **Griffiths Problem 1.53:** Check the divergence theorem for the function $\vec{v} = r^2 \cos \theta \hat{r} + r^2 \cos \phi \hat{\theta} - r^2 \cos \theta \sin \phi \hat{\phi}$. using as your volume one octant of the sphere of radius R (Figure 1.48, shown below). Make sure you include the *entire* surface. [Answer: $\frac{\pi}{4}R^4$]

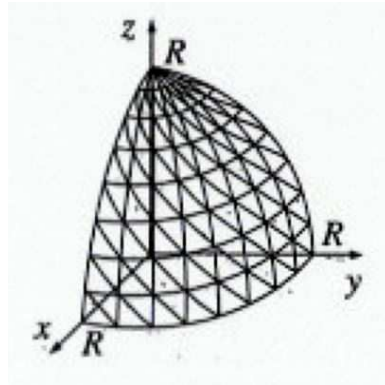


Figure 1.48