Physics 321, Autumn Quarter 2015
Electrodynamics: Homework Assignment 1

Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)

Due 9:30 am Thursday October 8

1. Miscellaneous mathematics problems.

a. In 10 words or less, explain why $\nabla\bullet(\rho\mathbf{v})$ is zero for an incompressible fluid. (As usual, ρ is the mass density, **v** is the velocity.)

b. Consider a river in which the water velocity **v** is proportional to the distance from the bottom, and the flow is in the z-direction according to $v_x=0$, $v_y=0$. $v_z=cx$. Find the curl of the velocity.

c. Consider a unit sphere centered at the origin. In terms of the Cartesian unit vectors *i*, *j* and *k*, find the unit normal vector on the surface.

d. Explain why the vector function **F**(x,y,z)=*i*x+*jy* does or does not have a divergence and curl. A sketch of the field lines may help.

e. Explain why the vector function $\mathbf{G}(x,y,z)=\dfrac{-iy+jx}{\sqrt{x^2+y^2}}$ does or does not have a divergence and curl. A sketch of the field lines may help.

2. Show the general form of Maxwell's Equations (left upper set of equations in the back cover) contain current & charge conservation $\nabla \bullet \mathbf{J} + \partial\rho/\partial t = 0$.

3. With **r** a position vector and **G** constant, find

a. $\mathbf{G}\times\mathbf{r}$ and b. $(\mathbf{G}\bullet\mathbf{r})\,\mathbf{r}$ and c. $\nabla\bullet\mathbf{r}$

4) Suppose $\nabla\bullet f(r)\mathbf{r}=0$. Find a scalar f(r) satisfying this condition.

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