Electromagnetc Theory: PHYS330

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Class Notes

Solutions to Warm Up

Hint: 2D Curl.

$$\nabla \times \mathbf{E} = \hat{z}\left(\frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y}\right) = 0 \tag{1}$$

$$\frac{\partial E_y}{\partial x} = \frac{\partial E_x}{\partial y} \tag{2}$$

Solutions to Warm Up

Hint: Get the **E**-field.

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r} \tag{3}$$

(a):

$$V(\mathbf{r}) = -\int_{\infty}^{\mathbf{r}} \frac{1}{4\pi\epsilon_0}\frac{q}{r'^2}dr' = \frac{1}{4\pi\epsilon_0}\frac{q}{r} \tag{4}$$

(b):

$$V(\mathbf{r}) = -\int_{\infty}^{\mathbf{r}} \mathbf{E}\cdot d\mathbf{l} = -\int_{\infty}^{R} \frac{kq}{r'^2}\hat{r}\cdot dr'\hat{r} - \int_{R}^{\mathbf{r}} 0\cdot d\mathbf{l} \tag{5}$$

$$V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\frac{q}{R} \tag{6}$$

Laplace’s Equation

Laplace's Equation in 1D

$$\nabla^2 V = 0 \tag{7}$$

$$\frac{d^2 V}{dx^2} = 0 \tag{8}$$

This implies:

$$V(x) = ax + V_0 \tag{9}$$