

Quiz #3, 04/18/2018

Name: _____ Signature: _____

If an electric field is given $\vec{E} = 6r\hat{r} + 9r\phi\hat{\phi} - 2r\hat{z}$ (V/m) in the region

$0 \leq r \leq 2$, $-\pi \leq \phi \leq \pi$, $0 \leq z \leq 1$, assuming $\epsilon_1 = 2\epsilon_0 = 1.77 \times 10^{-11} \text{ F/m}$, determine the volume charge density in this region.

Solution:

$$\rho_v = \nabla \cdot \vec{D} = \epsilon_1 \nabla \cdot \vec{E} = \epsilon_1 \nabla \cdot (6r\hat{r} + 9r\phi\hat{\phi} - 2r\hat{z}),$$

$$\rho_v = \epsilon_1 \left(\frac{1}{r} \frac{\partial}{\partial r} (r6r) + \frac{1}{r} \frac{\partial}{\partial \phi} (9r\phi) - \frac{\partial}{\partial z} (2r) \right)$$

$$= \epsilon_1 21$$

$$= 3.72 \times 10^{-10} \text{ C/m}^3$$