P3323 Reading Quiz 1-2
August 26, 2016
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1. Coulomb's law states
$$\mathbf{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{\mathbf{r}_{12}^2}\hat{\mathbf{r}}_{12}.$$
What are the dimensions of the permittivity of free space ϵ_0?

   A)
   $$\frac{\text{Coulombs}}{\text{Newton} - \text{meters}}$$

   B)
   $$\frac{(\text{Coulombs})^2}{\text{Newton} - \text{meters}}$$

   C)
   $$\frac{(\text{Coulombs})^2}{\text{Newton} - (\text{meters})^2}$$

   D)
   $$\frac{\text{Newton} - (\text{meters})^2}{(\text{Coulombs})^2}$$

2. Consider the square loop of charge as in Fig. 2.8 on Griffith's page 65. The length of the sides of the square is a and the linear charge density of the loop is λ. At a distance $z \gg a$, the electric field is

A)

$$\mathbf{E} \sim \frac{1}{4\pi\epsilon_0}\frac{\lambda}{z^2}\hat{\mathbf{z}}$$

B)

$$\mathbf{E} \sim \frac{1}{4\pi\epsilon_0}\frac{a\lambda}{z^2}\hat{\mathbf{z}}$$

C)

$$\mathbf{E} \sim \frac{1}{4\pi\epsilon_0}\frac{4a\lambda}{z^2}\hat{\mathbf{z}}$$

D)

$$\mathbf{E} \sim \frac{1}{4\pi\epsilon_0}\frac{4a\lambda}{z^2+a^2}\hat{\mathbf{z}}$$

3. The electric field at $\mathbf{r}$ due to charges q_i at $\mathbf{r}_i$ is given by

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0} \sum_{i=1}^{n} \frac{q_i}{|\Re_i|^2} \hat{\Re}_i$$

where $\Re_{\mathbf{i}} = \mathbf{r} - \mathbf{r}_i$. What are the dimensions of $\mathbf{E}(\mathbf{r})$?

A)

$$\text{Coulombs} - (\text{meters})^2$$

B)

$$\frac{\text{Coulombs}}{(\text{meters})^2}$$

C)

Newtons

D)

$$\frac{\text{Newtons}}{\text{Coulomb}}$$

4. Now consider the line charge in Fig. 2.7 on Griffith's page 65. The line segment L carries uniform line charge λ. What is the electric field at P?

A)

$$\mathbf{E}(x=0,z)_p = \frac{1}{4\pi\epsilon_0}\int_0^L \frac{\lambda dx}{z^2+x^2}\left(\frac{z\hat{\mathbf{z}} - x\hat{\mathbf{x}}}{\sqrt{z^2+x^2}}\right)$$

B)

$$\mathbf{E}(x=0,z)_p = \frac{1}{4\pi\epsilon_0}\int_0^L \frac{\lambda dx}{z^2+x^2}\left(z\hat{\mathbf{z}} - x\hat{\mathbf{x}}\right)$$

C)

$$\mathbf{E}(x=0,z)_p = \frac{1}{4\pi\epsilon_0}\int_0^L \frac{\lambda dx}{z^2+x^2}\left(z\hat{\mathbf{z}} + x\hat{\mathbf{x}}\right)$$

D)

$$\mathbf{E}(x=0,z)_p = \frac{1}{4\pi\epsilon_0}\int_0^L \frac{\lambda dx}{z^2+x^2}\left(\hat{\mathbf{z}} - \hat{\mathbf{x}}\right)$$