Name & ID

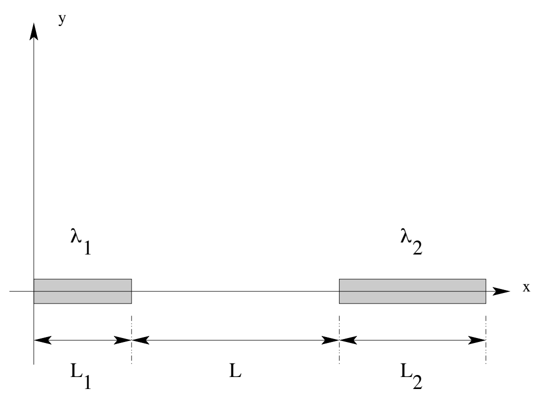
PH 126 / LeClair Fall 2009

Quiz 1: Electric fields and so forth

Things:

$$\vec{\mathbf{F}}_{12} = k_e \frac{q_1 q_2}{r^2}\,\hat{\mathbf{r}} = q_2 \vec{\mathbf{E}}_1$$
$$\vec{\mathbf{E}}_1 = \vec{\mathbf{F}}_{12}/q_2 = k_e \frac{q_1}{r^2}\,\hat{\mathbf{r}}$$
$$\vec{\mathbf{E}} = k_e \sum_i \frac{q_i}{r_i^2}\,\hat{\mathbf{r}}_i \rightarrow k_e \int \frac{dq}{r^2}\,\hat{\mathbf{r}} = k_e \int \frac{\rho \hat{\mathbf{r}}}{r^2}\, dV_{ol}$$

1. Two thin rigid rods lie along the x axis, as shown below. Both rods are uniformly charged. Rod 1 has a length L_1 and a charge per unit length λ_1. Rod 2 has a length L_2 and a charge per unit length λ_2. The distance between the right end of rod 1 and the left end of rod 2 is L.

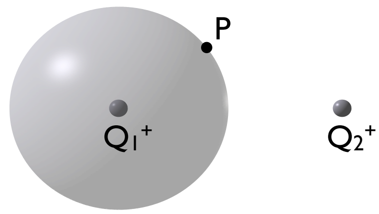


Which expression below could give the electric force between the two rods? Circle your answer.

$$\vec{\mathbf{F}}_{12,\text{tot}} = k_e \lambda_1 \lambda_2 \left[\frac{(L_2+L)(L_1+L)}{L(L+L_1+L_2)}\right]\hat{\mathbf{x}} \tag{1}$$
$$\vec{\mathbf{F}}_{12,\text{tot}} = k_e \lambda_1 \lambda_2 \ln\left[\frac{(L_2+L)(L_1+L)}{L(L+L_1+L_2)}\right]\hat{\mathbf{x}} \tag{2}$$
$$\vec{\mathbf{F}}_{12,\text{tot}} = k_e \lambda_1^2 \ln\left[\frac{L_1+L}{L+L_1+L_2}\right]\hat{\mathbf{y}} \tag{3}$$
$$\vec{\mathbf{F}}_{12,\text{tot}} = k_e \lambda_1 \lambda_2 \frac{L_1+L_2}{\left(L_1^2+L_2^2\right)^{3/2}+L^2}\,\hat{\mathbf{x}} \tag{4}$$

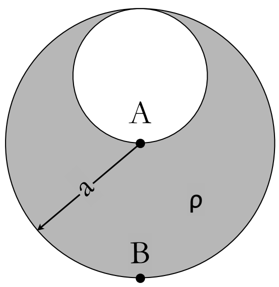
2. Suppose three positively charged particles are constrained to move on a fixed circular track. If all the charges were equal, an equilibrium arrangement would obviously be a symmetrical one with the particles spaced 120° apart around the circle. Suppose two of the charges have equal charge q, and the equilibrium arrangement is such that these two charges are 140° apart rather than 120°. What is the *relative* magnitude and sign of the third charge?

- ▫ larger than either q_1 or q_2 and positive
- ▫ smaller than either q_1 or q_2 and positive
- ▫ larger than either q_1 or q_2 and negative
- ▫ smaller than either q_1 or q_2 and negative



3. In the figure above, a point charge $1Q^+$ is at the center of an imaginary spherical Gaussian surface and another point charge $2Q^+$ is outside of the Gaussian surface. Point P is on the surface of the sphere. Which one of the following statements is true?

- ▫ Both charges contribute to the net electric flux through the sphere but only $2Q^+$ contributes to the electric field at point P.
- ▫ Only $1Q^+$ contributes to the net electric flux through the sphere but both charges contribute to the electric field at point P.
- ▫ Both contribute to the net electric flux through the sphere but only $1Q^+$ contributes to the electric field at point P.
- ▫ Only $2Q^+$ contributes to the net electric flux through the sphere but both charges contribute to the electric field at point P.
- ▫ Only $2Q^+$ contributes to the net electric flux through the sphere and to the electric field at point P on the sphere.
- ▫ Only $1Q^+$ contributes to the net electric flux through the sphere and to the electric field at point P on the sphere.
- ▫ I don't know (this answer is worth 1/5 of full credit)



4. The sphere of radius a was filled with positive charge at uniform density ρ. Then a smaller sphere of radius $a/2$ was carved out, as shown in the figure, and left empty. Which expression *could* give the expression for the electric field *anywhere* inside the cavity? The $\hat{\mathbf{y}}$ direction is vertical, and r is measured from the center of the large sphere. *Hint: if it is true anywhere inside the cavity, pick an easy example point. What superposition of simple charge distributions could give the one shown?*

- ☐ $\vec{\mathbf{E}} = \frac{2k_e\pi\rho}{r}\,\hat{\mathbf{y}}$
- ☐ $\vec{\mathbf{E}} = \frac{2k_e\pi\rho a}{r^2}\,\hat{\mathbf{y}}$
- ☐ $\vec{\mathbf{E}} = \frac{2k_e\pi\rho a}{3}\,\hat{\mathbf{y}}$
- ☐ $\vec{\mathbf{E}} = \frac{2k_e\pi\rho r}{a}\,\hat{\mathbf{y}}$