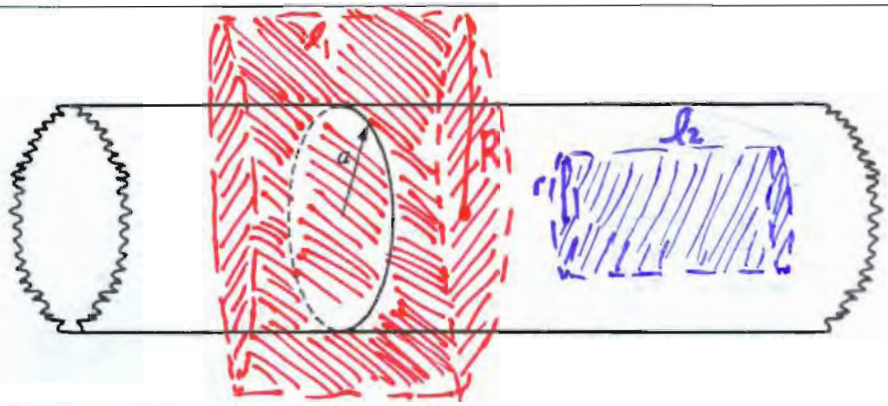
Name Key

AP Physics C
Drozdoff 8–9
Quiz — Chapter 24, 2/4/2008

This quiz is worth 13 points; 16 are available. It is calculator-unencumbered.



1 A very long solid insulating rod has radius a and a uniform positive charge per unit length λ. In terms of a, λ, and fundamental constants where applicable, perform the following tasks: (8)

a Determine the magnitude E of the electric field at some distance R from the axis of the rod, $R > a$. Sketch any construct(s) not shown in the picture you may use, labeling it/them appropriately. (3)

that means Gaussian surfaces!

$$\oint \vec{E}\cdot d\vec{S} = \frac{Q_{enc}}{\epsilon_0}$$

$$\|\vec{E}\|(2\pi R\ell) = \frac{\lambda \ell}{\epsilon_0}$$

$$\|\vec{E}\| = \frac{\lambda}{2\pi R \epsilon_0}$$

b Determine the magnitude E of the electric field at some distance r from the axis of the rod, $r < a$. Sketch any construct(s) not shown in the picture you may use, labeling it/them appropriately. (3)

$$\oint \vec{E}\cdot d\vec{S} = \frac{Q_{enc}}{\epsilon_0}$$

$$\|\vec{E}\|(2\pi r \ell_2) = \frac{\lambda \ell_2}{\epsilon_0}\left(\frac{\pi r^2 \ell_2}{\pi a^2 \ell_2}\right)$$

← account for only the charge enclosed

$$\|\vec{E}\| = \frac{\lambda r}{2\pi a^2 \epsilon_0}$$

c For each of the following situations in which a charge distribution is placed at the described position, indicate the direction in which the distribution will move, or indicate that the distribution does not move.

i A circular loop of negative charge is placed ourside the rod such that the rod and loop are concentric (1)

Does not move: it is pushed radially outward, but uniformly in all directions; antiparallel vectors cancel

ii A test charge is placed just on the surface of the rod (1)

moves radially outward: the (positive) test charge is repelled by the also positively-charged rod

2 A positive charge q is surrounded by n Gaussian spheres centered at the charge. Show (informally, Alex) that the flux through the surfaces is independent of the radius $r_1, r_2, \cdots, r_n$ of the Gaussian surface. (4)

Flux is proportional to the number of field lines penetrating a surface. Note that each "sphere" (represented by a dotted circle) has, in this diagram, 8 field lines piercing it regardless of its radius.

3 An infinite sheet has uniform positive surface charge density σ. Use a Gaussian pillbox to determine the field at a distance r from the sheet. If you simply remember the result from the example done in class, that's nice. If you can't show its derivation, you will receive no credit. Show a sketch. (4)

$$\oint \vec{E} \cdot d\vec{S} = \frac{Q_{enc}}{\epsilon_0}$$

$$\|\vec{E}\|(2A) = \frac{\sigma A}{\epsilon_0}$$

$$\|\vec{E}\| = \frac{\sigma}{2\epsilon_0}$$

$$\sigma = \frac{dQ}{dA} \Rightarrow dQ = \sigma\, dA$$

$$\Rightarrow Q = \int dQ = \iint \sigma\, dA = \sigma \iint dA = \sigma A$$