PHYS 102: General Physics KOÇ UNIVERSITY ~~Spring~~ Fall Semester 2016
College of Arts and Sciences
Quiz 1 Oct 7, 2016

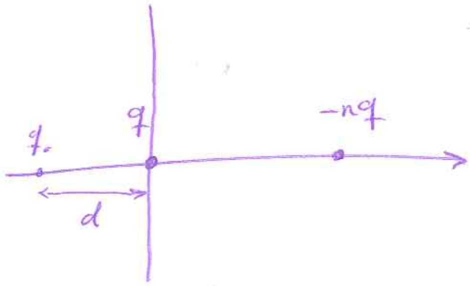
Closed book. No calculators are to be used for this quiz.
Quiz duration: 15 minutes
Name: Student ID: Signature:

$$k \simeq 9 \times 10^9 Nm^2/C^2$$
$$\epsilon_0 \simeq 9 \times 10^{-12} C^2/Nm^2$$
$$\pi \simeq 3$$

Q. A point charge q is fixed at $x = 0$ and another point charge $-nq$ is fixed at $x = 1$m. where n is a constant. Find the point on the x-axis where a test charge q_0 will remain stationary.(The answer does not depend on q or q_0.)

Assume $n > 1$:

Its obvious that point charge should not be in between.



must located on the left $(n>1)$: $\Sigma F = 0$

$$\Rightarrow k\frac{qq_0}{d^2} = k\frac{nqq_0}{(d+x)^2} \Rightarrow (d+x)^2 = nd^2 \Rightarrow d+x = \pm\sqrt{n}d$$

we take positive

$$d = \frac{x}{\sqrt{n}-1}$$

If $n<1$, we may consider Answer that we found (for $n>1$), but instead of "n" we put $\frac{1}{n}$!

if $n>1$ then $\frac{1}{n}<1$

$$\Rightarrow d = \frac{x}{\sqrt{\frac{1}{n}}-1} = \frac{x}{\sqrt{\frac{1}{n}}-1} \times \frac{\sqrt{n}}{\sqrt{n}} = \frac{\sqrt{n}}{1-\sqrt{n}}x$$

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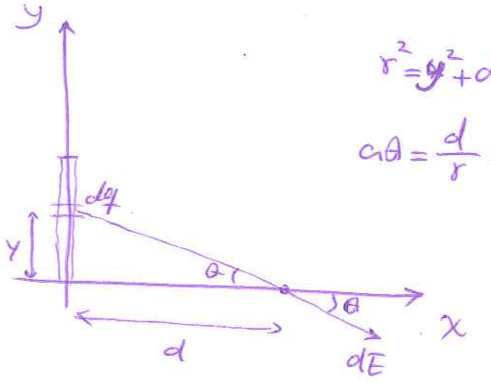
Q. A positive charge Q is distributed uniformly along the positive y-axis between $y = 0$ and $y = a$. Write down the integral expression for the x-component of the electric field produced at the point $x = d$ on the positive x-axis.



$$r^2 = y^2 + d^2$$

$$\cos\theta = \frac{d}{r} = \frac{d}{\sqrt{y^2+d^2}}$$

$$\begin{cases} dE_x = \int dE \cos\theta & (I) \\ dq = \left(\frac{dy}{a}\right) Q & (II) \end{cases}$$

$$dE = k\frac{dq}{r^2} \overset{(II)}{=} \frac{kQ}{a} \int \frac{dy}{y^2+d^2}$$

$$dE_x = \int dE \cos\theta = \frac{kQd}{a} \int \frac{dy}{(y^2+d^2)^{3/2}}$$

Integral Expression in x-direction

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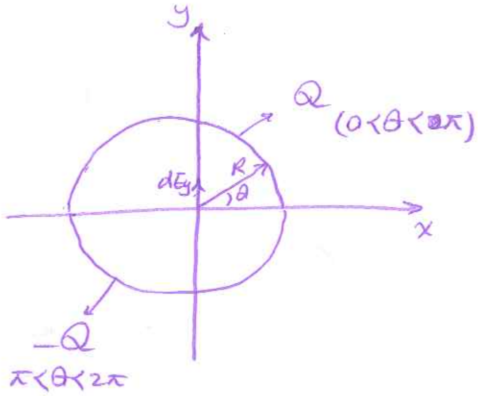
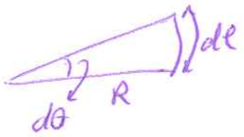
Q. The semicircular half of a thin plastic ring carries a uniformly distributed charge $Q = 1.0\mu$C, while the other half carries $-Q$ (again uniform). Find the magnitude of the electric field at the center of the ring if its radius is 1.0cm.



For $dq = \left(\frac{dl}{\pi R}\right) Q = \left(\frac{R d\theta}{\pi R}\right) Q = \frac{Q}{\pi} d\theta$



$dl = R d\theta$

In x-direction E_y for Q and $-Q$ will cancel!

In y-direction E_x for Q and $-Q$ will be equal in positive direction!

for Q

$$\hookrightarrow dE_y = \int dE \sin\theta = \frac{k}{R^2} \cdot dq \sin\theta = \frac{kQ}{\pi R^2} \int_0^{\pi} \sin\theta \, d\theta = \frac{kQ}{\pi R^2} \underbrace{\left(-\cos\pi + \cos 0\right)}_{2} = \frac{2kQ}{\pi R^2}$$

Same goes for $-Q$ $\rightarrow$ $E_{tot} = 2 \times \frac{2kQ}{\pi R^2} = \frac{4kQ}{\pi R^2}$

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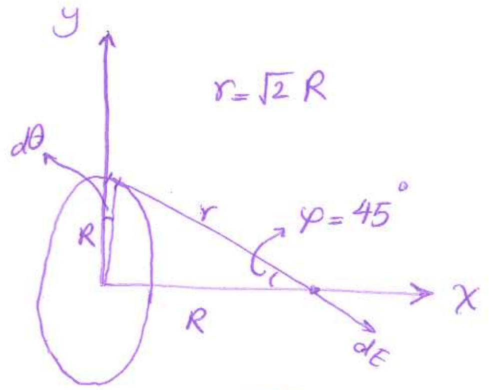
Q. An unknown point charge q resides at the center of a ring. The ring has radius $R = 1.0$cm and carries a uniformly distributed charge $Q = 1.0\mu$C. The electric field is measured to be zero at the point P on the ring axis where P is also at a distance R from the ring's center. Find the sign and magnitude of q.



- for E_y due to symmetry there will be NO field, since they will cancel eachother.

- for E_x:

$$dE_x = dE \cos 45 = k \frac{dq\sqrt{2}}{2r^2} = k \frac{\sqrt{2}Q}{4R^2}$$

if there is an unknown charge:

$$E_q = -E_Q \Rightarrow k\frac{q}{R^2} = \frac{-kQ}{R^2} \cdot \frac{\sqrt{2}}{4} \Rightarrow q = -\frac{\sqrt{2}Q}{4} = -\frac{\sqrt{2}}{4}\mu C$$

(E_q: field of unknown charge)