PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

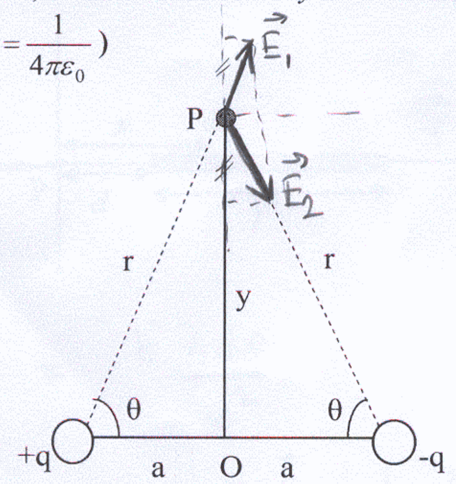
College of Sciences

Section 1 **Quiz 1** **25 February 2010**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

An electric dipole consists of a positive charge q and a negative charge $-q$ separated by a distance $2a$ as in the figure. Find the electric field E due to these charges along the y-axis at the point P, which is a distance y from the origin. Express your answer in terms of k, q, a, y. ($k = \frac{1}{4\pi\varepsilon_0}$)



$$E_1 = E_2 = k\frac{q}{r^2} = k\frac{q}{y^2+a^2}$$

$$E = 2E_1\cos\theta = 2k\frac{q}{y^2+a^2}\cdot\frac{a}{\sqrt{y^2+a^2}} = \frac{2kqa}{(y^2+a^2)^{3/2}}$$

$y \gg a$; $E = k\frac{2qa}{y^3}$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2010

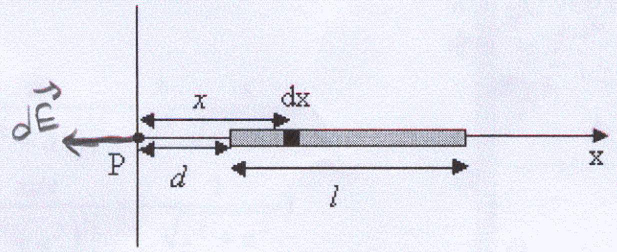
College of Sciences

Section 2 Quiz 1 25 February 2010

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: Student ID: Signature:

A rod of length l has a uniform positive charge per unit length λ and a total charge Q. Calculate the electric field at a point P along the axis of the rod, a distance d from one end. Express your answer in terms of k, Q, d, l. ($k = \frac{1}{4\pi\varepsilon_0}$)



$$dE = k\frac{dq}{x^2} = \frac{k\lambda dx}{x^2}$$

$$E = k\lambda\int\frac{dx}{x^2} = k\lambda\left[-\frac{1}{x}\Big|_d^{d+l}\right]$$

$$E = k\lambda\left[\frac{1}{d} - \frac{1}{d+l}\right] = \frac{k\lambda l}{d(d+l)} = \frac{kQ}{d(d+l)}$$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

College of Sciences

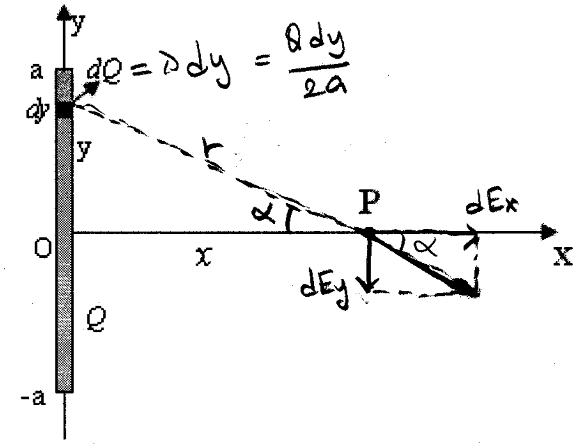
Section 3 **Quiz 1** **25 February 2010**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Positive electric charge Q is distributed uniformly along a line with length $2a$, lying along the y-axis between $y=-a$ and $y=+a$. Find the magnitude and the direction of the electric field at a point P on the x-axis at a distance x from the origin. Express your answer in terms of k, Q, x, a. ($k = \frac{1}{4\pi\varepsilon_0}$)

Integrals: $\int \frac{dx}{(x^2+a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2+a^2}}$, $\int \frac{x\,dx}{(x^2+a^2)^{3/2}} = -\frac{1}{\sqrt{x^2+a^2}}$)



$$dE_x = dE\cos\alpha ,$$

$$dE_y = -dE\sin\alpha ,$$

$$dE = k\frac{dQ}{r^2} = kQ\frac{dy}{2a(x^2+y^2)}.$$

$$\sin\alpha = \frac{y}{\sqrt{x^2+y^2}} , \quad \cos\alpha = \frac{x}{\sqrt{x^2+y^2}}$$

$$\Rightarrow \quad dE_x = kQ\frac{x\,dy}{2a(x^2+y^2)^{3/2}}$$

$$dE_y = -kQ\frac{y\,dy}{2a(x^2+y^2)^{3/2}}$$

$$E_x = \frac{kQx}{2a}\int_{-a}^{a}\frac{dy}{(x^2+y^2)^{3/2}} = kQ\frac{1}{x\sqrt{x^2+a^2}}$$

$$E_y = -\frac{kQ}{2a}\int_{-a}^{a}\frac{y\,dy}{(x^2+y^2)^{3/2}} = 0$$

$$\vec{E} = k\frac{Q}{x\sqrt{x^2+a^2}}\,\hat{\imath} , \quad |\vec{E}| = \frac{kQ}{x\sqrt{x^2+a^2}}$$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2010

College of Sciences

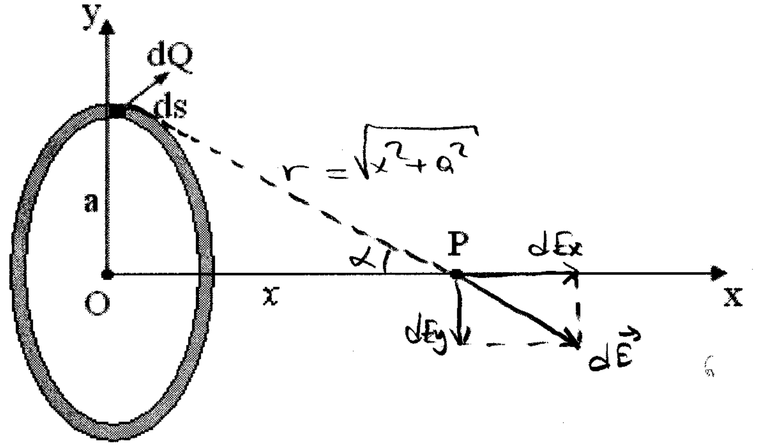
Section 4 Quiz 1 25 February 2010

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A ring shaped conductor with radius a carries a total charge Q uniformly distributed around it. Find the magnitude and the direction of electric field at a point P that lies on the axis of the ring at a distance x from its center.

Express your answer in terms of k, Q, x, a. ($k = \frac{1}{4\pi\varepsilon_0}$)



$$dE = k\frac{dQ}{x^2+a^2}$$

By symmetry; $dE_y = 0$

$$dE_x = dE\cos\alpha \quad , \quad \cos\alpha = \frac{x}{\sqrt{x^2+a^2}}$$

$$dE_x = k\frac{dQ}{x^2+a^2}\cdot\frac{x}{\sqrt{x^2+a^2}} = k\frac{x\,dQ}{(x^2+a^2)^{3/2}}$$

$$E_x = \int k\frac{x\,dQ}{(x^2+a^2)^{3/2}} = k\frac{xQ}{(x^2+a^2)^{3/2}}$$

$$\vec{E} = E_x\hat{i} = k\frac{xQ}{(x^2+a^2)^{3/2}}\hat{i}$$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2010

College of Sciences

Section 5 Quiz 1 25 February 2010

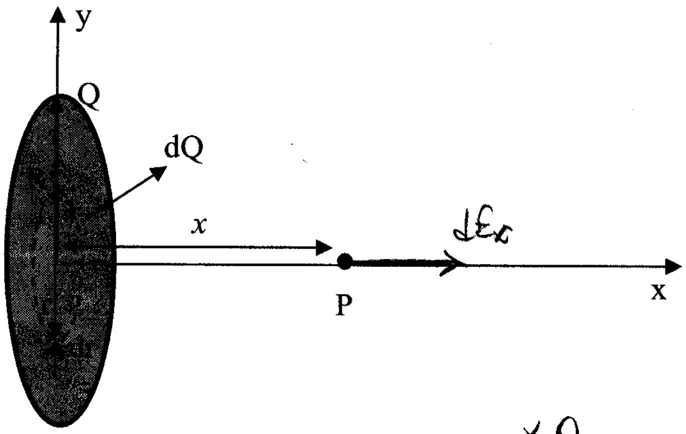
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: Student ID: Signature:

Find the electric field caused by a disk of radius R with a uniform surface charge density σ (charge per unit area), at a point along the axis of the disk a distance x from its center. (Assume that x is positive) Express your answer in terms of σ, ε_0, x, R.

Integrals: $\int \frac{dx}{(x^2+a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2+a^2}}$, $\int \frac{xdx}{(x^2+a^2)^{3/2}} = -\frac{1}{\sqrt{x^2+a^2}}$)

(Hint: Electric field of a ring shaped conductor with total charge Q and radius a at a distance x from its center is $E_x = \frac{Q}{4\pi\varepsilon_0}\frac{x}{(x^2+a^2)^{3/2}}$)



for ring with radius r ⇒ $E_x = \frac{xQ}{4\pi\varepsilon_0 (x^2+r^2)^{3/2}}$ ⇒

For disk; $dA = 2\pi r dr$, $dQ = \sigma dA$ ⇒ $dQ = 2\pi\sigma r dr$

$dE_x = \frac{1}{4\pi\varepsilon_0}\frac{x\, 2\pi\sigma r dr}{(x^2+r^2)^{3/2}}$, $dE_y = 0$, $dE_z = 0$ (By symmetry)

⇒ $E_x = \int_0^R \frac{1}{4\pi\varepsilon_0}\frac{(2\pi\sigma r dr)x}{(x^2+r^2)^{3/2}}$

$E_x = \frac{\sigma x}{2\varepsilon_0}\left[-\frac{1}{\sqrt{x^2+R^2}} + \frac{1}{x}\right] = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{1}{\sqrt{\frac{R^2}{x^2}+1}}\right]$

$\vec{E} = E_x\hat{i} = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{1}{\sqrt{\frac{R^2}{x^2}+1}}\right]\hat{i}$, when $R \gg x$; $E_x = \frac{\sigma}{2\varepsilon_0}$