PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semestre 2012

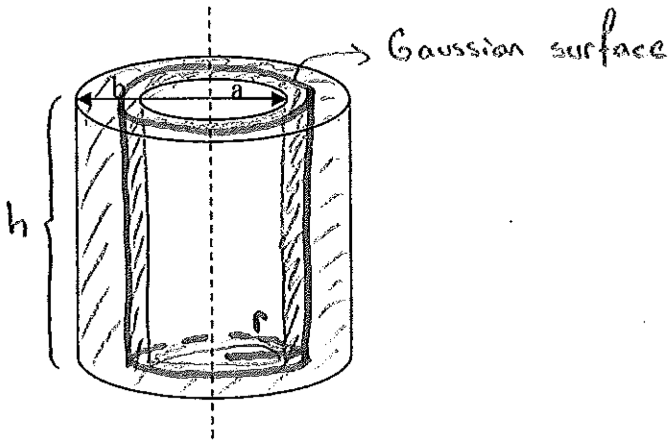
College of Arts and Sciences

Section 1 Quiz 2 23 February 2012

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

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

A very long hollow cylinder with inner radius a and outer radius b has positive charge uniformly distributed throughout it, with charge per unit volume ρ. Derive the expression for the electric field inside the volume at a distance r from the axis of the cylinder ($a < r < b$).



Gauss' Law:

$$\underbrace{\oint \vec{E} \cdot d\vec{a}}_{\Phi_{total}} = \frac{Q_{enc}}{\varepsilon_0}$$

$$\Phi_{total} = \underbrace{\cancel{\Phi_{top}}}_{0} + \underbrace{\cancel{\Phi_{bot}}}_{0} + \underbrace{\Phi_{side}}_{E \cdot 2\pi r \cdot h}$$

$$\boxed{\Phi_{total} = E 2\pi r h}$$

$$Q_{enc} = \rho \cdot V_{enc}$$

(Volume inside the Gaussian surface − Volume of cavity of radius a)

$$V_{enc} = \pi r^2 h - \pi a^2 h = \pi h (r^2 - a^2)$$

$$\boxed{Q_{enc} = \rho \pi h (r^2 - a^2)}$$

$$E \cdot 2\cancel{\pi} r \cancel{h} = \frac{\rho \cancel{\pi} \cancel{h} (r^2 - a^2)}{\varepsilon_0} \quad \text{(Gauss' Law)}$$

$$\boxed{\vec{E} = \frac{\rho (r^2 - a^2)}{2\varepsilon_0 r} \hat{r}}$$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semestre 2012**

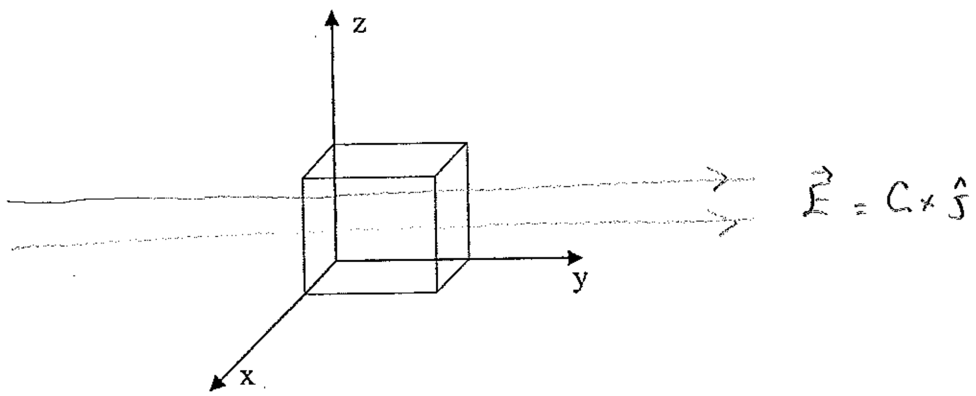
College of Arts and Sciences

Section 2 **Quiz 2** **23 February 2012**

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

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

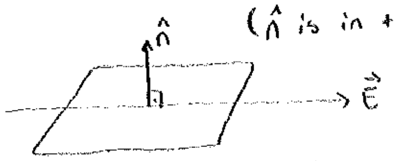
A cube has sides of length L. It is placed with one corner at the origin as shown below. The electric field is non-uniform and given by $\vec{E} = Cx\hat{j}$, where C is a positive constant, and x represents the x-coordinate. Find the total outward electric flux through the surface of the cube as a function of L, and C. Based on the Gauss' Law comment on whether total charge enclosed by the cube is zero or not.



$$\Phi_{total} = \Phi_{up} + \Phi_{bottom} + \Phi_{front} + \Phi_{back} + \Phi_{left} + \Phi_{right}$$

($\hat{n}$ is in +z-direction)

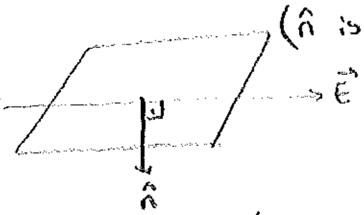
Φ_{up} :



$$\Phi_{up} = E.A.\cos\theta = CxL^2.\cancel{\cos 90}_{\,0} = 0$$

($\hat{n}$ is in -z direction)

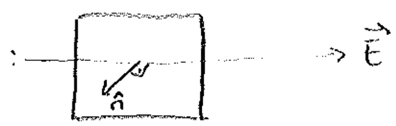
Φ_{bottom}:



$$\Phi_{bottom} = E.A.\cos\theta = CxL^2\,\cancel{\cos 90}_{\,0} = 0$$

($\hat{n}$ is in +x direction)

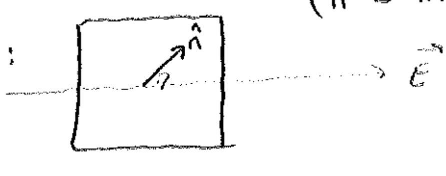
Φ_{front} :



$$\Phi_{front} = E.A.\cos\theta = CxL^2\,\cancel{\cos 90}_{\,0} = 0$$

($\hat{n}$ is in -x direction)

Φ_{back} :



$$\Phi_{back} = E.A.\cos\theta = CxL^2\,\cancel{\cos 90}_{\,0} = 0$$

continues on the back

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semestre 2012**

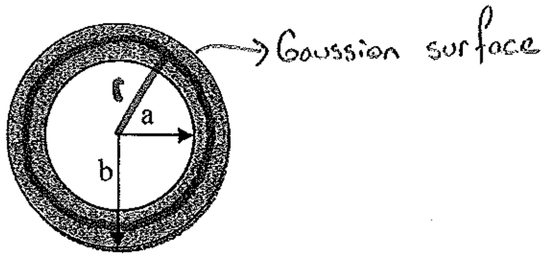
College of Arts and Sciences

Section 3 **Quiz 2** **23 February 2012**

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

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

An insulating spherical shell with inner radius a and outer radius b has positive charge uniformly distributed throughout it, with charge per unit volume ρ. Derive the expression for the electric field inside the volume at a distance r from the center of the sphere $(a < r < b)$.



Gauss' Law:

$$\underbrace{\oint \vec{E} \cdot d\vec{a}}_{\Phi_{total}} = \frac{Q_{enc}}{\varepsilon_0}$$

$$\boxed{\Phi_{total} = E \cdot 4\pi r^2}$$

$Q_{enc} = \rho \cdot V_{enc}$

$\downarrow$

(Volume inside the Gaussion surface − Volume of the cavity of radius a)

$$V_{enc} = \frac{4}{3}\pi r^3 - \frac{4}{3}\pi a^3$$

$$\boxed{Q_{enc} = \frac{4}{3}\pi \rho (r^3 - a^3)}$$

Gauss' Law:

$$E \cancel{4\pi} r^2 = \frac{\frac{4}{3}\cancel{\pi}\rho(r^3-a^3)}{\varepsilon_0}$$

$$\boxed{\vec{E} = \frac{\rho(r^3-a^3)}{3\varepsilon_0 r^2}\hat{r}}$$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semestre 2012

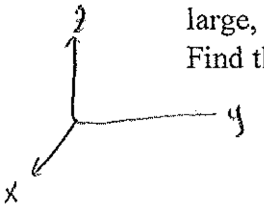
College of Arts and Sciences

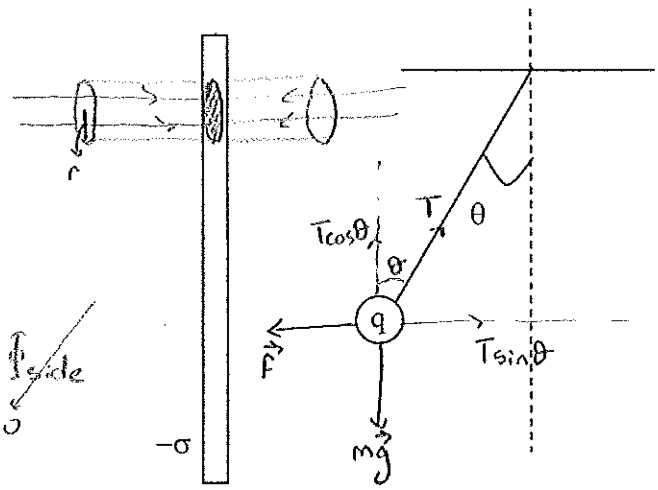
Section 4 Quiz 2 23 February 2012

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

Name: Student ID: Signature:

A small sphere with a mass m and carrying a cahrge q hangs from a thread near a very large, charged conducting sheet as shown below. The charge density on the sheet is $-\sigma$. Find the angle of the thread as a function of m, g, q, σ, and ε_0.





Gauss' Law:

$$\oint \vec{E}\cdot d\vec{a} = \frac{Q_{enc}}{\varepsilon_0}$$

$$\Phi_{total} = \underbrace{\Phi_{left}}_{E\pi r^2} + \underbrace{\Phi_{right}}_{E\pi r^2} + \underbrace{\cancel{\Phi_{side}}}_{0}$$

$$\boxed{\Phi_{total} = 2E\pi r^2}$$

$$\boxed{Q_{enc} = \sigma \pi r^2}$$

$$2E\cancel{\pi r^2} = \frac{\sigma \cancel{\pi r^2}}{\varepsilon_0}$$

$$\boxed{\vec{E} = \pm \frac{\sigma}{2\varepsilon_0}\hat{y}}$$

$$\vec{E} = \frac{\vec{F}}{q}$$

$$\vec{F} = \vec{E}\cdot q = \boxed{-\frac{\sigma}{2\varepsilon_0}\cdot q\hat{y} = \vec{F}}$$

$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

$$F = \frac{\sigma}{2\varepsilon_0} q = \cancel{T}\sin\theta$$

$$mg = \cancel{T}\cos\theta$$

$$\boxed{\tan\theta = \frac{\sigma q}{2\varepsilon_0 mg}}$$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semestre 2012

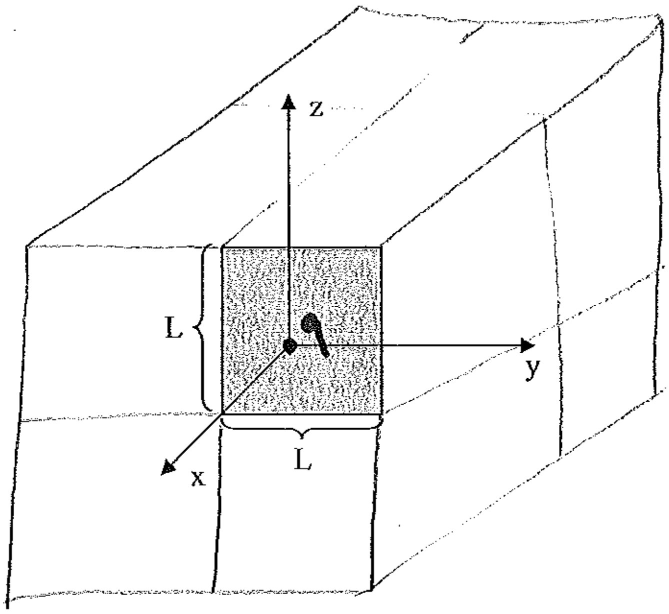
College of Arts and Sciences

Section 5 Quiz 2 23 February 2012

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

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

A flat, square surface with sides of length L (shown below) is described by the equations $x = L$, $0 \le y \le L$, and $0 \le z \le L$. Find the electric flux through the square due to a positive point charge q located at the origin as a function of q and ε_0. (Hint: Think of the square as part of a cube centered on the origin)



Consider the cube itself as a Gaussian surface.

Gauss' Law $\Phi_{total} = \dfrac{Q_{enc}}{\varepsilon_0}$

$$\Phi_{total} = \frac{q}{\varepsilon_0}$$

The cube consist of 24 $(L \times L)$-square, since the charged particle is at the center, every little square has the same flux, because their distance from the particle are the same.

$$\boxed{\Phi_{square} = \frac{q}{24\varepsilon_0}}$$