PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

College of Arts and Sciences

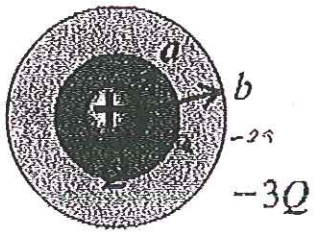
Section 1 **Quiz 2** **21 February 2013**

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

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

A conducting spherical shell with inner radius a and outer radius b contains a total charge $-3Q$. A positive point charge Q is located at the center of the spherical shell.

(a) Derive the expression for the electric field magnitude as a function of the distance r from the center for the regions $r < a$, $a < r < b$, and $r > b$.
(b) Graph the electric field magnitude as a function of r.
(c) What is the charge on the inner surface and on the outer surface of the conducting spherical shell?



a) $r < a \rightarrow \quad E \cdot (4\pi r^2) = \frac{Q}{\epsilon_0}$

$$E = \frac{Q}{4\pi\epsilon_0 r^2} \quad \text{(outward)}$$

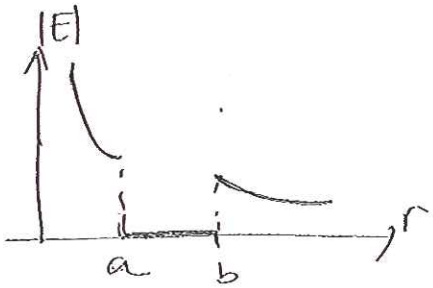
$a < r < b \rightarrow \quad E \cdot (4\pi r^2) = 0$

$$E = 0$$

$r > b \rightarrow \quad E \cdot (4\pi r^2) = -2Q/\epsilon_0$

$$E = -\frac{2Q}{4\pi\epsilon_0 r^2} \quad \text{(inward)}$$

b)



c) inner surface $\rightarrow -Q$
outer surface $\rightarrow -2Q$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

College of Arts and Sciences

Section 2 **Quiz 2** **21 February 2013**

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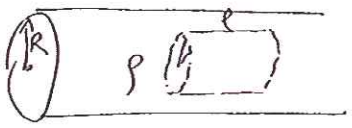
Quiz duration: 15 minutes

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

A very long, solid cylinder with radius R has positive charge uniformly distributed throughout it, with charge per unit volume ρ.

(a) Calculate the electric field in terms of the charge density ρ and the distance r from the axis of the cylinder for $r < R$ and $r > R$.
(b) Graph the electric-field magnitude as a function of r from $r = 0$ to $r = 3R$.



a) $r < R \rightarrow \oint E \cdot dA = Q_{enc}/\epsilon_0$

$Q_{enc} = \rho \cdot V_{enc.}$
$= \rho \cdot (\pi r^2 \ell)$

$E \cdot (2\pi r \ell) = \rho \cdot (\pi r^2 \ell)/\epsilon_0$

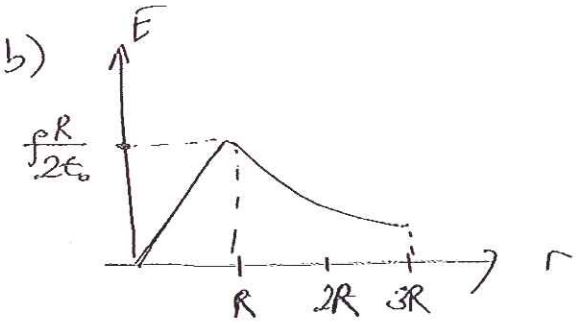
$E = \frac{\rho r}{2\epsilon_0}$ radially outward.

$r > R$ $\quad E \cdot (2\pi r \ell) = \rho \cdot \pi R^2 \ell/\epsilon_0$

$Q_{enc} = \rho \cdot V_{cyl.}$
$Q_{enc} = \rho \cdot (\pi R^2 \ell)$

$E = \frac{\rho R^2}{2 r \epsilon_0}$ radially outward

b)



PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

College of Arts and Sciences

Section 3 **Quiz 2** **21 February 2013**

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Quiz duration: 15 minutes

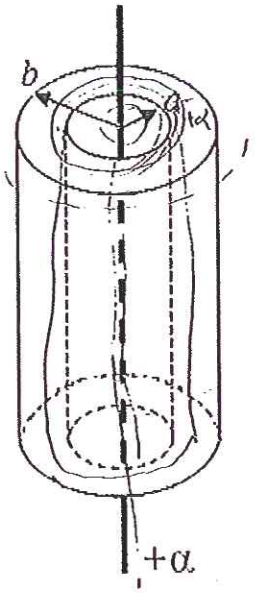
Name: **Student ID:** **Signature:**

A very long conducting tube (hollow cylinder) has inner radius *a* and outer radius *b*. It carries charge per unit length $+\alpha$, where α is the positive constant with units of C/m. A line of charge lies along the axis of the tube. The line of charge has charge per unit length $+\alpha$.

(a) Calculate the electric field in terms of α and the distance *r* from the axis of the tube for $r < a$, $a < r < b$ and $r > b$.

(b) Graph the electric field magnitude as a function of *r* in all the regions?

(c) What is the charge per unit length on (i) the inner surface of the tube and (ii) the outer surface of the tube? (Tube is the conducting hollow cylinder.)



a) $r < a$

$E(2\pi r\ell) = \alpha \cdot \ell / \epsilon_0$

$E = \frac{\alpha}{2\pi\epsilon_0 r}$ outward

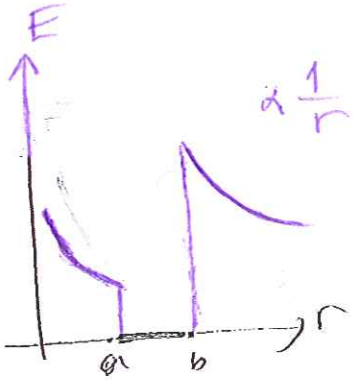
$a < r < b$

conductor $E = 0$

$r > b$ $E(2\pi r\ell) = \frac{\alpha L + \alpha L}{\epsilon_0}$

$E = \frac{\alpha}{\pi\epsilon_0 r}$

b)



c) inner surface → $-\alpha$

outer " → $+2\alpha$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

College of Arts and Sciences

Section 4 **Quiz 2** **21 February 2013**

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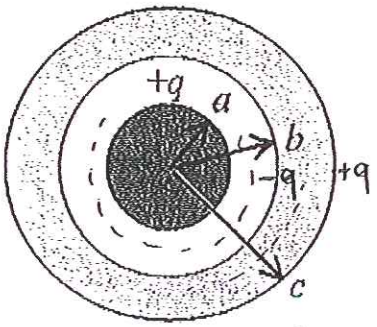
Quiz duration: 15 minutes

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

A solid conducting sphere carrying charge q has radius a. It is inside a concentric hollow conducting sphere with inner radius b and outer radius c. The hollow sphere has no net charge.

(a) Derive expressions for the electric field magnitude in terms of the distance r from the center fort he regions $r < a$, $a < r < b$, $b < r < c$, and $r > c$.
(b) Graph the magnitude of the electric field as a function of r from $r = 0$ to $r = 2c$.
(c) What is the charge on the inner surface and on the outer surface of the hollow sphere?



(c)

a) $r<a$ $E=0$ (conducting sphere)

$a<r<b$ $E\cdot(4\pi r^2) = +q/\epsilon_0$ ($+q$ inside Gaussian surface.)

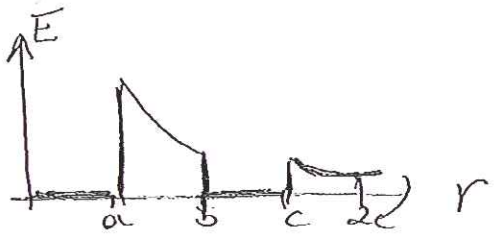
$$E = \frac{q}{4\pi\epsilon_0 r^2}$$

$b<r<c$

$E=0$ inside the (conductor)

$r>c$ $E(4\pi r^2) = q/\epsilon_0$, $E = q/4\pi\epsilon_0 r^2$

b)



PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2013

College of Arts and Sciences

Section 5 Quiz 2 21 February 2013

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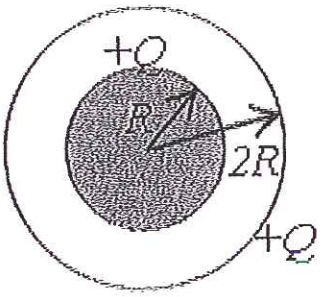
Quiz duration: 15 minutes

Name: Student ID: Signature:

A solid conducting sphere with radius R that carries positive charge Q is concentric with a very thin insulating shell of radius $2R$ that also carries charge Q.The charge Q is distributed uniformly over the insulating shell.

(a) Find the electric field (magnitude and direction) in each of the regions $0 < r < R$, $R < r < 2R$, and $r > 2R$.
(b) Graph the electric field magnitude as a function of r.



a) $0 < r < R$ $\quad E = 0$

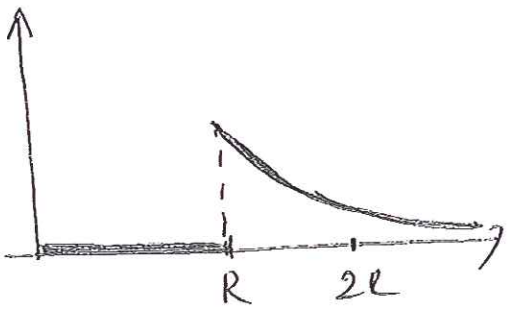
$R < r < 2R$ $\quad E \cdot (4\pi r^2) = \frac{Q}{\varepsilon_0}$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

$r > 2R$

$$E = \frac{2Q}{4\pi\varepsilon_0 r^2}$$

b)



PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2013**

College of Arts and Sciences

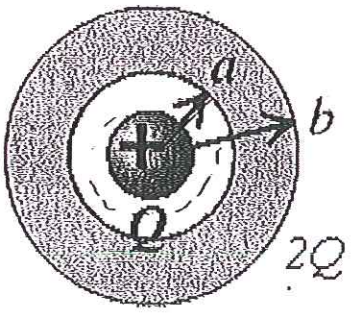
Section 6 **Quiz 2** **21 February 2013**

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

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

A conducting spherical shell with inner radius a and outer radius b contains a total charge $2Q$ .A positive point charge Q is located at the center of the spherical shell.

(a) Derive the expression for the electric field magnitude as a function of the distance r from the center for the regions $r < a$, $a < r < b$, and $r > b$.
(b) Graph the electric field magnitude as a function of r.
(c) What is the charge on the inner surface and on the outer surface of the conducting spherical shell?

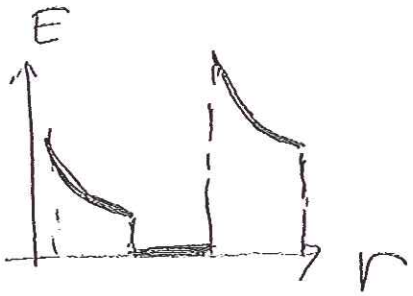


a) $r<a \rightarrow$ $E \cdot (4\pi r^2) = q/\epsilon_0$

$$E = \frac{q}{4\pi\epsilon_0 r^2}$$

$a<r<b$ $E=0$

$r>b$ $E = \frac{3Q}{4\pi\epsilon_0 r^2}$



c) $-Q$ on the inner surface

$+3Q$ on the outer surface.