PHYS 102:General Physics2 **KOÇ UNIVERSITY** **Spring Semester 2017**

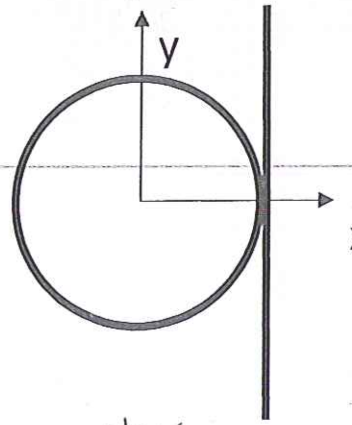
College of Sciences

Section 1 **Quiz 2** **February 20-21, 2017**

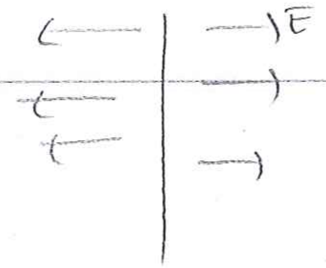
Closed book. Duration: 10 minutes

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

An infinite plane that is perpendicular to the *x*-axis and a spherical shell of radius a centered at the origin are tangent to each other. They both have uniform surface charge density σ (see figure). Find all three components of the electric field for points on the *y*-axis.

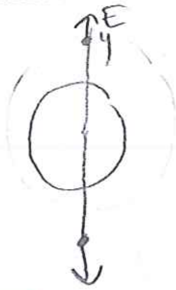


for inf. plane



$E_p = \frac{\sigma}{2\epsilon_0}(-\hat{x})$

for sphere



inside sphere shell $\vec{E} = 0$ (no charge)

$y > a$ $\quad E \cdot 4\pi y^2 = \frac{q_{enc}}{\epsilon_0} = \frac{\sigma \cdot 4\pi a^2}{\epsilon_0}$

$\Rightarrow \vec{E} = \frac{\sigma a^2}{\epsilon_0 y^2}\hat{y}$

$y < -a$ $\quad \vec{E} = \frac{\sigma a^2}{\epsilon_0 y^2}(-\hat{y})$

Sum all

$E = \frac{\sigma}{2\epsilon_0}(-\hat{x}) \quad |x| < a$

$E = -\frac{\sigma}{2\epsilon_0}\hat{x} + \frac{\sigma a^2}{\epsilon_0 y^2}\hat{y} \quad x > a$

$E = -\frac{\sigma}{2\epsilon_0}\hat{x} - \frac{\sigma a^2}{\epsilon_0 y^2} \quad x < -a$

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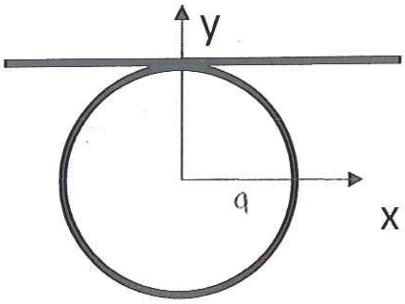
Section 4 **Quiz 2 February 20-21, 2017**

Closed book. Duration: 10 minutes

Name: Student ID: Signature:

An infinite plane that is perpendicular to the y-axis and a spherical shell of radius a centered at the origin are tangent to each other. They both have uniform surface charge density σ (see figure). Find all three components of the electric field for points on the x-axis.



for inf. plane

$\vec{E}_p = \frac{\sigma}{2\epsilon_0}(-\hat{y})$ on x axis!

for spherical shell

inside shell $-a < x < a$, $\vec{E}_{in} = 0$ (no charge inside)

$x > a \Rightarrow E \cdot 4\pi x^2 = \frac{q_{in}}{\epsilon_0} = \frac{\sigma \cdot 4\pi a^2}{\epsilon_0}$

$\Rightarrow \vec{E} = \frac{\sigma a^2}{\epsilon_0 x^2}\hat{x}$

$x < -a \Rightarrow E = \frac{\sigma a^2}{\epsilon_0 x^2}(-\hat{x})$

Sum all E

$\vec{E} = -\frac{\sigma}{2\epsilon_0}\hat{y}$ $|x| < a$ inside shell

$\vec{E} = -\frac{\sigma}{2\epsilon_0}\hat{y} + \frac{\sigma a^2}{\epsilon_0 x^2}\hat{x}$ $x > a$

$\vec{E} = \frac{-\sigma}{2\epsilon_0}y - \frac{\sigma a^2}{\epsilon_0 x^2}\hat{x}$ $x < -a$

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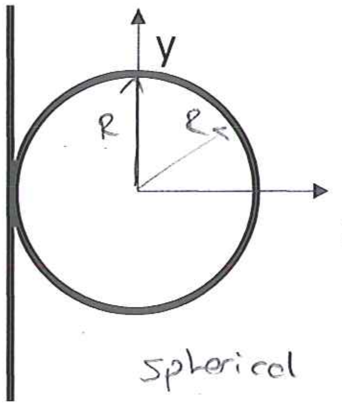
Section 2 **Quiz 2 February 20-21, 2017**

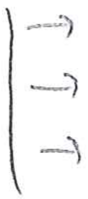
Closed book. Duration: 10 minutes

Name: Student ID: Signature:

An infinite plane that is perpendicular to the x-axis and a spherical shell of radius ~~a~~ R centered at the origin are tangent to each other. They both have uniform surface charge density σ (see figure). Find all three components of the electric field for points on the y-axis.



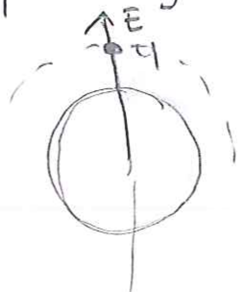
for infinite plane



$\vec{E}_p = \dfrac{\sigma}{2\epsilon_0}\hat{x}$ (for every point in ~~ϕ~~ y axis)

spherical shell

inside shell $-R < y < R$ no charge $\Rightarrow E_{in} = 0$



$E\,dA = q_{en}/\epsilon_0$

$y > R$ $\quad E \cdot 4\pi y^2 = \dfrac{\sigma \cdot 4\pi R^2}{\epsilon_0} \Rightarrow E = \dfrac{\sigma \cdot R^2}{\epsilon_0 y^2}\hat{y}$

(Note this is for a point choosen on +y axis)

$y < -R$ $\quad E \cdot 4\pi y^2 = \dfrac{\sigma\, 4\pi R^2}{\epsilon_0} \Rightarrow E = \dfrac{\sigma R^2}{\epsilon_0 y^2}(-\hat{y})$

so sum up

$$E = \frac{\sigma}{2\epsilon_0}\hat{x} \qquad |y| < |R| \quad \text{inside shell}$$

$$= \frac{\sigma}{2\epsilon_0}\hat{x} + \frac{\sigma R^2}{\epsilon_0 y^2}\hat{y} \qquad y > R$$

$$= \frac{\sigma}{2\epsilon_0}\hat{x} - \frac{\sigma R^2}{\epsilon_0 y^2}\hat{y} \qquad y < -R$$

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Section 3 **Quiz 2** **February 20-21, 2017**

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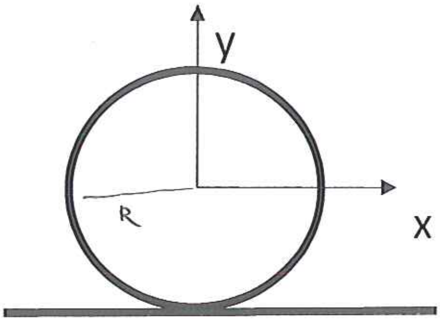
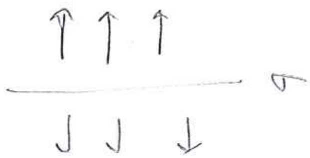
Name: **Student ID:** **Signature:**

An infinite plane that is perpendicular to the y-axis and a spherical shell of radius R centered at the origin are tangent to each other. They both have uniform surface charge density σ (see figure). Find all three components of the electric field for points on the x-axis.

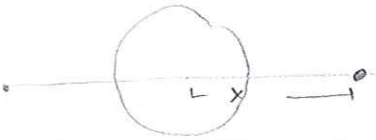


infin. plane $E_p = \frac{\sigma}{2\epsilon_0}\hat{y}$ on x axis



for spherical shell

inside $-R < x < R$, $E_{in} = 0$ (no charge inside)



for any point $x > R$ on x

$$E \cdot 4\pi x^2 = \frac{q_{enc}}{\epsilon_0} = \frac{\sigma \cdot 4\pi R^2}{\epsilon_0} \Rightarrow \vec{E} = \frac{\sigma R^2}{\epsilon_0 x^2}\hat{x}$$

when $x < -R$ on neg. x axis

$$\vec{E} = \frac{\sigma R^2}{\epsilon_0 x^2}(-\hat{x})$$

Sum all fields

$$\vec{E} = \frac{\sigma}{2\epsilon_0}\hat{y} \quad |x| < R \text{ (inside shell)}$$

$$E = \frac{\sigma}{2\epsilon_0}\hat{y} + \frac{\sigma R^2}{\epsilon_0 x^2}\hat{x} \quad x > R$$

$$E = \frac{\sigma}{2\epsilon_0}\hat{y} - \frac{\sigma R^2}{\epsilon_0 x^2}\hat{x} \quad x < -R$$