PHYS 102: General Physics 2 | KOÇ UNIVERSITY | Spring Semester 2017

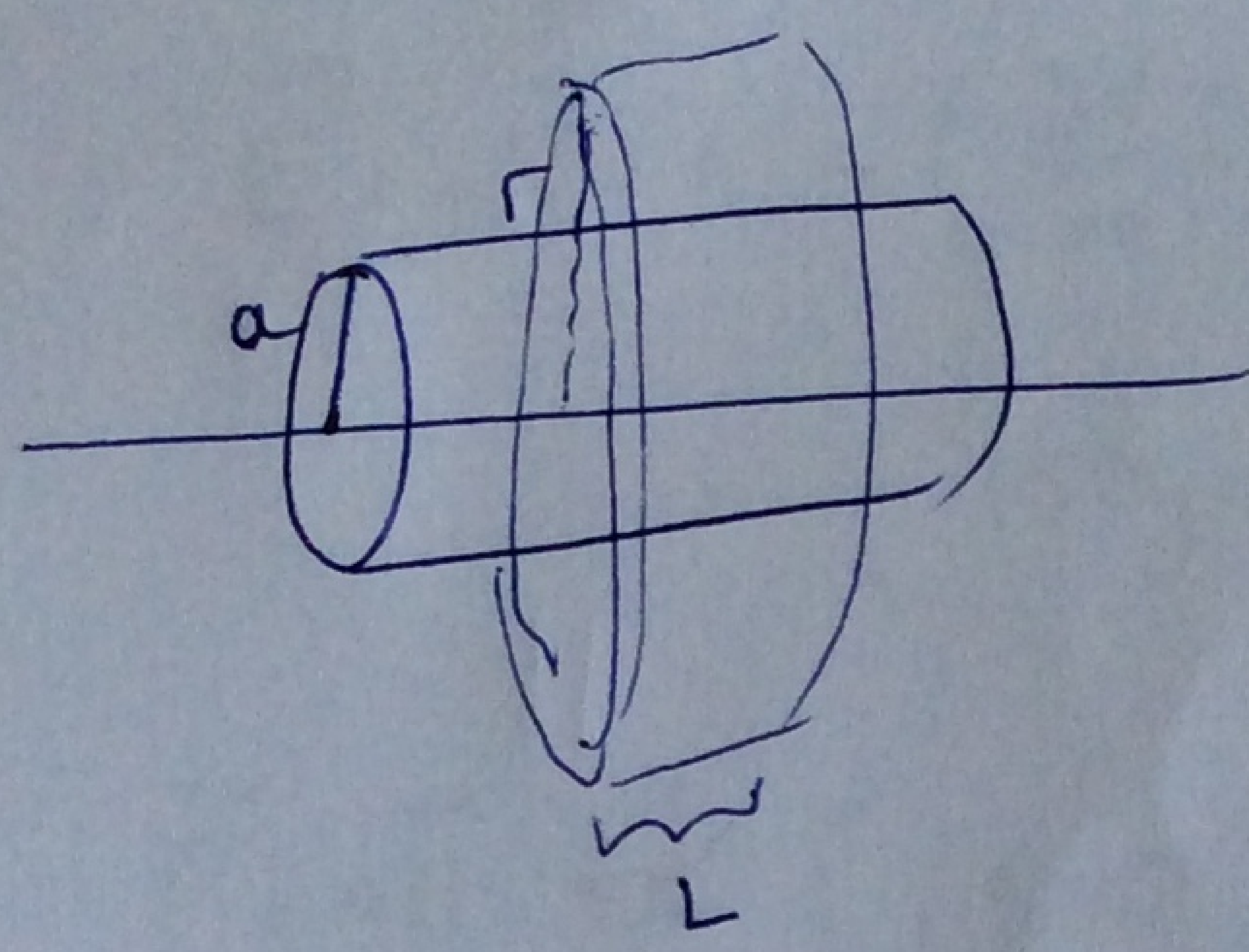
College of Sciences

Section 1 | Quiz 3 | 27 February 2017

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

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

Consider a long, conducting cylinder with radius a, and charge density λ (units: C/m). Find out the electric potential $V(r)$, outside the cylinder ($r>a$). Take $V=0$ at $r=a$.



$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

$$E(2\pi r L) = \frac{\lambda L}{\epsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r}$$

$$V_r - V_a = -\int_a^r \vec{E}\cdot d\vec{l}$$

$$= -\int_a^r E\,dr' = -\int_a^r \frac{\lambda}{2\pi\epsilon_0 r'}dr'$$

$$= \frac{\lambda}{2\pi\epsilon_0}\ln\left(\frac{a}{r}\right)$$

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Section 2 **Quiz 3** **27 February 2017**

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Quiz duration: 10 minutes

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

In an electric potential field given by $V(x,y) = 50xy-10x$, calculate the electrostatic force that would act on a charge of $q=+2C$ at location $(x, y) = (1\ m, 2m)$.
$(k = 9\times 10^{-9} N\cdot m^2/C^2)$

$$\vec{E} = -\vec{\nabla}V = -\left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j}\right)$$

$$= -\left((50y-10)\hat{i} + 50x\hat{j}\right)$$

$$\vec{F} = q\vec{E} = -2\cdot\left[(50\cdot 2-10)\hat{i} + 50\hat{j}\right]$$

$$\vec{F} = (-180\hat{i} - 100\hat{j})\ N.$$

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Section 3 **Quiz 3** **27 February 2017**

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Quiz duration: 10 minutes

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

(a) What is the net charge on a conducting sphere of radius R = 30 cm if the potential of the sphere is 300 000 V relative to 0 potential at infinity?
(b) What is the potential at the center of the sphere? ($k = 9\times10^{-9}\ N\cdot m^2/C^2$)

a) $V_R = 300{,}000\,V$

$V_\infty = 0\ V$

$k = \frac{1}{4\pi\epsilon_0}$

$V_R = -\int_\infty^R \vec{E}\cdot d\vec{l}$

$\vec{E} = \frac{Q}{4\pi\epsilon_0 r^2}\hat{r}$

$\vec{E}\cdot d\vec{l} = E\,dr$

$= -\int_\infty^R E\,dr$

$= \frac{Q}{4\pi\epsilon_0 R}$

$300000\,V = \frac{(9\times10^{-9}\frac{Nm^2}{C^2})Q}{(0{,}3\ m)} \Rightarrow Q = 10^{13}\ C.$

b) Since the electric field inside a conductor is zero; the potential inside and on the surface is the same.

$V(r=0) = V(r=R) = 300000\ V.$

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Section 4 **Quiz 3** **27 February 2017**

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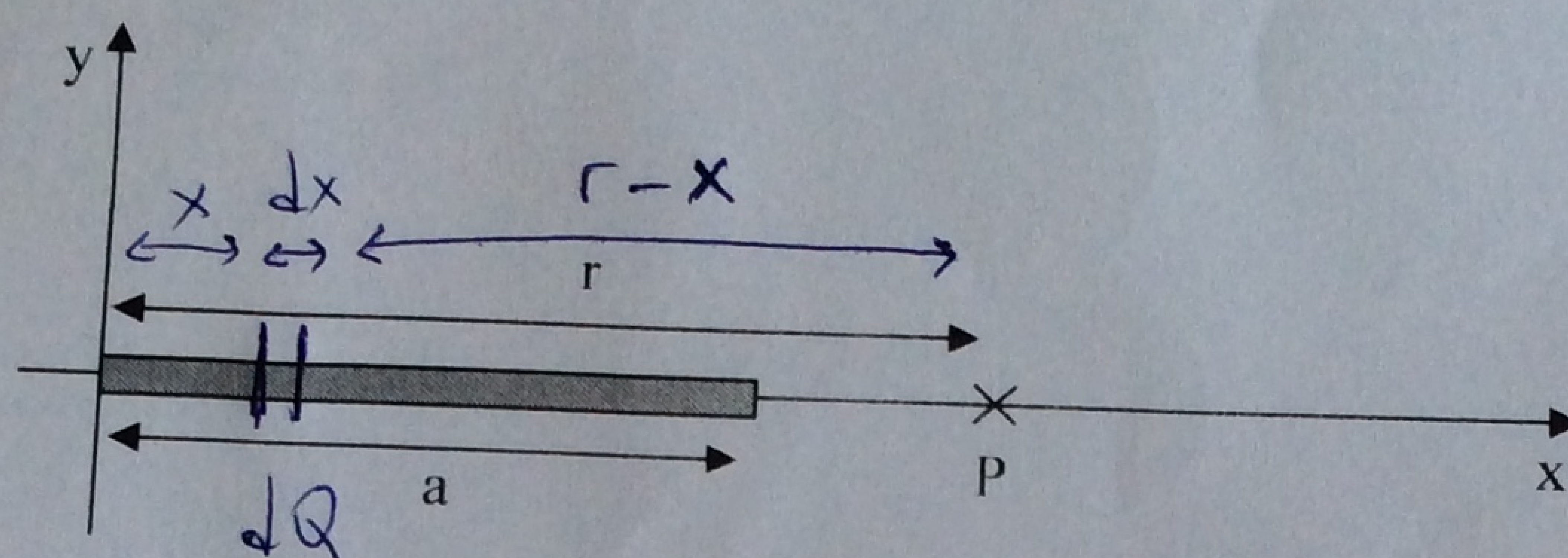
Quiz duration: 10 minutes

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

Positive charge Q is distributed uniformly along the x-axis from $x=0$ to $x=a$. Calculate the electric potential at the point P located on the positive x-axis at $x=r$, where $r>a$. Consider the electric potential to be zero at infinity.



$$dV = \frac{1}{4\pi\epsilon_0}\frac{dQ}{r'} \qquad dQ = \frac{Q}{a}dx$$

$$V = \int_0^a \frac{1}{4\pi\epsilon_0}\frac{Q}{a}\frac{dx}{(r-x)} \qquad r-x = u, \quad -dx = du$$

$$= -\int \frac{1}{4\pi\epsilon_0}\frac{Q}{a}\frac{du}{u}$$

$$= -\frac{1}{4\pi\epsilon_0}\frac{Q}{a}\ln u = -\frac{Q}{4\pi\epsilon_0 a}\ln(r-x)\Big|_0^a = \frac{1}{4\pi\epsilon_0}\frac{Q}{a}\ln\left(\frac{r}{r-a}\right)$$