PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semestre 2012

College of Arts and Sciences

Section 3 Quiz 11 03 May 2012

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

Name: Student ID: Signature:

A long, thin solenoid has 400 turns per meter and radius 1.10 cm. The current in the solenoid is increasing at a uniform rate *di/dt* . The induced electric field at a point near the center of the solenoid and 3.50 cm (mm) from its axis is 8.00×10^{-6} V/m. Calculate *di/dt*.

$n = 400 \ \frac{turns}{m}$

$a = 1.1$ cm

$\frac{di}{dt} > 0$

$E(r = 0.35 \text{ cm}) = 8 \times 10^{-6} \ \frac{V}{m}$

$\frac{di}{dt} = ?$

$$\begin{cases} \mathcal{E} = \Delta V = \oint \vec{E} \cdot d\vec{l} \\ \mathcal{E} = \frac{-d\phi}{dt} \end{cases}$$

$$\Rightarrow \left| \oint \vec{E} \cdot d\vec{l} \right| = \left| -\frac{d\phi}{dt} \right| \quad (1)$$

$$\begin{cases} B = \mu_0 n i \\ \phi_B = BA = \mu_0 n i A \end{cases}$$

$$\overset{(1)}{\Rightarrow} \quad E(2\pi r) = \frac{d\phi}{dt} = \frac{d}{dt}(\mu_0 n i A)$$

$$= \mu_0 n A \frac{di}{dt}$$

$$\Rightarrow \quad \frac{di}{dt} = \frac{E(2\pi r)}{\mu_0 n A} = \frac{8 \times 10^{-6} \times 2\pi \times (0.35 \times 10^{-2})}{4\pi \times 10^{-7} \times 400 \times \pi \times (1.1 \times 10^{-2})^2}$$

$$= \frac{8 \times 0.35 \times 10^{-8}}{2\pi \times 400 \times 1.21 \times 10^{-11}}$$

$$\Rightarrow \boxed{\frac{di}{dt} = 0.92 \ \frac{A}{s}}$$

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Section 5 Quiz 11 03 May 2012

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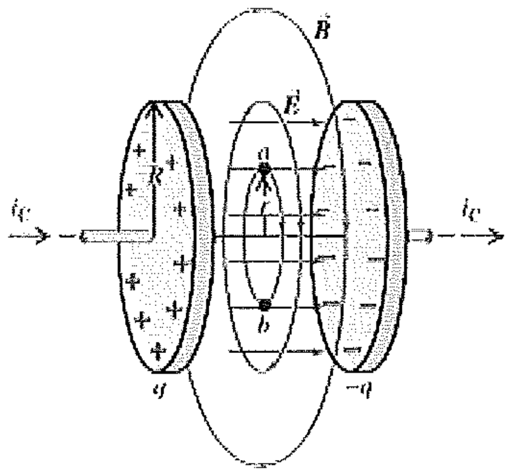
Quiz duration: 15 minutes

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

Consider an air-filled parallel plate capacitor having disk shaped plates with radius 4 cm as shown in the figure below. At a particular instant the conduction current flowing into the positive plate is 0.28 A. At that instant, what is the displacement current density j_D in the air space between the plates.



$R = 4$ cm

$i_c(t) = 0.28$ A

$j_D = ?$

$i_D = i_c \Rightarrow j_D = \frac{i_D}{A} = \frac{i_c}{A} = \frac{i_c}{\pi R^2} = \frac{0.28}{3.14 \times (4 \times 10^{-2})^2}$

$\Rightarrow j_D = 55.7 \frac{A}{m^2}$

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Section 2 | Quiz 11 | 03 May 2012

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

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

The electric flux as a function of time through a certain area of a dielectric is $9 \times 10^3 t^4$. The displacement current through that area is $12 \times 10^{-12} A$ at $t = 30 \times 10^{-3} s$. Calculate the dielectric constant for the dielectric.

$$\phi_E(t) = 9 \times 10^3 \, t^4$$

$$\begin{cases} i_D(t) = 12 \times 10^{-12} \, A \\ t = 30 \times 10^{-3} \, s \end{cases}$$

$$\varepsilon = ?$$

$$\phi_E(t) = A E(t) \Rightarrow E(t) = \frac{\phi_E(t)}{A} = \frac{9 \times 10^3 \, t^4}{A} \quad (1)$$

$$J_D(t) = \varepsilon \frac{dE}{dt} \Rightarrow \varepsilon = \frac{J_D(t)}{\frac{dE}{dt}}$$

$$\Rightarrow \varepsilon = \frac{\frac{i_D(t)}{A}}{\frac{dE}{dt}} \quad (2)$$

$$(1) \Rightarrow \frac{dE}{dt} = \frac{36}{A} \times 10^3 \, t^3 \xrightarrow{t = 30 \times 10^{-3} s} \frac{dE}{dt} = \frac{36}{A} \times 10^3 \times 27 \times 10^{-6}$$

$$\Rightarrow \frac{dE}{dt} = \frac{972}{A} \times 10^{-3} \quad (3)$$

$$(2) \& (3) \Rightarrow \varepsilon = \frac{\frac{i_D}{A}}{\frac{1}{A} 972 \times 10^{-3}} = \frac{i_D}{972 \times 10^{-3}} = \frac{12 \times 10^{-12}}{972 \times 10^{-3}}$$

$$\Rightarrow \varepsilon = 1.23 \times 10^{-11} \, \frac{N \cdot m^2}{C^2} \Rightarrow K = \frac{\varepsilon}{\varepsilon_0} \simeq 1.39$$

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Section 4 Quiz 11 03 May 2012

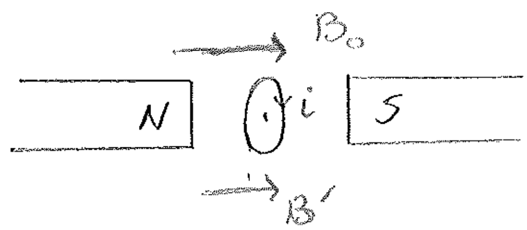
Closed book. No calculators are to be used for this quiz.
Quiz duration: 15 minutes

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

A metal ring 4.50 cm in diameter is placed between the north and south poles of large magnets with the plane of its area perpendicular to the magnetic field. These magnets produce an initial uniform field of 1.12 T between them but are gradually pulled apart, causing this field to remain uniform but decrease steadily at 0.250T/s.

(a) What is the magnitude of the electric field induced in the ring?
(b) In which direction (clockwise or counterclockwise) does the current flow as viewed by someone on the south pole of the magnet?

$d = 4.5$ cm $\Rightarrow R = \frac{d}{2} = 2.25$ cm



$\theta = 0$

$B_0 = 1.12$ T

$\frac{dB}{dt} = -0.25 \ \frac{T}{s} < 0$

ⓐ $E = ?$ $\quad \oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$

$\Rightarrow E(2\pi R) = -\frac{d}{dt}(BA) = -A\frac{dB}{dt}$, $A = \pi R^2$

$\Rightarrow E(2\pi R) = -\pi R^2 \frac{dB}{dt}$

$\Rightarrow E = \frac{-1}{2} R \frac{dB}{dt}$

$\Rightarrow E = -\frac{1}{2} \times 2.25 \times 10^{-2} \times (-0.25)$

$\Rightarrow E \approx 2.8 \times 10^{-3} \ (\frac{V}{m})$

ⓑ Induced magnetic field B', should be at the direction of B_0 in order to oppose its reduction. Thus, from the south pole i is counter clock-wise (CCW).

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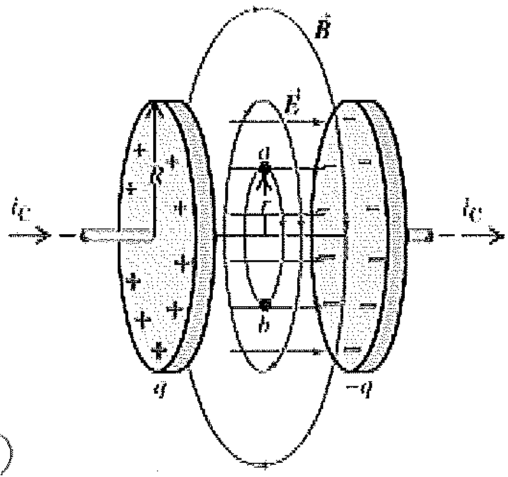
Section 1 **Quiz 11** **03 May 2012**

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

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

Consider an air-filled parallel plate capacitor having disk shaped plates with radius R as shown in the figure below. If the conduction current flowing into the positive plate is $i_C(t)$ find an expression for the magnetic field generated between the plates at a distance r from the axis of symmetry.



$\oint \vec{B}\cdot d\vec{l} = \mu_0 i_{in}$ (1)

$i_{in} = \dot{J}_{in} A = \dot{J}_D A = \dot{J}_C A = \left(\frac{i_C}{\pi R^2}\right)(\pi r^2)$

$\begin{cases} \theta = 0 \\ \cos\theta = 1 \end{cases}$ (1) $\Rightarrow B(2\pi r) = \mu_0 \frac{i_C}{\pi R^2} \pi r^2$

$\Rightarrow B = \frac{\mu_0}{2\pi} i_C \frac{r}{R^2}$

$B(r)$ linearly depends on r.