Quiz and Exam Formulæ & Constants

$$k = \frac{1}{4\pi\epsilon_0}$$
$$\Delta V = -\int \vec{E}\cdot d\vec{s}$$
$$V = k\frac{q}{r}$$
$$\Delta U = q\,\Delta V$$
$$I = dq/dt$$
$$P = I\,\Delta V$$
$$R = \frac{\Delta V}{I}$$

Series :
$$\frac{1}{C_{\text{eq}}} = \sum \frac{1}{C_i}$$
$$R_{\text{eq}} = \sum R_i$$

Parallel :
$$\frac{1}{R_{\text{eq}}} = \sum \frac{1}{R_i}$$
$$C_{\text{eq}} = \sum C_i$$

$$\vec{E} = k\frac{q}{r^2}\hat{r}$$
$$\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$$
$$\vec{F} = q\vec{E}$$
$$\vec{p} = q\vec{d}$$
$$\vec{\tau} = \vec{p}\times\vec{E}$$
$$U = -\vec{p}\cdot\vec{E}$$
$$|\vec{E}| \propto \frac{|\vec{p}|}{r^3}$$
$$\Phi_{\text{E}} = \int \vec{E}\cdot d\vec{A}$$
$$\epsilon_0 \oint \vec{E}\cdot d\vec{A} = q_{\text{enclosed}}$$
$$\oint \vec{E}\cdot d\vec{\ell} = -\frac{d\Phi_{\text{B}}}{dt}$$
$$C = \frac{Q}{\Delta V}$$
$$C = \epsilon_0\frac{A}{d}$$
$$U = \tfrac{1}{2}C\,[\Delta V]^2$$
$$R = \rho\frac{\ell}{A}$$
$$\tau_{\text{C}} = RC$$
$$u_{\text{E}} = \tfrac{1}{2}\epsilon_0 E^2$$

$$\vec{B} = \frac{\mu_0 q}{4\pi}\,\frac{\vec{v}\times\hat{r}}{r^2}$$
$$d\vec{B} = \frac{\mu_0 I}{4\pi}\,\frac{d\vec{\ell}\times\hat{r}}{r^2}$$
$$\vec{F} = q\vec{v}\times\vec{B}$$
$$\vec{F} = I\vec{\ell}\times\vec{B}$$
$$\vec{\mu} = NI\vec{A}$$
$$\vec{\tau} = \vec{\mu}\times\vec{B}$$
$$U = -\vec{\mu}\cdot\vec{B}$$
$$\Phi_{\text{B}} = \int \vec{B}\cdot d\vec{A}$$
$$\oint \vec{B}\cdot d\vec{A} = 0$$
$$\oint \vec{B}\cdot d\vec{\ell} = \mu_0(I_{\text{c}} + I_{\text{d}})$$
$$L = \frac{\Phi_{\text{B}}}{I}$$
$$L = \mu_0 N^2\frac{A}{\ell}$$
$$U = \tfrac{1}{2}LI^2$$
$$B = \mu_0 n I$$
$$\tau_{\text{L}} = L/R$$
$$u_{\text{B}} = \frac{1}{2\mu_0}B^2$$

$$q = q_{\max}\left(1 - e^{-t/\tau_{\text{C}}}\right)$$
$$q = q_0 e^{-t/\tau_{\text{C}}}$$
$$I = I_{\max}\left(1 - e^{-t/\tau_{\text{L}}}\right)$$
$$I = I_0 e^{-t/\tau_{\text{L}}}$$
$$I = \int \vec{J}\cdot d\vec{A}$$
$$\vec{J} = \sigma\vec{E}$$
$$\mathcal{E} = -N\frac{d\Phi_{\text{B}}}{dt}$$
$$I_d = \epsilon_0\,\frac{d\Phi_{\text{E}}}{dt}$$
$$\mathcal{E} = -L\,\frac{dI}{dt}$$
$$c = f\lambda = \frac{|\vec{E}|}{|\vec{B}|}$$
$$\vec{S} = \frac{1}{\mu_0}\,\vec{E}\times\vec{B}$$
$$I = \frac{P}{4\pi r^2}$$
$$P_r = \frac{(2)I}{c}$$
$$I_{\text{trans}} = I_0\cos^2\theta$$

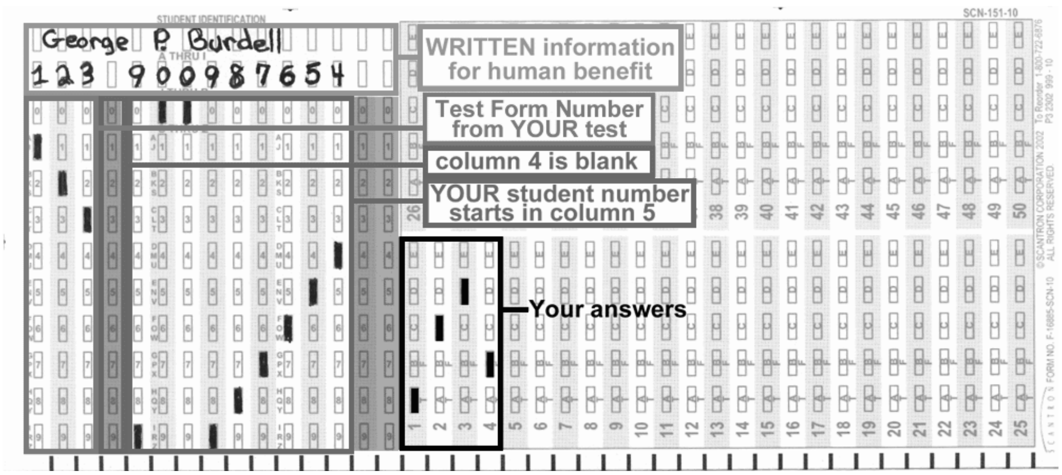
Fundamental Charge $e = 1.602\times10^{-19}\,\text{C}$
Coulomb constant $K = 8.988\times10^{9}\,\text{N·m}^2/\text{C}^2$
Earth's gravitational field $g = 9.81\,\text{N/kg}$

Mass of an Electron $m_{\text{e}} = 9.109\times10^{-31}\,\text{kg}$
Vacuum Permittivity $\epsilon_0 = 8.854\times10^{-12}\,\text{C}^2/\text{N·m}^2$
Vacuum Permeability $\mu_0 = 4\pi\times10^{-7}\,\text{T·m/A}$

Unless otherwise directed, friction, drag, and gravity should be neglected, and all batteries and wires are ideal.
All integrals in free-response problems must be evaluated.

Please remove this sheet from your Quiz or Exam

Version: A



YOUR form number is **241**

Recitation Sections

	Howey S-104	**Howey S-106**	**Howey S-107**
Wednesday			
1:05 pm		J01 Barrios, Maryrose	
2:05 pm		G01 Barrios, Maryrose	G02 Koh, Daegene
3:05 pm	J02 Naegele, James	G06/J05 Koh, Daegene	
4:05 pm		G08 Koh, Daegene	
5:05 pm	J06 Barrow, Kirk	G03 Koh, Daegene	J09 Barrios, Maryrose
Thursday			
12:05 pm		G04 Barrios, Maryrose	
1:05 pm		J10 Barrios, Maryrose	
2:05 pm	J03/J08 Barrow, Kirk	G09 Barrios, Maryrose	
3:05 pm	G10/J07 Barrow, Kirk		
4:05 pm		J04 Koh, Daegene	
5:05 pm		G05/G07 Koh, Daegene	

Version

A

Quiz #4 Form #241

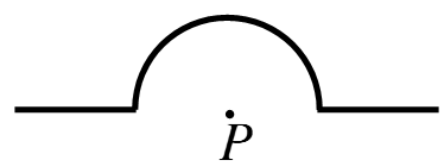
Physics 2212 GJ Fall 2015

Name:______________________________

Recitation Section:____________________

- Print your name, quiz form number (3 digits at the top of this form), and student number (9 digit Georgia Tech ID number) in the section of the answer card labeled "Student Identification."
- Bubble the Quiz Form Number in columns 1–3, skip column 4, then bubble your Student Number in columns 5–13.
- Free-response questions are numbered I–III. For each, make no marks and leave no space on your card. Show all your work clearly, including all steps and logic. Box your answer.
- Multiple-choice questions are numbered 1–10. For each, select the answer most nearly correct, circle this answer on your quiz, and bubble it on your answer card. Do not put any extra marks on the card.
- Turn in your quiz and answer card as you leave. Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is given.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.

I. (17 points) The magnetic field at point P due to a current through the wire is $5.0\,\mu\text{T}$ into the page. The curved portion of the wire is a semicircle of radius 2.0 cm, and the two straight segments are each 3.0 cm. Calculate the magnitude of the current. *Show your work, starting from a fundamental physical principle.* In what direction does it flow?



II. (17 points) A long, straight conducting wire of radius R has a nonuniform current density $\vec{J}(r)$ whose magnitude depends on the distance r from the center according to

$$J(r) = J_0 \left[1 - \frac{r^3}{R^3}\right]$$

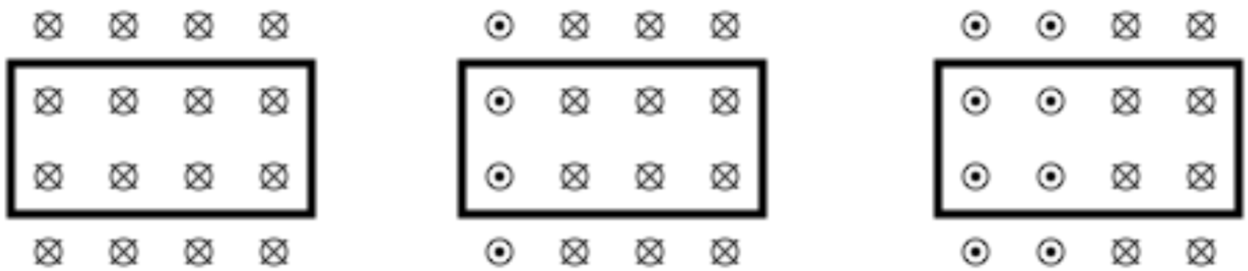
where J_0 is a positive constant. Find an expression for the magnetic field magnitude *inside* the wire, at radius $r < R$, in terms of parameters defined in the problem and physical or mathematical constants.

1. (5 points) Outside the wire in the problem above ($r > R$), how does the magnitude of the magnetic field B depend on the distance r from the center of the wire?

(a) Outside the wire, B is constant.
(b) Outside the wire, B depends on r the same way it does inside the wire.
(c) Outside the wire, B is proportional to r^3.
(d) Outside the wire, B is proportional to $1/r^2$.
(e) Outside the wire, B is proportional to $1/r$.

III. (16 points) A $12\,\mathrm{cm} \times 25\,\mathrm{cm}$ rectangular loop, which has a total resistance of $1.0\,\mathrm{m}\Omega$, is placed in a uniform $1.0\,\mathrm{mT}$ magnetic field, as shown in Figure (a). The applied field gradually flips direction — from into the page to out of the page — with the change sweeping slowly from left to right. The time elapsed between figures (a) and (c) is $0.50\,\mathrm{s}$.

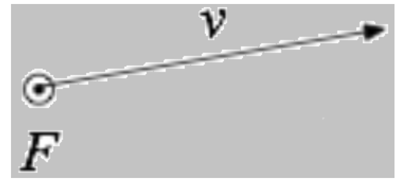
What is the induced current in the loop at time $t = 0.50\,\mathrm{s}$, when the field flip is halfway along the loop?



(a) $t = 0.00$ s (b) $t = 0.25$ s (c) $t = 0.50$ s

2. (5 points) What is the direction of the current, if any, in the loop in figure (c), as seen from above (the vantage point of the figures):
   (a) Counterclockwise on the left-hand side; clockwise on the right-hand side.
   (b) There is no induced current.
   (c) Clockwise.
   (d) Clockwise on the left-hand side; counterclockwise on the right-hand side.
   (e) Counterclockwise.

3. (5 points) A negatively charged particle, moving with velocity $\vec{v}$ as shown, experiences a magnetic Lorentz force oriented directly out of the page. What is the direction of the magnetic field at the particle's location?



(a) 

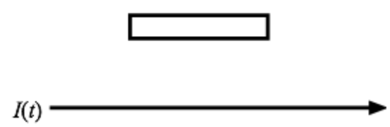
(b) 

(c) 

(d) 

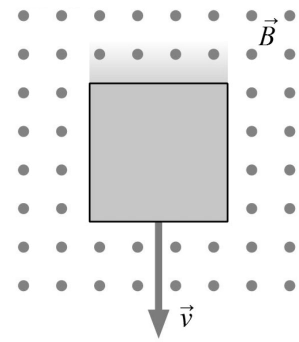
(e) 

4. (5 points) A rectangular conducting loop is positioned above a long wire that carries a current $I(t)$. If $I(t)$ is increasing with time, what force or torque does the loop experience?



(a) Only a force up the page.
(b) Both a force and a torque.
(c) Only a counterclockwise torque as seen from the right (the top edge of the loop is pulled out of the page and the bottom edge is pushed into the page).
(d) Only clockwise torque as seen from the right (the top edge of the loop is pushed into the page and the bottom edge is pulled out of the page).
(e) Only a force down the page.

5. (5 points) The conducting slab moves down the page with velocity $\vec{v}$, through a magnetic field $\vec{B}$ directed out of the page. At what location, if any, in the conductor is the electric potential highest?



(a) The electric potential is highest on the right edge of the conductor.
(b) The electric potential is highest on the left edge of the conductor.
(c) The electric potential is the same everywhere in the conductor.
(d) The electric potential is highest on the top edge of the conductor.
(e) The electric potential is highest on the bottom edge of the conductor.

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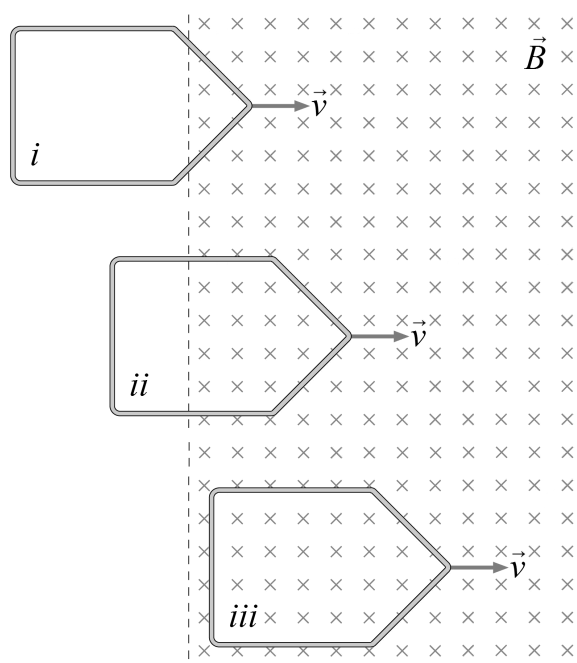
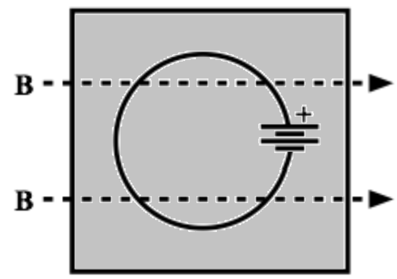
6. (5 points) Three identical conducting loops enter a magnetic field at identical velocities $\vec{v}$. At the instant shown, rank the current magnitudes in the loops from greatest to least.



(a) $I_i > I_{ii} > I_{iii}$
(b) $I_{iii} > I_{ii} > I_i$
(c) $I_{ii} > I_i > I_{iii}$
(d) $I_i = I_{ii} = I_{iii}$
(e) $I_{ii} = I_{iii} > I_i$

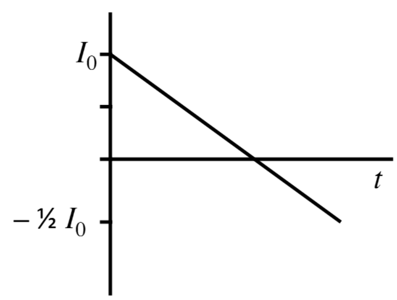
7. (5 points) A circular loop of current rests on a table top. A large, uniform magnetic field is applied parallel to the table top, oriented from left to right, as shown. How does the loop respond?

(a) It moves to the right along the table.
(b) Its left edge lifts off the table.
(c) Its right edge lifts off the table.
(d) It moves to the left along the table.
(e) An edge lifts off the table, *and* it moves along the table.

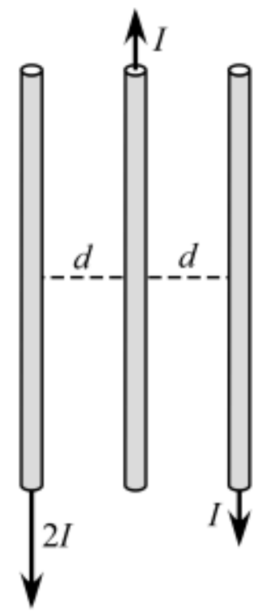


8. (5 points) Initially, an inductor stores magnetic energy U_0 with a current I_0 running through it. Starting at time $t = 0$, the current changes linearly, as indicated by the graph. What is the final energy stored in the inductor?

(a) $3U_0/2$
(b) $U_0/4$
(c) $-U_0/4$
(d) $U_0/2$
(e) $-U_0/2$



9. (5 points) Three long wires are aligned parallel to one another, with a uniform spacing d between wires. Each wire carries the current indicated in the figure. Rank order the magnitudes of the net force exerted on each wire.



(a) $F_{\text{center}} > F_{\text{left}} = F_{\text{right}}$
(b) $F_{\text{center}} = F_{\text{left}} = F_{\text{right}}$
(c) $F_{\text{left}} = F_{\text{center}} > F_{\text{right}}$
(d) $F_{\text{center}} > F_{\text{left}} > F_{\text{right}}$
(e) $F_{\text{left}} > F_{\text{center}} > F_{\text{right}}$

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10. (6 points) Consider a particle that is released from rest at the -500 V plate of a capacitor. It accelerates toward the +500 V plate, and passes through a small hole. Entering a uniform magnetic field directed into the page, its path is deflected up the page. Under what circumstances, if any, is this possible? (*Neglect the effects of gravity.*)

(a) This is possible if the particle has positive charge.
(b) This is possible if the particle is neutral.
(c) This is possible if the particle has positive charge or has negative charge (that is, as long as the particle isn't neutral).
(d) This is possible if the particle has negative charge.
(e) This is not possible.