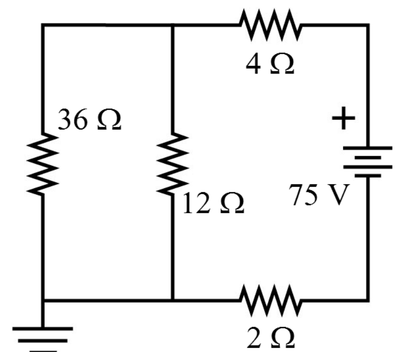
Version $\qquad$ Quiz #3 Form #231 $\qquad$ Name:____________________

A $\qquad$ Physics 2212 K Summer 2016 $\qquad$ 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. (18 points) For the circuit shown, what power is dissipated by the $36\,\Omega$ resistor?

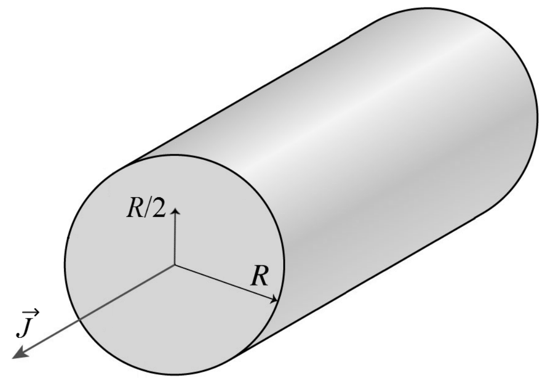


II. (16 points) A long, straight conducting wire of radius R has a nonuniform current density directed out of the page, with magnitude

$$J(r) = J_0 \left(\frac{r^2}{R^2} \right)$$

where r is the distance from the center of the wire and J_0 is a positive constant.

What is the magnitude of the magnetic field at a distance $R/2$ from the center? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



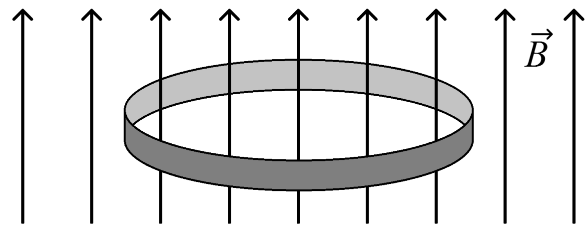
1. (5 points) In the problem above, what is the direction of the magnetic field at the point a distance $R/2$ above the center of the wire, as indicated on the figure?

   (a) Out of the page.
   (b) Down the page.
   (c) To the left.
   (d) Up the page.
   (e) To the right.

III. (16 points) A circular loop made from a flexible conducting wire is shrinking. Its radius r as a function of time t is

$$r = r_0 \left(\pi^2 - \frac{t}{T} \right)$$

where r_0 and T are positive constants. The loop is perpendicular to a steady, uniform magnetic field of magnitude B, as shown. What is the magnitude of the emf induced in the loop at time T? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



2. (5 points) In the problem above, what is the direction, if any, of the current induced in the loop at time T?

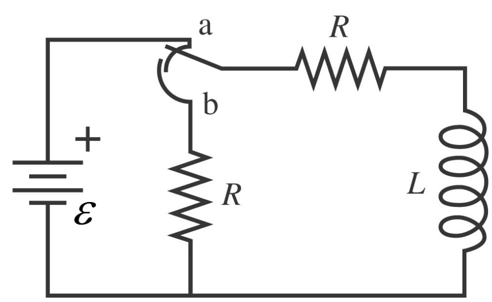
   (a) The current is to the left on the front of the loop, clockwise when viewed from above.
   (b) The current is to the right on the front of the loop, counter-clockwise when viewed from above.
   (c) There is no current induced in the loop at time T.

3. (5 points) The loop, shown in cross-section, has a current into the page at the top, and out of the page at the bottom. It is held centered between two permanent magnets, as shown. How, if at all, does the loop move upon release?

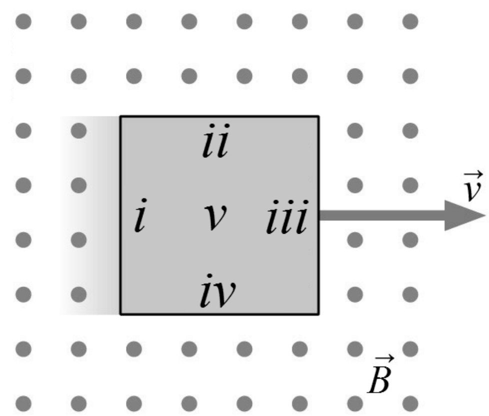
(a) It rotates counter-clockwise.
(b) It doesn't move.
(c) It moves rightward.
(d) It moves leftward.
(e) It rotates clockwise.

4. (5 points) The circuit shown consists of a battery with emf $\mathcal{E}$, an inductor with inductance L, two resistors each with resistance R, and a make-before-break switch. The switch has been in position "a" for a long time. What is the emf of the inductor immediately upon moving the switch to position "b"?

(a) Zero
(b) $\mathcal{E}/2$
(c) $2\mathcal{E}$
(d) $\mathcal{E}$
(e) ∞



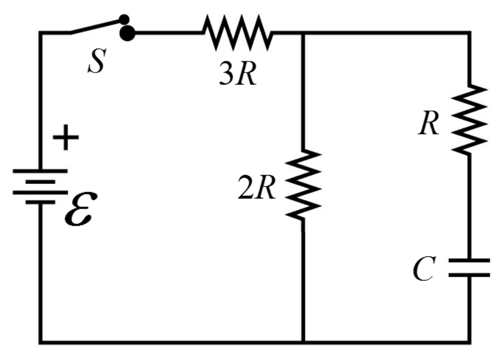
5. (5 points) A conducting plate moves to the right through a uniform magnetic field directed out of the page, as shown. Which location on the plate will be at greatest electric potential?



(a) location v, the center of the plate.
(b) location iii, the right edge of the plate.
(c) location i, the left edge of the plate.
(d) location ii, the top edge of the plate.
(e) location iv, the bottom edge of the plate.

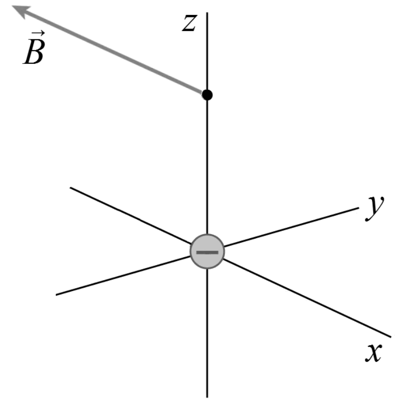
---

6. (5 points) What is the charge on the capacitor in the circuit shown, after the switch S has been closed for a very long time?



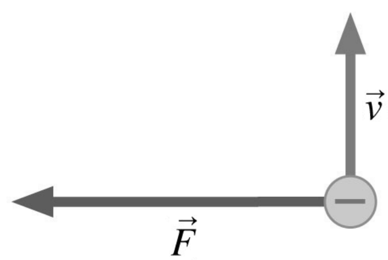
(a) $C\mathcal{E}$
(b) $2C\mathcal{E}/5$
(c) $3C\mathcal{E}/5$
(d) $C\mathcal{E}/4$
(e) $C\mathcal{E}/3$

7. (5 points) As an electron passes through the origin, it generates a magnetic field on the $+z$ axis that points in the $-x$ direction, as shown. In what direction could this negatively-charged particle be traveling?



(a) In the $+x$ direction.
(b) In the $-x$ direction.
(c) In the $-z$ direction.
(d) In the $+y$ direction.
(e) In the $-y$ direction.

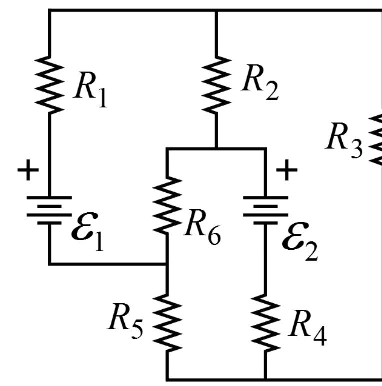
8. (5 points) An electron moves with velocity $\vec{v}$ perpendicular to a magnetic field and experiences a force $\vec{F}$, as shown. What is the direction of the field?



(a) To the right.
(b) In to the page.
(c) Down the page.
(d) Out of the page.
(e) To the left.

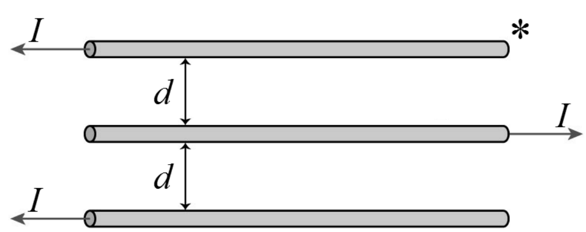
9. (5 points) Let the positive direction of current flow be up the page in the circuit shown. The current I_1 flows through resistor R_1, etc. Which is a valid expression of Kirchhoff's Loop Law?

(a) $+\mathcal{E}_1 - I_1R_1 + I_2R_2 - \mathcal{E}_2 + I_4R_4 - I_3R_3 = 0$
(b) $+\mathcal{E}_1 - I_1R_1 - I_2R_2 + \mathcal{E}_2 + I_4R_4 - I_5R_5 = 0$
(c) $+\mathcal{E}_1 - I_1R_1 + I_3R_3 - I_4R_4 + \mathcal{E}_2 + I_6R_6 = 0$
(d) $+\mathcal{E}_1 + \mathcal{E}_2 - I_1R_1 - I_2R_2 - I_3R_3 - I_4R_4 - I_5R_5 - I_6R_6 = 0$
(e) $+\mathcal{E}_1 + I_1R_1 - I_2R_2 - I_6R_6 + I_5R_5 - I_4R_4 = 0$



10. (5 points) Each of the three long straight wires carries the same current magnitude. What is the direction, if any, of the net force on the topmost wire, marked with an asterisk?

(a) No direction, as net force is zero.
(b) Down the page.
(c) Out of the page.
(d) Up the page.
(e) Into the page.



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

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

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

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

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

Mass of an Electron $m_{\text{e}} = 9.109\times10^{-31}\,\text{kg}$
Mass of a Proton $m_{\text{p}} = 1.673\times10^{-27}\,\text{kg}$
Vacuum Permittivity $\epsilon_0 = 8.854\times10^{-12}\,\text{C}^2/\text{N}\cdot\text{m}^2$

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

Please remove this sheet from your Quiz or Exam

Version: A