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 :

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

Parallel :

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

$$\vec{E} = k\frac{q}{r^2}\hat{r}$$
$$\vec{F} = k\frac{q_1q_2}{r^2}\hat{r}$$
$$\vec{F} = q\vec{E}$$
$$\vec{p} = q\vec{d}$$
$$\vec{\tau} = \vec{p}\times\vec{E}$$
$$U = -\vec{p}\cdot\vec{E}$$
$$|\vec{E}| \propto \frac{|\vec{p}|}{r^3}$$
$$\Phi_{\rm E} = \int \vec{E}\cdot d\vec{A}$$
$$\epsilon_0 \oint \vec{E}\cdot d\vec{A} = q_{\rm enclosed}$$
$$\oint \vec{E}\cdot d\vec{\ell} = -\frac{d\Phi_{\rm B}}{dt}$$
$$C = \frac{Q}{\Delta V}$$
$$C = \epsilon_0\frac{A}{d}$$
$$U = \tfrac{1}{2}C\,[\Delta V]^2$$
$$R = \rho\frac{\ell}{A}$$
$$\tau_{\rm C} = RC$$
$$u_{\rm E} = \tfrac{1}{2}\epsilon_0 E^2$$

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

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

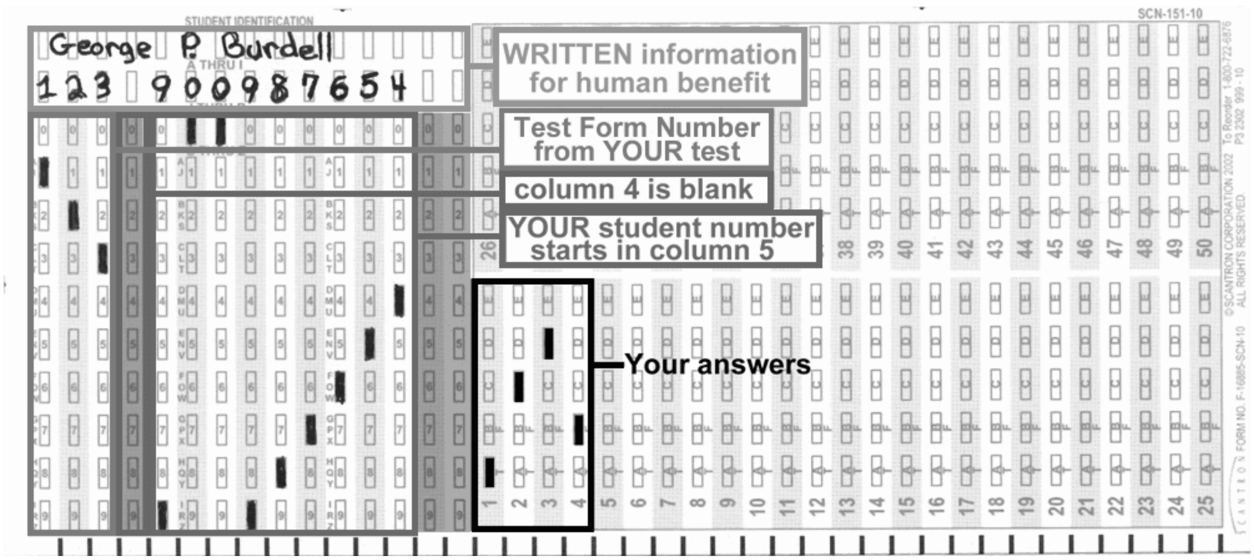
Fundamental Charge $e = 1.602\times10^{-19}\,\text{C}$
Earth's gravitational field $g = 9.81\,\text{N/kg}$
Coulomb constant $K = 8.988\times10^{9}\,\text{N·m}^2/\text{C}^2$
Speed of Light $c = 2.998\times10^{8}\,\text{m/s}$

Mass of an Electron $m_{\rm e} = 9.109\times10^{-31}\,\text{kg}$
Mass of a Proton $m_{\rm p} = 1.673\times10^{-27}\,\text{kg}$
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 derivatives and integrals in free-response problems must be evaluated.

Please remove this sheet from your Quiz or Exam

Version: A



YOUR form number is **425**

Recitation Sections

	Clough 127	Clough 131
Monday		
1:55 – 2:45 pm		J05 Girdhar, Anant
3:00 – 3:50 pm	G05 Girdhar, Anant	
4:30 – 5:20 pm	G06 Girdhar, Anant	J06 Bapat, Chaitanya
6:00 – 6:50 pm	G07 & J07 Bernardes, Sarah	
Tuesday		
12:00 – 12:50 pm	G08 Huang, Shengnan	J08 Daum, Marcus
3:00 – 3:50 pm	G09 Huang, Shengnan	J09 Daum, Marcus
4:30 – 5:20 pm	G10 Huang, Shengnan	J10 Daum, Marcus
Wednesday		
3:00 – 3:50 pm	G01 Bapat, Chaitanya	J01 Bernardes, Sarah
4:30 – 5:20 pm	G02 Bapat, Chaitanya	J02 Bernardes, Sarah
Thursday		
12:00 – 12:50 pm	G03 Huang, Shengnan	J03 Daum, Marcus
3:00 – 3:50 pm	G04 Huang, Shengnan	J04 Daum, Marcus

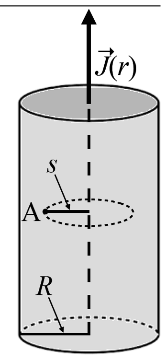
Version **A** Quiz #4 Form #425 Name:________________

Physics 2212 G&J Fall 2017 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 1–7. 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. (16 points) An infinitely long straight wire of radius R carries a non-uniform current density

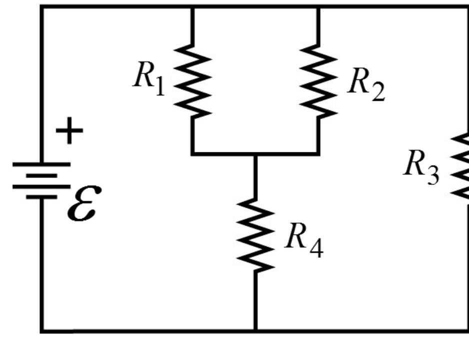
$$\vec{J}(r) = J_0 \left(\frac{R}{r}\right) \hat{k}$$



distributed along its cross-section, where r is the distance from the center of the wire. The value J_0 is the current density magnitude at the surface of the wire.

Determine the **magnitude and direction** of the magnetic field at the point A that is a distance s away from the wire center and inside the wire. Express your answer in terms of the parameters defined in the problem and physical or mathematical constants.

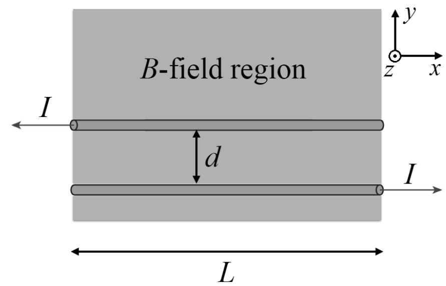
II. (16 points) The battery in the circuit shown has emf $\mathcal{E} = 24\,\text{V}$. The resistances are $R_1 = 4.0\,\Omega$, $R_2 = 12\,\Omega$, $R_3 = 8.0\,\Omega$, and $R_4 = 5.0\,\Omega$. What is the current through resistor R_2?

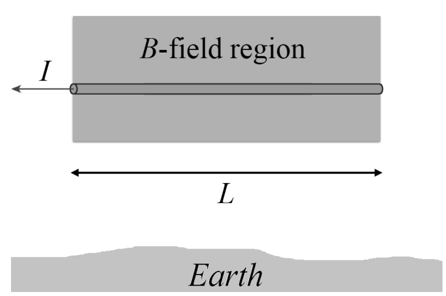


1. (6 points) In the problem above, compare the power P_1 dissipated in resistor R_1 to the power P_2 dissipated in resistor R_2.

   (a) $P_1 = P_2/9$
   (b) $P_1 = P_2$
   (c) $P_1 = 9P_2$
   (d) $P_1 = P_2/3$
   (e) $P_1 = 3P_2$

III. (16 points) Two identical current-carrying wires with mass m and length L have been placed in uniform background magnetic field with magnitude B_0 directed out of the page. The same current I flows through each wire as shown. If separation of the wires is d, find the **magnitude and direction** of the net force acting on the bottom wire. Express your answer in terms of the parameters defined in the problem and physical or mathematical constants. (*In space, far from any other electric, magnetic, or gravitational fields.*)

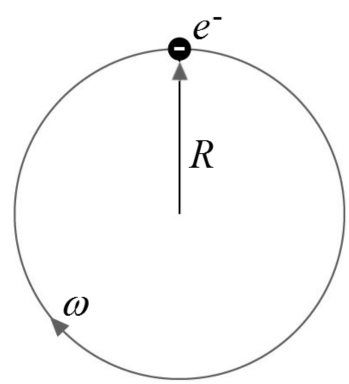




2. (6 points) A single wire of length L carrying current I is immersed in the uniform magnetic field of unknown magnitude and direction, as shown. If the mass of the current-carrying wire is m, what minimum magnetic field strength and direction will levitate the wire? (*On Earth—you may neglect the Earth's magnetic field, but do NOT neglect gravity.*)

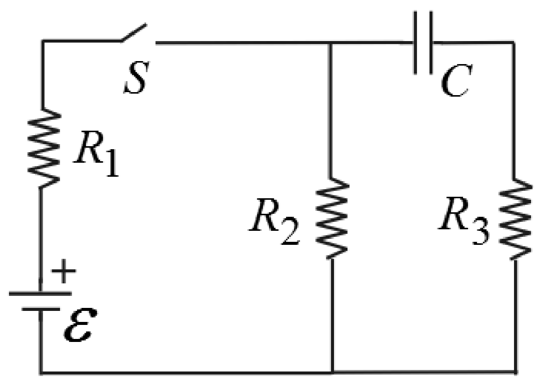
(a) $B = mg/IL$, directed toward the bottom of the page (toward the Earth)
(b) $B = mg/IL$, directed out of the page
(c) $B = mg/IL$, directed toward the top of the page (away from the Earth)
(d) There is no configuration of magnetic field for which levitation can be achieved
(e) $B = mg/IL$, directed in to the page

3. (8 points) An electron moves in a uniform magnetic field. Its circular path has radius R, and it has clockwise angular velocity ω. What is the direction of the magnetic field?



(a) Clockwise.
(b) Counter-clockwise.
(c) Into the page.
(d) Out of the page.
(e) Toward the top of the page.

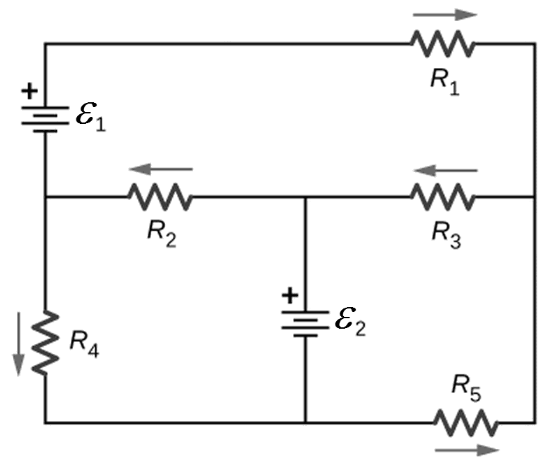
4. (8 points) In the circuit shown, the emf $\mathcal{E} = 24\,\mathrm{V}$ and the capacitance $C = 3\,\mu\mathrm{F}$. The resistances are $R_1 = 4\,\Omega$, $R_2 = 8\,\Omega$, and $R_3 = 20\,\Omega$. After the switch S has been closed for a very long time, what is the charge on the capacitor?



(a) $72\,\mu\mathrm{C}$
(b) $48\,\mu\mathrm{C}$
(c) $60\,\mu\mathrm{C}$
(d) $24\,\mu\mathrm{C}$
(e) $12\,\mu\mathrm{C}$

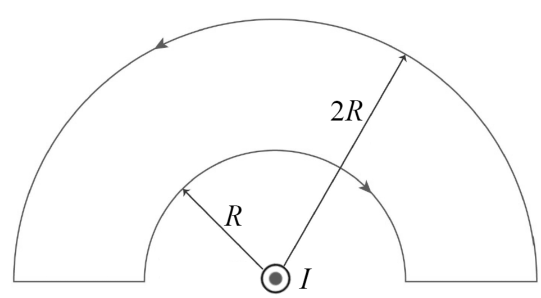
5. (8 points) In the circuit shown, the positive direction of current flow through each resistor has been defined as indicated with arrows. If the current through resistor R_1 is I_1, etc., which of the following is a valid expression of Kirchhoff's Loop Law?

(a) $+\mathcal{E}_1 - I_1R_1 - I_3R_3 + \mathcal{E}_2 - I_5R_5 = 0$
(b) $+\mathcal{E}_1 - I_1R_1 + I_5R_5 + \mathcal{E}2 - I_2R_2 = 0$
(c) $+\mathcal{E}_1 - I_1R_1 + I_5R_5 + I_4R_4 - I_2R_2 = 0$
(d) $+\mathcal{E}_1 - I_1R_1 - I_3R_3 - I_2R_2 - I_4R_4 - \mathcal{E}_2 = 0$
(e) $+\mathcal{E}_1 - I_1R_1 - I_2R_2 - I_3R_3 - I_4R_4 - I_5R_5 + \mathcal{E}_2 = 0$



6. (8 points) What is the line integral of the vector $\vec{B}$ along the loop shown in the figure below? The magnetic field is produced by the wire carrying a current I, located at the center of the loop's arc and oriented perpendicular to it. The direction of the current and integration loop are as illustrated in the figure.

(a) $-\mu_0 I$
(b) $-2\mu_0 I$
(c) $+2\mu_0 I$
(d) $+\mu_0 I$
(e) Zero



7. (8 points) A small circular coil of wire (seen edge-on in a cutaway view) is between the poles of a magnet. The coil carries a current in the direction indicated. What will be the effect of the magnetic field on the coil at the instant it is positioned as shown? The coil will experience …

(a) a net torque directed out of the page.
(b) a net torque directed into the page.
(c) a net torque directed to the left.
(d) a net force to the left.
(e) a net force to the right.