Name	**Physics 2212 GJ** Fall 2018	Nine-digit Tech ID

Quiz #
4A

- Put *nothing* other than your name and nine-digit Tech ID in the spaces above.
- Free-response problems are numbered I–III. Show all your work clearly, including all steps and logic. Write **darkly**. Blue or black ink is recommended. Do not make any erasures in your free-response work. Cross out anything you do not want evaluated. Box your answer.
- Multiple-choice questions are numbered 1–7. For each, select the answer most nearly correct, circle it on your quiz, and fill the bubble for your answer on this front page.
- Initial the odd pages in the top margin, in case the pages of your quiz get separated.
- The standard formula sheet is on the back of this page, which may be removed from the quiz form if you wish, but it must be submitted.
- If the page for a free-response problem has insufficient space for your work, ask a proctor for an additional sheet. If you wish this work to be evaluated, put your name on the sheet and make a note on the problem page, so graders know where to find your work.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.
- Your score will be posted when your quiz has been graded. Quiz grades become final when the next is given.

Fill in bubbles for your Multiple Choice answers darkly and neatly.

	a	b	c	d	e
1	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
2	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
3	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
4	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
5	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
6	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
7	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
	a	b	c	d	e

Quiz & Final Exam Formulæ & Constants

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$\vec{\omega} = \frac{d\vec{\theta}}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$

$$v_{\text{sf}} = v_{\text{si}} + a_{\text{s}}\,\Delta t$$

$$\omega_{\text{f}} = \omega_{\text{i}} + \alpha\,\Delta t$$

$$s_{\text{f}} = s_{\text{i}} + v_{\text{si}}\,\Delta t + \tfrac{1}{2}a_{\text{s}}\,(\Delta t)^2$$

$$\theta_{\text{f}} = \theta_{\text{i}} + \omega_{\text{si}}\,\Delta t + \tfrac{1}{2}\alpha\,(\Delta t)^2$$

$$s = r\theta$$

$$v = r\omega$$

$$a_{\text{t}} = r\alpha$$

$$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$

$$\sum \vec{F}_{\text{ext}} = M\vec{a}_{\text{cm}} = \frac{d\vec{P}}{dt}$$

$$\sum \vec{\tau}_{\text{ext}} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$

$$f_{\text{s,max}} = \mu_{\text{s}} n$$

$$f_{\text{k}} = \mu_{\text{k}} n$$

$$a_{\text{r}} = \frac{v^2}{r}$$

$$\vec{w} = m\vec{g}$$

$$|\vec{F}_{\text{G}}| = \frac{Gm_1m_2}{|\vec{r}|^2}$$

$$D = \tfrac{1}{2}C\rho A v^2$$

$$\vec{\tau} = \vec{r}\times\vec{F}$$

$$W = \int \vec{F}\cdot d\vec{s}$$

$$W_{\text{ext}} = \Delta K + \Delta U + \Delta E_{\text{th}}$$

$$K = \tfrac{1}{2}mv^2$$

$$K = \tfrac{1}{2}I\omega^2$$

$$U_{\text{g}} = mgy$$

$$U_{\text{s}} = \tfrac{1}{2}k\,(\Delta s)^2$$

$$U_{\text{G}} = -\frac{Gm_1m_2}{r}$$

$$P = \frac{dE_{\text{sys}}}{dt}$$

$$P = \vec{F}\cdot\vec{v}$$

$$\vec{J} = \int \vec{F}\,dt = \Delta\vec{p}$$

$$\vec{p} = m\vec{v}$$

$$\vec{r}_{\text{cm}} = \frac{\sum \vec{r}_i m_i}{\sum m_i}$$

$$\vec{r}_{\text{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$

$$I = \sum m_i r_i^2$$

$$I = \int r^2\,dm$$

$$I = I_{\text{cm}} + Md^2$$

$$\vec{L} = \vec{r}\times\vec{p}$$

$$\vec{L} = I\vec{\omega}$$

$$x = A\cos(\omega t + \phi_0)$$

$$\vec{a}_{\text{x}} = -\omega^2\vec{x}$$

$$\omega = \sqrt{k/m}$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

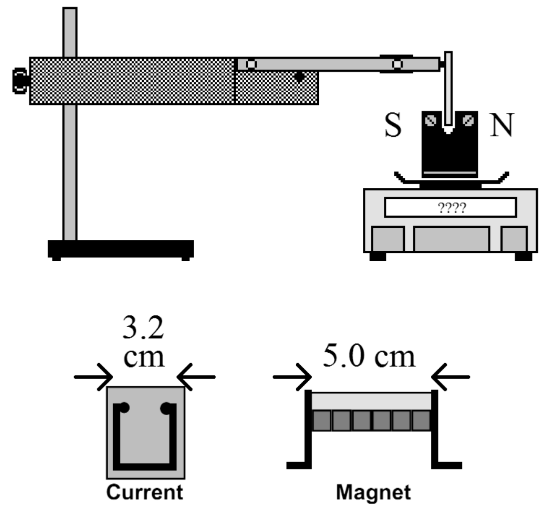
Physical Constants:

Universal Gravitation Constant $G = 6.673\times10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2$
Gravitational Acceleration at Earth's Surface $g = 9.81\,\text{m/s}^2$

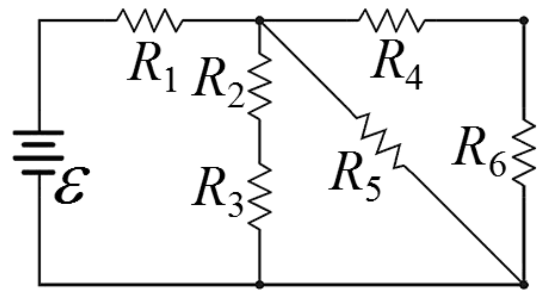
Unless otherwise directed, drag is to be neglected and all problems take place on Earth, use the gravitational definition of weight, and all springs, ropes and pulleys are ideal.

You may remove this sheet from your Quiz or Exam

I. (16 points) A magnet with a length of 5.0 cm has a uniform 11.76 mT field between its poles. It is placed on an electronic balance, with the North pole to the right and the South pole to the left, and the balance indicates 160.89 g. Then a wire 3.2 cm long is placed between the poles, and a current of 4.50 A flows into the page. What is the reading on the balance while the current is flowing? (*On Earth.*)



II. (16 points) The battery in the circuit shown has emf $\mathcal{E}$. All six resistors have identical resistance R. What is the current through resistor R_5? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



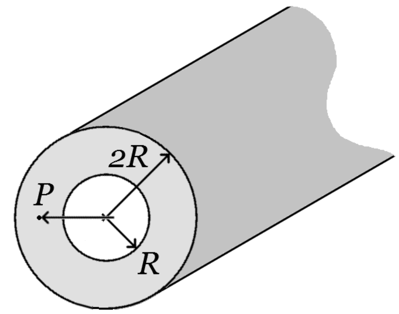
1. (6 points) Let the power dissipated in resistor R_5 in the problem above be P_5. If the emf of the battery were doubled, and the resistance of all the resistors was halved, what power P_5' would now be dissipated in resistor R_5?

   (a) $P_5' = 4P_5$
   (b) $P_5' = P_5/8$
   (c) $P_5' = 8P_5$
   (d) $P_5' = P_5$
   (e) $P_5' = P_5/4$

III. (16 points) An infinite straight hollow wire has inner radius R and outer radius $2R$, as illustrated. Its current density, $\vec{J}$, is directed out of the page and has a magnitude that varies with distance r from the center according to

$$J = J_0 \frac{R}{r}$$

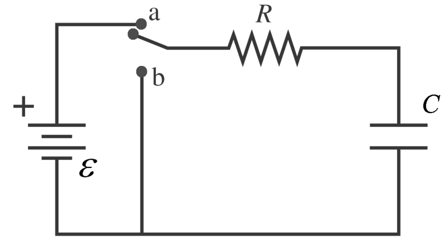
where J_0 is a positive constant. Find the magnetic field magnitude at a point P which is a distance $3R/2$ from the center, in terms of parameters defined in the problem, and physical or mathematical constants.



2. (6 points) In the problem above, what is the direction of the magnetic field at the illustrated point P?

(a) There is no direction, as the magnetic field magnitude is zero.
(b) Up the page.
(c) To the left (away from the center).
(d) Down the page.
(e) To the right (toward the center).

3. (8 points) The switch in the illustrated circuit is set to position "b" for a long time, then set to position "a" for a time t_a, then set back to position "b". What is the potential across the resistor at the instant the switch returns to "b"?



(a) 0
(b) $\mathcal{E}\left(1 - e^{-t_a/RC}\right)$
(c) $\mathcal{E}$
(d) $\mathcal{E}e^{-t_a/RC}$
(e) $\mathcal{E}\left(1 - e^{-t_a/RC}\right) e^{-t_a/RC}$

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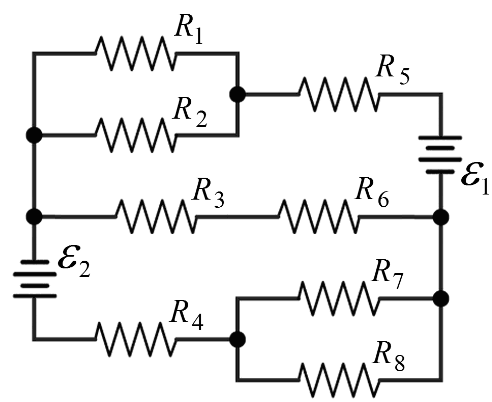
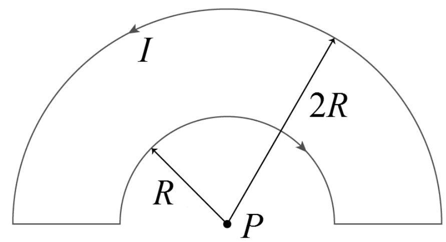
4. (8 points) Resistors R_1 through R_8 in the illustrated circuit carry currents I_1 through I_8, respectively. Let the positive direction of current flow be left to right through all the resistors. Which equation is a valid expression of Kirchhoff's Loop Law?



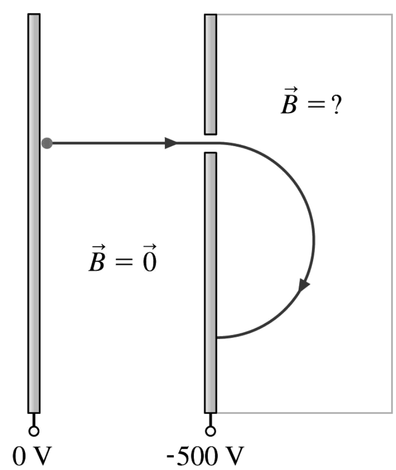
(a) $+\mathcal{E}_1 + I_5R_5 + I_2R_2 - I_3R_3 - I_6R_6 + I_7R_7 + I_4R_4 - \mathcal{E}_2 = 0$
(b) $+\mathcal{E}_1 + I_5R_5 + I_2R_2 + \mathcal{E}_2 + I_4R_4 + I_8R_8 = 0$
(c) $+\mathcal{E}_1 + I_5R_5 + I_1R_1 + \mathcal{E}_2 - I_4R_4 - I_7R_7 = 0$
(d) $+\mathcal{E}_1 - I_5R_5 - I_1R_1 + \mathcal{E}_2 + I_4R_4 + I_3R_3 + I_6R_6 = 0$
(e) $+\mathcal{E}_1 - I_5R_5 - I_1R_1 + \mathcal{E}_2 + I_4R_4 + I_7R_7 + I_8R_8 = 0$

5. (8 points) Current I flows counter-clockwise around the loop made of two connected arcs with radii R and $2R$, as shown. What is the magnetic field at the center of the arcs, P?



(a) Zero magnitude, no direction
(b) $\frac{\mu_0 I}{8R}$ in to the page
(c) $\frac{3\mu_0 I}{8R}$ in to the page
(d) $\frac{\mu_0 I}{8R}$ out of the page
(e) $\frac{3\mu_0 I}{8R}$ out of the page

6. (8 points) A charged particle is released from rest at a plate with an electric potential of 0 V. It accelerates toward a plate with an electric potential of -500 V, and passes through a small hole to enter a region of uniform magnetic field. If the path of the particle curves as shown, what is the direction of the magnetic field?



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

7. (8 points) The circuit shown has identical light bulbs A and B, switch S, and a battery with emf $\mathcal{E}$. Bulb A glows when switch S is open. When the switch is closed, the brightness of bulb A ...

(a) remains the same if the battery is ideal, and remains the same if the battery is real.
(b) remains the same if the battery is ideal, but decreases if the battery is real.
(c) decreases if the battery is ideal, and decreases if the battery is real.
(d) decreases if the battery is ideal, but remains the same if the battery is real.
(e) remains the same if the battery is ideal, but increases if the battery is real.