Version Quiz #3 Form #325 Name:____________________

A Physics 2212 G Spring 2018 Recitation Section:________________

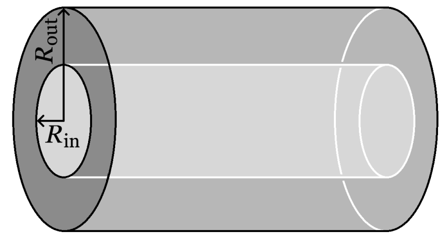
- Print your name, quiz form number (3 digits at the top of this form), and student number (9 digit Georgia Tech ID number) in the section of the answer card labeled "Student Identification."
- Bubble the Quiz Form Number in columns 1–3, skip column 4, then bubble your Student Number in columns 5–13.
- 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 electric field varies with position according to

$$\vec{E} = \left(6.0\,\mathrm{V/m^2}\right) x\,\hat{\imath} - \left(3.0\,\mathrm{V/m^3}\right) y^2\,\hat{\jmath}$$

What is the electric potential difference **from** the point $(x_1, y_1) = (1.0, 2.0)\,\mathrm{m}$ **to** the point $(x_2, y_2) = (2.0, -2.0)\,\mathrm{m}$?

II. (16 points) A hollow conducting wire has inner radius R_{in} and outer radius R_{out}. It carries a current whose density magnitude J varies with distance r from the central axis of the wire according to

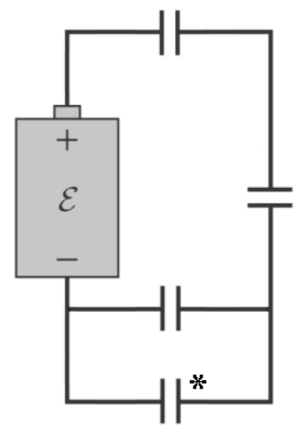


$$J = J_0 \frac{r - R_{\text{in}}}{r}$$

where J_0 is a positive constant. In terms of parameters defined in the problem and physical or mathematical constants, what is the magnitude of the current in the wire?

1. (6 points) In the problem above, at what distance, if any, from central axis is the drift speed of electrons in the wire zero?
   (a) At only $r = R_{\text{in}}$.
   (b) At both $r = R_{\text{in}}$ and $r = R_{\text{out}}$.
   (c) At no distances $R_{\text{in}} \leq r \leq R_{\text{out}}$.
   (d) At only $r = (R_{\text{in}} + R_{\text{out}})/2$.
   (e) At only $r = R_{\text{out}}$.

III. (16 points) The battery in the illustrated circuit has emf $\mathcal{E}$. Each of the four capacitors has the same capacitance, C. Once the circuit has been connected for a long time, what energy is stored in the bottom-most capacitor, marked with an asterisk, with respect to zero energy at zero charge? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



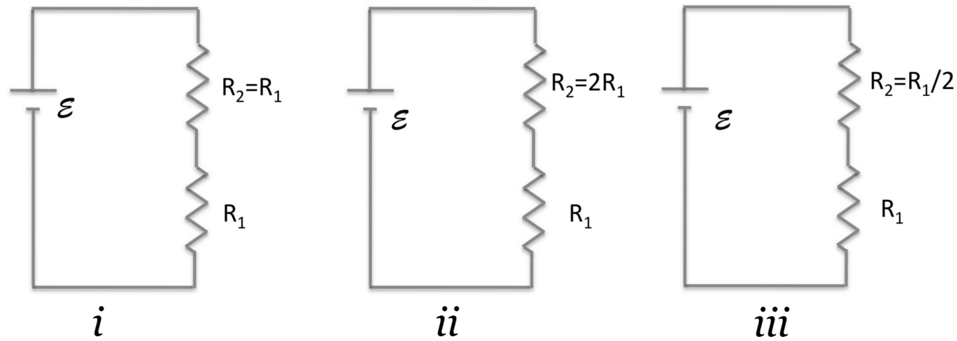
2. (6 points) If the energy found in the problem above is U_0, what energy would be stored in that same capacitor if the battery were replaced by one with twice the emf, $2\mathcal{E}$?

When the battery has emf $2\mathcal{E}$, the energy stored in the bottom-most capacitor is . . .

(a) $8U_0$. (b) $2U_0$. (c) $4U_0$. (d) $U_0/2$. (e) U_0.

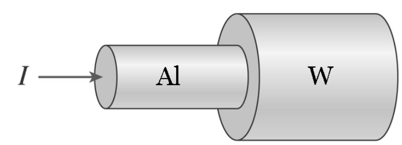
3. (8 points) Each of the circuits shown has an identical emf $\mathcal{E}$. Rank the circuits in order of power delivered to resistor R_1.

(a) $iii > ii > i$
(b) $ii > iii > i$
(c) $ii > i > iii$
(d) $iii > i > ii$
(e) $i > iii > ii$



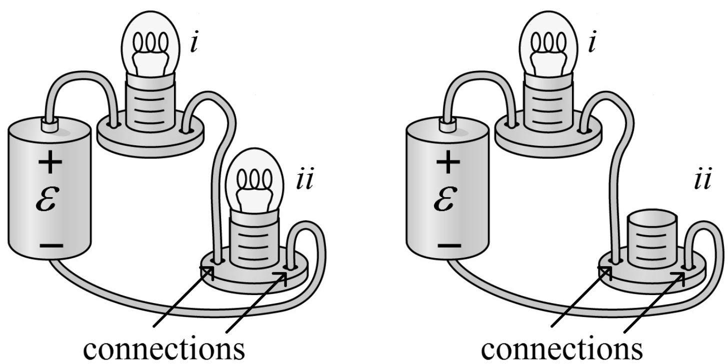
4. (8 points) A tungsten wire and an aluminum wire are joined to make a single wire. A current I enters the aluminum wire. The radius of the tungsten wire is twice that of the aluminum end. The conductivity of tungsten is half that of aluminum. How is the electric field magnitude in the tungsten wire E_{W} related to that in the aluminum wire E_{Al}?

(a) $E_{\mathrm{W}} = E_{\mathrm{Al}}/2$
(b) $E_{\mathrm{W}} = 4E_{\mathrm{Al}}$
(c) $E_{\mathrm{W}} = 2E_{\mathrm{Al}}$
(d) $E_{\mathrm{W}} = E_{\mathrm{Al}}$
(e) $E_{\mathrm{W}} = E_{\mathrm{Al}}/4$



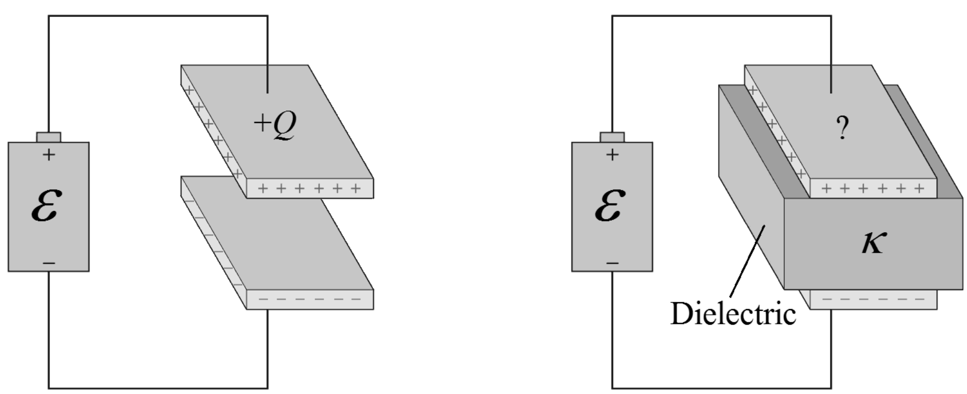
5. (8 points) A battery with emf $\mathcal{E}$ is connected to two identical bulbs, i and ii, as shown on the left. Then bulb ii is removed from its socket, as shown on the right. What is the potential difference between the connections to bulb ii's socket in each case?

(a) $\mathcal{E}$ with bulb ii in place, zero with bulb ii removed.
(b) $\mathcal{E}/2$ with bulb ii in place, zero with bulb ii removed.
(c) $\mathcal{E}$ with bulb ii in place, $\mathcal{E}$ with bulb ii removed.
(d) $\mathcal{E}/2$ with bulb ii in place, $\mathcal{E}$ with bulb ii removed.
(e) $\mathcal{E}/2$ with bulb ii in place, $\mathcal{E}/2$ with bulb ii removed.



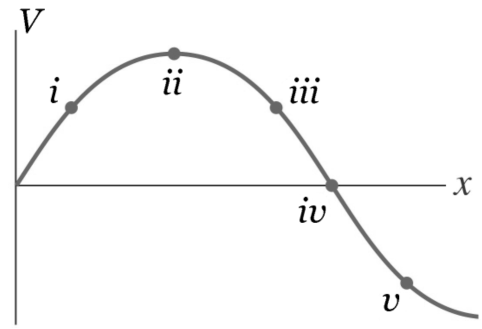
6. (8 points) When a battery with emf $\mathcal{E}$ is connected to the capacitor as shown on the left, a charge Q is found on the positive plate. If a material with dielectric constant κ is inserted to fill the gap while the battery remains connected as shown on the right, what charge will now be found on the positive plate?

(a) Q/κ
(b) Q/κ^2
(c) Q
(d) $\kappa^2 Q$
(e) κQ



7. (8 points) The electric potential has been graphed as a function of position along the x axis. At which of the indicated points does the electric field point in the negative x direction with the greatest magnitude?

(a) Point v
(b) Point iv
(c) Point iii
(d) Point ii
(e) Point i



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

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

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

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

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

Mass of an Electron $m_{\text{e}} = 9.109\times10^{-31}$ kg
Mass of a Proton $m_{\text{p}} = 1.673\times10^{-27}$ kg
Vacuum Permittivity $\epsilon_0 = 8.854\times10^{-12}$ C^2/N·m^2
Vacuum Permeability $\mu_0 = 4\pi\times10^{-7}$ 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