Version A

Quiz #2 Form #221

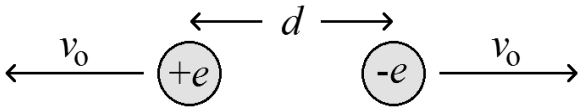
Physics 2212 K Summer 2016

Name:_____

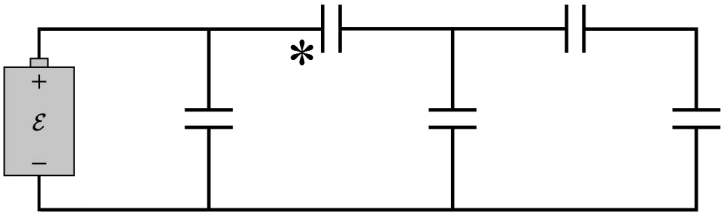
Recitation Section:_____

- 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. (18 points) A positron has the same mass as an electron, but has opposite charge. Consider a positron and an electron at rest, separated by a distance $d = 1.0\,\text{nm}$. What minimum velocity magnitude v_0 could be given to each particle, in opposite directions, so they move apart from each other and never return? If there is no such velocity magnitude because the particles will return for **any** v_0, prove it.



II. (16 points) All capacitors in this circuit have identical capacitances C. The battery has a potential difference $\Delta V = \mathcal{E}$ between its terminals. What is the energy stored (with respect to zero in the uncharged state) in the capacitor marked with an asterisk? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



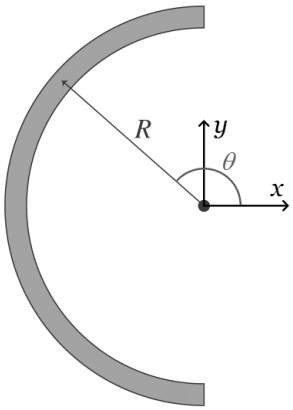
1. (5 points) In the problem above, let the energy you found stored in the asterisked capacitor be U_0. If the battery were replaced with one that had a potential difference $2\mathcal{E}$ between its terminal, what energy U would now be stored that capacitor?

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

III. (16 points) A rod of length L and cross-sectional area A is bent into a semi-circle about the origin. The rod has non-uniform volume charge density

$$\rho = \rho_0 \theta$$

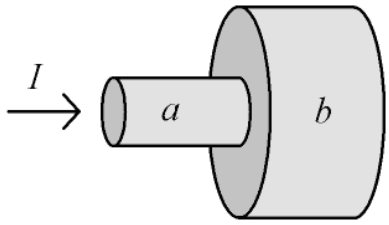
where ρ_0 is a positive constant, and θ is measured in radians from the $+x$ axis toward the $+y$ axis as shown. What is the electric potential at the origin, due to the rod, with respect to zero at infinity? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



2. (5 points) What is the direction of the electric potential at the origin?

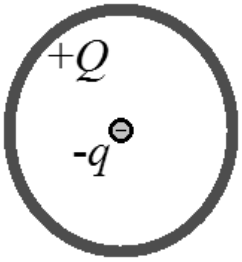
   (a) The electric potential at the origin is in the $+x$ direction.
   (b) The electric potential at the origin is in the $-x$ direction.
   (c) The electric potential at the origin has no direction.
   (d) The electric potential at the origin is in the $+y$ direction.
   (e) The electric potential at the origin is in the $-y$ direction.

3. (5 points) Current flows to the right through the wire shown. Segment b on the right has three times the diameter of segment a on the left. Segment b on the right has one half the conductivity of segment a on the left. Compare the electric field magnitude in segment b with that in segment a.



(a) $E_b = 2E_a/9$
(b) $E_b = 3E_a/2$
(c) $E_b = 3E_a/4$
(d) $E_b = 2E_a/3$
(e) $E_b = 9E_a/2$

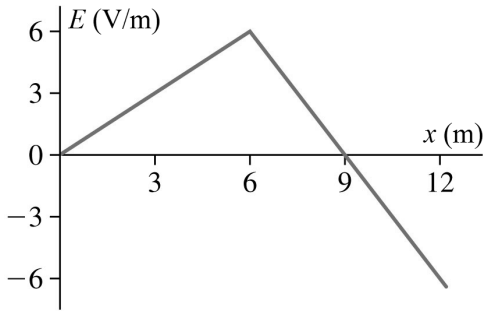
4. (5 points) A uniformly charged ring has radius R and total charge Q. With respect to zero at infinite separation, what is the electric potential energy U of a system consisting of this ring and a $-q$ point charge at its center?



(a) $U = +KQq/R$
(b) $U = +\infty$
(c) $U = -KQq/R$
(d) $U = 0$
(e) $U = -\infty$

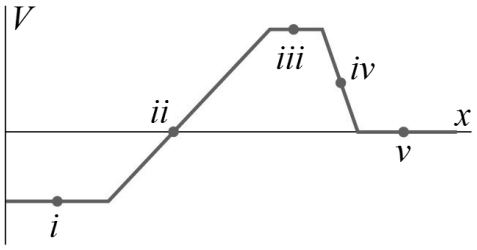
5. (5 points) A one-dimensional electric field points only in the $\pm x$ direction, with values shown in the graph. At which point in the range 0 m to 12 m does the electric potential have its maximum value?

(a) 6 m
(b) 9 m
(c) 12 m
(d) 0 m
(e) 3 m



6. (5 points) A one-dimensional electric field points only in the $\pm x$ direction. The electric potential associated with the field is shown in the graph. At which of the indicated points does the electric field point in the negative direction with greatest magnitude (that is, have its most negative value)?

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



7. (5 points) A parallel plate capacitor is charged with a battery. This results in energy U_0 being stored in the capacitor (with respect to zero in the uncharged state). The battery **is disconnected** from the capacitor and insulating handles are used to push the plates closer together, until they have half their original spacing. How much energy U is stored in the capacitor, now?

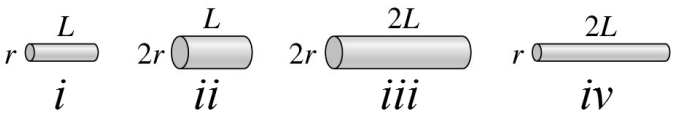
(a) $U = U_0$
(b) $U = 2U_0$
(c) $U = U_0/2$
(d) $U = 4U_0$
(e) $U = U_0/4$

8. (5 points) A parallel plate capacitor is charged with a battery. This results in energy U_0 being stored in the capacitor (with respect to zero in the uncharged state). The battery **remains connected** to the capacitor and insulating handles are used to push the plates closer together, until they have half their original spacing. How much energy U is stored in the capacitor, now?

(a) $U = 4U_0$
(b) $U = U_0/2$
(c) $U = U_0/4$
(d) $U = U_0$
(e) $U = 2U_0$

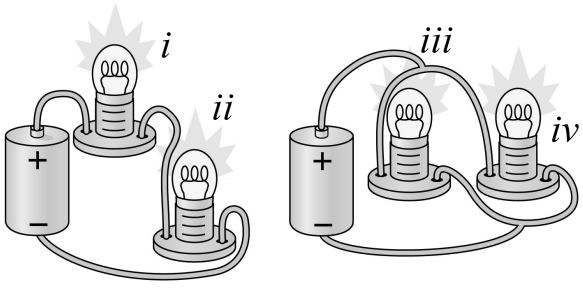
9. (5 points) Four wires are all made of the same material, but have different dimensions, as shown. Rank the resistances between the ends of the four wires from greatest to least.

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



10. (5 points) Four identical light bulbs are connected to two identical batteries, as shown. Which bulb(s) is brightest?

(a) Bulb ii is brightest.
(b) Bulbs iii and iv are equally bright, and brighter than bulbs i and ii.
(c) Bulb iv is brightest.
(d) Bulbs i and ii are equally bright, and brighter than bulbs iii and iv.
(e) Bulb i is brightest.



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

Series :

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

Parallel :

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

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

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

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

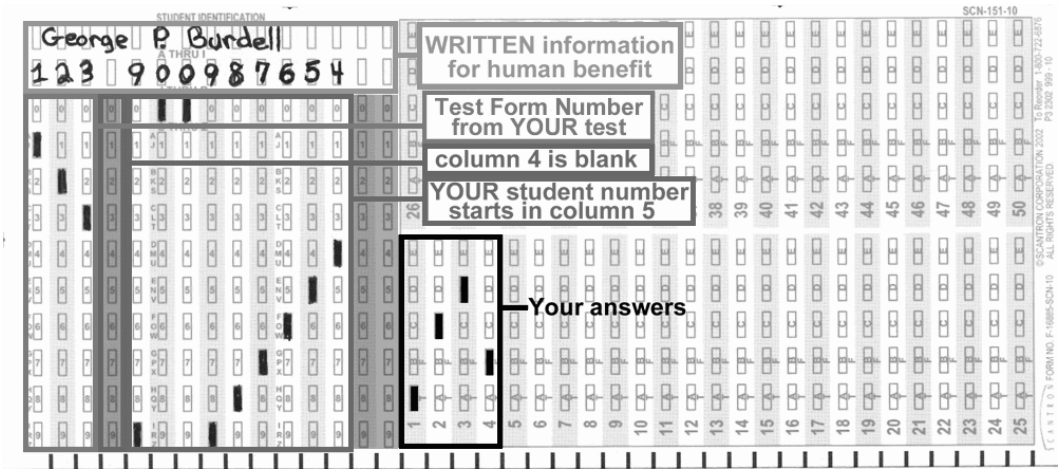
Fundamental Charge $e = 1.602\times10^{-19}\,\mathrm{C}$
Earth's gravitational field $g = 9.81\,\mathrm{N/kg}$
Coulomb constant $K = 8.988\times10^{9}\,\mathrm{N{\cdot}m^2/C^2}$

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

Unless otherwise directed, friction, drag, and gravity should be neglected.
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 **221**

Recitation Sections

	Room 131
TUESDAY	
2:20–3:10 pm	K04 Daum, Marcus
3:20–4:10 pm	K03 Daum, Marcus
4:20–5:10 pm	K01 Daum, Marcus
WEDNESDAY	
2:20–3:10 pm	K06 Koh, Daegene
3:20–4:10 pm	K05 Koh, Daegene
4:20–5:10 pm	K02 Koh, Daegene
THURSDAY	
2:20–3:10 pm	K08 Koh, Daegene
3:20–4:10 pm	
4:20–5:10 pm	K09 Daum, Marcus