Version

A

Quiz #1 Form #211

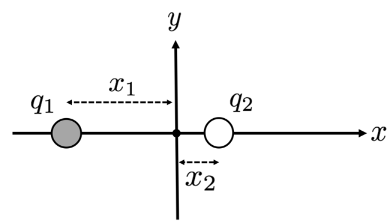
Physics 2212 GH Spring 2016

Name:______________________________

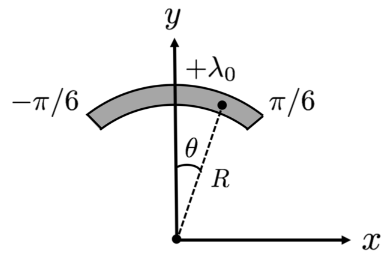
Recitation Section:_______________________

- 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. (14 points) Two positively-charged particles are located on the x axis as shown. The first particle carries charge $q_1 = +5.0\,\text{nC}$ and is located at $x_1 = -7.0\,\text{cm}$ from the origin. The second particle carries charge $q_2 = +8.0\,\text{nC}$ and is located at $x_2 = +3.0\,\text{cm}$ from the origin. At what location is the total electric field zero (other than infinity)?

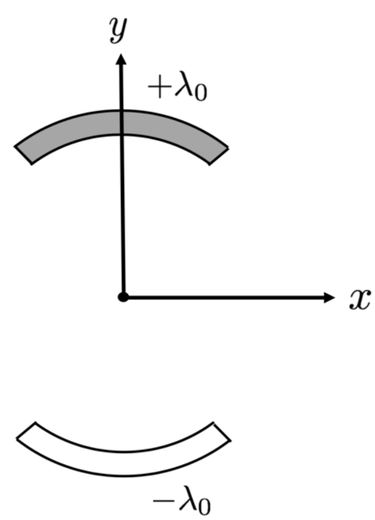


II. (18 points) A flexible rod is bent into an circular arc of radius R as shown. The arc subtends a total angle of $\pi/3$. It is charged and carries a uniform positive linear charge density $+\lambda_0$. Find an expression for the magnitude of the electric field E_0 at the origin, in terms of parameters defined in the problem and physical or mathematical constants.

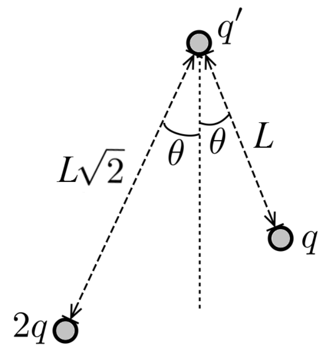


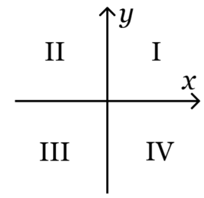
1. (5 points) An arc similar to the one in the problem above, but carrying a uniform linear charge density of opposite sign $-\lambda_0$, is added as shown. Both arcs share the same center. What is the magnitude of the new electric field $\left|\vec{E}_1\right|$ at the origin, compared to $\left|\vec{E}_0\right|$ found in the problem above?

   (a) $\left|\vec{E}_1\right| = \left|\vec{E}_0\right|/2$
   (b) $\left|\vec{E}_1\right| = 0$
   (c) $\left|\vec{E}_1\right| = \left|\vec{E}_0\right|/\sqrt{2}$
   (d) $\left|\vec{E}_1\right| = \left|\vec{E}_0\right|\sqrt{2}$
   (e) $\left|\vec{E}_1\right| = 2\left|\vec{E}_0\right|$



2. (5 points) What is the direction of the electric field at the location of the charge q', due to the other two charges? *Note:* All three charges are positive.





(a) In quadrant III, but not along an axis.
(b) In quadrant IV, but not along an axis.
(c) Directly along an axis.
(d) In quadrant II, but not along an axis.
(e) In quadrant I, but not along an axis.

III. (18 points) In the question above, $q = 2.0\,\text{nC}$, $q' = 5.0\,\text{nC}$, $L = 3.0\,\text{mm}$, and $\theta = 41°$. Calculate the magnitude of the net electrostatic force on charge q'.

3. (5 points) An uncharged ball of aluminum foil is hanging from a string. Which of the situations below will produce a force of repulsion on the foil ball?

   (a) Rub a glass rod with a piece of wool; then bring the rubbed end of the rod close to the foil ball.
   (b) There is no way to repel a neutral ball using a charged object.
   (c) Rub a glass rod with a piece of wool; connect the unrubbed end to the ground momentarily; then bring the rubbed end of the rob close to the foil ball.
   (d) Rub a glass rod with a piece of wool; then bring the wool close to the foil ball.
   (e) Rub a glass rod with a piece of wool; flip the rod around; then bring the unrubbed end close to the foil ball.

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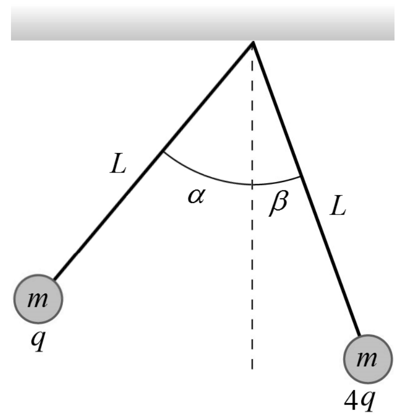
4. (5 points) A H^+ ion is hovering stationary in space when an electric field is switched for 0.50 seconds. After the field is switched off, the H^+ ion's speed is measured. The procedure is then repeated with a Ca^{2+} ion, which is exposed to the same electric field for the same length of time. What is the relation between the H^+ and Ca^{2+} ions' speeds? The ions are far enough apart that you can ignore any interaction between them. $m_{\mathrm{H}} = 1m_p$ and $m_{\mathrm{Ca}} = 40m_p$.

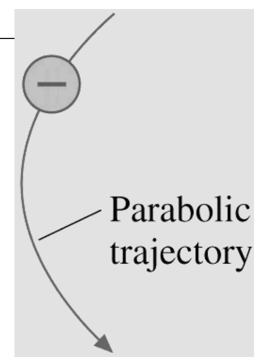
   (a) $v_{\mathrm{H}} = 20v_{\mathrm{Ca}}$
   (b) $v_{\mathrm{H}} = v_{\mathrm{Ca}}$
   (c) $v_{\mathrm{H}} = 400v_{\mathrm{Ca}}$
   (d) $v_{\mathrm{H}} = \sqrt{20}v_{\mathrm{Ca}}$
   (e) $v_{\mathrm{H}} = 40v_{\mathrm{Ca}}$

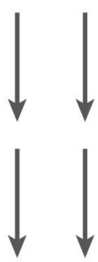
5. (5 points) Two small balls, each with mass m, hang from massless cords of length L. One ball has charge q and hangs at an angle α from the vertical. The other ball has charge $4q$ and hangs at angle β from the vertical. In the figure, $\alpha = 2\beta$. Is that the actual relationship between α and β? If not, what is the relationship? (*On Earth. Do NOT neglect gravity!*)

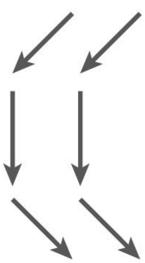


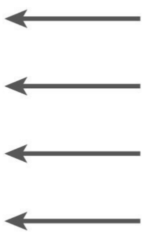
(a) No, $\alpha = \beta/2$.
(b) No, $\alpha = \beta$.
(c) Yes, $\alpha = 2\beta$.
(d) No, $\alpha < \beta$, but $\alpha \neq \beta/2$.
(e) No, $\alpha > \beta$, but $\alpha \neq 2\beta$.

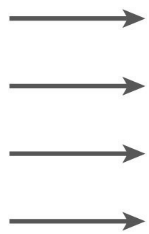
6. (5 points) A negatively-charged particle follows a parabolic trajectory. Which electric field is responsible?

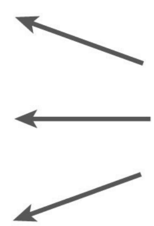


(a) 

(b) 

(c) 

(d) 

(e) 

7. (5 points) A very small copper sphere and a very small iron sphere are initially neutral. 10 million electrons are transferred from the copper sphere to the iron sphere. If the two spheres are $2.0\,\mu$m apart, what is the electrostatic force between them?

(a) 5.8×10^{-10} N
(b) 5.8×10^{-3} N
(c) 3.6×10^{16} N
(d) 1.2×10^{-8} N
(e) 1.2×10^{-1} N

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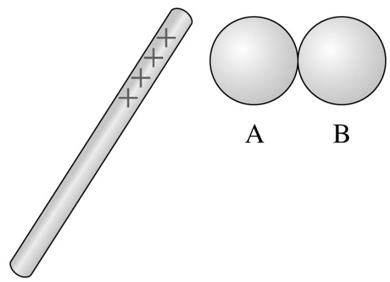
8. (5 points) In situation (i), an electric dipole is released near a fixed particle with positive charge $+q$. In situation (ii), an electric dipole is released near a fixed particle with negative charge $-q$. The two situations are separate (that is, the particles and dipoles do not interact with those in the other situation). After each dipole is released and is free to rotate and/or translate, how does each move?

(a) Both dipoles remain perfectly still.
(b) Both dipoles rotate and move toward the fixed charge.
(c) Both dipoles rotate. The dipole in situation i moves toward the fixed charge, and the dipole in situation ii moves away from it.
(d) Both dipoles rotate. The dipole in situation i moves away from the fixed charge, and the dipole in situation ii moves toward it.
(e) Both dipoles rotate and then remain in place.

9. (5 points) How could two identical conducting spheres be given equal non-zero charges?

Start with the spheres touching. Bring a charged object nearby, as shown. Then ...

(a) briefly connect the sphere B to ground, separate the spheres, and remove the charged object.
(b) separate the spheres, remove the charged object, and briefly connect sphere B to ground.
(c) briefly connect sphere B to ground, remove the charged object, and separate the spheres.
(d) separate the spheres, briefly connect sphere B to ground, and remove the charged object.
(e) separate the spheres, and remove the charged object.

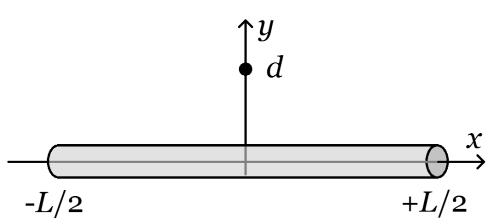


10. (5 points) A thin insulating rod of length L lies on the x axis, with its center at the origin, as shown. The rod has a non-uniform linear charge density λ that depends on position x according to

$$\lambda = \lambda_0 \sin\left(\pi \frac{x}{L}\right)$$

where λ_0 is a positive constant. What is the direction of the electric field, if any, at a distance d from the rod on the $+y$ axis?

(a) The electric field is in the $-y$ direction.
(b) The electric field is in the $+y$ direction.
(c) The electric field has no direction at that location, as its magnitude is zero.
(d) The electric field is in the $+x$ direction.
(e) The electric field is in the $-x$ direction.



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 :

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

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

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

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

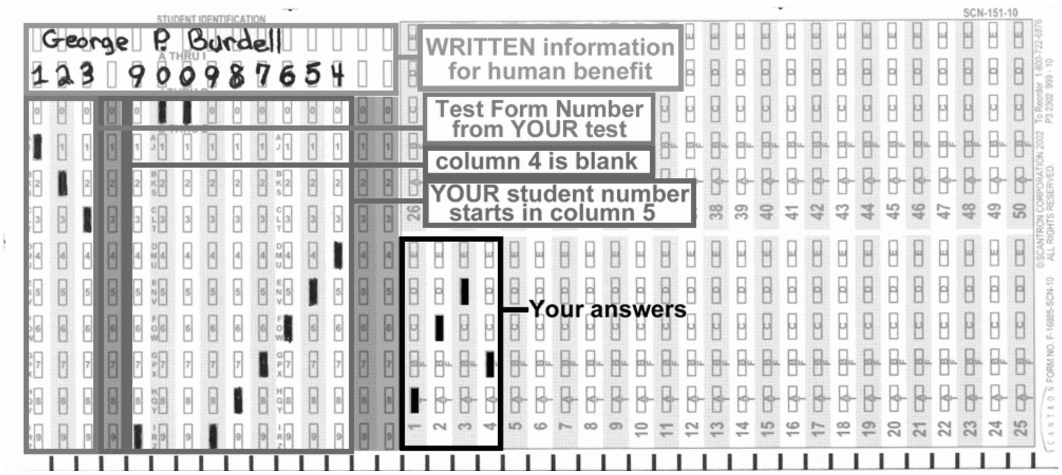
Fundamental Charge $e = 1.602\times10^{-19}\,\text{C}$
Earth's gravitational field $g = 9.81\,\text{N/kg}$
Coulomb constant $K = 8.988\times10^{9}\,\text{N}\cdot\text{m}^2/\text{C}^2$

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.

Version: A

Please remove this sheet from your Quiz or Exam



YOUR form number is **211**

Recitation Sections

	Clough 123	Clough 127	Clough 131	Clough 325	Clough 423
Wednesday					
1:05 pm				G01 Chang, Patrick **Note:** Meets in 323	
2:05 pm					G06/H01 Daum, Marcus
3:05 pm			G05/H05 Daum, Marcus		
4:05 pm		G02 Daum, Marcus		H02 Chang, Patrick	
5:05 pm	G09 Chang, Patrick	H06/H09 Daum, Marcus			
Thursday					
12:05 pm		H07 Daum, Marcus			
1:05 pm					
2:05 pm					
3:05 pm			G03 Daum, Marcus	G07 Chang, Patrick	H03 Tao, Liangyu
4:05 pm				G04 Chang, Patrick	
5:05 pm		G08 Tao, Liangyu		H04/H08 Chang, Patrick	