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

Series :

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

Parallel :

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

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

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

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

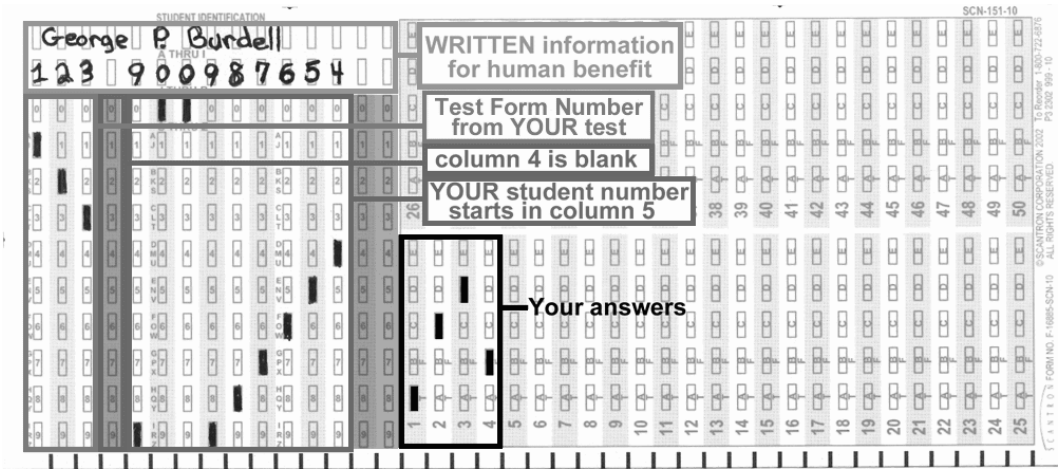
Fundamental Charge $e = 1.602\times10^{-19}\,\mathrm{C}$
Earth's gravitational field $g = 9.81\,\mathrm{N/kg}$
Coulomb constant $K = 8.988\times10^{9}\,\mathrm{N{\cdot}m^2/C^2}$

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 **211**

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

Version A

Quiz #1 Form #211

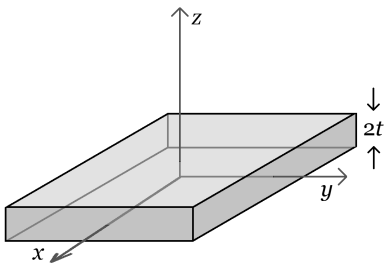
Physics 2212 K Summer 2016

Name:_____

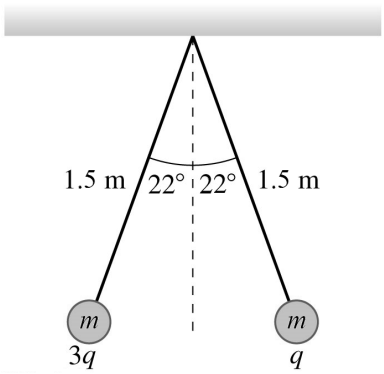
Recitation Section:_____

- 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 uniform infinite insulating slab of charge has a positive volume charge density ρ, and a thickness $2t$, extending from $-t$ to $+t$ in the z direction. In the x and y directions, it is infinite in extent. What is the magnitude of the electric field at a position $-3t/4$ inside the slab on the z axis? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



II. (16 points) Two point charges, each of mass $m = 4.0\,\text{g}$, on threads 1.5 m long, repel each other after being charged to q and $3q$ as shown in the figure below. What is the charge q? (*On Earth. Do NOT neglect gravity.*)



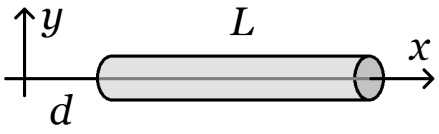
1. (5 points) Let the magnitude of the tension in the thread on the left, attached to the charge $3q$, be T_{left}. What is the magnitude of the tension in the thread on the right?

   (a) $T_{\text{right}} = T_{\text{left}}$
   (b) $T_{\text{right}} = T_{\text{left}}/9$
   (c) $T_{\text{right}} = 3T_{\text{left}}$
   (d) $T_{\text{right}} = T_{\text{left}}/3$
   (e) $T_{\text{right}} = 9T_{\text{left}}$

III. (16 points) A thin rod with cross-sectional area A and length L lies on the x axis. It has a non-uniform volume charge density ρ that depends on position x according to

$$\rho = \rho_0 \left(\frac{x}{L}\right)$$

What is the magnitude of the electric field at the origin? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.

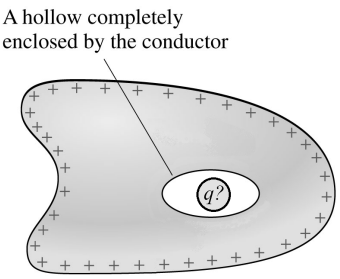


2. (5 points) What is the direction of the electric field at the origin?

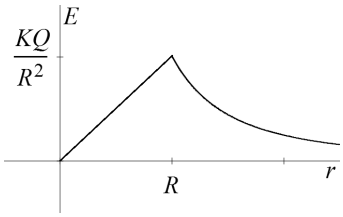
   (a) The field at the origin has no direction, as its magnitude is zero.
   (b) In the $+x$ direction regardless of the sign of ρ_0.
   (c) In the $-x$ direction regardless of the sign of ρ_0.
   (d) In the $+x$ direction if $\rho_0 > 0$, but in the $-x$ direction if $\rho_0 < 0$.
   (e) In the $-x$ direction if $\rho_0 > 0$, but in the $+x$ direction if $\rho_0 < 0$.

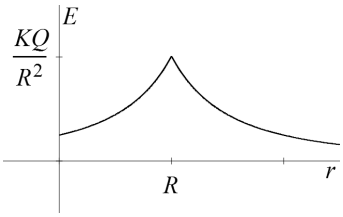
3. (5 points) A hollow conductor carries a net charge $Q = +5\,\mu$C, but the charge on the outer surface is found to $+3\,\mu$C. Describe the particle within the hollow.

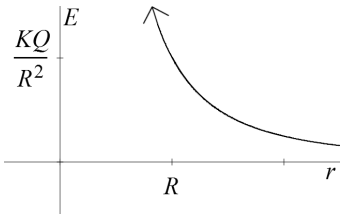
(a) The particle has a charge of $q = -2\,\mu$C.
(b) The particle is positively charged, but the amount of charge depends on the particular location of the particle within the hollow.
(c) The particle has a charge of $q = +2\,\mu$C.
(d) The particle is negatively charged, but the amount of charge depends on the particular location of the particle within the hollow.
(e) The particle is neutral.

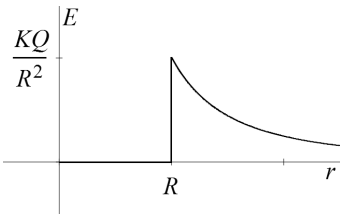


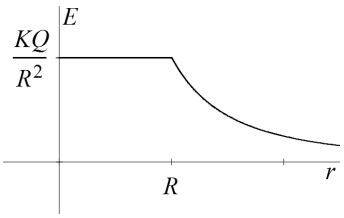
4. (5 points) A uniform solid sphere of charge has radius R and positive total charge Q. Which graph best represents the electric field it creates, as a function of distance r from the center?

(a)


(b)


(c)


(d)


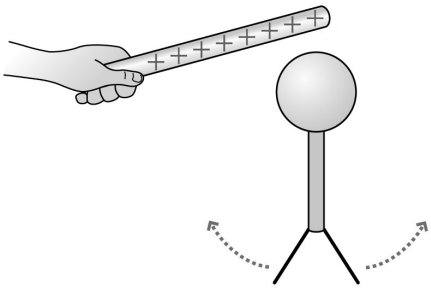
(e)


5. (5 points) When a particle of mass m and charge $-q$ is released from rest at the negative plate of a parallel-plate capacitor, it reaches the positive plate at a time Δt_1. When a particle of mass $2m$ and charge $+q$ released from rest at the positive plate of the same capacitor, it reaches the negative plate at a time Δt_2. What is the ratio of times, $\Delta t_2/\Delta t_1$?

(a) $\Delta t_2/\Delta t_1 = 2$
(b) $\Delta t_2/\Delta t_1 = 1$
(c) $\Delta t_2/\Delta t_1 = 1/2$
(d) $\Delta t_2/\Delta t_1 = \sqrt{2}$
(e) $\Delta t_2/\Delta t_1 = 1/\sqrt{2}$

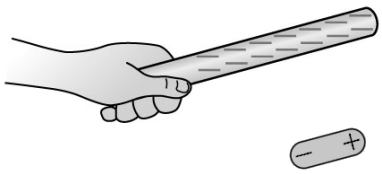
6. (5 points) An electroscope is originally neutral, then a positively-charged rod is brought nearby (but not touching) the sphere, as shown. Why do the leaves move apart?

(a) The electroscope remains neutral, but is polarized.
The negatively-charged leaves repel each other.
(b) The electroscope is now positively charged.
The positively-charged leaves repel each other.
(c) The electroscope remains neutral, but is polarized.
The negatively-charged leaves are attracted up toward the rod.
(d) The electroscope is now negatively charged.
The negatively-charged leaves are attracted up toward the rod.
(e) The electroscope remains neutral, but is polarized.
The positively-charged leaves repel each other.



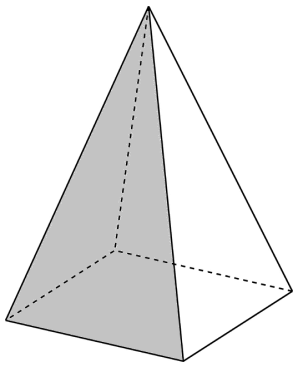
7. (5 points) The dipole is held near the negatively-charged rod as shown. If gravity can be neglected, how, if at all, will the dipole move when it is released?

(a) It doesn't rotate or move.
(b) It rotates clockwise and moves away from the rod.
(c) It rotates counter-clockwise and moves toward the rod.
(d) It just rotates counter-clockwise.
(e) It just rotates clockwise.



8. (5 points) A pyramid has a square base with $s = 14\,\text{cm}$ edges. The sides are isosceles triangles, with one edge of length s and two edges of length $2s$. The base is parallel to the ground, and a vertical uniform electric field of strength $285\,\text{N/C}$ passes upward through the pyramid. What is the electric flux through the front (shaded) side?

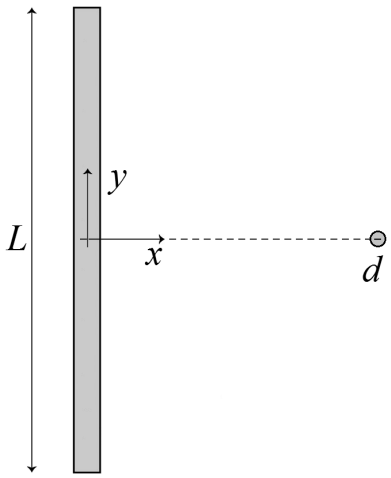
(a) $-0.36\,\text{N}\cdot\text{m}^2/\text{C}$
(b) $5.6\,\text{N}\cdot\text{m}^2/\text{C}$
(c) $1.4\,\text{N}\cdot\text{m}^2/\text{C}$
(d) $0.36\,\text{N}\cdot\text{m}^2/\text{C}$
(e) $-1.4\,\text{N}\cdot\text{m}^2/\text{C}$



9. (5 points) A thin insulating rod of length L lies on the y axis, with its center at the origin, as shown. The rod has a non-uniform linear charge density λ that depends on position y according to

$$\lambda = \lambda_0 \cos\left(\pi \frac{y}{L}\right)$$

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



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

10. (5 points) Thin rods of various lengths, but having the same uniform linear charge density λ, are bent into arcs with the same radius R. Since the rods are of various lengths, they will subtend various angles θ. For what angle θ will the magnitude of the electric field at the center of the arc be greatest?

(a) $\theta = 3\pi/4$
(b) $\theta = \pi/4$
(c) $\theta = \pi/2$
(d) $\theta = 3\pi/2$
(e) $\theta = \pi$