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

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

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

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

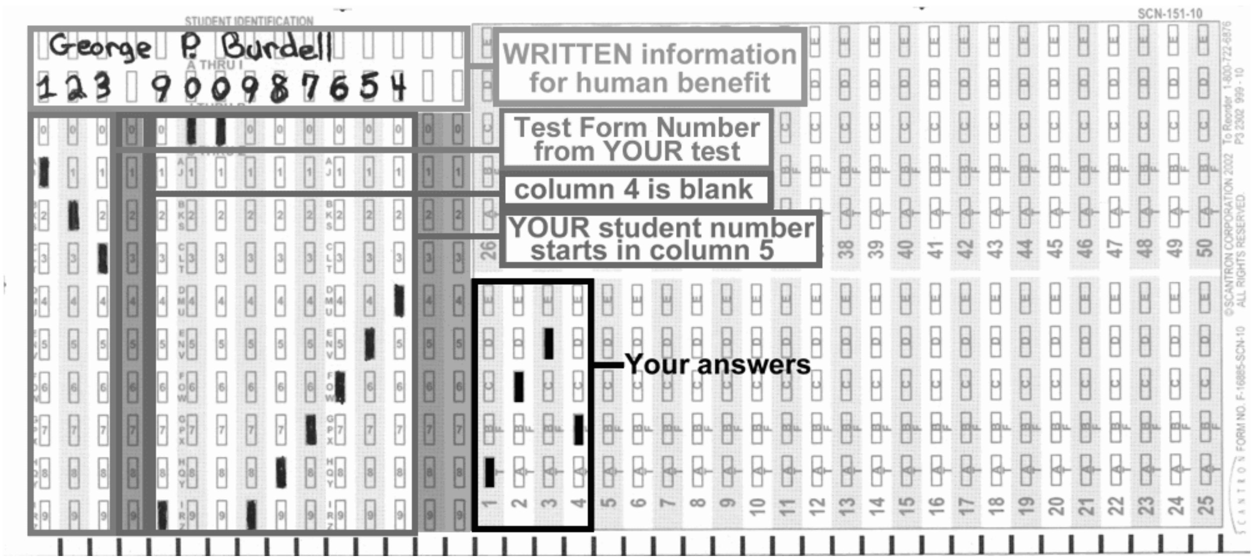
Fundamental Charge $e = 1.602\times10^{-19}\,\text{C}$
Earth's gravitational field $g = 9.81\,\text{N/kg}$
Coulomb constant $K = 8.988\times10^{9}\,\text{N}\cdot\text{m}^2/\text{C}^2$
Speed of Light $c = 2.998\times10^{8}\,\text{m/s}$

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 $\epsilon_0 = 8.854\times10^{-12}\,\text{C}^2/\text{N}\cdot\text{m}^2$
Vacuum Permeability $\mu_0 = 4\pi\times10^{-7}\,\text{T}\cdot\text{m/A}$

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



YOUR form number is **225**

Recitation Sections

	Clough 127	Clough 131
Monday		
1:55 – 2:45 pm		J05 Girdhar, Anant
3:00 – 3:50 pm	G05 Girdhar, Anant	
4:30 – 5:20 pm	G06 Girdhar, Anant	J06 Bapat, Chaitanya
6:00 – 6:50 pm	G07 & J07 Bernardes, Sarah	
Tuesday		
12:00 – 12:50 pm	G08 Huang, Shengnan	J08 Daum, Marcus
3:00 – 3:50 pm	G09 Huang, Shengnan	J09 Daum, Marcus
4:30 – 5:20 pm	G10 Huang, Shengnan	J10 Daum, Marcus
Wednesday		
3:00 – 3:50 pm	G01 Bapat, Chaitanya	J01 Bernardes, Sarah
4:30 – 5:20 pm	G02 Bapat, Chaitanya	J02 Bernardes, Sarah
Thursday		
12:00 – 12:50 pm	G03 Huang, Shengnan	J03 Daum, Marcus
3:00 – 3:50 pm	G04 Huang, Shengnan	J04 Daum, Marcus

Version A

Quiz #2 Form #225

Physics 2212 G&J Fall 2017

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 1–7. 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 electron (mass m_e, charge $-e$) is at rest on the surface of a fixed uniform insulating sphere with positive charge Q and radius R. The electron is then given a speed v_0 away from the sphere. What maximum distance from the center of the sphere will the electron reach? Express your answer in terms of the parameters defined in the problem, and physical or mathematical constants.

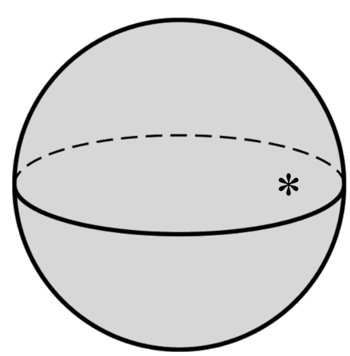
II. (16 points) A radially symmetric insulating sphere of charge has a radius R and a non-uniform volume charge density ρ that depends on distance r from the center according to

$$\rho = \rho_0 \left(\frac{r}{R}\right)^2$$

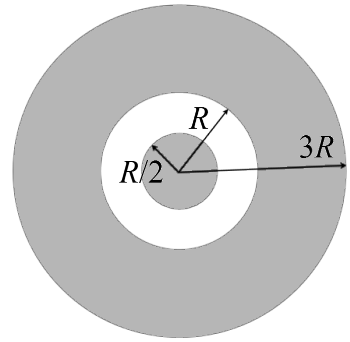
where ρ_0 is a positive constant. What is the magnitude of the electric field at a distance $2R/3$ from the center? Express your answer in terms of the parameters defined in the problem, and physical or mathematical constants.

1. (6 points) The sphere in the problem above is shown at the right. What is the direction of the electric field at the point indicated with an asterisk, a distance $2R/3$ from the center?

   (a) Away from the center.
   (b) Toward the center.
   (c) Up the page.
   (d) Out of the page.
   (e) Down the page.



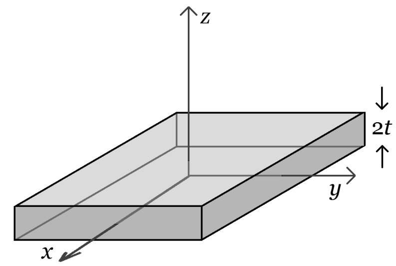
III. (16 points) A positively charged insulating cylinder with radius $R/2$ has the uniform volume charge density ρ_0. The cylinder is placed at the center of a negatively charged insulating hollow cylinder with inner radius R, outer radius $3R$, and volume charge density $-\rho_0/4$. Calculate the magnitude of electric field at a distance $2R$ from the center of the cylinders. Express your answer in terms of the parameters defined in the problem, and physical or mathematical constants.



2. (6 points) In the problem above, the charge per unit length of the hollow insulating cylinder is $\lambda_{\text{HC}} = -8\lambda_{\text{IC}}$, where λ_{IC} is the charge per unit length on the inner insulating cylinder. Consider two cylindrical Gaussian surfaces with the same length. Gaussian surface A has radius $R/2 < r_A < R$, and Gaussian surface B has radius $r_B = 4R$. What is the relationship between the electric fluxes Φ_A and Φ_B measured through the surfaces A and B, respectively?

(a) $\Phi_B = +9\Phi_A$
(b) $\Phi_B = -7\Phi_A$
(c) $\Phi_B = +7\Phi_A$
(d) $\Phi_B = \Phi_A$
(e) $\Phi_B = -8\Phi_A$

3. (8 points) An infinite insulating slab has thickness $2t$. It extends to $\pm\infty$ in the x and y directions, and is centered on the z axis, extending to $\pm t$. It has a non-uniform volume charge density ρ that depends on position z according to



$$\rho = \rho_0 \left(\frac{z}{t}\right)^2$$

where ρ_0 is a constant. If it can be determined, what is the magnitude of the electric field at the origin?

(a) The magnitude cannot be determined because the sign of ρ_0 is not specified.
(b) The magnitude cannot be determined because the slab is infinite.
(c) $K\rho_0/t^2$
(d) $K\rho_0/z^2$
(e) Zero.

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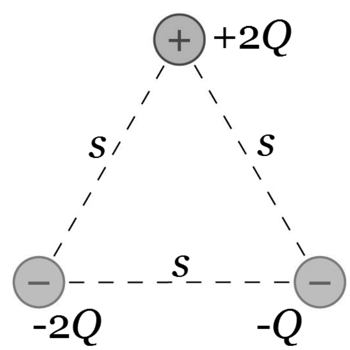
4. (8 points) Three particles with charges $+2Q$, $-2Q$, and $-Q$ are located at the vertices of an equilateral triangle with sides of length s. What is the electric potential energy of this system, with respect to zero at infinity?

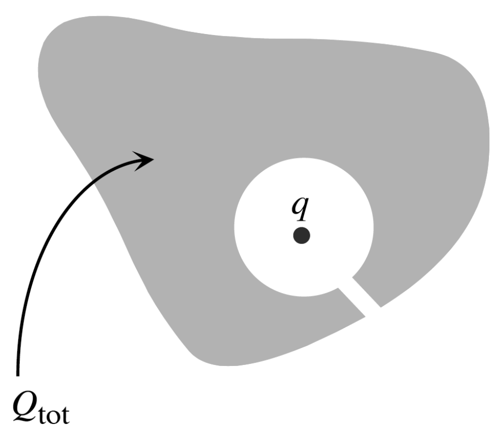


(a) $-KQ/s$
(b) $5KQ2/s$
(c) KQ^2/s^2
(d) $-4KQ^2/s$
(e) $4KQ^2/s$

5. (8 points) A negatively charged sphere is moved from some initial point to the final point in the direction of a uniform electric field. Considering a system consisting of the sphere and the source of the uniform field, during this displacement:

(a) the potential energy of the system decreases.
(b) the potential energy of the system increases if the speed of the sphere increases and the potential energy of the system decreases if the speed decreases.
(c) the potential energy of the system does not change.
(d) the potential energy of the system decreases if the speed of the sphere increases and the potential energy of the system increases if the speed decreases.
(e) the potential energy of the system increases.

6. (8 points) A conductor with a hollow cavity has a total charge Q_{tot} placed upon it. A small point charge q is then placed within the cavity, through a negligibly small hole in the conductor. What will be the resulting residual charge Q_{out} on the outer surface of the conductor, after equilibrium is reached?



(a) $Q_{\text{out}} = Q_{\text{tot}} - q$
(b) $Q_{\text{out}} = -Q_{\text{tot}} - q$
(c) $Q_{\text{out}} = -Q_{\text{tot}} + q$
(d) $Q_{\text{out}} = Q_{\text{tot}}$
(e) $Q_{\text{out}} = Q_{\text{tot}} + q$

7. (8 points) Two parallel conducting plates are separated by 7.5 cm and one of them is taken to be at zero volts. What is the potential difference between the plates if the electric potential 5.0 cm from the zero volt plate (and 2.5 cm away from the other plate) is +300 Volts?

   (a) +150 Volts
   (b) +900 Volts
   (c) -150 Volts
   (d) +450 Volts
   (e) +600 Volts