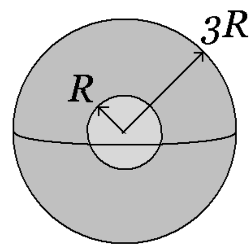
Version	Quiz #2 Form #225	Name:________________
A	Physics 2212 G Spring 2018	Recitation Section:____________

- 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.

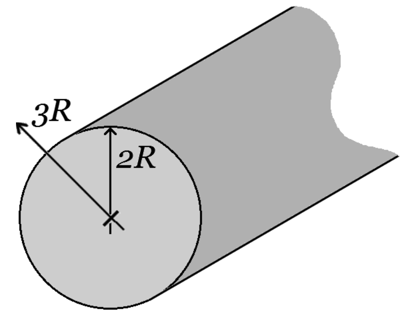
I. (16 points) A hollow insulating *sphere* has uniform volume charge density ρ, inner radius R, and outer radius $3R$. Find the magnitude of the electric field at a distance $2R$ from the center of the sphere. Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.



II. (16 points) An infinite solid insulating cylinder has radius $2R$, as illustrated. Its volume charge density, ρ, varies with distance r from the center according to

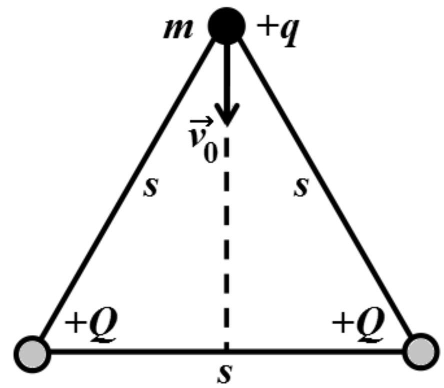
$$\rho = \rho_0 \frac{R}{r}$$

where ρ_0 is a positive constant. Find the electric field magnitude at a distance $3R$ from the center in terms of parameters defined in the problem, and physical or mathematical constants.



1. (6 points) In the problem above, what is the direction of the electric field at a distance $3R$ from the center?
   (a) Out of the page.
   (b) Away from the center.
   (c) This is not a meaningful question.
   (d) Toward the center.
   (e) Into the page.

III. (16 points) Two positive charges $+Q$ are fixed at the vertices of an equilateral triangle with sides of length s. A particle of positive charge $+q$ and mass m is positioned at the apex of the equilateral triangle as shown. It is launched from that point with an initial velocity $\vec{v}_0$ along the center line as shown. What must the minimum initial speed v_0 of this particle be so that it passes between the two fixed charges? Express your answer in terms of parameters defined in the problem and physical or mathematical constants. (*NOT on Earth—no gravity!*)

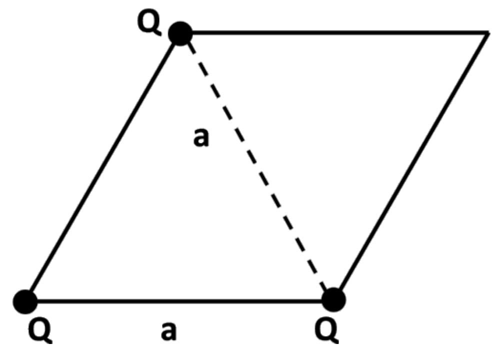


2. (6 points) Consider a situation in which the particle with charge q in the problem above were replaced by a particle with charge $q' = 2q$, and the fixed charges Q were each replaced with fixed charges $Q' = 2Q$. How does the minimum speed, v_0', required for the particle to pass the fixed charges in this situation, compare to your answer v_0 above?

(a) $v_0' = v_0/2$
(b) $v_0' = v_0/4$
(c) $v_0' = 2v_0$
(d) $v_0' = 4v_0$
(e) $v_0' = v_0$

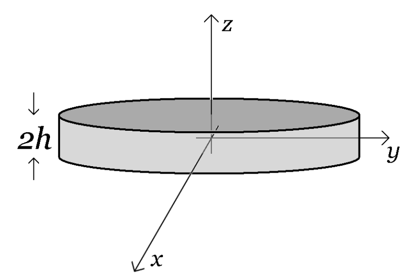
3. (8 points) Three particles, each with charge Q, are located as shown on different corners of a rhombus with sides of lengths a and a diagonal of length a (a rhombus has 4 equal length sides that do not intersect at right angles). With respect to zero at infinity, what is the electric potential at the empty vertex?

(a) $\frac{1}{\sqrt{3}}kQ/a$ (b) $\left(1+\frac{2}{\sqrt{3}}\right)kQ/a$ (c) $\left(2+\frac{1}{\sqrt{3}}\right)kQ/a$ (d) $\frac{2}{\sqrt{3}}kQ/a$ (e) $3kQ/a$



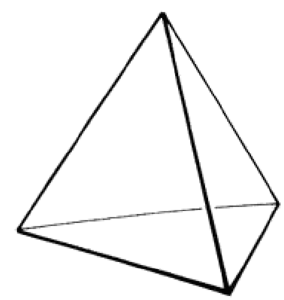
4. (8 points) An infinite slab with thickness $2h$ has uniform volume charge density ρ. The slab is infinite in the x and y directions and centered at the origin, extending from $-h$ to $+h$ along the z axis. A finite segment of the slab is illustrated. Are there any locations where the magnitude of the electric field is zero, and if so, where?

(a) Yes, the field has zero magnitude only at infinite distance, $z = \infty$.
(b) Yes, the field has zero magnitude only on the $x-y$ plane, $z = 0$.
(c) No, there are no locations at which the field has zero magnitude.
(d) Yes, the field has zero magnitude only at the slab surfaces, $z = \pm h$.
(e) Yes, the field has zero magnitude only at the origin, $z = x = y = 0$.



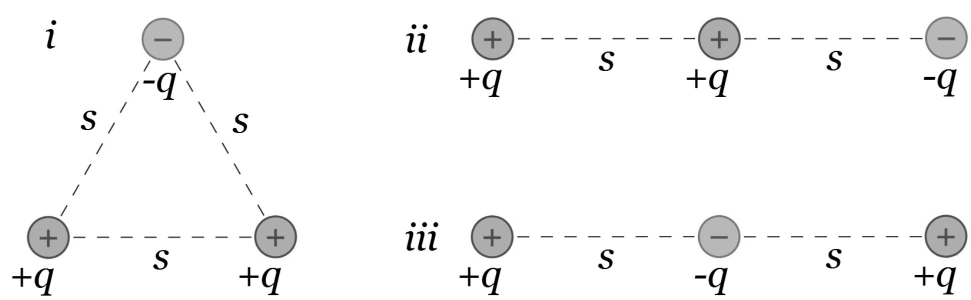
5. (8 points) A positive point charge $+q$ lies at the center of a tetrahedron, constructed of four equilateral triangles with edges a. What is the electric flux through the bottom face of the tetrahedron?

(a) $+q/\epsilon_0$
(b) $+qa^2\sqrt{3}/4\epsilon_0$
(c) $+qa^2\sqrt{3}/16\epsilon_0$
(d) $+q/4\epsilon_0$
(e) zero

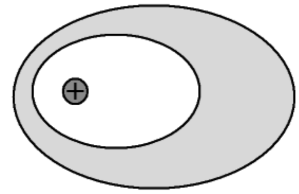


6. (8 points) Three isolated systems, i, ii, and iii, each consist of a negatively charged particle $-q$ and two positively charged particles $+q$, all with the same charge magnitude. Let the configuration with zero electric potential energy be the same for each system. Rank the electric potential energies U of the systems from greatest to least. (Remember that since the systems are isolated, there is no interaction between them.)

(a) $U_{ii} > U_i > U_{iii}$
(b) $U_{iii} > U_i > U_{ii}$
(c) $U_i = U_{iii} > U_{ii}$
(d) $U_i > U_{ii} > U_{iii}$
(e) $U_{ii} > U_{iii} = U_i$



7. (8 points) A hollow conductor, illustrated in cross-section, carries a net charge of -3 nC. Within its void lies a particle with a charge of +5 nC. What is the net charge on the inner and outer surfaces of the conductor at equilibrium?



(a) $Q_{\text{inner}} = 0\,\text{nC}$ while $Q_{\text{outer}} = -3\,\text{nC}$
(b) $Q_{\text{inner}} = -5\,\text{nC}$ while $Q_{\text{outer}} = +2\,\text{nC}$
(c) $Q_{\text{inner}} = -3\,\text{nC}$ while $Q_{\text{outer}} = 0\,\text{nC}$
(d) $Q_{\text{inner}} = -5\,\text{nC}$ while $Q_{\text{outer}} = -3\,\text{nC}$
(e) $Q_{\text{inner}} = -5\,\text{nC}$ while $Q_{\text{outer}} = +5\,\text{nC}$

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

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

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

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

Fundamental Charge $e = 1.602 \times 10^{-19}$ C
Earth's gravitational field $g = 9.81$ N/kg
Coulomb constant $K = 8.988 \times 10^{9}$ N·m^2/C^2
Speed of Light $c = 2.998 \times 10^{8}$ m/s

Mass of an Electron $m_{\text{e}} = 9.109 \times 10^{-31}$ kg
Mass of a Proton $m_{\text{p}} = 1.673 \times 10^{-27}$ kg
Vacuum Permittivity $\epsilon_0 = 8.854 \times 10^{-12}$ C^2/N·m^2
Vacuum Permeability $\mu_0 = 4\pi \times 10^{-7}$ 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