Name

Physics 2212 G

Spring 2019

Nine-digit Tech ID

Quiz #
1A

- **Print** your name and nine-digit Tech ID *very neatly* in the spaces above.
- Free-response problems are numbered I–III. Show all your work clearly, including all steps and logic. Write **darkly**. Blue or black ink is recommended. Do not make any erasures in your free-response work. Cross out anything you do not want evaluated. Box your answer.
- Multiple-choice questions are numbered 1–7. For each, select the answer most nearly correct, circle it on your quiz, and fill the bubble for your answer on this front page.
- Initial the odd pages in the top margin, in case the pages of your quiz get separated.
- The standard formula sheet is on the back of this page, which may be removed from the quiz form if you wish, but it must be submitted.
- If the page for a free-response problem has insufficient space for your work, ask a proctor for an additional sheet. If you wish this work to be evaluated, put your name on the sheet and make a note on the problem page, so graders will know where to look for your work.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.
- Your score will be posted when your quiz has been graded. Quiz grades become final when the next is given.

Fill in bubbles for your Multiple Choice answers darkly and neatly.

	a	b	c	d	e
1	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
2	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
3	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
4	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
5	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
6	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
7	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
	a	b	c	d	e

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 :

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

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

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

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

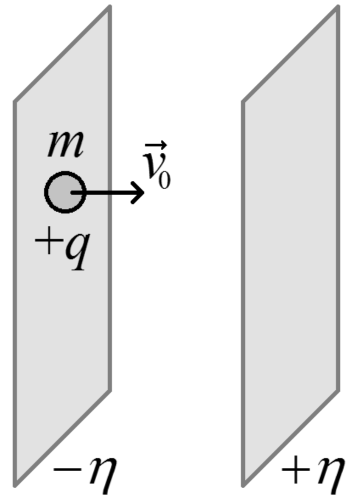
Fundamental Charge $e = 1.602\times10^{-19}\,\text{C}$
Earth's gravitational field $g = 9.81\,\text{N/kg}$
Coulomb constant $K = 8.988\times10^{9}\,\text{N}\cdot\text{m}^2/\text{C}^2$
Speed of Light $c = 2.998\times10^{8}\,\text{m/s}$

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 $\mu_0 = 4\pi\times10^{-7}\,\text{T}\cdot\text{m/A}$

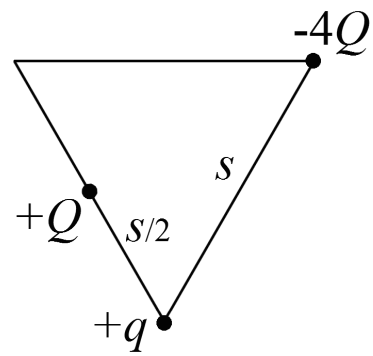
Unless otherwise directed, friction, drag, and gravity should be neglected, and all batteries and wires are ideal.
All derivatives and integrals in free-response problems must be evaluated.

You may remove this sheet from your Quiz or Exam

I. (16 points) A particle with mass $m = 36\,\text{g}$ and charge $q = 2.0\,\text{nC}$ is at rest against the negative plate of an ideal capacitor whose vertical plates have area charge density $\eta = \pm 6.0 \times 10^{-5}\,\text{C/m}^2$. The particle is launched at $\vec{v}_0 = 0.40\,\text{m/s}$ horizontally toward the positive plate. Assuming the distance between the plates is great enough that the particle does not strike the positive plate, how much time after launch is required for particle to return to the negative plate? (*On Earth, do* **NOT** *neglect gravity.*)



1. (6 points) Three charged particles are placed on an equilateral triangle with sides of length s. A positive charge $+q$ is placed at one vertex, and a negative charge $-4Q$ is placed at another. Finally, a positive charge $+Q$ is placed at the mid-point of one side, as shown. What is the direction of the electric force on the particle with charge $+q$?

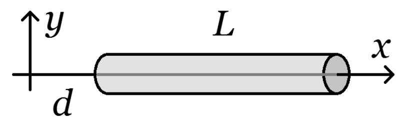


   (a) directly up the page
   (b) directly down the page
   (c) somewhere between rightward and up the page
   (d) directly rightward
   (e) somewhere between rightward and down the page

II. (16 points) In the problem above, what is the magnitude of the force on the particle with charge $+q$? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.

2. (6 points) A thin rod of length L lies on the x axis with one end at $x = d$, as shown. It has a non-uniform linear charge density λ the depends on position according to

$$\lambda = \lambda_0 \left(\frac{\pi x^2}{2L^2}\right) \cos\left[\left(\frac{\pi}{2}\right)\frac{x-d}{L}\right]$$



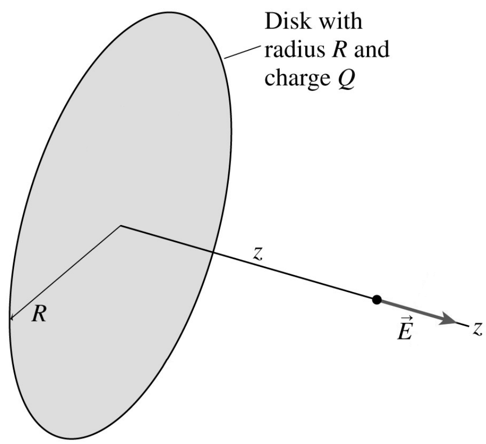
Where λ_0 is a constant. What is the direction of the electric field at the origin?

(a) Field is in the $+x$ direction regardless of the sign of λ_0.
(b) Field is in the $-x$ direction regardless of the sign of λ_0.
(c) Field has no direction, as the magnitude is zero.
(d) Field is in the $-x$ direction if λ_0 is positive, and in the $+x$ direction if λ_0 is negative.
(e) Field is in the $+x$ direction if λ_0 is positive, and in the $-x$ direction if λ_0 is negative.

III. (16 points) If λ_0 is a *positive* constant in the problem above, what is the magnitude of the electric field at the origin?

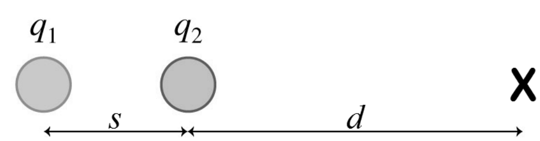
3. (8 points) A disk of radius R has uniform charge Q. Describe the electric field magnitude E on its axis z, near and far from the disk.

   (a) $E \propto 1/z^2$ both near and far from the disk.
   (b) The field approaches $Q/2\pi R^2\epsilon_0$ both near and far from the disk.
   (c) The field approaches $Q/2\pi R^2\epsilon_0$ near the disk. Far from the disk, $E \propto 1/z^2$.
   (d) $E \propto 1/z^2$ near the disk. Far from the disk, the field approaches $Q/2\pi R^2\epsilon_0$.
   (e) $E \propto 1/R^2$ near the disk. Far from the disk, $E \propto 1/z^2$.



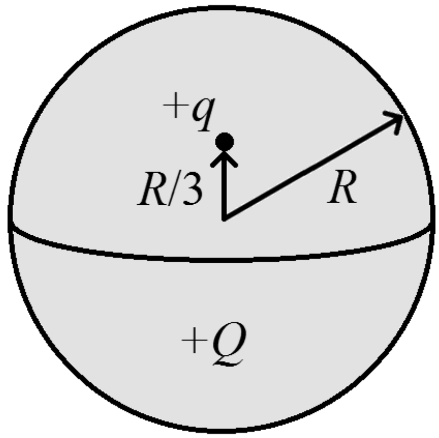
4. (8 points) Particles with charges q_1 and q_2 are separated by a distance s. There is a position "X" a distance d beyond q_2, as shown, where the electric field is zero. Compare q_1 and q_2.

   (a) q_1 and q_2 have the same sign, with $|q_2| = |q_1|$.
   (b) q_1 and q_2 have opposite signs, with $|q_2| < |q_1|$.
   (c) q_1 and q_2 have the same sign, with $|q_2| > |q_1|$.
   (d) q_1 and q_2 have the same sign, with $|q_2| < |q_1|$.
   (e) q_1 and q_2 have opposite signs, with $|q_2| > |q_1|$.



5. (8 points) A solid sphere of radius R has uniformly distributed charge $+Q$. A particle with charge $+q$ is embedded within it, a distance $R/3$ from the center. What is the magnitude of the electric force of the sphere on the particle?

   (a) $KQq/9R^2$
   (b) $KQq/3R^2$
   (c) $9KQq/R^2$
   (d) $KQq/27R^2$
   (e) $3KQq/R^2$



6. (8 points) Assume the charge separation distance s in the dipole shown is small compared to the distance r from the negative point charge to the dipole. If the dipole is released from rest in the position shown, what will its subsequent motion, if any, be?

   (a) It will rotate counterclockwise, then move down the page.
   (b) It will rotate counterclockwise, then move up the page.
   (c) It will rotate clockwise, then move up the page.
   (d) It will rotate clockwise, then move down the page.
   (e) It will remain motionless.

7. (8 points) The leaves of an initially neutral electroscope will spread apart if it is touched by a charged rod, or if the rod is just brought nearby. What happens to the leaves in those two situations when the charged rod is removed?
   (a) If the rod touched, the leaves collapse. But the second situation described is unphysical: if the rod is just brought nearby, the leaves would *not* spread.
   (b) The leaves collapse in both situations.
   (c) If the rod touched, the leaves collapse. If it was brought nearby, the leaves remain spread.
   (d) If the rod touched, the leaves remain spread. If it was brought nearby, the leaves collapse.
   (e) The leaves remain spread in both situations.