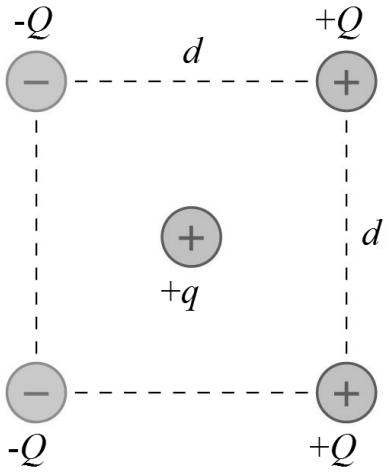
Name _____ Nine-digit Tech ID _____

Fall 2018 **Physics 2212 GJ** Quiz #

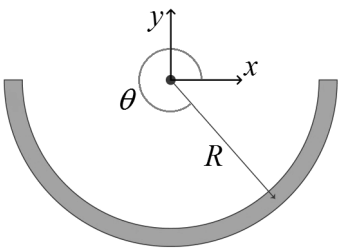
1A

- Put *nothing* other than your name and nine-digit Tech ID in the space 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. Box your answer.
- Multiple-choice questions are numbered 1–7. For each, select the answer most nearly correct, and fill the bubble for this answer on your quiz.
- 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.

I. (16 points) Five point particles are arranged on the corners and center of a square, as shown. If the square has sides of length $d = 2.5\,\text{cm}$, and $q = +1.5\,\mu\text{C}$ and $Q = +2.2\,\mu\text{C}$, what is the magnitude of the electric force on the particle with charge $+q$ in the center?



1. (6 points) A thin insulating rod is bent into a semi-circle of radius R about the origin from $\theta = \pi$ to $\theta = 2\pi$, as shown. It has a non-uniform linear charge density, λ, that depends on angular position according to



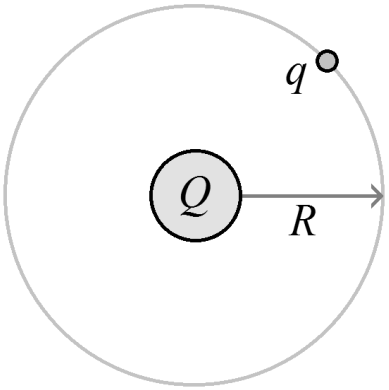
$$\lambda = \frac{\lambda_0}{\sin\theta}$$

where λ_0 is a positive constant. In what direction is the electric field at the origin?

ⓐ In the $+x$ direction.
ⓑ In the $-x$ direction.
ⓒ In the $+y$ direction.
ⓓ In the $-y$ direction.

II. (16 points) In the problem above, 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.

III. (16 points) A dust speck with mass $m = 22\,\mu\text{g}$ and charge $q = +0.17\,\mu\text{C}$ is in a circular orbit around a uniform sphere with mass $M = 0.25\,\text{kg}$ and charge $Q = -3.2\,\mu\text{C}$. If the orbit has radius $R = 7.5\,\text{cm}$, what is the speed of the dust speck?

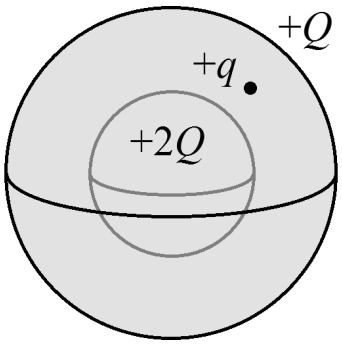


2. (6 points) In the problem above, let the speed of the dust speck be v_0. If the charge of the dust speck were doubled, but the charge of the sphere were halved, what would the new speed v' of the dust speck need to be, for the same orbit to be maintained?

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

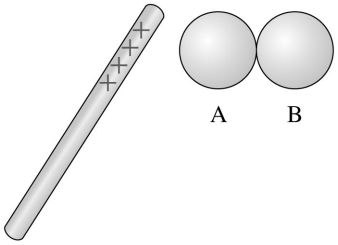
3. (8 points) A thin spherical shell has uniformly distributed positive charge $+Q$. Centered within it, a uniform solid sphere has positive charge $+2Q$. In the gap between them lies a particle with positive charge $+q$, a distance R from the center of the spheres. What is the electric force, if any, on the particle?

ⓐ KQq/R^2 away from the center
ⓑ KQq/R^2 toward the center
ⓒ $2KQq/R^2$ away from the center
ⓓ $3KQq/R^2$ away from the center
ⓔ There is no net force on the particle



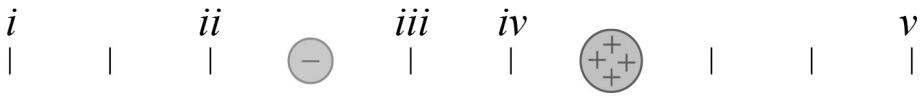
4. (8 points) Identical metal spheres A and B are initially neutral and touching. A positively charged rod is brought near sphere A, but not touching. Sphere B is briefly grounded, then the charged rod is removed. What is the resulting charge on each sphere?

ⓐ Sphere A has negative charge. Sphere B is neutral.
ⓑ Sphere A has negative charge. Sphere B has negative charge.
ⓒ Sphere A is neutral. Sphere B has positive charge.
ⓓ Sphere A has negative charge. Sphere B has positive charge.
ⓔ Sphere A is neutral. Sphere B is neutral.



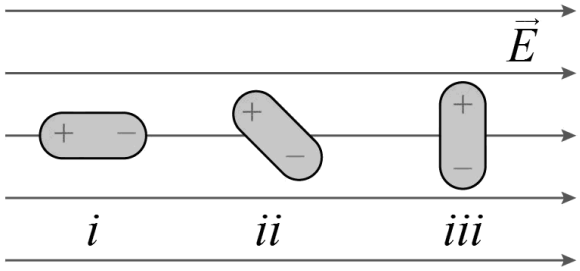
5. (8 points) The particle on the left has negative charge $-q$. The particle on the right has positive charge $+4q$. At which of the indicated locations is the electric field magnitude zero?

ⓐ At location iv.
ⓑ At location i.
ⓒ At location iii.
ⓓ At location ii.
ⓔ At location v.

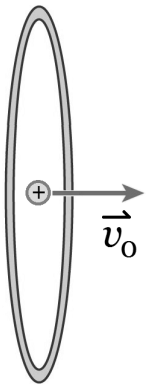


6. (8 points) Three identical electric dipoles lie in a uniform electric field. The dipoles are far apart, and do not interact with each other. Rank the torque magnitudes about the center of each dipole, from greatest to least.

ⓐ $iii > i > ii$
ⓑ $i > iii > ii$
ⓒ $ii > i > iii$
ⓓ $i > ii > iii$
ⓔ $iii > ii > i$



7. (8 points) The ring in the illustration carries a uniformly distributed positive charge. A small charged particle moves along the axis of the ring, having speed v_0 at the instant it passes through its center. Describe the acceleration of the particle as it moves away from the ring.



ⓐ The acceleration of the particle first increases, then decreases.
ⓑ The acceleration of the particle first decreases, then increases.
ⓒ The acceleration of the particle only increases.
ⓓ The acceleration of the particle only decreases.
ⓔ The acceleration of the particle remains constant.