Physics 4B
Fall 2017

average = 6.8
σ = 2.2

Name: Answer Key

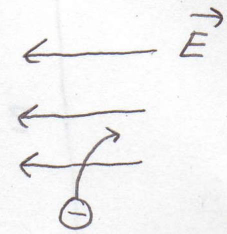
Lab (circle one): 8:00 am 11:15 am 2:45 pm

Quiz #2: Electric Fields

Problem 1 (2 points)
An electron traveling north enters a region where the electric field is uniform and points west. The electron:

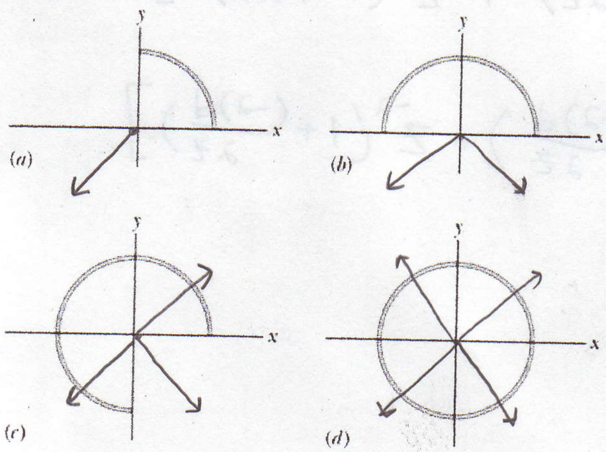
C

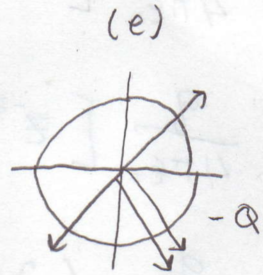
a) speeds up
b) slows down
c) veers east
d) veers west
e) continues with the same speed in the same direction



⇒ the force on a negative charge is in the opposite direction of $\vec{E}$

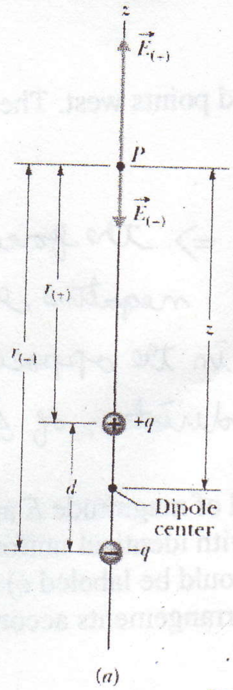
Problem 2 (3 points)
In Fig. *a*, a circular plastic rod with uniform charge $+Q$ produces an electric field of magnitude E at the center of curvature (at the origin). In Figs. *b*, *c*, and *d*, more circular rods, each with identical uniform charges $+Q$, are added until the circle is complete. A fifth arrangement (which would be labeled *e*) is like that in *d* except the rod in the fourth quadrant has charge $-Q$. Rank the five arrangements according to the magnitude of the electric field at the center of curvature, **greatest first**.

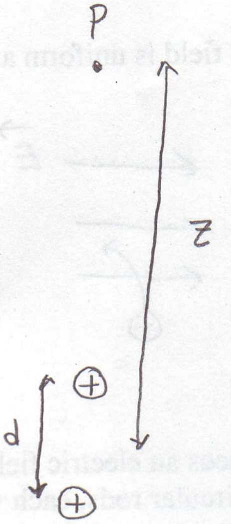




e, b, a = c, d

Problem 3 (5 points)
In the figure show below, instead of an electric dipole, assume that both charges are positive.
What is the electric field at point P, a distance z above the midpoint of the charges? Use the binomial expansion to simplify your answer in the limit that z >> d.





⇒ at point P, $\vec{E}$ from both charges points straight upwards

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{(z-d/2)^2} + \frac{1}{4\pi\varepsilon_0}\frac{q}{(z+d/2)^2}$$

$$E = \frac{q}{4\pi\varepsilon_0}\left[(z-d/2)^{-2} + (z+d/2)^{-2}\right]$$

$$E = \frac{q}{4\pi\varepsilon_0}\left[z^{-2}(1-d/2z)^{-2} + z^{-2}(1+d/2z)^{-2}\right]$$

$$= \frac{q}{4\pi\varepsilon_0}\left[z^{-2}\left(1+\frac{(-2)d}{2z}\right) + z^{-2}\left(1+\frac{(-2)d}{2z}\right)\right]$$

$$= \frac{q}{4\pi\varepsilon_0}(2z^{-2})$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2q}{z^2}(+\hat{j})$$

↓

note: for $z >> d$, the two charges look like a single point charge of charge $2q$