Ph202H/212H
W09 Homework – Due March 2, 2009

1. A rod of length L lies along the x axis between $x = 0$ and $x = L$. The portion of the rod between $x = 0$ and $x = L/2$ has a uniformly distributed negative charge $-Q/2$ and the portion of the rod between $x = L/2$ and $x = L$ has a uniformly distributed positive charge $+Q/2$.

(a) Find the electric field at a point P a distance d from the end of the rod on the x axis.

Answer: $E = \frac{Q}{4\pi\varepsilon_0}\left(-\frac{2}{d+L/2}+\frac{1}{d}+\frac{1}{d+L}\right)$

(b) In the limit $d >> L$, how would you expect the electric field to depend on the distance from the rod? Check that the electric field reduces to this in the limit. You will need to use the expansion $(1\pm x)^{-n} = 1 \mp nx + \frac{n(n+1)x^2}{2} + \cdots$

2. A rod of length L lies along the y axis between $y = -L/2$ and $y = +L/2$. The portion of the rod between $y = -L/2$ and $y = 0$ has a uniformly distributed negative charge $-Q/2$ and the portion of the rod between $y = 0$ and $y = +L/2$ has a uniformly distributed positive charge $+Q/2$.

(a) Find the electric field at a point P a distance d from the center of the rod on the x axis.

Answer: $E = \frac{Q}{2\pi\varepsilon_0 L}\left(-\frac{1}{d}+\frac{1}{\sqrt{d^2+L^2/4}}\right)$

(b) In the limit $d >> L$, how would you expect the electric field to depend on the distance from the rod? Check that the electric field reduces to this in the limit.

3. A rod in the shape of a semicircle of radius R carries a uniformly distributed charge $-Q/2$ on the lower quadrant and a uniformly distributed charge $+Q/2$ on its upper quadrant. What is the electric field at the center of the semicircle?

Answer: $E = \frac{Q}{2\pi^2\varepsilon_0 R^2}$

4. A long uniformly charged rod lies on the x axis and carries a linear charge density (charge per unit length) λ. Assume the rod extends from $x = 0$ to $x = \infty$. Find the electric field at point P at $x = 0$, $y = d$.

Answer: $E_x = -\frac{\lambda}{4\pi\varepsilon_0 d}$, $E_y = ???$