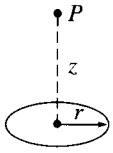
PHYSICS 507 – SPRING 2020
1st HOMEWORK
Dr. V. Lempesis

Hand in: Sunday 9th of February at 23:59

1. The electric field of a distance z above the center of a circular loop as shown in the figure, which carries a uniform line charge λ, is given by: $\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\frac{qz}{\left(r^2+z^2\right)^{3/2}}\hat{\mathbf{k}}$



What is the value of the field at a distance z such that $z << r$.? Give a qualitative explanation of the result. (2 marks)

2. (a) Find the value of the electric flux through the surface of a sphere containing 12 protons and 10 electrons. $|e| = 1.6\times10^{-19}\ C$, $\varepsilon_0 = 8.85\times10^{-12}\ F/m$.

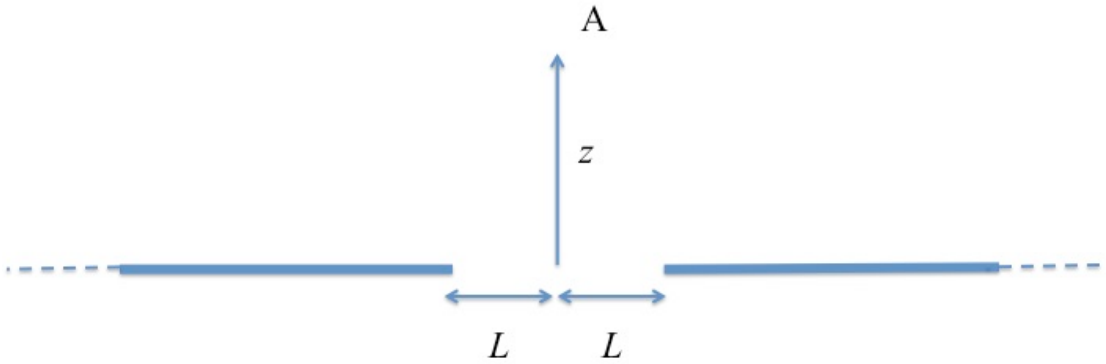
(2 marks)

(b) Does the size of the sphere matter in the answer of question (a)?

(1 mark)

3. Two infinite parallel planes carry equal but opposite uniform charge densities $\pm\sigma$. Find the field in each of three regions: (i) to the left of both, (ii) between them, (iii) to the right of both. (5 marks)

4. An infinitely long wire carries positive charge with uniform linear charge density λ. As the figure shows there is an interruption of the wire of total length $2L$. Find the total electric field at point A at a distance z from the center of the interrupted region (5 marks).



5. Find the charge density ρ if the electric field in the region is given by the relation

$$\mathbf{E} = \frac{az}{r}\hat{r} + br\hat{\phi} + cr^2z^2\hat{k}$$

where a, b, c are known positive constants and the vectors shown are the unit vectors in spherical coordinates. (5 marks)