BPHO & PUPC Class No. 20210612

Assignment 5 Electrostatics 20/07/2021 **Due on 11:00 pm 27/07/2021**

Please try your best to finish the assignment. You may not be able to complete every question, however, please write as much as you can. It is required that all the answers are written independently by yourself.

Please print the documents, write your solutions to each question and scan it so that you can post yours to our study group directly. It is better for you to combine all your documents in a single .pdf profile. Other format of documents is acceptable as well, please compress them in a single file with your name.

This assignment is totally worth 40 points.

Good luck!

Name: _____ Score: _____

Q1(10 points)

Force from a cone $**$

(a) A charge q is located at the tip of a hollow cone (such as an ice cream cone without the ice cream) with surface charge density σ. The slant height of the cone is L, and the half-angle at the vertex is θ. What can you say about the force on the charge q due to the cone?

(b) If the top half of the cone is removed and thrown away (see Fig. 1.31), what is the force on the charge q due to the remaining part of the cone? For what angle θ is this force maximum?

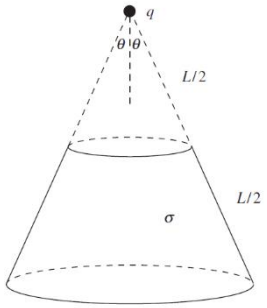

Figure 1.31.

Q2(8 points)

45-degree field line $**$

A half-infinite line has linear charge density λ. Find the electric field at a point that is "even" with the end, a distance ℓ from it, as shown in Fig. 1.33. You should find that the field always points up at a 45° angle, independent of ℓ.

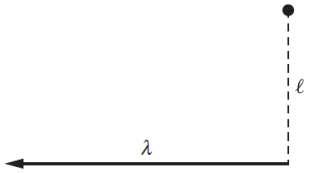

Figure 1.33.

Q3(12 points)

Hole in a plane $**$

(a) A hole of radius R is cut out from a very large flat sheet with uniform charge density σ. Let L be the line perpendicular to the sheet, passing through the center of the hole. What is the electric field at a point on L, a distance z from the center of the hole? *Hint:* Consider the plane to consist of many concentric rings.

(b) If a charge $-q$ with mass m is released from rest on L, very close to the center of the hole, show that it undergoes oscillatory motion, and find the frequency ω of these oscillations. What is ω if $m = 1$ g, $-q = -10^{-8}$ C, $\sigma = 10^{-6}$ C/m^2, and $R = 0.1$ m?

(c) If a charge $-q$ with mass m is released from rest on L, a distance z from the sheet, what is its speed when it passes through the center of the hole? What does your answer reduce to for large z (or, equivalently, small R)?