BPHO & PUPC Class No. 20210612

Assignment 6 Electrostatics2 26/07/2021 **Due on 11:00 pm 01/08/2021**

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(15 points)

A ring with radius R has uniform positive charge density λ. A particle with positive charge q and mass m is initially located at the center of the ring and is then given a tiny kick. If it is constrained to move in the plane of the ring, show that it undergoes simple harmonic motion (for small oscillations), and find the frequency. *Hint:* Find the potential energy of the particle when it is at a (small) radius, r, by integrating over the ring, and then take the negative derivative to find the force. You will need to use the law of cosines and also the Taylor series $1/\sqrt{1+\epsilon} \approx 1 - \epsilon/2 + 3\epsilon^2/8$.

Q2(15 points)

Consider a large flat horizontal sheet with thickness x and volume charge density ρ. This sheet is tangent to a sphere with radius R and volume charge density ρ_0, as shown in Fig. 1.38. Let A be the point of tangency, and let B be the point opposite to A on the top side of the sheet. Show that the net upward electric field (from the sphere plus the sheet) at B is larger than at A if $\rho > (2/3)\rho_0$. (Assume $x \ll R$.)

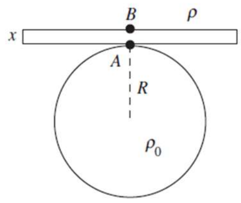

Figure 1.38.

Q3(10 points)

The electric field outside and an infinitesimal distance away from a uniformly charged spherical shell, with radius R and surface charge density σ, is given by Eq. (1.42) as σ/ϵ_0. Derive this in the following way.

(a) Slice the shell into rings (symmetrically located with respect to the point in question), and then integrate the field contributions from all the rings. You should obtain the incorrect result of $\sigma/2\epsilon_0$.

(b) Why isn't the result correct? Explain how to modify it to obtain the correct result of σ/ϵ_0. *Hint:* You could very well have performed the above integral in an effort to obtain the electric field an infinitesimal distance *inside* the shell, where we know the field is zero. Does the above integration provide a good description of what's going on for points on the shell that are very close to the point in question?