Department of Physics

IIT Kanpur, 2021-22 Ist Semester

PHY103AA (Physics - II) Tutorial # 4 28-12-2021

<u>Problems 4.1, 4.2, 4.3 and 4.4 will be discussed during the Tutorial Hour.</u>

Problem 4.1: A thick metallic shell of inner radius a and outer radius b has a charge Q on it. A point charge q is kept at the center of the shell. Calculate the charge on each surface of the shell. Also, calculate the electric field and potential everywhere.

Problem 4.2: Do the following problems explicitly by calculating force and also by energy method.

(a) Two large metal plates (each of area A) are held a small distance d apart. Suppose we put a charge Q on each plate; what is the electrostatic pressure on the plates?

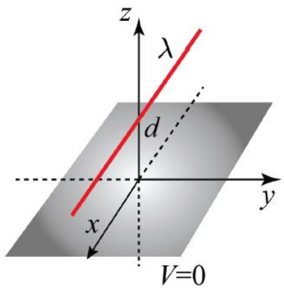
(b) A metallic sphere of radius R carries a total charge Q. what is the force of repulsion between the "northern" hemisphere and the "southern" hemisphere?

Problem 4.3: Find the average potential over a spherical surface of radius R due to a point charge q located inside the sphere. Also, show that in general

$$V_{ave} = V_{center} + \frac{Q_{enc}}{4\pi\varepsilon_0 R}$$

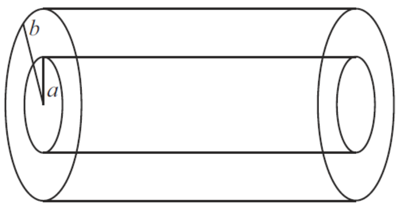
where V_{center} is potential at the center due to all the external charges and Q_{enc} is the total enclosed charge.

Problem 4.4: An infinite line charge runs parallel to the x-axis at a distance d from the xy plane, which is an infinite grounded conductor as shown in the figure.
(a) What is the potential in the region above the plane.
(b) Find the charge density σ induced on the conducting plane.



Problem 4.5: Two infinite parallel grounded conducting planes are held a distance a apart. A point charge q is placed in the region between them, a distance x from one plate. Find the force on q. Check your answer for special cases, (i) a $\rightarrow \infty$ and (ii) $x = a/2$.

Problem 4.6: Find the capacitance per unit length of two coaxial metal cylindrical cylinders, of radii a and b (see Figure).



Problem 4.7: Two infinitely long wires running parallel to the x axis carry uniform charge densities $+\lambda$ and $-\lambda$, as shown in the figure.
(a) Find the potential at any point (x, y, z), using the origin as your reference.
(b) Show that the equipotential surfaces are circular cylinders, and locate the axis and radius of the cylinder corresponding to a given potential V_0.