Module 03 Homework

1. Two solid spheres, both of radius R, carry identical total charges, Q. One sphere is a good conductor while the other is an insulator. If the charge on the insulating sphere is uniformly distributed throughout its interior volume, how do the electric fields outside these two spheres compare? How do the fields inside the two spheres compare?

2. A common demonstration ivolves charging a rubber balloon, which is an insulator, by rubbing it on your hair and touching the balloon to a ceiling or wall, which is also an insulator. The electrical attraction between the charged balloon and neutral wall results in the balloon sticking to the wall. Imagine now that we have two infinitely large flat sheets of insulating material. One is charged and the other is neutral. If these are brought into contact, will an attractive force exist between them, as there was for the balloon and wall?

3. For this question, consider Figure 1. A cone with base radius $R = 10\,\text{cm}$ and height $h = 15\,\text{cm}$ is located on a horizontal table. A horizontal uniform field with magnitude $E = 2\,\frac{\text{N}}{\text{C}}$ penetrates the cone. Determine the electric flux that enters the left-hand side of the cone.

4. A nuclear submarine has four charged objects located inside with net charges $5\,\mu\text{C}$, $-9\,\mu\text{C}$, $27\,\mu\text{C}$, and $-84\,\mu\text{C}$. Determine the net electric flux through the hull of the submarine. Is the number of electric field lines leaving the submarine greater than, equal to, or less than the number entering it?

5. A solid sphere of radius 40 cm has a total positive charge of $26\,\mu\text{C}$ *uniformly* distributed throughout its volume.

    1. What is the magnitude of the electric field at the center of the sphere?

    2. What is the magnitude of the electric field at the 10 cm from the center of the sphere?

    3. What is the magnitude of the electric field at the surface of the sphere?

    4. What is the magnitude of the electric field at the 80 cm from the center of the sphere?

6. A large horizontal sheet of charge has a uniform charge density of $9\,\frac{\mu\text{C}}{\text{m}^2}$. Assume that the sheet sits in the x-y plane and determine the electric field just above the middle of the sheet on the z axis.

7. **Example Problem Writeup:** Consider a charge Q distributed *uniformly* throughout a spherical volume of radius R compared to being on a solid conducting sphere of radius R. Sketch a graph of the x component of the electric field along the x axis for each case, assuming the spheres are centered at the origin.

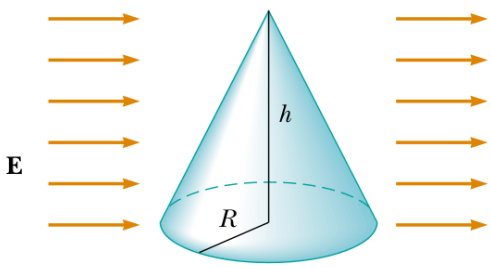

Figure 1: