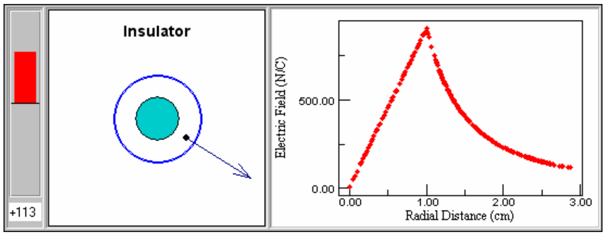
# *Worksheet for Exploration 24.3: Conducting and Insulating Sphere*




What is the difference between the electric fields inside and outside of a solid insulating sphere (with charge distributed throughout the volume of the sphere) and those inside and outside of a conducting sphere? Move the test charge to map out the magnitude of the electric field as a function of distance from the center **(position is given in centimeters, electric field strength is given in N/C, and flux is given in N $cm^2$/C)**.

a. Compare the electric fields inside and outside of the two spheres. What is the same and what is different (same total charge on both spheres)?
   i. In each case sketch the plot of the Electric field magnitude vs. R.

Conductor plot | Insulator plot

b. If a Gaussian surface larger than the two spheres is put around each, how will the flux through each compare? Why?

Try putting a big Gaussian surface around the insulator. The bar measures the flux. Now try around the conductor.

Flux Insulator=______________

Flux Conductor=______________

c. Why is the flux the same?
   i. Also discuss what the electric field is at the surface of the big Gaussian surface for each case.

d. How much charge is on each sphere? How do you know?

$q_{insulator}$=__________ $q_{conductor}$=__________

e. What do you expect the flux to be through a Gaussian surface inside the conductor? Why? Try it and explain the results.

Flux Inside Conductor=______________________

Now try putting the same size small Gaussian surface inside the insulator.

f. What flux value do you get?

Flux inside insulator=______________________

g. How much charge is enclosed in this smaller surface?

$q_{enclosed\ smaller\ surface\ insulator}$=______________________

h. What is the ratio of the charge enclosed in the small surface to the total charge on the insulating sphere?

$$\frac{q_{small}}{q_{total}} = \_\_\_\_\_\_\_\_\_\_$$

i. What is the ratio of the volume of the small surface compared to the volume of the insulating sphere? Explain why the two ratios in (h) and (i) are the same.

$$\frac{V_{small}}{V_{total}} = \_\_\_\_\_\_\_\_\_\_$$

j. Use Gauss's law for the smaller surface to calculate the field at that point inside the sphere. Verify that it agrees with the value on the graph.

$E_{Gauss\ Law}$=__________

$E_{measured}$=__________

As a reminder, Gauss's law relates the flux to the charge enclosed ($q_{enclosed}$) in a Gaussian surface through the following equation:

$\Phi = q_{enclosed}/\varepsilon_0$ (and Flux = $\Phi = \int \mathbf{E} \cdot d\mathbf{A} = \int E \cos\theta \, dA$)

where $\varepsilon_0$ is the permittivity of free space ($8.85 \times 10^{-12}\ C^2/Nm^2$), **E** is the electric field, d**A** is the unit normal to the surface, and θ is the angle between the electric field vector and the surface normal. The surface area of a sphere is $4\pi r^2$.