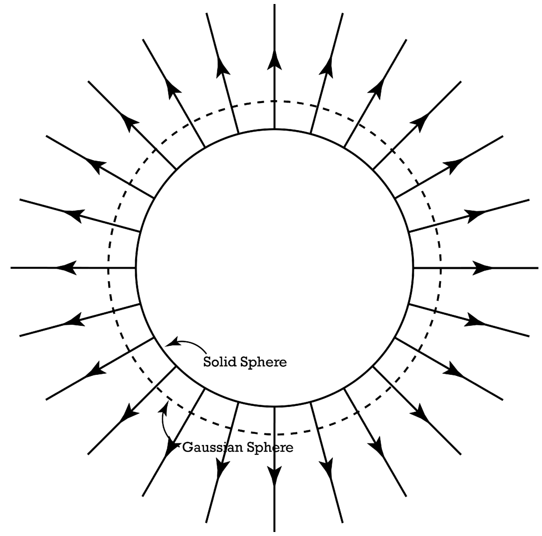
Flipping Physics Lecture Notes:
Gauss's Law
Charged Sphere Electric Field
http://www.flippingphysics.com/gauss-law-sphere.html



Outside the surface of a uniformly charged sphere, the electric field is the same as if the charged sphere were a point particle.

- Example: Solid, uniformly charged sphere with charge Q and radius, a.
- Create a Gaussian surface which is a concentric sphere with radius r > a.

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q_{enclosed}}{\varepsilon_0}$$

$$\Rightarrow \Phi_E = \int_{sphere} E \cos\theta \, dA = \int_{sphere} E \cos(0°) \, dA = \frac{q_{enclosed}}{\varepsilon_0}$$

$$\Rightarrow E \int_{sphere} dA = EA_{sphere} = E\left(4\pi r^2\right) = \frac{Q}{\varepsilon_0}$$

$$\Rightarrow E = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{Q}{r^2} \Rightarrow E = \frac{kQ}{r^2}$$

- This is true of a conductor or an insulator, however, the electric field inside a conductor will be zero, and inside an insulator the electric field depends on the radius and charge distribution, and can be derived in a similar manner.