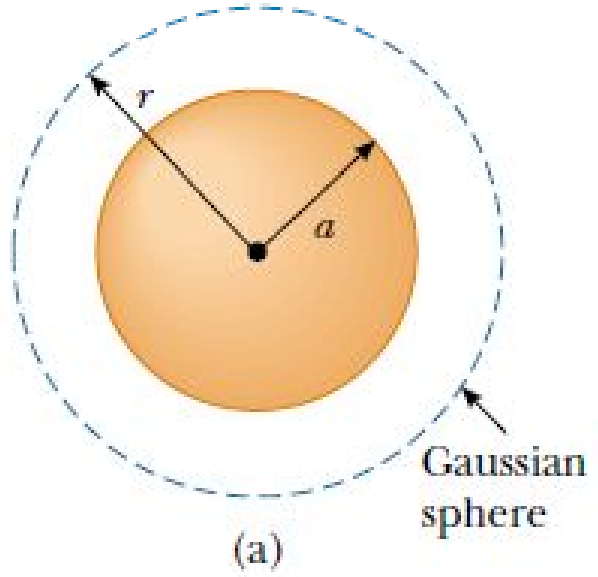
GAUSS THEOREM

An insulating solid sphere of radius a has a uniform volume charge density and carries a total positive charge Q. (a) Calculate the magnitude of the electric field at a point outside the sphere. (b) Find the magnitude of the electric field at a point inside the sphere.

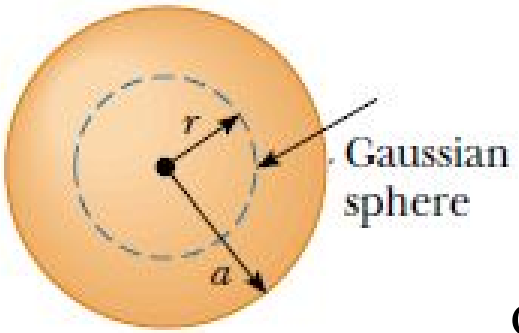


$$(a)\ \phi = \oint_S \vec{E}.d\vec{A} = \oint_S E.dS\cos 0$$

$$\phi = \oint_S E.dS = E\oint_S dS = E.4\pi r^2$$

$$\phi = \frac{Q}{\varepsilon_0} = E.4\pi r^2 \Rightarrow E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

GAUSS THEOREM



(b)

$$(b)\ \phi = \oint_S \vec{E}.d\vec{A} = \oint_S E.dS\cos 0$$

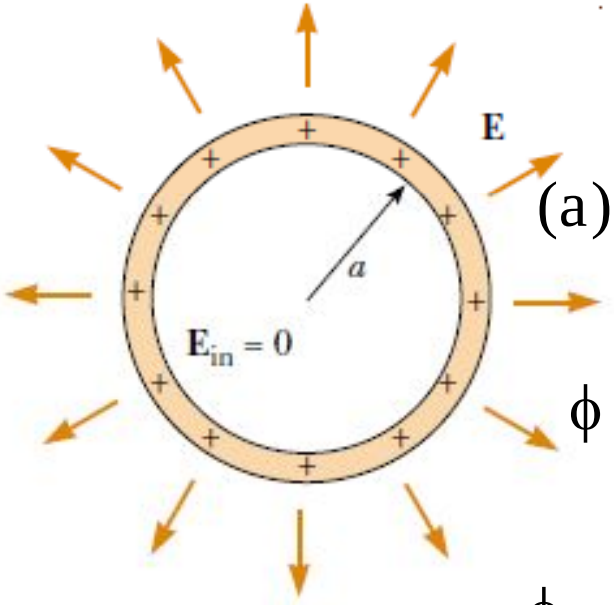
$$\phi = \oint_S E.dS = E\oint_S dS = E.4\pi r^2 \qquad \rho = \frac{Q}{V} = \frac{3Q}{4\pi a^3}$$

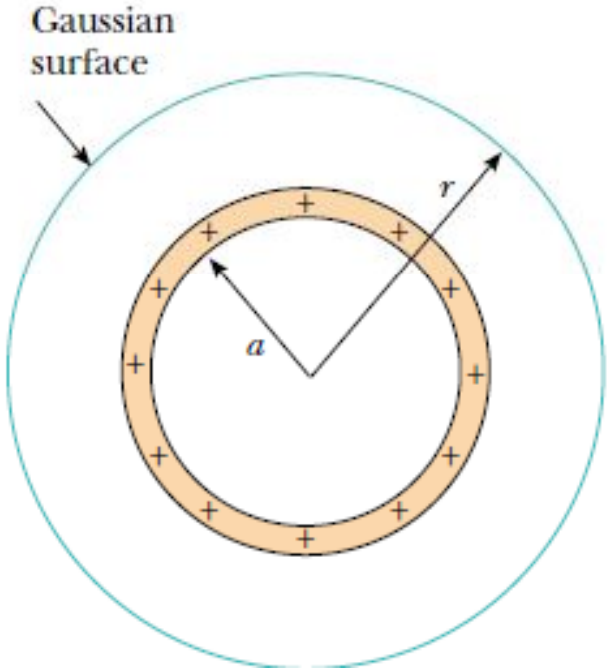
$$Q_1 = \rho V_1 = \rho\frac{4}{3}\pi r^3 \quad = \frac{3Q}{4\pi a^3}\frac{4}{3}\pi r^3 = \frac{Qr^3}{a^3}$$

$$\phi = \frac{Qr^3}{a^3}.\frac{1}{\varepsilon_0} = \frac{Qr^3}{\varepsilon_0 a^3} \quad \Rightarrow E.4\pi r^2 = \frac{Qr^3}{\varepsilon_0 a^3} \Rightarrow E = \frac{Qr}{4\pi\varepsilon_0 a^3}$$

GAUSS THEOREM

A thin spherical shell of radius a has a total charge Q distributed uniformly over its surface. Find the electric field at points (a) outside and (b) inside the shell.



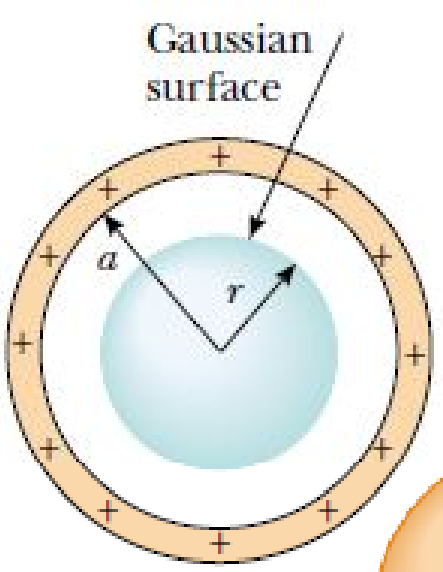


$$(a)\ \phi = \oint_S \vec{E}.d\vec{A} = \oint_S E.dS\cos 0$$

$$\phi = \oint_S E.dS = E\oint_S dS = E.4\pi r^2$$

$$\phi = \frac{Q}{\varepsilon_0} = E.4\pi r^2 \Rightarrow E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

GAUSS THEOREM



(b) $\phi = \oint_S \vec{E}.d\vec{A} = \oint_S E.dS\cos 0$

$$\phi = \oint_S E.dS = E\oint_S dS = E.4\pi r^2$$

$$\phi = \frac{Q}{\varepsilon_0} = 0 \Rightarrow E.4\pi r^2 = 0 \Rightarrow E = 0$$