$\mu=10^{-6}$ $n=10^{-9}$ $\varepsilon 0=8.85\times10^{-12}$ $NC^{-2}m^2$
Surface area of sphere = $4\pi r^2$
Volume of sphere=$4/3\pi r^3$

NAME:
GRADE:

1

Quiz for January 26 2005 - Physics 151-001 - Prof. Thomson

(1 pt)

(1) State Gauss's Law mathematically and explain what it means in words.

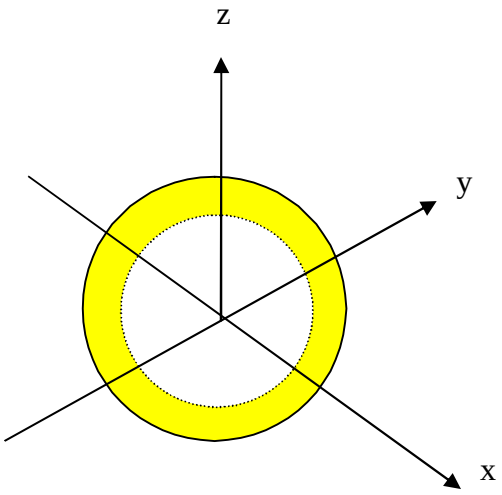
$$\oint \vec{E}.\vec{dA} = \frac{q_{enclosed}}{\varepsilon_0}$$

The total electric flux through a closed surface is proportional to the total charge enclosed by the surface.

(2 pts)

(2) We have a sphere of radius R=3m with uniform volume charge density $\rho=6nC/m^3$.

(a) Use Gauss's Law to derive the electric field strength inside the sphere at a distance r<R.



Gaussian surface is a sphere of radius r

$$\oint \vec{E}.\vec{dA} = \frac{q_{enclosed}}{\varepsilon_0}$$

$$E 4\pi r^2 = \frac{\rho \frac{4}{3}\pi r^3}{\varepsilon_0}$$

$$E = \frac{\rho r}{3\varepsilon_0}$$ **in radial direction**

3 versions of quiz
v1 $\rho=6nC/m^3$
v2 $\rho=3nC/m^3$
v3 $\rho=8nC/m^3$

(2 pts)

(b) Evaluate the electric field due to this ball of charge at x=2,y=0, z=1m

$E_x(2,0,1)$=450 N/C (V2: 225 N/C V3: 600 N/C)

$E_y(2,0,1)=0$

$E_z(2,0,1)$=225 N/C (V2: 112 N/C V3: 300 N/C)

Angle θ is angle between point (2,0,1) and the x-y plane.

$$E_x = \frac{\rho r}{3\varepsilon_0}\cos\theta = \frac{\rho r}{3\varepsilon_0}\frac{x}{r} = \frac{\rho x}{3\varepsilon_0} = 450 N/C$$

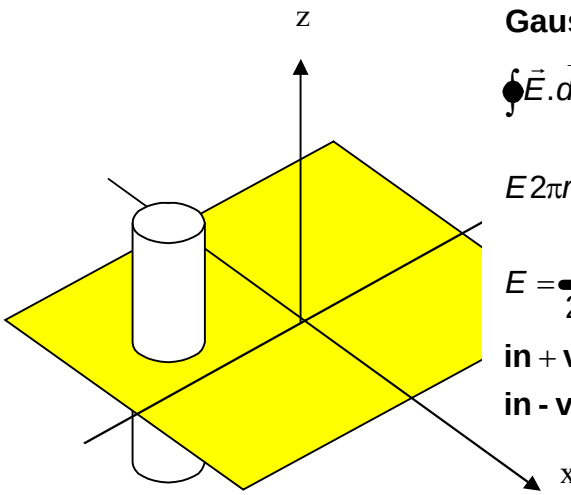
$$E_y = 0$$

$$E_z = \frac{\rho r}{3\varepsilon_0}\sin\theta = \frac{\rho r}{3\varepsilon_0}\frac{z}{r} = \frac{\rho z}{3\varepsilon_0} = 225 N/C$$

(3) We have an insulating sheet in the x-y plane with uniform surface charge density σ=4 nC/m^2. The sheet extends to infinity.

(2 pts)

(a) Use Gauss's Law to derive the electric field strength at a distance z from the sheet.



Gaussian surface is a cylinder of radius r and height h

$$\oint \vec{E}.\vec{dA} = \frac{q_{enclosed}}{\varepsilon_0}$$

$$E2\pi r^2 + 0x2\pi rh = \frac{\sigma \pi r^2}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$

in + ve z direction above and in - ve z direction below sheet

3 versions of quiz
v1 σ=4 nC/m^2
v2 σ=2 nC/m^2
v3 σ=6 nC/m^2

(2 pts)

(b) Evaluate the electric field due to this sheet at the point x=2, y=0, z=1 m.

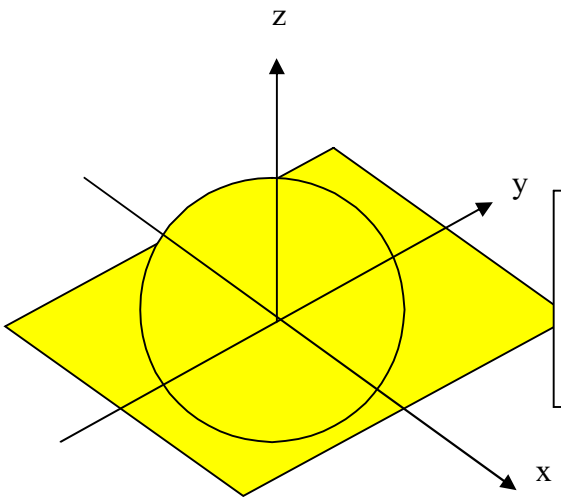
$E_x(2,0,1)=0$

$E_y(2,0,1)=0$

$E_z(2,0,1)=225$ N/C (V2: 112 N/C V3: 338 N/C)

(1 pt)

(4) Now the two charge distributions are superimposed. Find the resultant electric field at x=2, y=0, z=1 m.



$E_x(2,0,1)=450+0=450$ N/C (V2:225 N/C V3 600 N/C)

$E_y(2,0,1)=0$

$E_z(2,0,1)=225+225=450$ N/C (V2:225 N/C V3: 638 N/C)