Homework 23.1

The square surface shown in Fig. 23-30 measures 3.2 mm on a each side. It is immersed in a uniform electric field with magnitude E = 1800 N/C and with field lines at an angle of $\theta = 35^o$ with the normal to the surface as shown. Take that normal to be directed "outward" as though the surface were one face of a box. Calculate the electric flux through the surface.

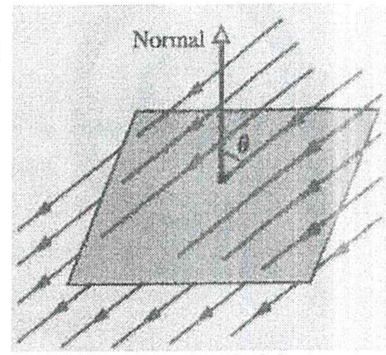


Figure 23-30

$A = L^2 = (3.2 \times 10^{-3})^2 \, m^2$

$\phi = \vec{E} \cdot d\vec{A} = E A \cos\theta$

$= (3.2 \times 10^{-3})^2 \, 1800 \cos 35^o$

$\phi = -0.015 \, m^2 N/C$

Inward since the Normal is assumed to be Outward

Homework 23.11

Figure 23-35 shows a closed Gaussian surface in the shape of a cube of edge length 2.00 m, with one corner at x_1 = 5.00 m, y_1 = 4.00 m. The cube lies in a region where the electric field vector is given by **E** = - 3.00 i - 4.00 y^2 j + 3.00 k N/C What is the net charge contained in the cube?

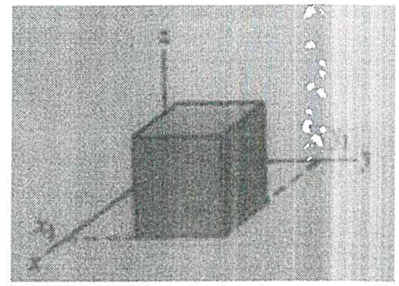


Figure 23-35

$\phi_{net} = \frac{q_{enc}}{\epsilon_0}$

$\phi = A \cdot E$ Only the component of E perpendicular to the surface contribute to the flux

$\phi_{TOP} = -\phi_{BOTTOM}$ since E_z is constant

also $\phi_{FRONT} = -\phi_{BACK}$

The flux through the Right Side = $A E_y (y = y_1)$ = 4

A = 4 $\phi_{RIGHT} = 4(-4 * 4^2) = -265$

On the Left y = 2 $\phi_{Left} = A E_y (y=2) = 4 * 4 * 2^2 = 64$ outward ∴ positive

$\Sigma \phi = \phi_{net} = -265 + 64 = -192$

$\phi_{net} = \frac{q_{enc}}{\epsilon_0}$

$q_{enc} = \epsilon_0 \phi_{net} = -8.854 \times 10^{-12} \times 192 = -1.69 \times 10^{-9}$ C

Homework 23.13

The electric field in a certain region of the Earth's atmosphere is directed vertically down. At an altitude of 300 m, the field has a magnitude of 60 N/C; at an altitude of 200 m, the magnitude is 100 N/C. Find the amount of charge contained in a cube 100 m on edge, with horizontal faces a altitudes of 200 and 300 m.

$$\phi_{Net} = \frac{q_{enc}}{\epsilon_0}$$

$$q_{enc} = \epsilon_0 \phi_{Net}$$

$$\phi_{Net} = A \cdot E_1 - A \cdot E_2$$

$$= A[E_1 - E_2] = (100)^2 [100 - 60]$$

$$q_{enc} = \epsilon_0 (100)^2 * 40$$

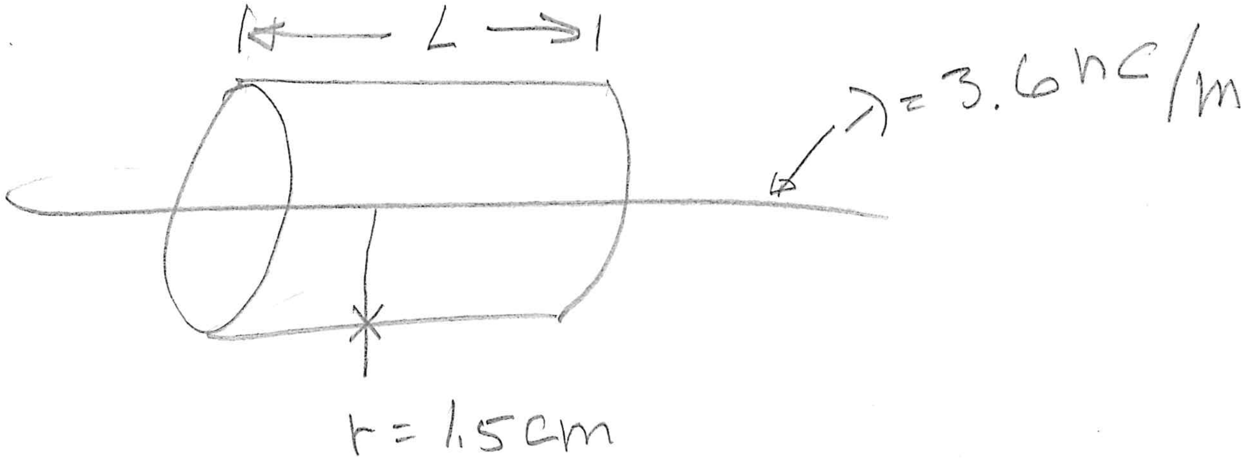
$$= 8.854 \times 10^{-12} \times 10^4 \times 40$$

$$\approx 354 \times 10^{-8}$$

$$q_{enc} = 3.54 \times 10^{-6}\ C$$

Homework 23.27

A long, straight wire has a fixed negative charge with a linear charge density of magnitude 3.6 nC/m. The wire is to be enclosed by a thin-walled nonconducting cylindrical shell of radius 1.5 cm. The shell is to have positive charge on its outside surface with a charge density σ that makes the net external electric field zero. Calculate σ



Q_1 = charge on the wire = λL

Q_2 = Charge on the cylinder = σ × AREA
= $\sigma L 2\pi r$

$Q_{enc} = 0 = Q_1 + Q_2$

$\lambda L + \sigma L 2\pi r = 0$

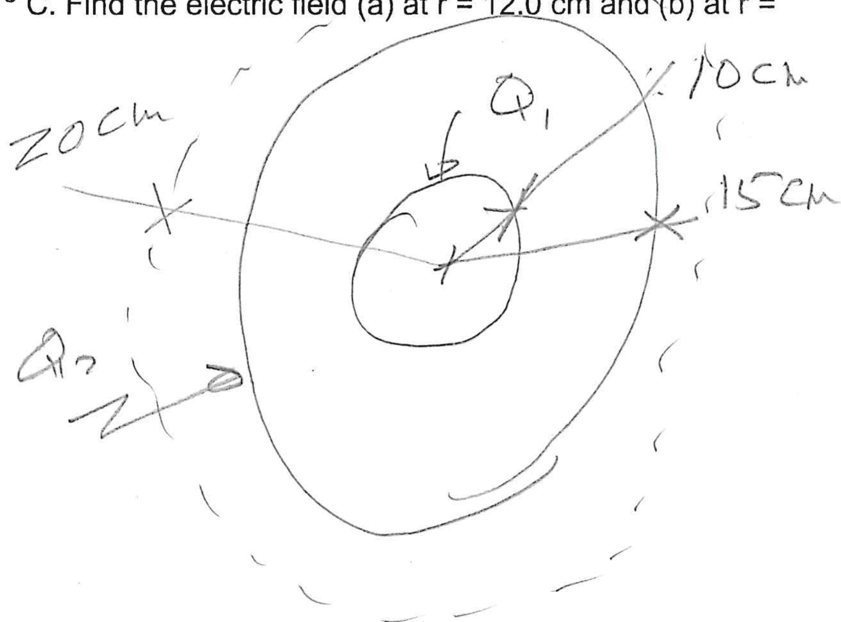
$\sigma = \frac{-\lambda}{2\pi r} = \frac{3.6 \times 10^{-9}}{2\pi (0.015)}$

$\sigma = 38.2 \times 10^{-9}\ C/m^2$

$\sigma = 38.2\ nC/m^2$

Homework 23.45

Two charged concentric spherical shells have radii 10.0 cm and 15.0 cm. The charge on the inner shell is 4.00×10^{-8} C, and that on the outer shell is 2×10^{-8} C. Find the electric field (a) at r = 12.0 cm and (b) at r = 20.0 cm.



$$\phi_{net} = \frac{q_{enc}}{\varepsilon_0}$$

$$\phi_{net} = \oint E \cdot dA$$

$$= E\,4\pi r^2$$

$$E = \frac{q_{enc}}{4\pi\varepsilon_0 r^2}$$

at r = 12 cm $\quad Q_{enc} = Q_1$ the charge on the inner Sphere

@ r = 12

$$E = \frac{Q_1}{4\pi\varepsilon_0 (0.12)^2}$$

a) $$E = \frac{4 \times 10^{-8}}{4\pi\, 8.854 \times 10^{-12} (0.12)^2} = 2.5 \times 10^{3}\ N/C$$

b) @ r = 20 cm $\quad Q_{enc} = Q_1 + Q_2 = 6 \times 10^{-8}$ C

$$E = \frac{6 \times 10^{-8}}{4\pi\, 8.854 \times 10^{-12} (0.2)^2} = \underline{1.35 \times 10^{4}\ N/C}$$