MULTI COURSES

General Physics II course

Sheet 2 – Gauss's Law

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Question 1

- A flat surface of area 3.20 m^2 is rotated in a uniform electric field of magnitude $E = 6.20 \times 10^5$ N/C. Determine the electric flux through this area (a) when the electric field is perpendicular to the surface and (b) when the electric field is parallel to the surface → $\theta = 0$

Solution :

$A = 3.20\ m^2$

$E = 6.20 \times 10^5\ N/C$

$\phi = ?$

a) $\phi = E \cdot A \cdot \cos\theta$ (E ⊥ A → $\theta = 0$)

$= (6.20 \times 10^5) \times (3.20) \cdot (\cos(0))$

$= 1984000 = 1.984 \times 10^6\ N \cdot m^2/C$

b) (E // A → $\theta = 90$)

$\phi = E A \cos\theta$

$= (6.20 \times 10^5)(3.20) \cdot \cos(90)$

$=$ Zero $N\ m^2/C$

Question 2

- A 40.0-cm-diameter loop is rotated in a uniform electric field until the position of maximum electric flux is found. The flux in this position is measured to be 5.20×10^5 $N.m^2/C$. What is the magnitude of the electric field?

Solution :

$d = 40\ cm = 40 \times 10^{-2}\ m$

$\Phi = 5.20 \times 10^5\ N.m^2/C$

$E = ?$

$r = 20\ cm = 20 \times 10^{-2}\ m$

$\Phi = E \cdot A \rightarrow E = \frac{\Phi}{A} \rightarrow ?$

- A of loop $= \pi r^2 = \pi (20 \times 10^{-2})^2 = \frac{1}{25}\pi = 0.13\ m^2$

$E = \frac{\Phi}{A} = \frac{5.20 \times 10^5}{0.13} = 4000000\ N/C$ ✓

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$= 4 \times 10^6\ N/C$ ✓

$= 4.14\ MN/C$ ✓

Question 3

- **Find the net electric flux through the spherical closed surface shown in figure. The two charges on the right are inside the spherical surface.**

Solution :

$$\phi = \frac{q_{in}}{\epsilon_0} = \frac{(1\times10^{-9} - 3\times10^{-9})}{8.85\times10^{-12}}$$

$$\epsilon_0 = 8.85\times10^{-12}$$

$$= -225.99 \ N\cdot m^2/C$$

$$\approx -226 \ N\cdot m^2/C$$

+2.00 nC

لا تؤثر لوجودها خارج الشكل المغلق

Question 4

- An uncharged nonconducting hollow sphere of radius 10.0 cm surrounds a 10.0 μC charge located at the origin of a cartesian coordinate system. A drill with a radius of 1.00 mm is aligned along the z axis, and a hole is drilled in the sphere. Calculate the electric flux through the hole.

Solution :

$r = 10\ cm = 10 \times 10^{-2}\ m$

$q = 10\ \mu C = 10 \times 10^{-6}\ C$

$r_{drill} = 1\ mm = 1 \times 10^{-3}\ m$

$$\phi = E \cdot A$$

$$\phi = \left(\frac{k \cdot q}{r^2}\right)(\pi r^2)$$

$$\phi = \left(\frac{9 \times 10^9 \times 10 \times 10^{-6}}{(10 \times 10^{-2})^2}\right)\left(\pi (1 \times 10^{-3})^2\right)$$

$$\phi = 9\pi = 28.27\ N \cdot m^2/C$$

Question 5

- A spherically symmetric charge distribution has a charge density given by $\rho = a/r$, where a is constant. Find the electric field within the charge distribution as a function of r. Note: The volume element dV for a spherical shell of radius r and thickness dr is equal to $4\pi r^2 dr$

Solution :

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End of Sheet 2

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