Electric Charges and Field

DPP-09

1. A cylinder of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The total flux for the surface of the cylinder is given by

(A) $2\pi R^2 E$
(B) $\pi R^2 / E$
(C) $(\pi R^2 - \pi R^2) / E$
(D) Zero

2. An electric charge q is placed at the centre of a cube of side α. The electric flux through one of its faces will be

(A) $\frac{q}{6\varepsilon_0}$ (B) $\frac{q}{\varepsilon_0 a^2}$
(C) $\frac{q}{4\pi\varepsilon_0 a^2}$ (D) $\frac{q}{\varepsilon_0}$

3. A cube of side l is placed in a uniform field E, where $E = E\hat{i}$. The net electric flux through the cube is

(A) Zero (B) $l^2 E$
(C) $4l^2 E$ (D) $6l^2 E$

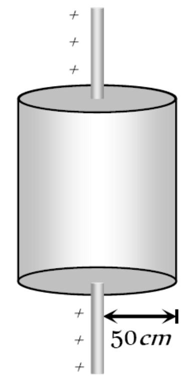
4. Eight dipoles of charges of magnitude e are placed inside a cube. The total electric flux coming out of the cube will be

(A) $\frac{8e}{\varepsilon_0}$ (B) $\frac{16e}{\varepsilon_0}$
(C) $\frac{e}{\varepsilon_0}$ (D) Zero

5. A point charge $+q$ is placed at the centre of a cube of side L. The electric flux emerging from the cube is

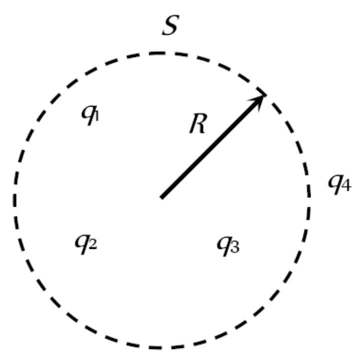
(A) $\frac{q}{\varepsilon_0}$ (B) Zero
(C) $\frac{6qL^2}{\varepsilon_0}$ (D) $\frac{q}{6L^2\varepsilon_0}$

6. Electric charge is uniformly distributed along a long straight wire of radius 1mm. The charge per cm length of the wire is Q coulomb. Another cylindrical surface of radius 50 cm and length 1m symmetrically encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is



(A) $\frac{Q}{\varepsilon_0}$ (B) $\frac{100Q}{\varepsilon_0}$
(C) $\frac{10Q}{(\pi\varepsilon_0)}$ (D) $\frac{100Q}{(\pi\varepsilon_0)}$

7. q_1, q_2, q_3 and q_4 are point charges located at points as shown in the figure and S is a spherical Gaussian surface of radius R. Which of the following is true according to the Gauss's law



(A) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4).d\vec{A} = \frac{q_1 + q_2 + q_3}{2\varepsilon_0}$
(B) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4).d\vec{A} = \frac{(q_1 + q_2 + q_3)}{\varepsilon_0}$
(C) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4).d\vec{A} = \frac{(q_1 + q_2 + q_3 + q_4)}{\varepsilon_0}$
(D) None of the above

8. A long string with charge per unit length λ passes through a cube of length ℓ. The maximum flux through the cube will be

(A) $\frac{\lambda\ell}{\varepsilon_0}$ (B) $\frac{\sqrt{2}\lambda\ell}{\varepsilon_0}$
(C) $\frac{\sqrt{3}\lambda\ell}{\varepsilon_0}$ (D) $\frac{2\lambda\ell}{\varepsilon_0}$

9. If ϕ_1 is the electric flux entering in a closed surface and ϕ_2 is the electric flux leaving the same closed surface, then the electric charge inside the surface will be

(A) $(\phi_1 + \phi_2)\varepsilon_0$ (B) $(\phi_2 - \phi_1)\varepsilon_0$

(C) $(\phi_1 + \phi_2)/\varepsilon_0$ (D) $(\phi_2 - \phi_1)/\varepsilon_0$

10. A uniform electric field $\vec{E} = a\hat{i} + b\hat{j}$, intersects a surface of area A. What is the flux through this area if the surface lies in the *yz* plane

(A) aA   (B) 0

(C) bA   (D) $A\sqrt{a^2 + b^2}$

Answer Key

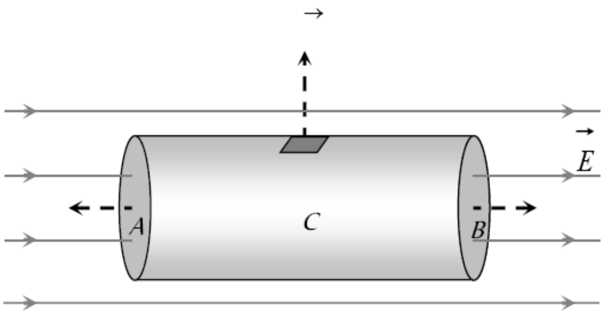
1. **(D)**
2. **(A)**
3. **(A)**
4. **(D)**
5. **(A)**
6. **(B)**
7. **(B)**
8. **(C)**
9. **(B)**
10. **(A)**

Hints and Solutions

1. **(D)**

Flux through surface $A \phi_A = E \times \pi R^2$ and

$\phi_B = -E \times \pi R^2$



Flux through curved surface

$C = \int \vec{E}.\vec{ds} = \int Eds \cos 90^o = 0$

$\therefore$ Total flux through cylinder

$= \phi_A + \phi_B + \phi_C = 0$

2. **(A)**

By Gauss's theorem. Total flux $\varphi = \dfrac{q}{\varepsilon_0}$

So the flux through one face = $\dfrac{q}{6\varepsilon_0}$

3. **(A)**

As there is no charge residing inside the cube, hence net flux is zero.

4. **(D)**

$\varphi = \dfrac{\Sigma q}{\varepsilon_0}$ = 0 i.e., net charge on dipole is zero.

5. **(A)**

Electric flux coming out through a closed surface is q/ε_0.

6. **(B)**

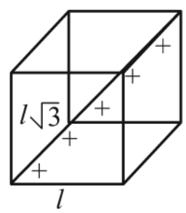
Charge enclosed by cylindrical surface (length 100 cm) is $Q_{enc.}$ = 100 Q. By applying Gauss's law

$\varphi = \dfrac{1}{\varepsilon_0}(Q_{enc.}) = \dfrac{1}{\varepsilon_0}(100\ Q)$

7. **(B)**

By using $\int \vec{E} \cdot \vec{dA} = \dfrac{1}{\varepsilon_0}(Q_{enc})$

8. **(C)**



$\phi = \dfrac{q}{\varepsilon_0} = \dfrac{\lambda l \sqrt{3}}{\varepsilon_0}$

9. **(B)**

$\phi_2 - \phi_1 = \dfrac{q}{\varepsilon_0}$ (sign convention of flux)

$q = (\phi_2 - \phi_1)\varepsilon_0$

10. **(A)**

$\phi = \vec{E}.\vec{A}$

$= (a\hat{i} + b\hat{j}).A\hat{i}$

$= aA$