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Chapter End Test

Max. Mark : 25	Electric Charge and Field	CLASS
Time : 45 Min.		XII

1. If a glass rod is rubbed with silk it acquires a positive charge because:
(a) Protons are added to it
(b) Protons are removed from it
(c) Electrons are added to it
(d) Electrons are removed from it

2. A positively charged body is brought near an uncharged gold leaf electroscope, then:
(a) No charge is induced in the leaves
(b) Positive charge is induced in both the leaves
(c) Negative charge is induced in both the leaves
(d) Positive charge is induced in one leaf and negative in the other

3. The unit of permittivity of free space, is:
(a) Coulomb/Newton-metre
(b) $Coulomb^2/Newton\text{-}metre^2$
(c) $Newton\text{-}metre^2/coulomb^2$
(d) $Coulomb^2/(Newton\text{-}metre)^2$

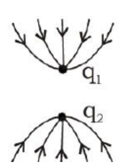
4. The ratio of the force between two small conducting spheres of equal charge in (i) a medium of dielectric constant 2, and (ii) air is respectively
(a) 1 : 4
(b) 4 : 1
(c) 1 : 2
(d) 2 : 1

5. The number of electrons in a charge of 4800×10^{-19} Coulomb of charge is
(a) 3
(b) 30
(c) 300
(d) 3000

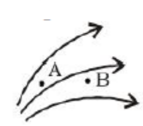
6. Two particles having charges q_1 and q_2 when kept at a certain distance, exert a force F on each other. If the distance between the two particles is reduced to half and the charge on each particle is doubled the force between the particles would be:
(a) 2F
(b) 4F
(c) 8F
(d) 16F

7. An electric dipole has charges +q and –q at a separation r. At distance d>>r along the axis of the dipole, the field is proportional to:
(a) q/d
(b) qr/d^2
(c) q^2/d^3
(d) qr/d^3

8. The Figures is a plot of lines of force due to two charges q_1 and q_2. Find out the sign of charges:
(a) Both negative
(b) Upper positive and lower negative
(c) Both positive
(d) Upper negative and lower positive



9. The Figure shows electric lines of force. If E_A and E_B are electric fields at A and B and distance AB = r, then:
(a) $E_A > E_B$
(b) $E_A = E_B/r$
(c) $E_A < E_B$
(d) $E_A = E_B/r^2$

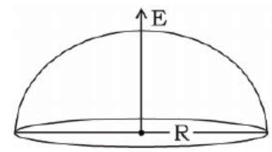


10. A charge Q is situated at the centre of a cube. The electric flux through one of the faces of the cube is:

(a) $(Q/\in_0)$ (b) $(Q/2\in_0)$

(c) $(Q/4\in_0)$ (d) $(Q/6\in_0)$

11. A hemispherical surface of radius R is placed with its cross-section perpendicular to a uniform electric field E as shown in figure. Flux linked with its curved surface is:



(a) Zero (b) $2\pi R^2E$

(c) πR^2E (d) $E/2\in_0$

12. A charge Q is placed at the centre of the open end of a cylindrical vessel. The electric flux through the surface of the vessel is:

(a) Zero (b) $(q/\in_0)$

(c) $(q/2\in_0)$ (d) $(2q/\in_0)$

13. Total electric flux coming out of a unit positive charge put in air is:

(a) $\in_0$ (b) $\in_0^{-1}$

(c) $(4\pi\in_0)^{-1}$ (d) $4\pi\in_0$

14. A charged body has an electric flux ϕ associated with it. The body is now placed inside a metallic container. The electric flux ϕ_1 outside the container will be

(a) $\phi_1 = 0$ (b) $0 < \phi_1 < \phi$

(c) $\phi_1 = \phi$ (d) $\phi_1 > \phi$

15. The electric flux through a surface will be minimum, when the angle between E and A is

(a) 60° (b) 90°

(c) 0° (d) 45°

16. The electric flux through a closed surface depends on the

(a) Magnitude of the charge enclosed by the surface

(b) Position of the charge enclosed by the surface

(c) The shape of the surface

(d) None of these

17. A spherical balloon carries a charge that is uniformly distributed over its surface. How does the total electric flux coming out of the surface change, if the balloon is blown up and increases in size?

(a) It will also increase (b) It will decrease

(c) It will remain uncharged (d) It will first increase then remain constant

18. At what point is the electric field intensity due to a uniformly charged spherical shell maximum?

(a) outside the spherical shell (b) at the surface of spherical shell

(c) at the centre of spherical shell (d) inside the spherical shell

19. On which of the following factors does the electric field due to an infinitely long wire does not depend?

(a) surface area of the wire (b) distance from the wire

(c) nature of the medium (d) line charge density

20. On which of the following factors does the electric field due to uniformly charged infinite plane depend?

(a) thickness of the plane

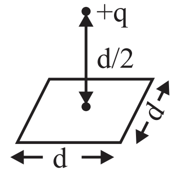
(b) distance from the plane

(c) surface charge density of the plane

(d) none of these

21. Force between two point electric charges kept at a distance r apart in air is F. If these charges are kept at the same distance in water, (K = 80), how does the force between them change? **[1]**

22. In the figure, a charge of $+q$ at a distance $d/2$ directly above the centre of a square of side d. What is the magnitude of electric flux through the square? **[1]**



23. A charge q is placed at the center of the line joining the two charges (each of magnitude Q). Prove that the system of three charges will be in equilibrium if $q = -Q/4$. **[2]**

24. State and prove the Gauss's theorem in electrostatics. Using the same, estimate the electric field due to a charged spherical shell. **[3]**

25. S_1 and S_2 are two hollow concentric spheres of radius r_1 and r_2 respectively enclosing charge Q and 2Q respectively, and $r_1 < r_2$. **[3]**

(i) What is the ratio of electric flux through S_1 and S_2.

(ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 5 is introduced in the space inside S_1 in place of air.

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Hints/Solutions to Chapter End Test

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1.	(d)	**2.**	(b)	**3.**	(b)	**4.**	(c)	**5.**	(d)
6.	(d)	**7.**	(d)	**8.**	(a)	**9.**	(a)	**10.**	(d)
11.	(c)	**12.**	(c)	**13.**	(b)	**14.**	(c)	**15.**	(b)
16.	(a)	**17.**	(c)	**18.**	(b)	**19.**	(a)	**20.**	(c)

21. $F = \frac{kq_1q_2}{r^2}$ and $F_w = \frac{k'q_1q_2}{r^2}$

$$\frac{F_w}{F} = \frac{k'}{k}$$

$\Rightarrow \quad \frac{F_w}{F} = \frac{k'}{k}$ = 1/80 (the dielectric constant of water is 80)

$\therefore$ Force will reduce 80 times.

22. $q/6\varepsilon_0$

23. The system of three charges will be in equilibrium if the force on any one of the charge Q is zero. $(1/r^2)$ $(4kQq + kQQ) = 0$ making $q = -Q/4$.

24. Gauss's Law

Gauss' Law states that

The net flux through any closed surface equals the net (total) charge inside that surface divided by ε_0.

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{net}}{\varepsilon_0}$$

Note that the integral is over a closed surface

Electric field intensity due to spherical cell of radius R

(a) Field outside the shell-

Let us find out electric field intensity at a point P outside the spherical shell, such that OP = r. Here we take Gaussian surface as a sphere of radius r. the electric field intensity, $\vec{E}$ is same at every point of Gaussian surface, directed radially outwards (as is unit vector $\hat{n}$, so that θ = 0°)

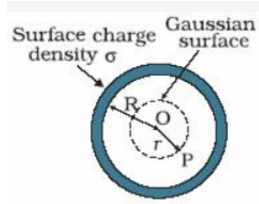
According Gauss's Theorem

$$\oint_S \vec{E} \cdot d\vec{S} = \oint_S \vec{E} \cdot \hat{n} dS = \frac{q}{\varepsilon_0}$$

Or $E\oint dS = \frac{q}{\varepsilon_0}$

$$E(4\pi r^2) = \frac{q}{\varepsilon_0}$$

Or $E = \frac{q}{4\pi r^2 \varepsilon_0}$



Hence it is clear that electric intensity at any point outside the spherical shell is such, as if the entire charge is concentrated at the centre of the shell.

(b) Field at the surface of the shell-

For this we have r = R

$$\therefore E = \frac{q}{4\pi R^2 \varepsilon_0}$$

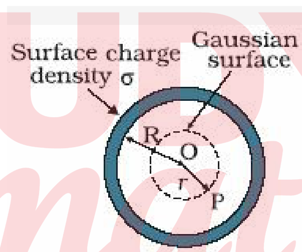
If σ Cm^{-2} is the charge density on the shell, then

$$q = 4\pi R^2 \cdot \sigma$$

$$\therefore E = \frac{4\pi R^2 \cdot \sigma}{4\pi R^2 \cdot \varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

(c) Field inside the shell-

If the point P lies inside the spherical shell, then Gaussian surface is a surface of sphere of radius r(As there is no charge inside the spherical shell, Gaussian surface encloses no charge.)



That is q = 0 $\quad\therefore\quad$ E = 0

Hence the field inside the spherical shell is always zero.

25. (i) Surface S_1 encloses charge Q only, therefore, electric flux through S_1 is $\phi_1 = \frac{Q}{\varepsilon_0}$

Surface S_2 enclosed both charges Q and $2Q$ (*i.e.*, total charge $3Q$); therefore electric flux through S_2 is $\phi_2 = \frac{3Q}{\varepsilon_0}$

Ratio $\phi_1 : \phi_2 = \frac{Q}{\varepsilon_0} : \frac{3Q}{\varepsilon_0}$

$\Rightarrow \phi_1 : \phi_2 \equiv 1 : 3$

(ii) When a medium of dielectric constant $K = 5$ is introduced in the space inside S_1, the electric flux through S_1 will become

$$\phi_1' = \frac{Q}{K\varepsilon_0} = \frac{Q/\varepsilon_0}{K} = \frac{\phi_1}{5}$$

i.e., The electric flux through S_1 will become one-fifth of that in air.

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