CHAPTER 1

Electric Charges and Fields

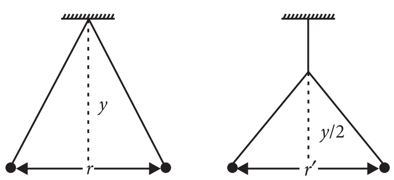
1.6 Coulomb's Law

1. Two point charges A and B, having charges $+Q$ and $-Q$ respectively, are placed at certain distance apart and force acting between them is F. If 25% charge of A is transferred to B, then force between the charges becomes
(a) $\frac{4F}{3}$ (b) F (c) $\frac{9F}{16}$ (d) $\frac{16F}{9}$
(NEET 2019)

2. Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of
[Given: mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg]
(a) 10^{-23} C (b) 10^{-37} C
(c) 10^{-47} C (d) 10^{-20} C *(NEET 2017)*

3. Two identical charged spheres suspended from a common point by two massless strings of lengths l, are initially at a distance d $(d << l)$ apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v. Then v varies as a function of the distance x between the spheres, as
(a) $v \propto x^{-1/2}$ (b) $v \propto x^{-1}$
(c) $v \propto x^{1/2}$ (d) $v \propto x$ *(NEET-I 2016)*

4. Two pith balls carrying equal charges are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become



(a) $\left(\frac{2r}{\sqrt{3}}\right)$ (b) $\left(\frac{2r}{3}\right)$
(c) $\left(\frac{1}{\sqrt{2}}\right)^2$ (d) $\left(\frac{r}{\sqrt[3]{2}}\right)$ *(NEET 2013)*

5. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron)
(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$
(c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$ (d) $\frac{4\pi\varepsilon_0 Fd^2}{q^2}$ *(2010)*

6. When air is replaced by a dielectric medium of constant K, the maximum force of attraction between two charges separated by a distance
(a) increases K times (b) remains unchanged
(c) decreases K times (d) increases K^{-1} times.
(1999)

1.7 Forces between Multiple Charges

7. A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium if q is equal to
(a) $-Q/4$ (b) $Q/4$ (c) $-Q/2$ (d) $Q/2$
(Karnataka NEET 2013, 1995)

8. Point charges $+4q$, $-q$ and $+4q$ are kept on the X-axis at point $x = 0$, $x = a$ and $x = 2a$ respectively. Then
(a) only $-q$ is in stable equilibrium
(b) all the charges are in stable equilibrium
(c) all of the charges are in unstable equilibrium
(d) none of the charges is in equilibrium. *(1988)*

1.8 Electric Field

9. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now

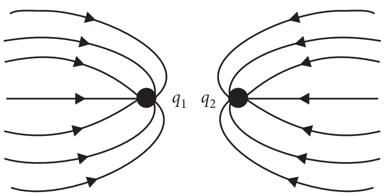
reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is
(a) smaller (b) 5 times greater
(c) 10 times greater (d) equal *(NEET 2018)*

10. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m s^{-1} in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively
(a) 2 m s^{-1}, 4 m s^{-1} (b) 1 m s^{-1}, 3 m s^{-1}
(c) 1 m s^{-1}, 3.5 m s^{-1} (d) 1.5 m s^{-1}, 3 m s^{-1}
(NEET 2018)

11. A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is
(a) qEy (b) qE^2y
(c) qEy^2 (d) q^2Ey *(1998)*

1.9 Electric Field Lines

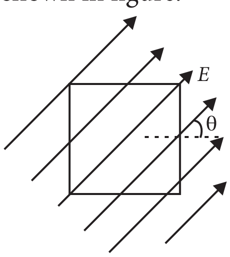
12. The given figure gives electric lines of force due to two charges q_1 and q_2. What are the signs of the two charges?



(a) q_1 is positive but q_2 is negative.
(b) q_1 is negative but q_2 is positive.
(c) both are negative.
(d) both are positive. *(1994)*

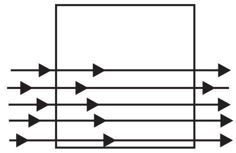
1.10 Electric Flux

13. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E(volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt m is



(a) EL^2
(b) $EL^2\cos\theta$
(c) $EL^2\sin\theta$
(d) zero
(2010)

14. A square surface of side L metres is in the plane of the paper. A uniform electric field $\vec{E}$ (volt/m), also in the plane of the paper is limited only to the lower half of the square surface (see figure). The electric flux in SI units associated with the surface is



(a) EL^2 (b) $EL^2/2\varepsilon_0$
(c) $EL^2/2$ (d) zero *(2006)*

1.11 Electric Dipole

15. Three point charges $+q$, $-2q$ and $+q$ are placed at points $(x = 0, y = a, z = 0)$, $(x = 0, y = 0, z = 0)$ and $(x = a, y = 0, z = 0)$ respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are
(a) $\sqrt{2}qa$ along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$
(b) qa along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$
(c) $\sqrt{2}qa$ along $+x$ direction
(d) $\sqrt{2}qa$ along $+y$ direction. *(2007)*

16. A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then the electric field at Q is proportional to
(a) p^2 and r^{-3} (b) p and r^{-2}
(c) p^{-1} and r^{-2} (d) p and r^{-3} *(1998)*

1.12 Dipole in a Uniform External Field

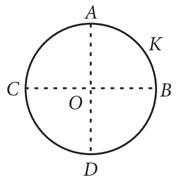
17. An electric dipole is placed at an angle of 30° with an electric field intensity 2×10^5 N C^{-1}. It experiences a torque equal to 4 N m. The charge on the dipole, if the dipole length is 2 cm, is
(a) 8 mC (b) 2 mC
(c) 5 mC (d) 7 μC *(NEET -II 2016)*

18. A dipole of dipole moment $\vec{p}$ is placed in uniform electric field $\vec{E}$, then torque acting on it is given by
(a) $\vec{\tau} = \vec{p} \cdot \vec{E}$ (b) $\vec{\tau} = \vec{p} \times \vec{E}$
(c) $\vec{\tau} = \vec{p} + \vec{E}$ (d) $\vec{\tau} = \vec{p} - \vec{E}$ *(2001)*

1.13 Continuous Charge Distribution

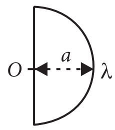
19. A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere? $\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ N m}^2/\text{C}^2\right)$
(a) 1.28×10^4 N/C (b) 1.28×10^5 N/C
(c) 1.28×10^6 N/C (d) 1.28×10^7 N/C *(NEET 2020)*

20. A thin conducting ring of radius R is given a charge $+Q$. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part $ACDB$ of the ring is



(a) E along KO
(b) $3E$ along OK
(c) $3E$ along KO
(d) E along OK *(2008)*

21. Electric field at centre O of semicircle of radius a having linear charge density λ given as



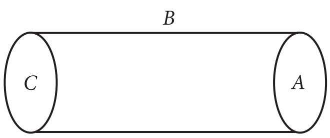
(a) $\frac{2\lambda}{\varepsilon_0 a}$ (b) $\frac{\lambda\pi}{\varepsilon_0 a}$
(c) $\frac{\lambda}{2\pi\varepsilon_0 a}$ (d) $\frac{\lambda}{\pi\varepsilon_0 a}$ *(2000)*

1.14 Gauss's Law

22. What is the flux through a cube of side a if a point charge of q is at one of its corner?
(a) $\frac{2q}{\varepsilon_0}$ (b) $\frac{q}{8\varepsilon_0}$ (c) $\frac{q}{\varepsilon_0}$ (d) $\frac{q}{2\varepsilon_0}6a^2$ *(2012)*

23. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will
(a) increase four times (b) be reduced to half
(c) remain the same (d) be doubled *(2011)*

24. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of volt meter associated with the curved surface B, the flux linked with the plane surface A in units of V-m will be



(a) $\frac{q}{2\varepsilon_0}$
(b) $\frac{\phi}{3}$
(c) $\frac{q}{\varepsilon_0}-\phi$ (d) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$ *(2007)*

25. A charge q is located at the centre of a cube. The electric flux through any face is
(a) $\frac{2\pi q}{6(4\pi\varepsilon_0)}$ (b) $\frac{4\pi q}{6(4\pi\varepsilon_0)}$
(c) $\frac{\pi q}{6(4\pi\varepsilon_0)}$ (d) $\frac{q}{6(4\pi\varepsilon_0)}$ *(2003)*

26. A charge Q μC is placed at the centre of a cube, the flux coming out from each face will be
(a) $\frac{Q}{6\varepsilon_0}\times10^{-6}$ (b) $\frac{Q}{6\varepsilon_0}\times10^{-3}$
(c) $\frac{Q}{24\varepsilon_0}$ (d) $\frac{Q}{8\varepsilon_0}$ *(2001)*

27. A charge Q is situated at the corner of a cube, the electric flux passed through all the six faces of the cube is
(a) $\frac{Q}{6\varepsilon_0}$ (b) $\frac{Q}{8\varepsilon_0}$ (c) $\frac{Q}{\varepsilon_0}$ (d) $\frac{Q}{2\varepsilon_0}$ *(2000)*

28. A point charge $+q$ is placed at the centre of a cube of side l. The electric flux emerging from the cube is
(a) $\frac{6ql^2}{\varepsilon_0}$ (b) $\frac{q}{6l^2\varepsilon_0}$ (c) zero (d) $\frac{q}{\varepsilon_0}$ *(1996)*

1.15 Applications of Gauss's Law

29. A hollow metal sphere of radius R is uniformly charged. The electric field due to the sphere at a distance r from the centre
(a) decreases as r increases for $r < R$ and for $r > R$
(b) increases as r increases for $r < R$ and for $r > R$
(c) zero as r increases for $r < R$, decreases as r increases for $r > R$
(d) zero as r increases for $r < R$, increases as r increases for $r > R$ *(NEET 2019)*

30. Two parallel infinite line charges with linear charge densities $+\lambda$ C/m and $-\lambda$ C/m are placed at a distance of $2R$ in free space. What is the electric field mid-way between the two line charges ?
(a) $\frac{\lambda}{2\pi\varepsilon_0 R}$ N/C (b) zero
(c) $\frac{2\lambda}{\pi\varepsilon_0 R}$ N/C (d) $\frac{\lambda}{\pi\varepsilon_0 R}$ N/C *(NEET 2019)*

31. The electric field at a distance $\frac{3R}{2}$ from the centre of a charged conducting spherical shell of radius R is E. The electric field at a distance $\frac{R}{2}$ from the centre of the sphere is
(a) zero (b) E (c) $\frac{E}{2}$ (d) $\frac{E}{3}$ *(Mains 2010)*

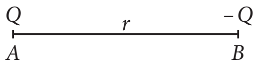
32. A hollow insulated conduction sphere is given a positive charge of 10 μC. What will be the electric field at the centre of the sphere if its radius is 2 metres ?
(a) 20 μC m^{-2} (b) 5 μC m^{-2}
(c) zero (d) 8 mC m^{-2} *(1998)*

ANSWER KEY

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(d)	**5.**	(c)	**6.**	(c)	**7.**	(a)	**8.**	(c)	**9.**	(a)	**10.**	(b)
11.	(a)	**12.**	(c)	**13.**	(d)	**14.**	(d)	**15.**	(a)	**16.**	(d)	**17.**	(b)	**18.**	(b)	**19.**	(b)	**20.**	(d)
21.	(c)	**22.**	(b)	**23.**	(c)	**24.**	(d)	**25.**	(b)	**26.**	(a)	**27.**	(b)	**28.**	(d)	**29.**	(c)	**30.**	(d)
31.	(a)	**32.**	(c)																

Hints & Explanations

1. (c) : In case I :



$$F = -\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{r^2} \qquad \text{....(i)}$$

In Case II : $Q_A = Q - \frac{Q}{4},\ Q_B = -Q + \frac{Q}{4}$

$$\therefore \quad F' = \frac{1}{4\pi\varepsilon_0}\frac{\left(Q-\frac{Q}{4}\right)\left(-Q+\frac{Q}{4}\right)}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{\left(\frac{3}{4}Q\right)\left(\frac{-3}{4}Q\right)}{r^2} = -\frac{1}{4\pi\varepsilon_0}\frac{9}{16}\frac{Q^2}{r^2} \qquad \text{...(ii)}$$

From equations (i) and (ii), $F' = \frac{9}{16}F$

2. (b) : A hydrogen atom consists of an electron and a proton.

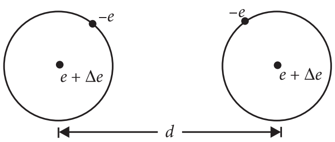
$\therefore$ Charge on one hydrogen atom

$= q_e + q_p = -e + (e + \Delta e) = \Delta e$

Since a hydrogen atom carries a net charge Δe

$$\therefore \quad \text{Electrostatic force, } F_e = \frac{1}{4\pi\varepsilon_o}\frac{(\Delta e)^2}{d^2} \qquad \text{...(i)}$$

will act between two hydrogen atoms.



The gravitational force between two hydrogen atoms is given as

$$F_g = \frac{G m_h m_h}{d^2} \qquad \text{...(ii)}$$

Since, the net force on the system is zero, $F_e = F_g$

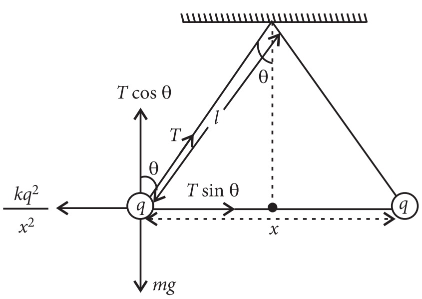
Using eqns. (i) and (ii), we get

$$\frac{(\Delta e)^2}{4\pi\varepsilon_o d^2} = \frac{G m_h^2}{d^2} \quad \text{or,} \quad (\Delta e)^2 = 4\pi\varepsilon_0 G m_h^2$$

$$= 6.67 \times 10^{-11} \times (1.67 \times 10^{-27})^2\ [1/(9 \times 10^9)]$$

$$\Delta e \approx 10^{-37}\ \text{C}$$

3. (a) :



From figure, $T\cos\theta = mg$ ...(i)

$$T\sin\theta = \frac{kq^2}{x^2} \qquad \text{...(ii)}$$

From eqns. (i) and (ii), $\tan\theta = \frac{kq^2}{x^2 mg}$

Since θ is small, $\therefore \quad \tan\theta \approx \sin\theta = \frac{x}{2l}$

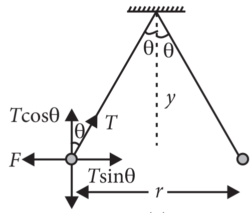
$$\therefore \quad \frac{x}{2l} = \frac{kq^2}{x^2 mg} \Rightarrow q^2 = x^3\frac{mg}{2lk} \text{ or } q \propto x^{3/2}$$

$$\Rightarrow \quad \frac{dq}{dt} \propto \frac{3}{2}\sqrt{x}\frac{dx}{dt} = \frac{3}{2}\sqrt{x}\,v$$

Since, $\frac{dq}{dt} = \text{constant}$; $\therefore \quad v \propto \frac{1}{\sqrt{x}}$

4. (d) : Let m be mass of each ball and q be charge on each ball. Force of repulsion,

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$$



(a)

In equilibrium

$T\cos\theta = mg$ ...(i)

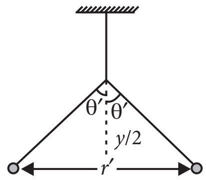
$T\sin\theta = F$ ...(ii)

Divide (ii) by (i), we get, $\tan\theta = \frac{F}{mg} = \frac{\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}}{mg}$

From figure (a),

$$\frac{r/2}{y} = \frac{\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}}{mg} \qquad \text{...(iii)}$$

For figure (b)



(b)

$$\tan\theta' = \frac{\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r'^2}}{mg} \Rightarrow \frac{r'/2}{y/2} = \frac{\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r'^2}}{mg} \qquad \text{...(iv)}$$

Divide (iv) by (iii), we get

$$\frac{2r'}{r} = \frac{r^2}{r'^2} \Rightarrow r'^3 = \frac{r^3}{2} \Rightarrow r' = \frac{r}{\sqrt[3]{2}}$$

5. (c) : According to Coulomb's law, the force of repulsion between the two positive ions each of charge q, separated by a distance d is given by

$$F = \frac{1}{4\pi\varepsilon_0}\frac{(q)(q)}{d^2} \quad \text{or} \quad F = \frac{q^2}{4\pi\varepsilon_0 d^2}$$

$q^2 = 4\pi\varepsilon_0 F d^2$ or $q = \sqrt{4\pi\varepsilon_0 F d^2}$ ...(i)

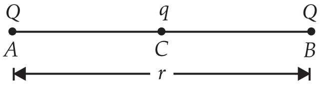
Since, $q = ne$

where, n = number of electrons missing from each ion, e = magnitude of charge on electron

$\therefore \quad n = \frac{q}{e} = \sqrt{\frac{4\pi\varepsilon_0 F d^2}{e^2}}$ (Using (i))

6. (c) : $F_m = \frac{F_0}{K}$ *i.e.*, decreases K times

7. (a) : The situation is as shown in the figure.



Let two equal charges Q each placed at points A and B at a distance r apart. C is the centre of AB where charge q is placed.

For equilibrium, net force on charge $Q = 0$

$$\therefore \quad \frac{1}{4\pi\varepsilon_0}\frac{QQ}{r^2} + \frac{1}{4\pi\varepsilon_0}\frac{Qq}{(r/2)^2} = 0$$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{r^2} = -\frac{1}{4\pi\varepsilon_0}\frac{4Qq}{r^2} \text{ or } Q = -4q \text{ or } q = -\frac{Q}{4}$$

8. (c) : Net force on each of the charge due to the other charges is zero. However, disturbance in any direction other than along the line on which the charges lie, will not make the charges return.

9. (a) : Force experienced by a charged particle in an electric field, $F = qE$

As $F = ma$

$$\therefore \quad ma = qE \Rightarrow a = \frac{qE}{m} \qquad \text{....(i)}$$

As electron and proton both fall from same height at rest. Then initial velocity = 0

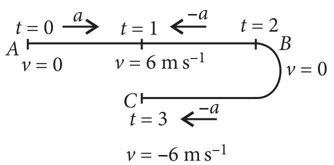
From $s = ut + \frac{1}{2}at^2 \qquad (\because u = 0)$

$$\therefore \quad h = \frac{1}{2}at^2 \Rightarrow h = \frac{1}{2}\frac{qE}{m}t^2 \qquad \text{[Using (i)]}$$

$\therefore \quad t = \sqrt{\frac{2hm}{qE}} \Rightarrow t \propto \sqrt{m}$ as 'q' is same for electron and proton.

As electron has smaller mass so it will take smaller time.

10. (b) :



$$\text{Acceleration, } a = \frac{6-0}{1} = 6 \text{ m s}^{-2}$$

$$\text{For } t = 0 \text{ to } t = 1 \text{ s, } s_1 = \frac{1}{2}\times 6(1)^2 = 3 \text{ m}$$

$$\text{For } t = 1 \text{ s to } t = 2 \text{ s, } s_2 = 6\times 1 - \frac{1}{2}\times 6(1)^2 = 3 \text{ m}$$

$$\text{For } t = 2 \text{ s to } t = 3 \text{ s, } s_3 = 0 - \frac{1}{2}\times 6(1)^2 = -3 \text{ m}$$

Total displacement $s = s_1 + s_2 + s_3 = 3$ m

$$\text{Average velocity} = \frac{3}{3} = 1 \text{ m s}^{-1}$$

Total distance travelled = 9 m

$$\text{Average speed} = \frac{9}{3} = 3 \text{ m s}^{-1}$$

11. (a) : As $v^2 = 0^2 + 2ay = 2(F/m)y = 2\left(\frac{qE}{m}\right)y$

$$\text{K.E.} = \frac{1}{2}mv^2$$

$$\therefore \quad \text{K.E.} = \frac{1}{2}m\left[2\frac{(qE)}{m}y\right] \Rightarrow \text{K.E.} = qEy$$

12. (c) : Electric lines of force start from the positive charge and end at the negative charge. Since the electric lines for both the charges are ending, therefore both q_1 and q_2 are negative charges.

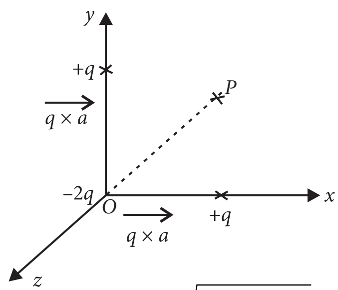
13. (d)

14. (d) : Electric flux, $\phi_E = \int \vec{E}\cdot d\vec{S}$

$$= \int EdS\cos\theta = \int EdS\cos 90° = 0.$$

The lines are parallel to the surface.

15. (a) : This consists of two dipoles, $-q$ and $+q$ with dipole moment along with the $+y$-direction and $-q$ and $+q$ along the x-direction.



$$\therefore \quad \text{The resultant moment} = \sqrt{q^2a^2 + q^2a^2} = \sqrt{2}qa$$

Along the direction 45° that is along OP, where P is $(+a, +a, 0)$.

16. (d) : The electric field at a point on equatorial line (perpendicular bisector) of dipole at a distance r is given by

$$E = \frac{p}{4\pi\varepsilon_0}\cdot\frac{1}{(r^2 + a^2)^{3/2}}$$

where $2a$ = length of dipole

For $r >> a$

$$\therefore \quad E = \frac{p}{4\pi\varepsilon_0}\cdot\frac{1}{r^3} \quad \textit{i.e.,}\ E \propto p \text{ and } E \propto r^{-3}$$

17. (b) : Here, $\theta = 30°$, $E = 2 \times 10^5$ N C^{-1}, $\tau = 4$ N m, $l = 2$ cm $= 0.02$ m, $q = ?$

$\tau = pE\sin\theta = (ql)E\sin\theta$

$$\therefore \quad q = \frac{\tau}{El\sin\theta} = \frac{4}{2\times 10^5 \times 0.02 \times \frac{1}{2}}$$

$$= \frac{4}{2\times 10^3} = 2\times 10^{-3}\text{ C} = 2 \text{ mC}$$

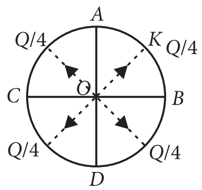
18. (b) : When an electric dipole is placed in a uniform electrical field $\vec{E}$, the torque on the dipole is given by $\vec{\tau} = \vec{p} \times \vec{E}$

19. (b) : Here, $r = 10$ cm, $q = 3.2 \times 10^{-7}$ C

$$E = \frac{kq}{r^2} = \frac{9 \times 10^9 \times 3.2 \times 10^{-7}}{225 \times 10^{-4}}$$

$E = 1.28 \times 10^5$ N/C

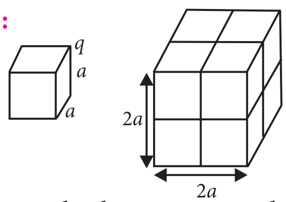
20. (d) :



The fields at O due to AC and BD cancel each other. The field due to CD is acting in the direction OK and equal in magnitude to E due to AKB.

21. (c)

22. (b) :



Eight identical cubes are required so that the given charge q appears at the centre of the bigger cube.
Thus, the electric flux passing through the given cube is

$$\phi = \frac{1}{8}\left(\frac{q}{\varepsilon_0}\right) = \frac{q}{8\varepsilon_0}$$

23. (c) : According to Gauss's law

$$\phi_E = \frac{Q_{enclosed}}{\varepsilon_0}$$

If the radius of the Gaussian surface is doubled, the outward electric flux will remain the same. This is because electric flux depends only on the charge enclosed by the surface.

24. (d) : Let ϕ_A, ϕ_B and ϕ_C are the electric flux linked with surface is A, B and C.
According to Gauss theorem,

$$\phi_A + \phi_B + \phi_C = \frac{q}{\varepsilon_0}$$

Since $\phi_A = \phi_C$,

$$\therefore \quad 2\phi_A + \phi_B = \frac{q}{\varepsilon_0} \quad \text{or} \quad 2\phi_A = \frac{q}{\varepsilon_0} - \phi_B$$

$$\text{or,} \quad 2\phi_A = \frac{q}{\varepsilon_0} - \phi \qquad (\text{Given}: \phi_B = \phi)$$

$$\therefore \quad \phi_A = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$$

25. (b) : The total flux through the cube

$$\phi_{total} = \frac{q}{\varepsilon_0}$$

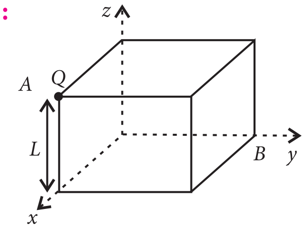
$\therefore$ The electric flux through any face

$$\phi_{face} = \frac{q}{6\,\varepsilon_0} = \frac{4\pi q}{6(4\pi\varepsilon_0)}$$

26. (a) : For complete cube, $\phi = \frac{Q}{\varepsilon_0} \times 10^{-6}$

For each face, $\phi = \frac{1}{6}\frac{Q}{\varepsilon_0} \times 10^{-6}$

27. (b) :



As at a corner, 8 cubes can be placed symmetrically, flux linked with each cube (due to a charge Q at the corner) will be $\frac{Q}{8\varepsilon_0}$.
Now for the faces passing through the edge A, electric field E at a face will be parallel to area of face and so flux for these three faces will be zero. Now as the cube has six faces and flux linked with three faces (through A) is zero, so flux linked with remaining three faces will be $\frac{Q}{8\varepsilon_0}$.

Hence, electric flux passed through all the six faces of the cube is $\frac{Q}{8\varepsilon_0}$.

28. (d) : Electric flux emerging from the cube does not depend on size of cube.

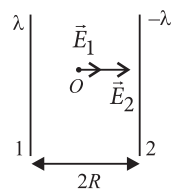
Total flux $= \frac{q}{\varepsilon_0}$

29. (c) : In a uniformly charged hollow conducting sphere,

(i) For $r < R$, $\vec{E} = 0$

(ii) For $r > R$, $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{|\vec{r}^2|}\hat{r}$; $\vec{E}$ decreases

30. (d) : Electric field due to an infinite line charge, $E = \frac{\lambda}{2\pi\varepsilon_0 r}$



Net electric field at mid-point O,
$\vec{E}_0 = \vec{E}_1 + \vec{E}_2$

As, $E_1 = E_2 = \frac{\lambda}{2\pi\varepsilon_0 R}$ $\therefore E_0 = 2E_1 = \frac{\lambda}{\pi\varepsilon_0 R}$ N C^{-1}

31. (a) : Electric field inside the charged spherical shell is zero as there is no charge inside it.

32. (c) : Field inside a conducting sphere = 0.

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