Electric Charges and Fields Important Questions With Answers

NEET Physics 2023

1. A short electric dipole has a dipole moment of $16 \times 10^{9}\ \mathrm{cm}$. The electric potential due to the dipole at a point at a distance of 0.6 m from the centre of the dipole, situated on a line making an angle of 60° with the dipole axis is: $\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^{9}\mathrm{Nm}^2/\mathrm{C}^2\right)$

   a) zero b) 50 V **c) 200 V** d) 400 V

   Solution : -

   The electric potential due to the dipole

   $V = \frac{kP\cos\theta}{r^2} = \frac{9\times10^{9}\times16\times10^{-9}}{(0.6)^2} \times \frac{1}{2}$

   $V = 200\ \mathrm{V}$

2. A spherical conductor of radius 10 cm has a charge of $3.2 \times 10^{-7}\mathrm{C}$ distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere? $\left(\frac{1}{4\pi\epsilon_0} = 9 \times 10^{9}\mathrm{Nm}^2/\mathrm{C}^2\right)$

   a) $1.28 \times 10^{7}\ \mathrm{N/C}$ b) $1.28 \times 10^{4}\ \mathrm{N/C}$ **c)** $1.28 \times 10^{5}\ \mathrm{N/C}$ d) $1.28 \times 10^{6}\ \mathrm{N/C}$

   Solution : -

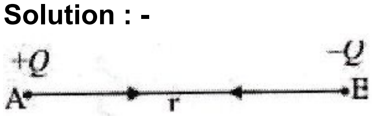
   $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} = \frac{9\times10^{9}\times3.2\times10^{-7}}{(15\times10^{-2})^2}$

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

3. 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) $\frac{9\,\mathrm{F}}{16}$ b) $\frac{16\,\mathrm{F}}{9}$ c) $\frac{4\,\mathrm{F}}{3}$ d) F

   Solution : -

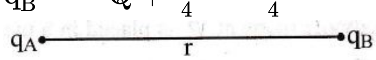
   

   $\mathrm{F} = \frac{\mathrm{KQ}^2}{\mathrm{r}^2}$

   If 25 % of charge of A transferred to B then

   $\mathrm{q_A} = \mathrm{Q} - \frac{\mathrm{Q}}{4} = \frac{3\mathrm{Q}}{4}$ and

   $\mathrm{q_B} = -\mathrm{Q} + \frac{\mathrm{Q}}{4} = \frac{-3\mathrm{Q}}{4}$

   $F_1 = \frac{kq_Aq_B}{r^2}$

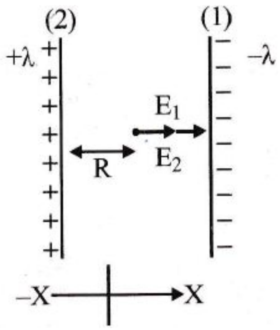
   $F_1 = \frac{k\left(\frac{3Q}{4}\right)^2}{r^2}$

   $F_1 = \frac{9}{16}\frac{kQ^2}{r^2}$

   $F_1 = \frac{9F}{16}$

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

Solution : -



Electric field due to line charge (1)
$\vec{E}_1 = \frac{\lambda}{2\pi\varepsilon_0 \mathrm{R}} \hat{\mathrm{i}} \mathrm{N/C}$
Electric field due to line charge (2)
$\vec{E}_2 = \frac{\lambda}{2\pi\varepsilon_0 \mathrm{R}} \hat{\mathrm{i}} \mathrm{N/C}$
$\vec{E}_{\text{net}} = \vec{E}_1 + \vec{E}_2$
$= \frac{\lambda}{2\pi\varepsilon_0 R} \hat{i} + \frac{\lambda}{2\pi\varepsilon_0 R} \hat{i}$
$= \frac{\lambda}{2\pi\varepsilon_0 R} \hat{i}\ \mathrm{N/C}$

5. The electric field in a certain region is acting radially outward and is given by E=Ar. A charge contained in a sphere of radius ' a ' centred at the origin of the field, will be given by:
a) $A\varepsilon_0 a_1^2$ **b)** $4\pi\varepsilon_0 A a^3$ c) $\varepsilon_0 A a^3$ d) $4\pi\varepsilon_0 \mathrm{Aa}^2$

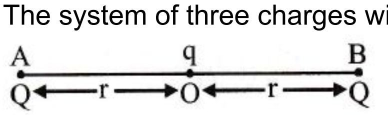
Solution : -
Net flux emmited from a spherical surface of radius according to Gauss's theorem
$\phi_{net} = \frac{q_{in}}{\varepsilon_0}$
$\text{or, } (Aa)\left(4\pi a^2\right) = \frac{q_{in}}{\varepsilon_0}$
$\text{So, } q_{\text{in}} = 4\pi\varepsilon_0 \mathrm{Aa}^3$

6. An electric dipole of dipole moment p is aligned parallel to a uniform electric field E. The energy required to rotate the dipole by 90° is _______________.
a) pE^2 b) p^2E **c) pE** d) Infinity

Solution : -
When electric dipole is aligned parallel $\mathrm{q} = 0^\circ$ and the dipole is rotated by 90° i.e., $\mathrm{q} = 90^\circ$.
Energy needed to rotate the dipole $\mathrm{W} = \mathrm{U_f} - \mathrm{U_i} = (-\mathrm{pE}\cos 90^\circ) - (-\mathrm{pE}\cos 0^\circ) = \mathrm{pE}.$

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/2 **b) -Q/4** c) Q/4 d) -Q/2

Solution : -
The system of three charges will be in equilibrium



For this, force between charge at A and B+ force between charge at point O and either at A or B is zero.
$\text{i.e., } \frac{KQ^2}{r^2} + \frac{KQq}{(r/2)^2} = 0$

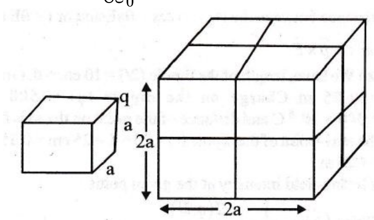
$KQ^2 + 4KQ_q = 0$
$\Rightarrow 4q = -Q$
$\Rightarrow q = -\frac{Q}{4}$

8. Two metallic spheres of radii 1 m and 3 cm are given charges of $-1 \times 10^{-2} \mathrm{C}$ and $5 \times 10^{-2} \mathrm{C}$, respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is:
   a) $2 \times 10^{-2} \mathrm{C}$ **b)** $3 \times 10^{-2} \mathrm{C}$ c) $4 \times 10^{-2} \mathrm{C}$ d) $1 \times 10^{-2} \mathrm{C}$

   Solution : -
   At equilibrium potential of both sphere becomes same if charge of sphere one x and other sphere Q-x then where Q = $4 \times 10^{-2} C$
   $v_1 = v_2$
   $\frac{kx}{1 \text{ cm}} = \frac{k(Q-x)}{3 \text{ cm}}$
   $3x = Q - x \Rightarrow 4x = Q$
   $\therefore x = \frac{Q}{4} = \frac{4 \times 10^{-2}}{4} C = 1 \times 10^{-2}$
   $Q = Q - x = 3 \times 10^{-2} C$

9. 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) $\frac{q}{2\varepsilon_0} 6a^2$

   Solution : -
   Eight identical cubes are required to be arranged so that this charge is at centre of the cube so formed
   $\therefore \phi = \frac{q}{8\varepsilon_0}$



10. The electric potential V at any point (x, y, z) all in metres in space is given by $V = 4x^2$ volt. The electric field at the point (1,0,2) in volt/metre is:
    a) 8 along positive X-axis b) 16 along negative X-axis c) 16 along positive X-axis
    d) 8 along negative X-axis

    Solution : -
    $\vec{E} = -\left[\frac{dv}{dx}\hat{i} + \frac{dv}{dy}\hat{j} + \frac{dv}{dz}\hat{k}\right]$
    $= -8 \times \hat{i} \text{ volt / metre}$
    $\therefore E_{(1,0,2)} = -8\hat{i} V/m$

11. 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

    Solution : -
    According to Gauss's theorem,
    $\phi = \frac{Q_{in}}{\varepsilon_0}$
    Therefore, the net flux depends only on the charge enclosed by the surface. Thus, there will be no effect on the net flux if the radius of the surface is doubled.

12. 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) $\frac{E}{2}$ **b) zero** c) E d) $\frac{E}{2}$

Solution : -

Electric field at a point inside a charged conducting spherical shell is zero.

13. 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 of 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) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{q^2}}$

Solution : -

Suppose n be the number of electron missing.

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

$\Rightarrow q = \sqrt{4\pi\varepsilon_0 d^2 F} = ne$

$= \therefore n = \sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$

14. The mean free path of electrons in a metal is 4×10^{-8} m. The electric field which can give on an average 2 eV energy to an electron in the metal will be in units of V/m.

a) 5×10^{-11} b) 8×10^{-11} **c)** 5×10^7 d) 8×10^7

Solution : -

$E = \frac{V}{d} = \frac{2}{4\times10^{-8}}$

$= 0.5 \times 10^8 = 5 \times 10^7 \mathrm{Vm}^{-1}$

15. Three point charges +q, -q 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:

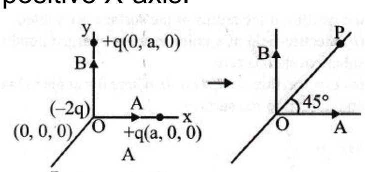
a) $\sqrt{2}qa$ along the line joining points (x=0, y=0, z=0) and (x=a, y=a, z=0)

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 +ve x direction,

d) $\sqrt{2}$qa along +ve y direction,

Solution : -

Three point charges $+$q, -2q and +q are placed at points B(x=0, y=a, z=0), $\mathrm{O}(x = 0, y = 0, z = 0)$ and A(x=a, y=0, z=0) The system consists of two dipole moment vectors because of (+q and -q) and again because of (+q and -q) charges having equal magnitudes qa units - one along $\overrightarrow{OA}$ and other along $\overrightarrow{OB}$. Hence, net dipole moment, $\mathrm{p_{net}} = \sqrt{(qa)^2 + (qa)^2} = \sqrt{2}qa$ along $\overrightarrow{OP}$ at an angle 45° with positive X-axis.



16. An electric dipole of moment $\vec{p}$ is lying along a uniform electric field $\vec{E}$. The work done in rotating the dipole by $90^\circ$is ___________ .

a) $\frac{pE}{2}$ b) 2pE **c) pE** d) $\sqrt{2}pE$

Solution : -

During dipole rotating work done $= \mathrm{p(E)(1 - cosq)}$

If $\mathrm{q} = 90^\circ$ work done $= \mathrm{pE(1 - 0) = pE}$

17. A charge q is located at the centre of a cube. The electric flux through any face is _______________ .

a) $\frac{q}{6(4\pi\varepsilon_0)}$ b) $\frac{2\pi q}{6(4\pi\varepsilon_0)}$ **c)** $\frac{4\pi q}{6(4\pi\varepsilon_0)}$ d) $\frac{\pi q}{6(4\pi\varepsilon_0)}$

Solution : -

Cube has 6 faces. Flux through any face is given by
$\phi=\frac{q}{6\varepsilon_0}=\frac{q4\pi}{6(4\pi\varepsilon_0)}$

18. An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The coulomb force $\vec{F}$ between the two is (where $K=\frac{1}{4K\varepsilon_0}$)

a) $K\frac{e^2}{r^3}\vec{r}$ b) $K\frac{e^2}{r^2}\hat{r}$ c) $-K\frac{e^2}{r^3}\hat{r}$ **d)** $-K\frac{e^2}{r^3}\vec{r}$

Solution : -

Charges (-e) on electron and (e) on proton exert a force of attraction given by
$\text{Force }=(K)\frac{(-e)(e)}{r^2}\hat{r}=\frac{-Ke^2}{r^3}\vec{r}$
$\left[\because\hat{r}=\frac{\vec{r}}{|r|}\right]$

19. A charge Q mc is placed at the centre of a cube, the flux coming out from any surface 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) $\frac{Q}{8\varepsilon_0}$

Solution : -

Total flux out of all six faces
$=\frac{Q\times10^{-6}}{\varepsilon_0}$
Therefore, flux coming out of each face
$=\frac{Q}{6\varepsilon_0}\times10^{-6}\mathrm{C}$

20. If a dipole of dipole moment $\vec{p}$ is placed in a 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) $\vec{\tau}=\vec{p}-\vec{E}$

Solution : -

We have Dipole moment of the dipole $=\vec{p}$ and uniform electric field $=\vec{E}$. We know that dipole moment $(p)=\theta$.a (where θ is the charge and a is dipole length). And when a dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$, then Torque (t)= Either force x perpendicular distance between the two forces $=\theta\mathrm{aEsinq}$ or $\mathrm{t}=\theta\mathrm{E}\sin\theta$ or $\vec{\tau}=\vec{p}\times\vec{E}$.

21. The electric intensity due to a dipole of length 10 cm and having a charge of 500 mC, at a point on the axis at a distance 20 cm from one of the charges in air, is ______________ .

a) $6.25\times10^7\ \mathrm{N/C}$ b) $9.28\times10^7\ \mathrm{N/C}$ c) $13.1\times10^{11}\ \mathrm{N/C}$ d) $20.5\times10^7\ \mathrm{N/C}$

Solution : -

We have, length of the dipole (2l)=10 cm=0.1 m or 1 =0.05 m Charge on the dipole (q)=500 mc $=500\times10^{-6}\mathrm{C}$ and distance of the point on the axis from the mid-point of the dipole
$(\mathrm{r})=20+5=25\ \mathrm{cm}=0.25\ \mathrm{cm}=0.25\ \mathrm{m}.$
Electric field intensity at the given point
$\text{Point }(E)=\frac{1}{4\pi\varepsilon_0}\times\frac{2(q.2l)r}{(r^2-l^2)^2}$
$=9\times10^9\times\frac{2(500\times10^{-6}\times0.1)\times0.25}{\left[(0.25)^2-(0.05)^2\right]^2}$
$=\frac{225\times10^3}{3.6\times10^{-3}}=6.25\times10^7\ \mathrm{N/C}$

22. One metallic sphere A is given positive charge whereas another identical metallic sphere B of exactly same mass as of A is given equal amount of negative charge. Then

a) mass of A and mass of B still remain equal b) mass of A increases c) mass of B decreases
d) mass of B increases

23. In general, metallic ropes are suspended from the carriers to the ground which take inflammable material. The reason is

a) their speed is controlled   b) to keep the gravity of the carrier nearer to the earth
c) to keep the body of the carrier in contact with the earth   d) nothing should be placed under the carrier

24. In charging by induction
a) body to be charged must be an insulator   b) body to be charged must be a semiconductor
c) body to be charged must be a conductor   d) any type of body can be charged by induction

25. Charge on a body is q1 and it is used to charge another body by induction. Charge on second body is found to be q2 after charging. Then
a) $\frac{q_1}{q_2} = 1$ b) $\frac{q_1}{q_2} < 1$ c) $\frac{q_1}{q_2} \leq 1$ **d)** $\frac{q_1}{q_2} \geq 1$

26. An object of mass 1kg contains 4 x 10^{20} atoms. If one electron is removed from every atom of the solid, the charge gained by the solid of 1g is _______
a) 2.8 C   **b) 6.4 x 10^{-2} C**   c) 3.6 x 10^{-3} C   d) 9.2 x 10^{-4} C

27. Number of electrons present in a negative charge of 8 C is ____________
a) 5 x10^{19}   b) 2.5 x 10^{19} c) 12.8 x 10^{19} d) 1.6 x 10^{19}

28. SI unit of electrical permittivity is
a) N-m ^{2}C^{-2} b) Am $^{-2}$ c) NC^{-1} **d) $C^2N^{-1}m^{-2}$**

29. Two charges + 1 μ Cand +4μ C are situated at a distance in air. The ratio of the forces acting on them is
a) 1 : 4   b) 4 : 1   **c) 1 : 1**   d) 1 : 16

30. A force of 2.25 N acts on a chrage of 15 x 10^{-4} C. The intensity of electric field at that point is
a) 150 NC^{-1} b) 15 NC^{-1} **c) 1500 NC $^{-1}$**   d) 1.5 NC^{-1}

31. A hemisphere is uniformly charged. The electric field at a point on a diameter away from the centre is directed
a) perpendicular to the diameter   b) parallel to the diameter   c) at an angle tilted towards the diameter
d) at an angle tilted away from the diameter

32. Two equal and opposite charges each of 2C are placed at a distance of 0.04 m. Dipole moment of the system will be
a) 6 x 10^{-8} C-m   **b) 8 x 10^{-2} C-m**   c) 1.5 x 10^{2} C-m   d) 8 x 10^{-6} C-m

33. What is the angle between the electric dipole moment and the electric field strength due to it on the equatorial line?
a) 0^o b) 90^o **c) 180^o**   d) None of these

34. In an electric field E, the torque acting on a dipole moment p is
a) p·E   **b) p x E**   c) zero   d) E x p

35. When an electric dipole p is placed in a uniform electric field E,then at what angle between p and E the value of torque will be maximum?
a) 90^o   b) 0^o c) 180^o d) 45^o

36. In a system, 'n' electric dipole are placed in a closed surface. The value of emergent electric flux from enclosed surface is
a) $\frac{q}{\varepsilon_0}$ b) $\frac{2q}{\varepsilon_0}$ c) $-\frac{2q}{\varepsilon_0}$ **d) zero**

37. The intensity of electric field at the surface of conducting hollow sphere is 10 NC^{-1} and its radius is 10 cm. The value of electric field at the centre of sphere is
a) zero   b) 10 NC^{-1} c) 1 NC^{-1} d) 100 NC^{-1}

38. The surface densities on the surfaces of two charged spherical conductors of radii R_1 and R_2 are equal. The ratio of electric intensities on the surfaces are
a) R_1^2/R_2^2 b) R_2^2/R_1^2 c) R_1/R_2 **d) 1:1**

39. The electric flux in a charged spherical conductor is

a) zero inside and outside the sphere b) maximum inside the sphere and zero outside the sphere
c) zero inside the sphere and decreases outside the sphere with increase of square of distance.
d) maximum inside the sphere and decreases outside the sphere with increase of distance.

40. Radius of a hollow sphere is R and a charge q is placed at the centre of hollow sphere. If the radius of sphere becomes half and charge also becomes half, then the value of emergent total flux from the surface of sphere is
a) $4q/\varepsilon_0$ b) $2q/\varepsilon_0$ **c)** $q/2\varepsilon_0$ d) q/ε_0

41. The number of electrons that must be removed from an electrically neutral silver dollar to give it a charge of + 2.4 C is
a) 2.5 x 10^{19} **b) 1.5 x 10^{19}** c) 1.5 x 10^{-19} d) 2.5 x 10^{-19}

42. Two identical metallic spheres having charges +4q and -2q are placed with their centres r distance apart. Force of attraction between the spheres is F. If the two spheres are brought in contact and then placed at the same distance r apart, the force between them
a) F b) F/2 c) F/4 **d) F/8**

43. The unit of intensity of electric field is
a) N/m b) C/N **c) N/C** d) J/N

44. Electric field of a system of charges does not depend on
a) position of charges forming the system
b) distance of point (at which fieldis being observed) from the charges forming system
c) value of test charge used to find out the field d) separation of charges forming the system

45. Gauss' law is true only if force due to charges varies as
a) r^{-1} **b) r^{-2}** c) r^{-3} d) r^{-4}

46. For a given surface, the $\oint \mathbf{E} \cdot d\mathbf{S} = 0$ From this, we can conclude that
a) E is necessarily zero on the surface. b) E is perpendicular to the surface at every point
c) the total flux through the surfaceis zero d) the flux is only going out of the surface

47. A charge on a sphere of radius 2 cm is 2 μC while charge on sphere of radius 5 cm is 5μC. Find the ratio of an electric field on distance of 10 crn from centre of the sphere.
a) 1 : 1 b) 2 : 5 **c) 5 : 2** d) 4 : 25

48. When a glass rod is rubbed with silk, it
a) gains electrons from silk. **b) gives electrons to silk** c) gains protons from silk d) gives protons to silk.

49. Two similar spheres having +Q and -Q charges are kept at a certain distance. F force acts between the two. If at the middle of two spheres, another similar sphere having +Q charge is kept, then it experiences a force in magnitude and direction as
a) zero having no direction. b) SF towards +Q charge. **c) SF towards -Q charge.**
d) 4F towards +Q charge

50. A charge Q is divided into two parts of q and Q - q. If the coulomb repulsion between them when they are separated is to be maximum, the ratio of Q/q should be
a) 2 : 1 b) 1/2 c) 4 : 1 d) 1/4