# Topic 2: Electric Field, Electric Field Lines & Dipole

1) There is an electric field E in x – direction. If the work done on moving a charge of 0.2 C through a distance of 2m along a line making an angle of 60° with x – axis is 4J, then what is the value of E?

(a) 3 N/C
(b) 4 N/C
(c) 5 N/C
(d) 20 N/C

2) An electric dipole, consisting of two opposite charges of $2 \times 10^{-6}$ C each separated by a distance 3 cm is placed in an electric field of $2 \times 10^{5}$ N/C. Torque acting on the dipole is

(a) $12 \times 10^{-1}$ Nm
(b) $12 \times 10^{-2}$ Nm
(c) $12 \times 10^{-3}$ Nm
(d) $12 \times 10^{-4}$ Nm

3) The formation of a dipole is due to two equal and dissimilar point charges placed at a

(a) short distance
(b) long distance
(c) above each other
(d) none of these

4) Intensity of an electric field (E) depends on distance r, due to a dipole, is related as

(a) $E \propto \frac{1}{r}$
(b) $E \propto \frac{1}{r^2}$
(c) $E \propto \frac{1}{r^3}$
(d) $E \propto \frac{1}{r^4}$

5) From a point charge, there is a fixed point A. At A, there is an electric field of 500 V/m and potential difference of 3000 V. Distance between point charge and A will be

(a) 6 m
(b) 12 m
(c) 16 m
(d) 24 m

6) 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) $p^{-1}$ and $r^{-2}$
(b) p and $r^{-2}$
(c) $p^2$ and $r^{-3}$
(d) p and $r^{-3}$

7) 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 meters?

(a) zero
(b) 5 $\mu Cm^{-2}$
(c) 20 $\mu Cm^{-2}$
(d) 8 $\mu Cm^{-2}$

8) A semi – circular arc of radius 'a' is charged uniformly and the charge per unit length is λ. The electric field at the centre of this arc is

(a) $\frac{\lambda}{2\pi\varepsilon_0 a}$ (b) $\frac{\lambda}{2\pi\varepsilon_0 a^2}$

(c) $\frac{\lambda}{4\pi^2\varepsilon_0 a}$ (d) $\frac{\lambda^2}{2\pi\varepsilon_0 a}$

9) 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) $\vec{\tau} = \vec{p}.\vec{E}$ (b) $\vec{\tau} = \vec{p} \times \vec{E}$

(c) $\vec{\tau} = \vec{p} + \vec{E}$ (d) $\vec{\tau} = \vec{p} - \vec{E}$

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

(a) $6.25 \times 10^7$ N/C (b) $9.28 \times 10^7$ N/C

(c) $13.1 \times 10^{11}$ N/C (d) $20.5 \times 10^7$ N/C

11) 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

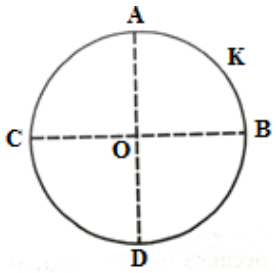
(a) $\sqrt{2}$qa along the line joining points (x = 0, y = 0, z = 0) and (x = a, y = a, z = 0)

(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

12) 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 E. The electric field at the centre due to the charge on the part ACDB of the ring is




(a) E along KO (b) E along OK

(c) 2E along KO (d) 3E along OK

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

(a) $5 \times 10^{-11}$ (b) $8 \times 10^{-11}$

(c) $5 \times 10^{7}$ (d) $8 \times 10^{7}$

14) 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) $\frac{E}{4}$

15) 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/meter 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

16) An electric dipole of moment 'p' is placed in an electric field of intensity 'E'. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when = 90°, the torque and the potential energy of the dipole will respectively be:

(a) pE sin θ, –pE cos θ (b) pE sin θ, –2pE cos θ

(c) pE sin θ, 2pE cos θ (d) pE cos θ, –pE cos θ

17) 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

18) A charged oil drop is suspended in a uniform field of $3 \times 10^4$ v/m so that it neither falls nor rises. The charge on the drop will be (Take the mass of the charge = $9.9 \times 10^{-15}$ kg and g = 10 m/s$^2$)

(a) $1.6 \times 10^{-18}$ C (b) $3.2 \times 10^{-18}$ C

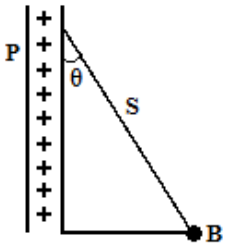
(c) $3.3 \times 10^{-18}$ C (d) $4.8 \times 10^{-18}$ C

19) Four charges equal to –Q are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium the value of q is

(a) $-\frac{Q}{2}(1 + 2\sqrt{2})$ (b) $\frac{Q}{4}(1 + 2\sqrt{2})$

(c) $-\frac{Q}{4}(1+2\sqrt{2})$ (d) $\frac{Q}{2}(1+2\sqrt{2})$

20) A charged ball B hangs from a silk thread S, which makes an angle θ with a large charged conducting sheet P, as shown in the figure. The surface charge density σ of the sheet is proportional to




(a) cot θ (b) cos θ

(c) tan θ (d) sin θ

21) Two point charges +8q and –2q are located at x = 0 and x = L respectively. The location of a point on the x - axis at which the net electric field due to these two point charges is zero is

(a) $\frac{L}{4}$ (b) 2L

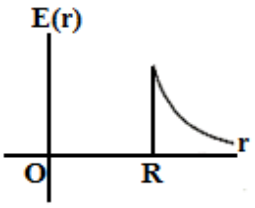
(c) 4L (d) 8L

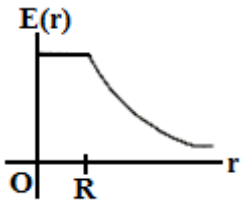
22) Two spherical conductors A and B of radii 1mm and 2mm are separated by a distance of 5cm and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surfaces of the spheres A and B is

(a) 4 : 1 (b) 1 : 2

(c) 2 : 1 (d) 1 : 4

23) A thin spherical shell of radius R has charge Q spread uniformly over its surface. Which of the following graphs most closely represents the electric field E(r) produced by the shell in the range $0 \leq r < \infty$, where r is the distance from the centre of the shell?

(a)



(b)
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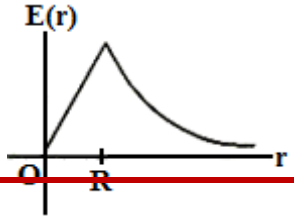
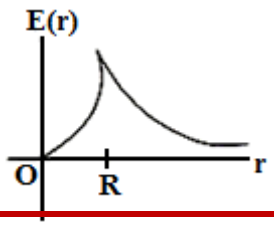



(d)


24) Let $\rho(r) = \frac{Q}{\pi R^4} r$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point 'P' inside the sphere at distance $r_1$ from the centre of the sphere, the magnitude of electric field is:

(a) $\frac{Q}{4\pi\epsilon_0 r_1^2}$

(b) $\frac{Qr_1^2}{4\pi\epsilon_0 R^4}$

(c) $\frac{Qr_1^2}{3\pi\epsilon_0 R^4}$

(d) 0

25) This question contains Statement –1 and Statement – 2. Of the four choices given after the statements, choose the one that best describes the two statements.

**Statement – 1:** For a charged particle moving from a point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.

**Statement – 2:** The net work done by a conservative force on an object moving along a closed loop is zero.

(a) Statement – 1 is true, Statement – 2 is true; Statement – 2 is the correct explanation of Statement – 1.

(b) Statement – 1 is true, Statement – 2 is true; Statement – 2 is not the correct explanation of Statement – 1.

(c) Statement – 1 is false, Statement – 2 is true.

(d) Statement – 1 is true, Statement – 2 is false.

26) Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0 \left(\frac{5}{3} - \frac{r}{R}\right)$ upto r = R, and $\rho(r) = 0$ for $r > R$, where r is the distance from the origin. The electric field at a distance r ($r < R$) from the origin is given by

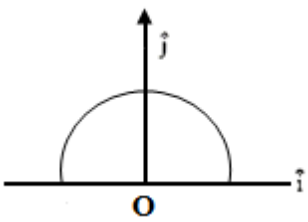
(a) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$

(b) $\frac{4\pi\rho_0 r}{3\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$

(c) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$

(d) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$

27) A thin semi- circular ring of radius r has a positive charge q distributed uniformly over it. The net field $\vec{E}$ at the centre O is



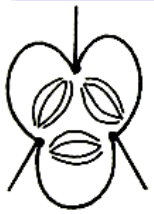
(a) $\frac{q}{4\pi^2\varepsilon_0 r^2}\hat{j}$

(b) $-\frac{q}{4\pi^2\varepsilon_0 r^2}\hat{j}$

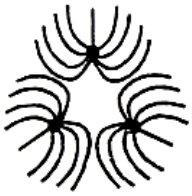
(c) $-\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$

(d) $\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$

28) Three positive charges of equal value q are placed at vertices of an equilateral triangle. The resulting lines of force should be as in

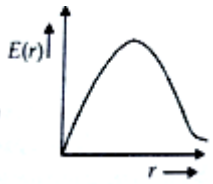
(a) 

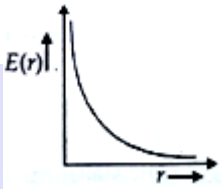
(b) 

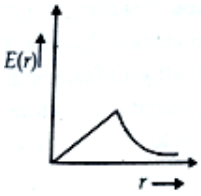
(c) 

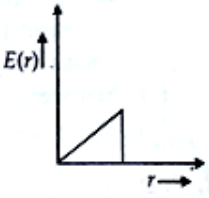
(d) 

29) In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as function of distance from the centre. The graph which would correspond to the above will be:

(a) 


(b) 


(c) 


(d) 


30) A liquid drop having 6 excess electrons is kept stationary under a uniform electric field of 25.5kVm$^{-1}$. The density of liquid is $1.26 \times 10^3$ kg m$^{-3}$. The radius of the drop is (neglect buoyancy).

(a) $4.3 \times 10^{-7}$m

(b) $7.8 \times 10^{-7}$m

(c) $0.078 \times 10^{-7}$m

(d) $3.4 \times 10^{-7}$m

31) The surface charge density of a thin charged disc of radius R is σ. The value of the electric field at the centre of the disc is $\frac{\sigma}{2\epsilon_0}$. What respect to the field at the centre, the electric field along the axis at a distance R from the centre of the disc:

(a) reduces by 70.7%

(b) reduces by 29.3%

(c) reduces by 9.7%

(d) reduces by 14.6%

32) The magnitude of the average electric field normally present in the atmosphere just above the surface of the Earth is about 150 N/C, directed inward towards the centre of the Earth. This gives the total net surface charge carried by the Earth to be: (Given $\varepsilon_0 = 8.85 \times 10^{-12} C^2/N - m^2$, $R_E = 6.37 \times 10^6$ m)

(a) +670kC

(b) –670kC

(c) –680kC

(d) +680kC

33) A spherically symmetric charge distribution is characterized by a charge density having the following variations:

$\rho(r) = \rho_0 \left(1 - \frac{r}{R}\right)$ for $r < R$

$\rho(r) = 0$ for $r \geq R$

Where r is the distance from the centre of the charge distribution $\rho_0$ is a constant. The electric field at an internal point ($r < R$) is:

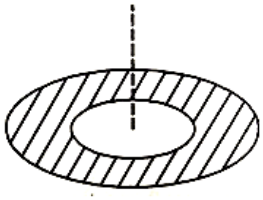
(a) $\frac{\rho_0}{4\varepsilon_0}\left(\frac{r}{3} - \frac{r^2}{4R}\right)$

(b) $\frac{\rho_0}{\varepsilon_0}\left(\frac{r}{3} - \frac{r^2}{4R}\right)$

(c) $\frac{\rho_0}{3\varepsilon_0}\left(\frac{r}{3} - \frac{r^2}{4R}\right)$

(d) $\frac{\rho_0}{12\varepsilon_0}\left(\frac{r}{3} - \frac{r^2}{4R}\right)$

34) A thin disc of radius b = 2a has a concentric hole of radius 'a' in it (see figure). It carries uniform surface charge 'σ' on it. If the electric field on its axis at height 'h' ($h \ll a$) from its centre is given as 'Ch' then value of 'C' is:



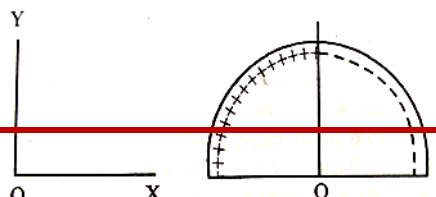
(a) $\frac{\sigma}{4a\epsilon_0}$

(b) $\frac{\sigma}{8a\epsilon_0}$

(c) $\frac{\sigma}{a\epsilon_0}$

(d) $\frac{\sigma}{2a\epsilon_0}$

35) A wire of length L (=20 cm), is bent into a semicircular arc. If the two equal halves of the arc were each to be uniformly charged with charges $\pm Q$,[$|Q| = 10^3\varepsilon_0$ Coulomb where $\varepsilon_0$ is the permittivity (in SI units) of free space] the net electric field at the centre O of the semicircular arc would be :



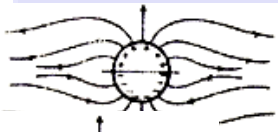
(a) $(50 \times 10^3$ N/C)ĵ

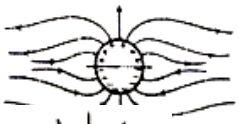
(b) $(50 \times 10^3$ N/C)î

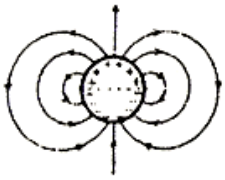
(c) $(25 \times 10^3$ N/C)ĵ

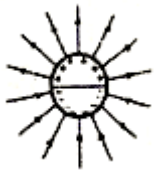
(d) $(25 \times 10^3$ N/C)î

36) A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge –σ in the lower half. The electric field lines around the cylinder will look like figure given in: (figures are schematic and not drawn to scale)

(a) 

(b) 

(c) 

(d) 

| ANSWER KEY | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| d | c | a | c | a | d | a | a | b | a |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| a | b | c | b | d | a | c | c | b | c |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| b | c | a | b | a | a | c | c | c | b |
| 31 | 32 | 33 | 34 | 35 | 36 | | | | |
| a | c | b | a | d | c | | | | |

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