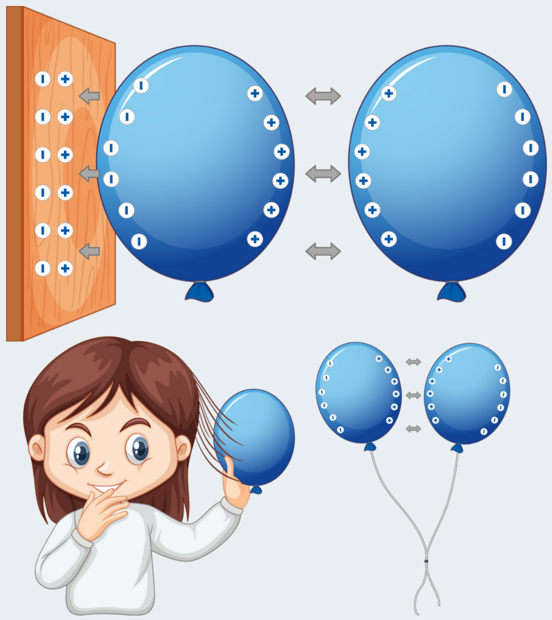
ALLEN CAREER INSTITUTE
KOTA (RAJASTHAN)
path to success

TG: @Chalnaayaaar

PRE-MEDICAL

PHYSICS

ENTHUSIAST | LEADER | ACHIEVER



EXERCISE

Electrostatics

ENGLISH MEDIUM

ANSWERS

BEGINNER'S BOX-1

1. 80 C **2.** 3×10^{25} electrons.

3. (a) Yes, (b) No , (c) No

4. 3.2×10^{-10} C **5.** 2.18×10^{10}

6. For proton $\Rightarrow$ u, u, d and For neutron $\Rightarrow$ d, d, u

7. (a) 2×10^{12} ; (b) 18.2×10^{-19} kg

8. A will have positive charge and B will have negative charge.

BEGINNER'S BOX-2

1. $\frac{F}{8}$ **2.** 2 **3.** 10^{-10}

4. 44.4 N **5.** (i) 8×10^{-5} C (ii) 5×10^{14}

6. $q = -\frac{1}{2}\,\mu C$ **7.** $F_{net} = 9 \times 10^{3}$ N along to $\overrightarrow{CA}$

8. d = 0.118 m **9.** $F = \frac{kQ^2}{a^2}\sqrt{2}$

BEGINNER'S BOX-3

1. 20 cm **2.** 5×10^{-6} C ; +ve charge

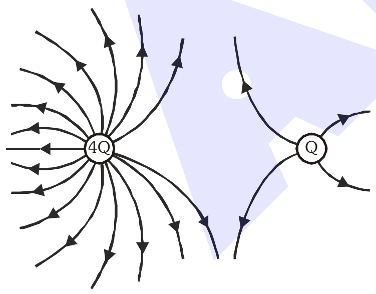
3. 6.25×10^{12} electrons should be removed

4. $|\vec{E}| = 2.5 \times 10^{4}$ N/C electric field along y-direction

5. 45 cm

6. $E_{net} = 16.46 \times 10^{3}$ N/C Direction of net electric field is perpendicular and away from the line AB

BEGINNER'S BOX-4

1. 

x = 8 cm

2. 20 V/m **3.** Zero **4.** D

5. $\frac{5}{6}\frac{q}{\epsilon_0}$ **6.** 2.25×10^{5} Nm^2/C

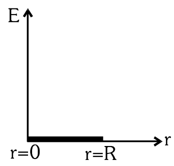
7. (a) -5.31×10^{-14} C

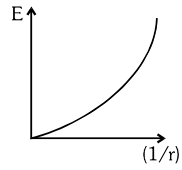
(b) Flux remains the same

8. All i.e. q_1, q_2, q_3 & q_4

9. Yes, *Ex :* A dipole placed in a closed surface

10. (a) Zero (b) 1.92 V/m

11. (a) 

(b) 

BEGINNER'S BOX-5

1. 1 : 4 **2.** Zero **3.** Zero

4. 36 m/s each **5.** (i) -0.7 J, (ii) 0.7 J

6. (i) 4×10^{4} V (ii) 8×10^{-5} J, No

7. 2.7×10^{6} V

8. (i) 2.5×10^{5} V,

(ii) The more distant point from the charge

9. (i) 0.54 m, (ii) 7.5 kV, a decrease

10. 3.1×10^{5} V **11.** -1.3×10^{6} V

12. $-2\hat{i} + 2\hat{j} - 2\hat{k}$ **13.** 12.6 m

14. (i) against the field 3.0×10^{4} V; in the field direction -3.0×10^{4} V, (ii) Zero

15. (a) $V_P - V_Q$ is positive

$V_B - V_A$ is positive

(b) $U_Q - U_P$ is positive

$U_A - U_B$ is positive

(c) negative (d) positive (e) decreases

BEGINNER'S BOX-6

1. 8.5×10^{-26} Nm **2.** 0 **3.** 10^{-3} C or 1 mC

4. (1) –ve, (2) –ve (3) +ve

Particle (1) has largest charge to mass ratio.

5. 0.176 cm

6. Total charge = 0;

Dipole moment $= -7.5 \times 10^{-8}$ C-m

BEGINNER'S BOX-7

1. (C) **2.** (D) **3.** (B)

EXERCISE-I (Conceptual Questions)

Build Up Your Understanding

ELECTRIC CHARGE & METHODS OF CHARGING

1. Which of the following charges can not be present on an oil drop in Millikan's experiment :–

(1) 4.0×10^{-19} C

(2) 6.0×10^{-19} C

(3) 10.0×10^{-19} C

(4) all of them

ES0001

2. In nature, the electric charge of any system is always equal to :

(1) half integral multiple of the least amount of charge

(2) zero

(3) square of the least amount of charge

(4) integral multiple of the least amount of charge

ES0002

3. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then :

(1) negative and distributed uniformly over its surface.

(2) negative and appears only at the point on the sphere closest to the point charge

(3) negative and distributed non-uniformly over its entire surface of the sphere

(4) zero

ES0003

COULOMB'S LAW AND EQUILIBRIUM OF CHARGE SYSTEM

4. Force between two identical spheres charged with same charge is F. If 50% charge of one sphere is transferred to the other sphere then the new force will be :–

(1) $\frac{3}{4}$F (2) $\frac{3}{8}$F

(3) $\frac{3}{2}$F (4) none of these

ES0004

5. Two point charges placed at a distance 'r' in air exert a force 'F'. The distance at which they exert same force when placed in a certain medium (dielectric constant K) is :–

(1) rK (2) r/K

(3) $r/\sqrt{K}$ (4) $r\sqrt{K}$

ES0005

6. Two charges are placed as shown in figure. Where should a third charge be placed so that it remains at rest ?

(1) 30 cm from 9e (2) 40 cm from 16e

(3) 40 cm from 9e (4) (1) or (2)

ES0006

7. Two point charges +9q and +q are kept 16 cm apart. Where should a third charge Q be placed between them so that the system remains in equilibrium ?

(1) 24 cm from + 9q (2) 12 cm from + 9q

(3) 24 cm from + q (4) 12 cm from + q

ES0007

8. Two balls carrying charges +7 μC and –5 μC attract each other with a force F. If a charge –2 μC is added to both, the force between them will be :–

(1) F (2) $\frac{F}{2}$ (3) 2F (4) zero

ES0008

9. Two equal and like charges when placed 5 cm apart experience a repulsive force of 0.144 newtons. The magnitude of the charge in micro–coulomb will be

(1) 0.2 (2) 2 (3) 20 (4) 12

ES0009

10. Two point charges of + 2 μC and + 6 μC repel each other with a force of 12 N. If each is given an additional charge of – 4 μC, then force will become:–

(1) 4 N (attractive) (2) 60 N (attractive)

(3) 4 N (repulsive) (4) 12 N (attractive)

ES0010

11. What equal charges should to be placed on earth and moon to neutralize their gravitational attraction ? (mass of earth = 10^{25} kg, mass of moon = 10^{23} kg)

(1) 8.6×10^{13} C (2) 6.8×10^{26} C
(3) 8.6×10^{3} C (4) 9×10^{6} C

ES0011

12. A point charge q_1 exerts a force F upon another point charge q_2. If a third charge q_3 be placed quite close to the charge q_2 then the force that charge q_1 exerts on the charge q_2 will be :-

(1) F (2) > F (3) < F (4) zero

ES0012

13. A charge Q is divided in two parts Q_1 and Q_2 and these charges are placed at a distance R. There will be maximum repulsion between them when :-

(1) $Q_1 = Q - q;\ Q_2 = q$

(2) $Q_1 = \frac{2Q}{3}, Q_2 = \frac{Q}{3}$

(3) $Q_1 = \frac{3Q}{4}, Q_2 = \frac{Q}{4}$

(4) $Q_1 = Q_2 = \frac{Q}{2}$

ES0013

14. The force of repulsion between two point charges is F, when these are 1 m apart. Now the point charges are replaced by conducting spheres of radii 5 cm having the charge same as that of point charges. The distance between their centres is 1 m, then the force of replusion will :–

(1) increase (2) decrease
(3) remain same (4) become $\frac{10F}{9}$

ES0014

15. Two charges 4q and q are placed at a distance ℓ apart. A third charged particle Q is placed at the middle of them. If resultant force on q is zero then the value of Q is :–

(1) q (2) – q (3) 2q (4) – 2q

ES0015

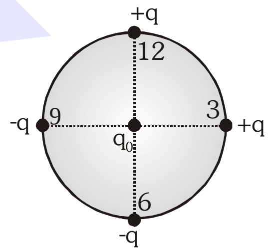
16. Two similar spheres having +q and –q charges are kept at a certain separation. F force acts between them. If another similar sphere having +q charge is kept in the middle of them, it experiences a force in magnitude and direction as :–

(1) zero having no direction
(2) 8F towards +q charge
(3) 8F towards –q charge
(4) 4F towards +q charge

ES0016

17. Four charges are placed at the circumference of the dial of a clock as shown in figure. If the clock has only hour hand, then the resultant force on a positive charge q_0 placed at the centre, points in the direction which shows the time as :–

(1) 1:30
(2) 7:30
(3) 4:30
(4) 10:30



ES0017

18. Two small spheres each having a charge +Q are suspended by insulating threads of length L from a hook. This arrangement is taken to a space where there is no gravitational effect, then the angle between the two threads and the tension in each will be :-

(1) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$ (2) $90°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

(3) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$ (4) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

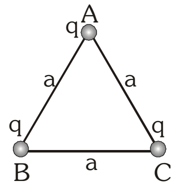
ES0018

19. Identify the wrong statement in the following :-
Coulomb's law correctly describes the electric force that.

(1) binds the electrons of an atom to it's nucleus
(2) binds the protons and neutrons in the nucleus of an atom
(3) binds the atoms together to form molecules
(4) binds the atoms and molecules together to form solids

ES0019

20. In the fig. force on charge at A in the direction normal to BC will be :–



(1) $-\frac{kq}{a^2}$ (2) $-\frac{kq^2}{2a^2}$

(3) $\frac{kq^2}{2a^2}$ (4) $\frac{\sqrt{3}kq^2}{a^2}$

ES0077

ELECTRIC FIELD INTENSITY

21. Two charges 9e and 3e are placed at a separation r. The distance of the point where the electric field intensity will be zero, is :–

(1) $\frac{r}{(1+\sqrt{3})}$ from 9e charge

(2) $\frac{\sqrt{3}r}{\sqrt{3}+1}$ from 9e charge

(3) $\frac{r}{(1-\sqrt{3})}$ from 3e charge

(4) $\frac{\sqrt{3}r}{1+\sqrt{3}}$ from 3e charge

ES0020

22. A ring of radius R is charged uniformly with a charge + Q . The electric field at a point on its axis at a distance r from any point on the ring will be :–

(1) $\frac{KQ}{(r^2-R^2)}$ (2) $\frac{KQ}{r^2}$

(3) $\frac{KQ}{r^3}\left(r^2-R^2\right)^{1/2}$ (4) $\frac{KQr}{R^3}$

ES0021

23. Two positive charges of 1 μC and 2 μC are placed 1 metre apart. The value of electric field in N/C at the mid point of the two charges will be :–

(1) 10.8×10^4 (2) 3.6×10^4

(3) 1.8×10^4 (4) 5.4×10^4

ES0022

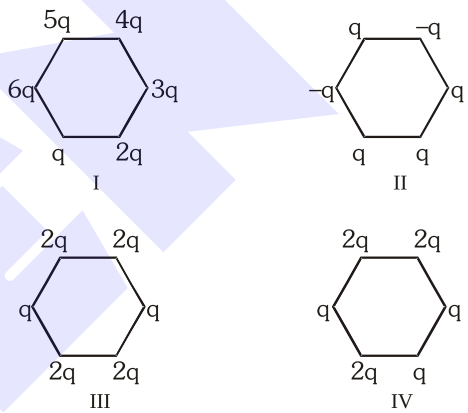
24. The electric field in a certain region is given by $\vec{E} = (\frac{K}{x^3})\hat{i}$. The dimensions of K are :–

(1) $MLT^{-3}A^{-1}$ (2) $ML^{-2}T^{-3}A^{-1}$

(3) $ML^4T^{-3}A^{-1}$ (4) $M^0L^0T^0A^0$

ES0023

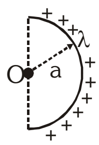
25. Figure below shows regular hexagon, with different charges placed at the vertices. In which of the following cases is the electric field at the centre zero ?



(1) IV (2) III (3) I (4) II

ES0024

26. Electric field at the centre 'O' of a semicircle of radius 'a' having linear charge density λ is given as :-



(1) $\frac{2\lambda}{\epsilon_0 a}$ (2) $\frac{\lambda\pi}{\epsilon_0 a}$

(3) $\frac{\lambda}{2\pi\epsilon_0 a}$ (4) $\frac{\lambda}{\pi\epsilon_0 a}$

ES0025

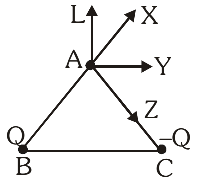
27. A semicircular ring of radius 0.5 m is uniformly charged with a total charge of 1.4×10^{-9} C. The electric field intensity at the centre of this ring is :–

(1) zero (2) 320 V/m.

(3) 64 V/m. (4) 32 V/m.

ES0026

28. For the given figure the direction of electric field at A will be :



(1) towards AL (2) towards AY
(3) towards AX (4) towards AZ

ES0027

29. -1×10^{-6} C charge is on a drop of water having mass 10^{-6} kg. What electric field should be applied on the drop so that it is in the balanced condition with its weight ?

(1) 10 V/m upward

(2) 10 V/m downward

(3) 0.1 V/m downward

(4) 0.1 V/m upward

ES0028

30. Two small identical spheres, each of mass 1 g and carrying same charge 10^{-9} C are suspended by threads of equal lengths. If the distance between the centres of the spheres is 0.3 cm in equilibrium then the inclination of the thread with the vertical will be :–

(1) $\tan^{-1}(0.1)$ (2) $\tan^{-1}(2)$
(3) $\tan^{-1}(1.5)$ (4) $\tan^{-1}(0.6)$

ES0029

ELECTRIC FIELD LINES, ELECTRIC FLUX & GAUS'S THEOREM

31. Two infinitely long parallel wires having linear charge densities λ_1 and λ_2 respectively are placed at a distance R. The force per unit length on either wire will be :–

(1) $\frac{k2\lambda_1\lambda_2}{R^2}$ (2) $\frac{k2\lambda_1\lambda_2}{R}$

(3) $\frac{k\lambda_1\lambda_2}{R^2}$ (4) $\frac{k\lambda_1\lambda_2}{R}$

ES0030

32. Choose the correct statement regarding electric lines of force :–

(1) They emerge from negative charge and terminate at positive charge

(2) The electric field in that region is weak where the density of electric lines of force are more

(3) They are in radial directions for a point charge

(4) They have a physical existence

ES0031

33. A solid sphere of radius R, is charged uniformly with a total charge Q. Then the correct expression for electric field is (r = distance from centre) :–

(1) $\frac{KQr}{R^3}$, where $r < R$

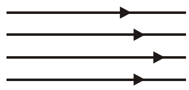
(2) $\frac{KQ}{r^2}$, where $r \geq R$

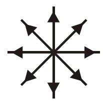
(3) it is zero, at all points

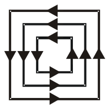
(4) (1) and (2) both

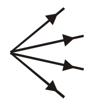
ES0032

34. Which one of the following pattern of electrostatic lines of force is not possible ?

(1) 

(2) 

(3) 

(4) 

ES0033

35. A sphere of radius R and charge Q is placed inside a concentric imaginary sphere of radius 2R. The flux associated with the imaginary sphere is :–

(1) $\frac{Q}{\epsilon_0}$ (2) $\frac{Q}{2\epsilon_0}$

(3) $\frac{4Q}{\epsilon_0}$ (4) $\frac{2Q}{\epsilon_0}$

ES0034

36. A nonconducting solid sphere of radius R is charged uniformly. The magnitude of the electric field due to the sphere at a distance r from its centre :–

(a) increases as r increases, for $r < R$

(b) decreases as r increases, for $0 < r < \infty$

(c) decreases as r increases, for $R < r < \infty$

(d) is discontinuous at $r = R$

(1) a, c (2) c, d (3) a, b (4) b, d

ES0035

37. 20 μC charge is placed inside a closed surface; then flux linked with the surface is ϕ. If 80 μC charge is put inside the surface then change in flux is :–

(1) 4ϕ (2) 5ϕ (3) ϕ (4) 8ϕ

ES0036

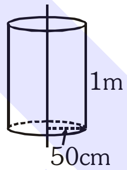
38. In a region of space the electric field is given by $\vec{E} = 8\hat{i} + 4\hat{j} + 3\hat{k}$. The electric flux through a surface of area of 100 units in the x–y plane is :–

(1) 800 units (2) 300 units

(3) 400 units (4) 1500 units

ES0037

39. Electric charge is uniformly distributed over a long straight wire of radius 1 mm. The charge per cm length of the wire is Q coulombs. A cylindrical surface of radius 50 cm and length 1m encloses the wire symmetrically as shown in fig. The total flux passing through the cylindrical surface is :–



(1) $\frac{Q}{\epsilon_0}$ (2) $\frac{100Q}{\epsilon_0}$

(3) $\frac{10Q}{\pi \epsilon_0}$ (4) $\frac{100Q}{\pi \epsilon_0}$

ES0038

40. Gaus's law is given by $\epsilon_0 \oint_s \vec{E}.d\vec{s} = q$, if net charge enclosed by a Gaussian surface is zero then :–

(1) E must be zero on the surface

(2) Number of incoming and outgoing electric lines are equal

(3) there is a net incoming of electric lines

(4) none

ES0039

41. The electric field is 100 V/m, at a distance of 20 cm from the centre of a dielectric sphere of radius 10 cm. Then E at 3 cm distance from the centre of sphere is :–

(1) 100 V/m (2) 125 V/m

(3) 120 V/m (4) zero

ES0040

42. If the electric flux entering and leaving a closed surface is ϕ_1 and ϕ_2 respectively then electric charge inside the surface will be :-

(1) $(\phi_1 + \phi_2)\varepsilon_0$ (2) $(\phi_2 - \phi_1)\varepsilon_0$

(3) $\frac{\phi_1 + \phi_2}{\varepsilon_0}$ (4) $\frac{\phi_2 - \phi_1}{\varepsilon_0}$

ES0041

43. The electric field in a region of space is given by $E = (5\hat{i} + 2\hat{j})$ N/C. The electric flux through an area of 2 m² lying in the YZ plane, in S.I. units is:–

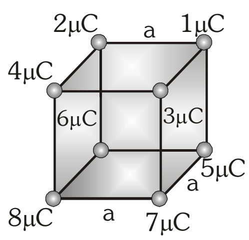
(1) 10 (2) 20

(3) $10\sqrt{2}$ (4) $2\sqrt{29}$

ES0042

44. The total flux associated with the given cube will be- where 'a' is side of the cube :–

$(\frac{1}{\epsilon_0} = 4\pi \times 9 \times 10^9$ SI units)



(1) $162\pi \times 10^{-3}$ Nm²/C

(2) $162\pi \times 10^{3}$ Nm²/C

(3) $162\pi \times 10^{-6}$ Nm²/C

(4) $162\pi \times 10^{6}$ Nm²/C

ES0043

45. A point charge is placed at a distance $\frac{a}{2}$ perpendicular to the plane and above the centre of a square of side a. The electric flux through the square is :–

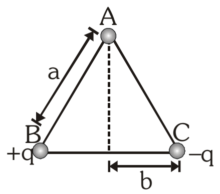
(1) $\frac{q}{\epsilon_0}$ (2) $\frac{q}{\pi \epsilon_0}$

(3) $\frac{q}{4 \epsilon_0}$ (4) $\frac{q}{6 \epsilon_0}$

ES0044

ELECTRIC POTENTIAL, EQUIPOTENTIAL SURFACE & RELATION BETWEEN FIELD & POTENTIAL

46. As shown in the fig. charges + q and – q are placed at the vertices B and C of an isosceles triangle. The potential at the vertex A is :-



(1) $\frac{1}{4\pi\epsilon_0}\cdot\frac{2q}{\sqrt{a^2+b^2}}$ (2) zero

(3) $\frac{1}{4\pi\epsilon_0}\cdot\frac{q}{\sqrt{a^2+b^2}}$ (4) $\frac{1}{4\pi\epsilon_0}\cdot\frac{-q}{\sqrt{a^2+b^2}}$

ES0045

47. At any point on the perpendicular bisector of the line joining two equal and opposite charges :-
(1) the electric field is zero
(2) the electric potential is zero
(3) the electric potential decreases with increasing distance from their mid point
(4) the electric field is perpendicular to the line joining the charges

ES0046

48. What is the electric potential at a distance 'x' from the centre, inside a conducting sphere having a charge Q and radius R ?

(1) $\frac{1}{4\pi\epsilon_0}\frac{Q}{R}$ (2) $\frac{1}{4\pi\epsilon_0}\frac{Q}{x}$

(3) $\frac{1}{4\pi\epsilon_0}\cdot\frac{QX}{R^2}$ (4) zero

ES0047

49. Certain positive charge is given to a conductor. Then its potential :–
(1) is maximum at the surface
(2) is maximum at the centre
(3) remains same throughout the conductor
(4) is maximum somewhere between the surface and the centre

ES0048

50. Potential inside a charged spherical shell is :–
(1) uniform
(2) proportional to the distance from the centre
(3) inversely proportional to the distance
(4) inversely proportional to square of distance from the centre

ES0049

51. A solid conducting sphere having a charge Q is surrounded by an uncharged concentric conducting spherical shell. Let the potential difference between the surface of the solid sphere and the outer surface of the shell be V. If the shell is now given a charge -3Q the new potential difference between the same two surfaces is :-
(1) V (2) 2V (3) 4V (4) –2V

ES0050

52. Four charges 2C, – 3C, –4C and 5C respectively are placed at the four corners of a square. Which of the following statements is true for the point of intersection of the diagonals ?
(1) E = 0, V = 0 (2) $E \neq 0$, V = 0
(3) E = 0, $V \neq 0$ (4) $E \neq 0$, $V \neq 0$

ES0051

53. A non - conducting ring is of radius 0.5 m. 1.11 x 10^{-10} coulombs charge is non - uniformly distributed over the circumference of ring which produces electric field E around itself. If ℓ = 0 is the centre of the ring, then the value of $\int_{\ell=\infty}^{\ell=0} -\vec{E}.d\ell$ is :–
(1) 2 V (2) – 2 V (3) –1 V (4) zero

ES0052

54. A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 volts. The electric field at the centre of the sphere will be :-
(1) 50 volt/meter (2) 10 volt/meter
(3) 5 volt/meter (4) zero

ES0053

55. The potential at a distance R/2 from the centre of a conducting sphere of radius R containing charge Q will be :-

(1) 0 (2) $\frac{Q}{8\pi\epsilon_0 R}$

(3) $\frac{Q}{4\pi\epsilon_0 R}$ (4) $\frac{Q}{2\pi\epsilon_0 R}$

ES0054

56. Four charges +Q, –Q, +Q and –Q are situated at the corners of a square; in a sequence then at the centre of the square :-

(1) E = 0, V=0 (2) $E = 0, V \neq 0$

(3) $E \neq 0$, V=0 (4) $E \neq 0, V \neq 0$

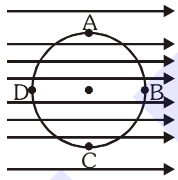
ES0055

57. Electric field at a distance x from the origin is given as E = $\frac{100N-m^2/C}{x^2}$. Then potential difference between the points situated at x = 10 m and x = 20 m is :-

(1) 5 V (2) 10 V (3) 15 V (4) 4V

ES0056

58. A circle of radius R is drawn in a uniform electric field E as shown in the fig. V_A, V_B, V_C and V_D are respectively the potentials of points A, B, C and D on the circle then :-



(1) $V_A > V_C, V_B = V_D$

(2) $V_A < V_C, V_B = V_D$

(3) $V_A = V_C, V_B < V_D$

(4) $V_A = V_C, V_B > V_D$

ES0057

59. A uniform electric field pointing in positive x–direction exists in a region. Let A be the origin, B be the point on the x–axis at x = +1 cm and C be the point on the y–axis at y = +1 cm. Then the potentials at the points A, B and C satisfy :-

(1) $V_A < V_B$ (2) $V_A > V_B$

(3) $V_A < V_C$ (4) $V_A > V_C$

ES0058

60. The electric potential V is given as a function of distance x (metre) by V = $(5x^2–10x–9)$ volts. The value of eletriec field at x=1 m is :–

(1) 20 V/m (2) 6 V/m (3) 11 V/m (4) zero

ES0059

61. The electric potential and electric field at a point due to a point charge are 600 V and 200 N/C respectively. Then magnitude of the point charge should be :-

(1) 3 μC (2) 30 μC

(3) 0.2 μC (4) 0.5 μC

ES0060

62. Two concentric spheres of radii R and r have similar charges with equal surface charge densities (σ) . What is the electric potential at their common centre?

(1) σ / ε_0

(2) $\frac{\sigma}{\varepsilon_0}(R-r)$

(3) $\frac{\sigma}{\varepsilon_0}(R+r)$

(4) None of these

ES0061

63. Three charges 2q, -q, -q are located at the vertices of an equilateral triangle. At the centre of the triangle :-

(1) the field is zero but potential is non-zero

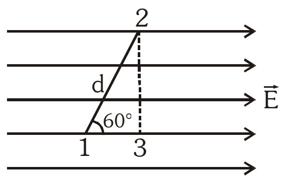
(2) the field is non-zero but potential is zero

(3) both field and potential are zero

(4) both field and potential are non-zero

ES0062

64. The electric field $\vec{E}$ is constant in both magnitude and direction. Consider a path of length d at an angle $\theta = 60^0$ with respect to field lines as shown in figure. The potential difference between points 1 and 2 is :-



(1) $\frac{E}{d\sin 60°}$

(2) Ed cos 60^0

(3) $\frac{Ed}{\cos 60°}$

(4) $\frac{E}{d}\sin 60°$

ES0063

65. The electric potential in a certain region is expressed by V = $6x - 8xy^2 - 8y + 6yz - 4z^2$ volts.
The magnitude of the force acting on a charge of 2 C situated at the origin will be :–

(1) 2 N (2) 6 N

(3) 8 N (4) 20 N

ES0064

66. Which statement is true ?

(i) A ring of radius R carries a uniformly distributed charge +Q. A point charge –q is placed on the axis of the ring at a distance 2R from its centre and released. The particle executes simple harmonic motion along the axis of the ring.

(ii) Electrons move from a region of higher potential to that of lower potential

(1) only (i) (2) only (ii)

(3) (i), (ii) (4) none of them

ES0065

67. Two conducting spheres of radii r_1 and r_2 have same electric field near their surfaces. The ratio of their electric potentials is :-

(1) r_1^2 / r_2^2 (2) r_2^2 / r_1^2 (3) r_1 / r_2 (4) r_2 / r_1

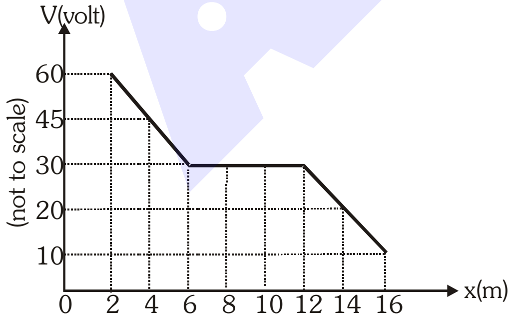
ES0066

68. A charged hollow metal sphere has a radius r. if the potential difference between its surface and a point at distance 3r from the centre is V, the electric intensity at a distance 3r from the centre is :-

(1) $\frac{V}{6r}$ (2) $\frac{V}{4r}$ (3) $\frac{V}{3r}$ (4) $\frac{V}{2r}$

ES0067

69. The variation of potential with distance x from a fixed point is shown in figure. The electric field at x =13 m is



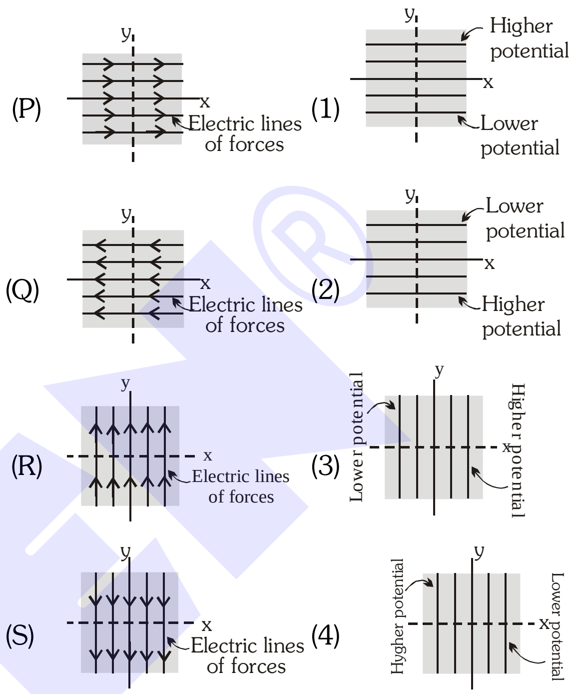
(1) 7.5 volt/meter (2) –7.5 volt/meter

(3) 5 volt/meter (4) –5 volt/meter

ES0068

70. List I gives certain situations in which electric field is represented by electric lines of forces in x-y plane. List II gives corresponding representation of equipotential lines in x-y plane. Match the figures in List I with the figures in List II and indicate your answer.

List - I **List - II**

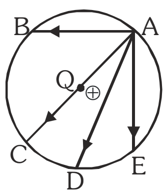


Codes	P	Q	R	S
(1)	1	2	3	4
(2)	4	3	2	1
(3)	3	4	2	1
(4)	2	1	3	4

ES0069

ELECTRICAL POTENTIAL ENERGY

71. In the electric field of charge Q, another charge is carried from A to B, A to C, A to D and A to E, then work done will be :-



(1) minimum along the path AB

(2) minimum along the path AD

(3) minimum along the path AE

(4) zero along each path

ES0070

72. Choose the incorrect statement :–

(1) the potential energy per unit positive charge in an electric field at some point is called the electric potential.

(2) the work required to be done to move a point charge from one point to another in an electric field depends on the position of the points

(3) the potential energy of the system will increase if a positive charge is moved against the Coulombian force

(4) the value of fundamental charge is not equivalent to the electronic charge.

ES0071

73. A charge of 10 esu is placed at a distance of 2 cm from a charge of 40 esu and 4 cm from another charge of – 20 esu. The potential energy of the charge 10 esu is :– (in ergs)

(1) 87.5 (2) 112.5

(3) 150 (4) zero

ES0072

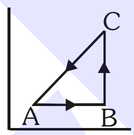
74. As shown in figure, on bringing a charge Q from point A to B and from B to C, the work done are 2 joules and – 3 joules respectively. The work done in bringing the charge from C to A will be

(1) – 1 joule

(2) 1 joule

(3) 2 joules

(4) 5 joules



ES0073

75. 15 joule of work has to be done against an existing electric field to take a charge of 0.01 C from A to B. Then the potential difference $(V_B - V_A)$ is :–

(1) 1500 volts (2) – 1500 volts

(3) 0.15 volt s (4) none of these

ES0074

76. A 5 C charge experiences a force of 2000 N when moved between two points along the field separated by a distance of 2 cm in a uniform electric field. The potential difference between the two points is :–

(1) 8 volts (2) 80 volts

(3) 800 volts (4) 8000 volts

ES0075

77. When the separation between two charges is increased, the electric potential energy of the system of charges :-

(1) increases

(2) decreases

(3) remains the same

(4) may increase or decrease

ES0076

MOTION OF CHARGED PARTICLE IN ELECTRIC FIELD AND ELECTRIC DIPOLE

78. An electron enters an electric field with its velocity in the direction of the electric field lines then :–

(1) the path of the electron will be a circle

(2) the path of the electron will be a parabola

(3) the velocity of the electron will decrease just after the entry

(4) the velocity of the electron will increase just after the entry

ES0078

79. An electron and a proton are set free in a uniform electric field. The ratio of their accelerations is :–

(1) unity (2) zero (3) $\frac{m_p}{m_e}$ (4) $\frac{m_e}{m_p}$

ES0079

80. A particle of mass m and charge q is released from rest in an electric field E. Then the K.E. after time t will be :-

(1) $\frac{2E^2t^2}{mq}$ (2) $\frac{E^2q^2t^2}{2m}$ (3) $\frac{Eq^2m}{2t^2}$ (4) $\frac{Eqm}{2t}$

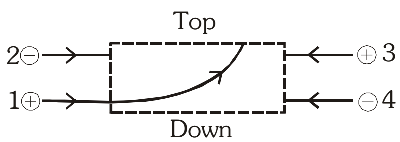
ES0080

81. A charge q is projected into a uniform electric field E; work done when it suffers a displacement Y along the field direction is :-

(1) qEY (2) $\frac{qY}{E}$ (3) $\frac{qE}{Y}$ (4) $\frac{Y}{qE}$

ES0081

82. The figure below shows the path of a positively charged particle 1 through a rectangular region of uniform electric field as shown in the figure. What are the direction movement of particles 2, 3 and 4 ?



(1) Down, top, down (2) Down, down, top

(3) Top, top, down (4) Top, down down

ES0082

83. For a dipole, the value of each charge is 10^{-10} stat coulomb and their separation is 1Å, then its dipole moment is :–

(1) one debye (2) 2 debye

(3) 10^{-3} debye (4) 3×10^{-20} debye

ES0083

84. The electric potential and field at a point due to an electric dipole are proportional to :-

(1) r, r^{-1} (2) r^{-1}, r^{-2}

(3) r^{-2}, r^{-3} (4) r^{-2}, r^{-2}

ES0084

85. When an electric dipole $\vec{p}$ is kept in a uniform electric field $\vec{E}$ then for what value of angle between $\vec{p}$ and $\vec{E}$, will the torque be maximum ?

(1) 90° (2) 0° (3) 180° (4) 45°

ES0085

86. What will be the ratio of electric field at a point on the axis and an equidistant point on the equatorial line of a dipole :–

(1) 1 : 2 (2) 2 : 1 (3) 4 : 1 (4) 1 : 4

ES0086

87. For a dipole q = 2×10^{-6} C ; d = 0.01m; find the maximum torque on the dipole if $E = 5 \times 10^5$ N/C :–

(1) 1×10^{-3} Nm^{-1}

(2) 10×10^{-3} Nm^{-1}

(3) 10×10^{-3} Nm

(4) 1×10^{-4} Nm

ES0087

88. Two particles each of mass M is attached to the two ends of a massless rigid non-conducting rod of length L. The two particles carry charges +q and –q respectively. This arrangement is held in a region of uniform electric field E such that the rod makes a small angle $\theta\ (< 5^0)$ with the field direction. The time period of rod is (rod oscillates about its centre of mass) :-

(1) $2\pi\sqrt{\frac{ML}{2qE}}$ (2) $\pi\sqrt{\frac{ML}{2qE}}$

(3) $\frac{\pi}{2}\sqrt{\frac{ML}{2qE}}$ (4) $4\pi\sqrt{\frac{ML}{2qE}}$

ES0088

89. The electric potential at a point due to an electric dipole will be :-

(1) $k\frac{\vec{p}\cdot\vec{r}}{r^3}$ (2) $k\frac{\vec{p}\cdot\vec{r}}{r^2}$

(3) $k\frac{\vec{p}\times\vec{r}}{r^3}$ (4) $k\frac{\vec{p}\times\vec{r}}{r^2}$

ES0089

90. The force on a charge situated on the axis of a dipole is F; if the charge is shifted to double the distance, the force acting will be :-

(1) zero (2) $\frac{F}{2}$ (3) $\frac{F}{4}$ (4) $\frac{F}{8}$

ES0090

91. A small electric dipole is of dipole moment p. The electric potential at a distance 'r' from its centre and making an angle θ from the axis of dipole will be :-

(1) $\frac{kp\sin\theta}{r^2}$ (2) $\frac{kp\cos\theta}{r^2}$

(3) $\frac{kp}{r^3}\sqrt{1+3\cos^2\theta}$ (4) $\frac{kp}{r^3}\sqrt{1+3\sin^2\theta}$

ES0091

92. If an electric dipole is placed in an electric field generated by a point charge then :–

(1) the net electric force on the dipole must be zero

(2) the net electric force on the dipole may be zero

(3) the torque on the dipole due to the field must be zero

(4) the torque on the dipole due to the field may be zero

ES0092

CONDUCTORS

93. Two conductors are of same shape and size. One of copper and the other of aluminium (less conducting) are placed in an uniform electric field. The charge induced in aluminium :-

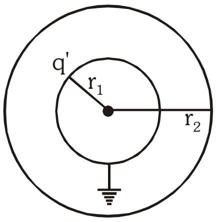
(1) will be less than that in copper
(2) will be more than that in copper
(3) will be equal to that in copper
(4) cannot be compared with that of copper

ES0093

94. A big hollow metal sphere A is charged to 100 volts and another smaller hollow sphere B is charged to 50 volts. If B is put inside A and joined with a metallic wire, then the direction of charge flow :-
(1) is from A to B
(2) is from B to A
(3) no charge flows
(4) depends on the radii of spheres

ES0094

95. Two concentric conducting spheres are of radii r_1 and r_2. The outer sphere is given a charge q. The charge q' on the inner sphere will be (inner sphere is grounded) :-



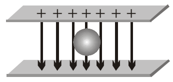
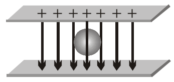
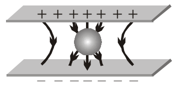
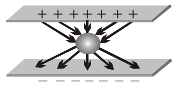
(1) q
(2) -q
(3) $-q\frac{r_1}{r_2}$
(4) Zero

ES0095

96. A charge given to any conductor resides on its outer surface, because :-
(1) the free charge tends to be in its miniumum potential energy state.
(2) the free charge tends to be in its minimum kinetic energy state.
(3) the free charge tends to be in its maximum potential energy state.
(4) the free charge tends to be in its maximum kinetic energy state.

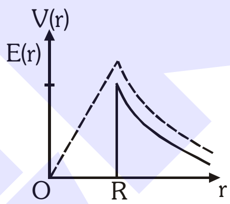
ES0096

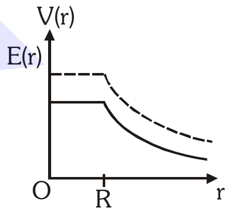
97. An uncharged sphere of metal is placed in between two charged plates as shown. The lines of force appear as :-

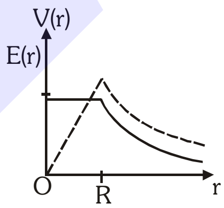
(1) 
(2) 
(3) 
(4) 

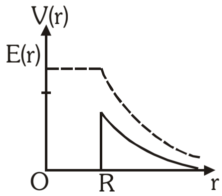
ES0097

98. Consider a conducting spherical shell of radius R with its centre at the origin, carrying uniform positive surface charge density. The variation of the magnitude of the electric field $|\vec{E}(r)|$ and the electric potential V(r) with the distance r from the centre, is best represented by the graph (Here dotted line represents potential curve and bold line represents electric field curve) :-

(1) 

(2) 

(3) 

(4) 

ES0098

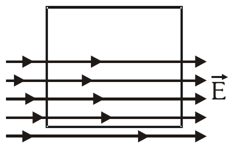
EXERCISE-I (Conceptual Questions) Build Up Your Understanding

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	4	4	1	3	4	2	1	1	1	1	1	4	2	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	2	1	2	4	2	3	2	3	2	3	4	2	2	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	2	3	4	3	1	1	1	2	2	2	3	2	1	2	4
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	2	1	3	1	1	2	1	4	3	1	1	3	2	4
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	3	2	2	4	4	3	1	3	2	4	4	3	2	1
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	1	4	3	3	2	1	1	1	3	1	2	3	1	1	4
Que.	91	92	93	94	95	96	97	98							
Ans.	2	4	3	2	3	1	3	4							

EXERCISE-II (Previous Year Questions) AIPMT/NEET

AIPMT 2006

1. 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 :–



(1) zero (2) EL^2 (3) $\frac{EL^2}{2\epsilon_0}$ (4) $\frac{EL^2}{2}$

ES0099

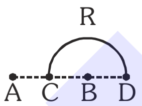
2. An electric dipole of dipole moment $\vec{p}$ is lying along a uniform electric field $\vec{E}$. The work done in rotating the dipole by 90° is :–

(1) 2pE (2) pE (3) $\sqrt{2}$pE (4) $\frac{pE}{2}$

ES0100

AIPMT 2007

3. Charges +q and –q are placed at points A and B respectively which are a distance 2L apart, C is the mid point of A and B. The work done in moving a charge +Q along the semicircle CRD is :-

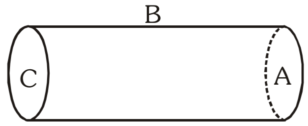


(1) $-\frac{qQ}{6\pi\epsilon_0 L}$ (2) $\frac{qQ}{4\pi\epsilon_0 L}$

(3) $\frac{qQ}{2\pi\epsilon_0 L}$ (4) $\frac{qQ}{6\pi\epsilon_0 L}$

ES0103

4. A hollow cylinder has a charge q coulombs located within it symmetrically. 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 volt-meters will be :-



(1) $\frac{q}{\epsilon_0}-\phi$ (2) $\frac{1}{2}\left[\frac{q}{\epsilon_0}-\phi\right]$

(3) $\frac{q}{2\epsilon_0}$ (4) $\frac{\phi}{3}$

ES0104

5. 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 :–

(1) $\sqrt{2}$qa along + x direction

(2) $\sqrt{2}$qa along + y direction

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

(4) qa along the line joining points (x = 0, y = 0, z = 0) and (x = a, y = a, z = 0)

ES0105

AIPMT 2008

6. The electric potential at a point in free space due to a charge Q coulombs is Q × 10^{11} volts. The electric field at that point is :-

(1) $4\pi\epsilon_0 Q \times 10^{20}$ volts/m

(2) $12\pi\epsilon_0 Q \times 10^{22}$ volts/m

(3) $4\pi\epsilon_0 Q \times 10^{22}$ volts/m

(4) $12\pi\epsilon_0 Q \times 10^{20}$ volts/m

ES0106

AIPMT(Mains) 2009

7. The electric potential at a point (x, y, z) is given by:

$V = -x^2y - xz^3 + 4$

The electric field $\vec{E}$ at that point is :-

(1) $\vec{E} = \hat{i}(2xy - z^3) + \hat{j}xy^2 + \hat{k}3z^2x$

(2) $\vec{E} = \hat{i}(2xy + z^3) + \hat{j}x^2 + \hat{k}3xz^2$

(3) $\vec{E} = \hat{i}2xy + \hat{j}(x^2 + y^2) + \hat{k}(3xz - y^2)$

(4) $\vec{E} = \hat{i}z^3 + \hat{j}xyz + \hat{k}z^2$

ES0107

AIPMT(Pre) 2010

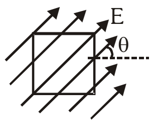
8. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, then the number of electrons missing from each ion will be (e being the charge on an electron) :-

(1) $\frac{4\pi\in_0 Fd^2}{q^2}$ (2) $\frac{4\pi\in_0 Fd^2}{e^2}$

(3) $\sqrt{\frac{4\pi\in_0 Fe^2}{d^2}}$ (4) $\sqrt{\frac{4\pi\in_0 Fd^2}{e^2}}$

ES0108

9. A square surface of side L meters in the plane of the paper is placed in a uniform electric field E (volts/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 :-



(1) Zero
(2) EL^2
(3) $EL^2\cos\theta$
(4) $EL^2\sin\theta$

ES0109

AIPMT(Mains) 2010

10. 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 :-

(1) E (2) $\frac{E}{2}$ (3) $\frac{E}{3}$ (4) Zero

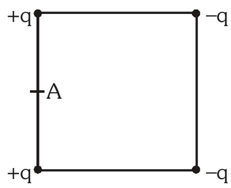
ES0110

AIPMT(Pre) 2011

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 :-
(1) increase four times
(2) be reduced to half
(3) remain the same
(4) be doubled

ES0114

12. Four electric charges + q, +q, − q and − q are placed at the corners of a square of side 2L(see figure). The electric potential at point A, midway between the two charges +q and +q, is :-



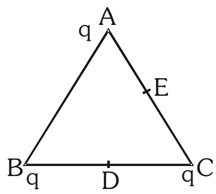
(1) $\frac{1}{4\pi\in_0}\frac{2q}{L}(1+\sqrt{5})$ (2) $\frac{1}{4\pi\in_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

(3) $\frac{1}{4\pi\in_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$ (4) Zero

ES0115

AIPMT(Mains) 2011

13. Three charges each +q are placed at the three corners of an isosceles triangle ABC with sides BC and AC each equal to 2a. D and E are the mid points of BC and CA respectively. The work done in taking a charge Q from D to E is :-



(1) $\frac{3qQ}{4\pi\in_0 a}$

(2) $\frac{3qQ}{8\pi\in_0 a}$

(3) $\frac{qQ}{4\pi\in_0 a}$

(4) Zero

ES0116

14. The electric potential V at any point (x, y, z). (all in metres) in space is given by $V = 4x^2$ volts. The electric field at the point (1, 0, 2) in volt/meter, is :-
(1) 8 along negative X-axis
(2) 8 along positive X-axis
(3) 16 along negative X-axis
(4) 16 along positive X-axis

ES0117

15. What is the flux through a cube of side 'a' if a point charge q is at one of its corner ?

(1) $\frac{q}{\in_0}$ (2) $\frac{q}{2\in_0}6a^2$ (3) $\frac{2q}{\in_0}$ (4) $\frac{q}{8\in_0}$

ES0118

AIPMT(Pre) 2012

16. An electrical 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 is zero when θ = 90°, the torque and the potential energy of the dipole will be respectively :-

(1) $pE\sin\theta$, $2pE\cos\theta$

(2) $pE\cos\theta$, $-pE\sin\theta$

(3) $pE\sin\theta$, $-pE\cos\theta$

(4) $pE\sin\theta$, $-2pE\cos\theta$

ES0119

17. Four point charges –Q, –q, 2q and 2Q are placed, at different corners of a square. The relation between Q and q for which the potential at the centre of the square is zero is :-

(1) $Q = q$ (2) $Q = \frac{1}{q}$

(3) $Q = -q$ (4) $Q = -\frac{1}{q}$

ES0120

AIPMT(Mains) 2012

18. Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is :-

(1) 4×10^{-2} C

(2) 1×10^{-2} C

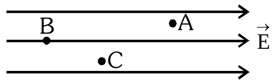
(3) 2×10^{-2} C

(4) 3×10^{-2} C

ES0121

NEET-UG 2013

19. A, B and C are three points in a uniform electric field. The electric potential is :-



(1) same at all the three points A,B and C

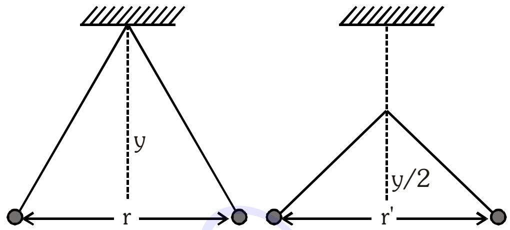
(2) maximum at A

(3) maximum at B

(4) maximum at C

ES0124

20. 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 :



(1) $\left(\frac{2r}{3}\right)$ (2) $\left(\frac{1}{\sqrt{2}}\right)^2$

(3) $\left(\frac{r}{\sqrt[3]{2}}\right)$ (4) $\left(\frac{2r}{\sqrt{3}}\right)$

ES0229

AIPMT 2014

21. A conducting sphere of radius R is given a charge Q. The electric potential and the electric field at the centre of the sphere are respectively :-

(1) Zero and $\frac{Q}{4\pi\epsilon_0 R^2}$

(2) $\frac{Q}{4\pi\epsilon_0 R}$ and Zero

(3) $\frac{Q}{4\pi\epsilon_0 R}$ and $\frac{Q}{4\pi\epsilon_0 R^2}$

(4) Both are zero

ES0127

22. In a region, the potential is represented by $V(x, y, z) = 6x - 8xy - 8y + 6yz$, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulombs situated at the point (1, 1, 1) is :-

(1) $6\sqrt{5}$ N (2) 30 N

(3) 24 N (4) $4\sqrt{35}$ N

ES0128

AIPMT 2015

23. The electric field in a certain region is acting radially outward and is given by E = Ar. The charge contained in a sphere of radius 'a' centred at the origin of the field, will be given by :

(1) $A\varepsilon_0 a^2$ (2) $4\pi\varepsilon_0 Aa^3$

(3) $\varepsilon_0 Aa^3$ (4) $4\pi\varepsilon_0 Aa^2$

ES0129

Re-AIPMT 2015

24. If potential (in volts) in a region is expressed as V (x,y,z) = 6xy − y + 2yz, the electric field (in N/C) at point (1,1,0) is :

(1) $-(6\hat{i}+9\hat{j}+\hat{k})$ (2) $-(3\hat{i}+5\hat{j}+3\hat{k})$

(3) $-(6\hat{i}+5\hat{j}+2\hat{k})$ (4) $-(2\hat{i}+3\hat{j}+\hat{k})$

ES0130

NEET-II 2016

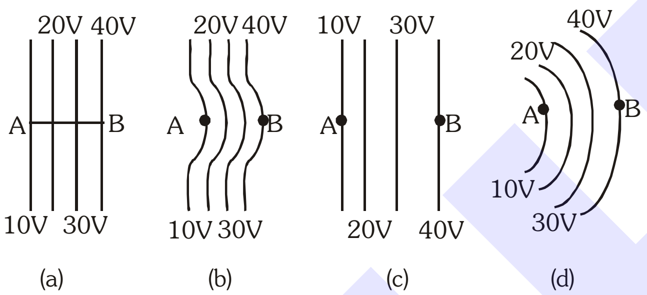
25. An electric dipole is placed at an angle of 30° with an electric field intensity 2×10^5 N/C. It experiences a torque equal to 4 Nm. The charge on the dipole, if the dipole length is 2 cm, is :-

(1) 5 mC (2) 7 μC (3) 8 mC (4) 2 mC

ES0134

NEET(UG)-2017

26. The diagrams below show regions of equipotentials:-



A positive charge is moved from A to B in each diagram.

(1) In all the four cases the work done is the same

(2) Minimum work is required to move q in figure (a)

(3) Maximum work is required to move q in figure (b)

(4) Maximum work is required to move q in figure (c)

ES0137

27. Suppose the charge of a proton and an electron differ slightly. One of them is − e, the other is (e + Δe). 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]

(1) 10^{-23} C (2) 10^{-37} C

(3) 10^{-47} C (4) 10^{-20} C

ES0138

NEET(UG)-2018

28. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electrical field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is :-

(1) smaller (2) 5 times greater

(3) 10 times greater (4) equal

ES0144

NEET(UG)-2019

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 :

(1) increases as r increases for r < R and for r > R

(2) zero as r increases for r < R, decreases as r increases for r > R

(3) zero as r increases for r < R, increases as r increases for r > R

(4) decreases as r increases for r < R and for r > R

ES0225

30. Two parallel infinite line charges with linear charge densities +λ C/m and −λ C/m are placed at a distance of 2R in free space. What is the electric field mid-way between the two line charges?

(1) zero

(2) $\frac{2\lambda}{\pi \in_0 R}$ N/C

(3) $\frac{\lambda}{\pi \in_0 R}$ N/C

(4) $\frac{\lambda}{2\pi \in_0 R}$ N/C

ES0226

31. 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:

(1) F
(2) $\frac{9F}{16}$
(3) $\frac{16F}{9}$
(4) $\frac{4F}{3}$

ES0227

NEET(UG)-2019 (Odisha)

32. A sphere encloses an electric dipole with charge $\pm 3 \times 10^{-6}$ C. What is the total electric flux across the sphere ?

(1) -3×10^{-6} Nm^2/C
(2) zero
(3) 3×10^{-6} Nm^2/C
(4) 6×10^{-6} Nm^2/C

ES0228

NEET(UG)-2020

33. A short electric dipole has a dipole moment of 16×10^{-9} C m. 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 :

$\left(\frac{1}{4\pi \in_0} = 9 \times 10^9 \text{Nm}^2 / \text{C}^2\right)$

(1) zero
(2) 50 V
(3) 200 V
(4) 400 V

ES0230

34. In a certain region of space with volume 0.2 m^3 the electric potential is found to be 5 V throughout. The magnitude of electric field in this region is :

(1) 5 N/C
(2) Zero
(3) 0.5 N/C
(4) 1 N/C

ES0231

35. 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 ?

$\left(\frac{1}{4\pi \in_0} = 9 \times 10^9 \text{Nm}^2 / \text{C}^2\right)$

(1) 1.28×10^7 N/C
(2) 1.28×10^4 N/C
(3) 1.28×10^5 N/C
(4) 1.28×10^6 N/C

ES0232

NEET(UG)-2020 (Covid-19)

36. The electric field at a point on the equatorial plane at a distance r from the centre of a dipole having dipole moment $\vec{p}$ is given by

(r >> separation of two charges forming the dipole, $\in_0$ - permittivity of free space)

(1) $\vec{E} = \frac{\vec{p}}{4\pi \in_0 r^3}$
(2) $\vec{E} = \frac{2\vec{p}}{4\pi \in_0 r^3}$
(3) $\vec{E} = -\frac{\vec{p}}{4\pi \in_0 r^2}$
(4) $\vec{E} = -\frac{\vec{p}}{4\pi \in_0 r^3}$

ES0233

37. The acceleration of an electron due to the mutual attraction between the electron and a proton when they are 1.6 Å apart is,

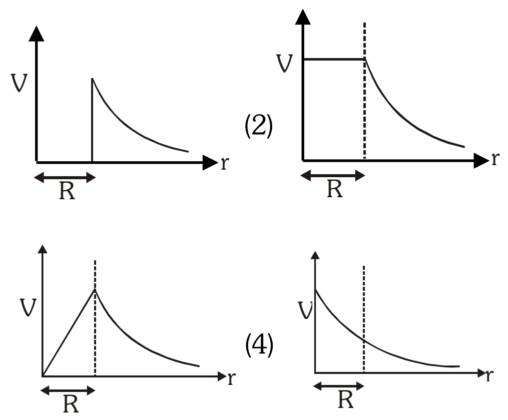
($m_e \simeq 9 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C)

(Take $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ Nm^2 C^{-2})

(1) 10^{24} m/s^2
(2) 10^{23} m/s^2
(3) 10^{22} m/s^2
(4) 10^{25} m/s^2

ES0234

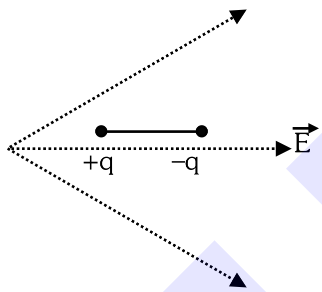
38. The variation of electrostatic potential with radial distance *r* from the centre of a positively charged metallic thin shell of radius R is given by the graph



ES0235

NEET(UG)-2021

39. A dipole is placed in an electric field as shown. In which direction will it move ?



(1) towards the left as its potential energy will increase.
(2) towards the right as its potential energy will decrease.
(3) towards the left as its potential energy will decrease.
(4) towards the right as its potential energy will increase.

ES0236

40. Two charged spherical conductors of radius R_1 and R_2 are connected by a wire. Then the ratio of surface charge densities of the spheres (σ_1/σ_2) is:

(1) $\frac{R_1}{R_2}$ (2) $\frac{R_2}{R_1}$
(3) $\sqrt{\frac{R_1}{R_2}}$ (4) $\frac{R_1^2}{R_2^2}$

ES0237

41. Twenty seven drops of same size are charged at 220 V each. They combine to form a bigger drop. Calculate the potential of the bigger drop.

(1) 660 V (2) 1320 V
(3) 1520 V (4) 1980 V

ES0238

NEET(UG)-2021 (Paper-2)

42. Three point charges $\sqrt{3}Q, -\sqrt{3}Q$ and $\sqrt{3}Q$ are placed on the vertices of an equilateral triangle of side L. How much work will be done in displacing a point charge q from the mid-point of a side containing charges $\sqrt{3}Q, 4 \& \sqrt{3}Q$ to the centre of triangle ?

(1) $\frac{1}{4\pi\varepsilon_0}.\frac{\sqrt{3}Qq}{L}$ (2) $\frac{1}{4\pi\varepsilon_0}.\frac{Qq}{\sqrt{3}L}$
(3) $\frac{1}{4\pi\varepsilon_0}.\frac{\sqrt{2}Qq}{L}$ (4) $\frac{1}{4\pi\varepsilon_0}.\frac{Qq}{L}$

ES0239

NEET(UG)-2022

43. Two hollow conducting spheres of radii R_1 and R_2 $(R_1 >> R_2)$ have equal charges. The potential would be

(1) more on smaller sphere
(2) equal on both the spheres
(3) dependent on the material property of the sphere
(4) more on bigger sphere

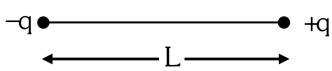
ES0240

44. The angle between the electric lines of force and the equipotential surface is:

(1) 45° (2) 90°
(3) 180° (4) 0°

ES0241

45. Two point charges –q and +q are placed at a distance of L, as shown in the figure.



The magnitude of electric field intensity at a distance R (R >>L) varies as :

(1) $\frac{1}{R^3}$ (2) $\frac{1}{R^4}$
(3) $\frac{1}{R^6}$ (4) $\frac{1}{R^2}$

ES0242

NEET(UG)-2022 (Overseas)

46. Twelve point charges each of charge q coulomb are placed at the circumference of a circle of radius r with equal angular spacing. If one of the charges is removed, the net electric field (in N/C) at the centre of the circle is : (ε_0 – permittivity of free space)

(1) $\frac{13q}{4\pi\varepsilon_0 r^2}$ (2) zero

(3) $\frac{q}{4\pi\varepsilon_0 r^2}$ (4) $\frac{12q}{4\pi\varepsilon_0 r^2}$

ES0243

47. A hollow metal sphere of radius R is given '+Q' charge to its outer surface. The electric potential at a distance $\frac{R}{3}$ from the centre of the sphere will be:

(1) $\frac{3}{4\pi\varepsilon_0}\frac{Q}{R}$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{3R}$

(3) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$ (4) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{9R}$

ES0244

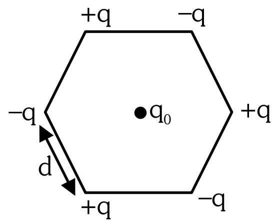
48. When a particle with charge +q is thrown with an initial velocity v towards another stationary charge +Q, it is respelled back after reaching the nearest distance r from +Q. The closest distance that it can reach if it is thrown with initial velocity 2v, is:

(1) $\frac{r}{2}$ (2) $\frac{r}{16}$ (3) $\frac{r}{8}$ (4) $\frac{r}{4}$

ES0245

Re-NEET(UG)-2022

49. Six charges +q, –q, +q, –q, +q and –q are fixed at the corners of a hexagon of side d as shown in the figure. The work done in bringing a charge q_0 to the centre of the hexagon from infinity is : (ε_0 – permittivity of free space)



(1) Zero (2) $\frac{-q^2}{4\pi\varepsilon_0 d}$

(3) $\frac{-q^2}{4\pi\varepsilon_0 d}\left(3-\frac{1}{\sqrt{2}}\right)$ (4) $\frac{-q^2}{4\pi\varepsilon_0 d}\left(6-\frac{1}{\sqrt{2}}\right)$

ES0246

50. The ratio of coulomb's electrostatic force to the gravitational force between an electron and a proton separated by some distance is 2.4×10^{39}. The ratio of the proportionality constant, $K = \frac{1}{4\pi\varepsilon_0}$ to the Gravitational constant G is nearly (Given that the charge of the proton and electron each = 1.6×10^{-19} C, the mass of the electron = 9.11×10^{-31} kg, the mass of the proton = 1.67×10^{-27} kg):

(1) 10^{20} (2) 10^{30}

(3) 10^{40} (4) 10

ES0247

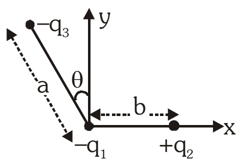
EXERCISE-II (Previous Year Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	1	2	3	3	2	4	1	4	3	3	4	1	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	3	4	3	3	2	4	2	3	4	1	2	1	2	3
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	2	2	3	2	3	4	3	2	2	2	4	4	1	2	1
Que.	46	47	48	49	50										
Ans.	3	3	4	1	1										

EXERCISE-III (Analytical Questions)

Master Your Understanding

1. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x–component of the force on $-q_1$ is proportional to :-



(1) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\sin\theta$ (2) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\cos\theta$

(3) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\theta$ (4) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\cos\theta$

ES0150

2. An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The Coulomb force $\vec{F}$ on the electron is :-

(1) $K\frac{e^2}{r^2}\hat{r}$ (2) $-K\frac{e^2}{r^3}\hat{r}$

(3) $K\frac{e^2}{r^3}\hat{r}$ (4) $-K\frac{e^2}{r^3}\vec{r}$

ES0151

3. A charge q is placed in the middle of two equal and like point charges Q. For this system to remain in equilibrium the value of q is :–

(1) $-\frac{Q}{3}$ (2) $-\frac{Q}{4}$

(3) $\frac{Q}{2}$ (4) $-\frac{Q}{2}$

ES0152

4. Two positive charges each of equal magnitude q are placed at a separation 2a perpendicular to X-axis. Another negative charge of mass m, is placed midway between the two charges on X–axis. If this charge is displaced from equilibrium state to a distance x(x << a), then the particle :–

(1) will execute simple harmonic motion about its its equilibrium position

(2) will oscillate about its equilibrium position but will not execute simple harmonic motion

(3) will not return back to the equilibrium position

(4) will stop at equilibrium position

ES0153

5. Two equal negative charges each – q, are placed at points (0,a) and (0,–a) on Y- axis, A positive charge q is released from point (2a, 0). This charge will be :-

(1) execute S.H.M. about the origin.

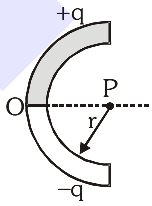
(2) oscillate but not execute S.H.M.

(3) move towards origin and will become stationary.

(4) execute S.H.M. along Y-axis.

ES0154

6. A thin glass rod is bent into a semicircle of radius r. A charge +q is uniformly distributed along the upper half and a charge –q is uniformly distributed along the lower half, as shown in the figure .The magnitude and direction of the electric field $\vec{E}$ produced at P, the centre of the circle, will be :-



(1) 0

(2) $\frac{q}{\varepsilon_0\pi^2 r^2}$ perpendicular to the line OP and directed downward

(3) $\frac{q}{\varepsilon_0\pi r^2}$ perpendicular to the line OP and directed downward

(4) $\frac{q}{\varepsilon_0\pi r^2}$ along the axis OP

ES0155

7. A circular wire loop of radius 'r' carries a total charge 'Q' distributed uniformly over its length. A small length dl of the wire is cut off. The electric field at the centre due to the remaining wire :-

(1) $\frac{Qd\ell}{8\pi^2\epsilon_0 r^3}$ (2) $\frac{Qd\ell}{2\pi^2\epsilon_0 r^3}$

(3) $\frac{Qd\ell}{8\pi\epsilon_0 r^3}$ (4) $\frac{Qd\ell}{4\pi^2\epsilon_0 r^3}$

ES0157

8. A solid metallic sphere has a charge + 3Q. Concentric with this sphere is a conducting spherical shell having charge –Q. The radius of the sphere is 'a' and that of the spherical shell is 'b' (b > a). What is the electric field at a distance R (a < R < b) from the centre ?

(1) $\frac{4Q}{2\pi\varepsilon_0 R^2}$ (2) $\frac{3Q}{4\pi\varepsilon_0 R^2}$

(3) $\frac{3Q}{2\pi\varepsilon_0 R^2}$ (4) $\frac{Q}{2\pi\varepsilon_0 R}$

ES0159

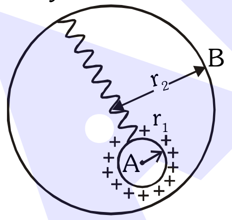
9. A sphere of 4 cm radius is suspended within a hollow sphere of 6 cm radius. The inner sphere is charged to a potential 3 e.s.u. when the outer sphere is earthed, the charge on the inner sphere is :-

(1) 54 e.s.u (2) $\frac{1}{4}$ e.s.u

(3) 30 e.s.u (4) 36 e.s.u

ES0160

10. A metal sphere A of radius r_1 charged to a potential ϕ_1 is enveloped by a thin walled conducting spherical shell B of radius r_2. Then potential ϕ_2 of the sphere A after it is connected to the shell B by a thin conducting wire will be :-

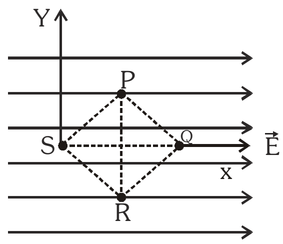


(1) $\phi_1 \frac{r_1}{r_2}$ (2) $\phi_1\left(\frac{r_2}{r_1}\right)$

(3) $\phi_1\left(1-\frac{r_2}{r_1}\right)$ (4) $\phi_1\left(\frac{r_1 r_2}{r_1+r_2}\right)$

ES0161

11. A point charge q moves from point P to point S along the path PQRS (figure) in a uniform electric field E pointing parallel to the positive direction of the X-axis. The co-ordinates of the points P,Q,R and S are (a, b, 0), (2a, 0, 0), (a, –b, 0) and (0, 0, 0) respectively. The work done by the field in the above process is :-



(1) qEa (2) -qEa

(3) $qEa\sqrt{2}$ (4) $qE\sqrt{[(2a)^2+b^2]}$

ES0162

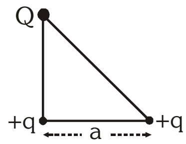
12. Two positive point charges of 12 μC and 8 μC are 10 cm apart. The work done in bringing them 4 cm closer is :-

(1) 1.3 eV (2) 13 J

(3) 5.8 J (4) 5.8 eV

ES0163

13. Three charges Q, +q and +q are placed at the vertices of a right-angled isosceles triangle as shown in figure. The net electrostatic energy of the configuration is zero. Q is equal to :-



(1) $\frac{-q}{1+\sqrt{2}}$ (2) $\frac{-2q}{2+\sqrt{2}}$

(3) –2q (4) +q

ES0164

14. A ball of mass 1g and charge 10^{-8} C moves from a point A (V_A = 600 V) to a point B whose potential is zero. Velocity of the ball at point B is 20 cms^{-1}. Velocity of the ball at point A is :–

(1) 16.7 ms^{-1} (2) 16.7 cms^{-1}

(3) 2.8 ms^{-1} (4) 2.8 cms^{-1}

ES0165

15. If a charged spherical conductor of radius 10 cm has potential V at a point distant 5 cm from its centre, then the potential at a point 15 cm away from the centre will be :-

(1) 3V (2) $\frac{3}{2}$V

(3) $\frac{2}{3}$V (4) $\frac{1}{3}$V

ES0166

16. Identical charges (– q) are placed at each corners of a cube of side 'b' then E.P.E. of a charge (+ q) placed at the centre of the cube will be :-

(1) $\frac{-4\sqrt{2}q^2}{\sqrt{3}\pi\epsilon_0 b}$ (2) $\frac{-8\sqrt{2}q^2}{\sqrt{3}\pi\epsilon_0 b}$

(3) $\frac{-4q^2}{\sqrt{3}\pi\epsilon_0 b}$ (4) $\frac{8\sqrt{2}q^2}{4\pi\epsilon_0 b}$

ES0167

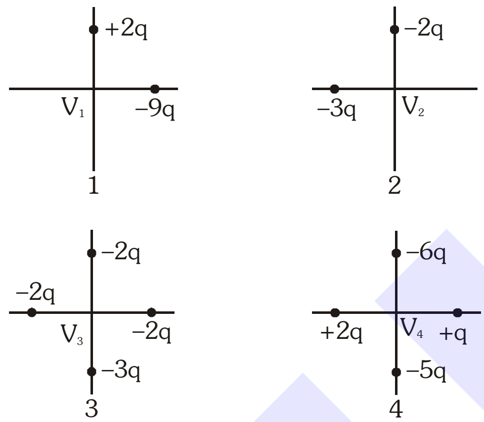
17. A spherical conducting shell of radius R has a charge q. A point charge Q is placed at its centre. The electrostatic potential at point P at a distance $\frac{R}{2}$ from the centre of the shell is :-

(1) $\frac{(q+Q)}{4\pi\varepsilon_0}\frac{2}{R}$ (2) $\frac{2Q}{4\pi\varepsilon_0 R}$

(3) $\frac{2Q}{4\pi\varepsilon_0 R}-\frac{2q}{4\pi\varepsilon_0 R}$ (4) $\frac{2Q}{4\pi\varepsilon_0 R}+\frac{q}{4\pi\varepsilon_0 R}$

ES0168

18. Figure given shows four arrangement of charged particles, all at the same distance from the origin. Rank the situations according to the net electric potentials (V_1, V_2, V_3, V_4) at the origin, most positive first :-

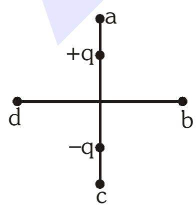


(1) $V_1 > V_2 > V_3 > V_4$ (2) $V_2 > V_1 > V_3 > V_4$

(3) $V_2 > V_1 > V_4 > V_3$ (4) $V_4 > V_1 > V_3 > V_2$

ES0169

19. Four points a, b, c and d are set at equal distance from the centre of a dipole as shown in the figure. The electrostatic potentials V_a, V_b, V_c and V_d would satisfy the following relation :-



(1) $V_a > V_b > V_c > V_d$ (2) $V_a > V_b = V_d > V_c$

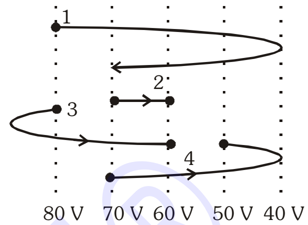
(3) $V_a = V_c > V_b = V_d$ (4) $V_b = V_d > V_a > V_c$

ES0171

20. Figure shows a family of parallel equipotential surfaces and four paths along which an electron is made to move from one surface to another as shown.

(A) What is the direction of the electric field?

(B) Rank the paths according to work done, greatest first.



(1) Rightward; 4 > 3 > 2 > 1

(2) Leftward; 1 > 2 > 3 > 4

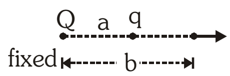
(3) Rightward; 3 = 4 > 2 = 1

(4) Leftward; 1 > 2 > 3 = 4

ES0172

21. A charge $q = 10^{-6}$ C of mass 2 g (fig.) is free to move when released at a distance 'a' from the fixed charge Q. Calculate its speed, when it recedes to a distance b :-

[Assume a = 1 m, b = 10 m, $Q = 10^{-3}$ C]



(1) 90 m/s.

(2) 9 m/s.

(3) 900 m/s.

(4) none of these

ES0173

22. A point charge q of mass m is located at the centre of a ring having radius R and charge Q with its axis oriented along X- axis. When the point charge is displaced slightly, it accelerates along the X–axis to infinity; the ultimate speed of the point charge (consider no energy loss in radiation) is :-

(1) $\sqrt{\frac{2kQq}{mR}}$ (2) $\sqrt{\frac{kQq}{mR}}$

(3) $\sqrt{\frac{kQq}{2mR}}$ (4) zero

ES0174

23. An electron of mass m_e initially at rest moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p also initially at rest takes time t_2 to move through an equal distance in this uniform electric field. Neglecting the effect of gravity, the ratio of t_2/t_1 is nearly equal to :-

(1) 1 (2) $(m_p/m_e)^{1/2}$

(3) $(m_e/m_p)^{1/2}$ (4) 1836

ES0175

24. There is a uniform electric field of strength 10^3 V/m along y–axis. A body of mass 1 g and charge 10^{-6} C is projected into the field from origin along the positive x–axis with a velocity 10 m/s. Its speed in m/s after 10 s is :- (neglect gravitation)

(1) 10 (2) $5\sqrt{2}$

(3) $10\sqrt{2}$ (4) 20

ES0176

25. An elementary particle of mass m and charge +e is projected with velocity v towards a much more massive particle of charge Ze, where Z > 0. What is the closest possible distance of approach of the incident particle ?

(1) $\dfrac{Ze^2}{2\pi\varepsilon_0 mv^2}$

(2) $\dfrac{Ze}{4\pi\varepsilon_0 mv^2}$

(3) $\dfrac{Ze^2}{8\pi\varepsilon_0 mv^2}$

(4) $\dfrac{Ze}{8\pi\varepsilon_0 mv^2}$

ES0177

26. An electric dipole is placed in a non uniform electric field, then it experiences :–

(1) a force which must be zero

(2) a torque which must be non zero

(3) a force which must be non zero

(4) both a force and a torque which may be non zero

ES0178

27. Consider the following statements about electric dipole and select the correct ones :-

S1 : Electric dipole moment vector $\vec{p}$ is directed from negative charge to positive charge.

S2 : The electric field of a dipole at a point with position vector $\vec{r}$ depends on $|\vec{r}|$ as well as the angle between $\vec{r}$ and $\vec{p}$.

S3 : The electric dipole potential falls off as $\dfrac{1}{r^2}$ and not as $\dfrac{1}{r}$.

S4 : In a uniform electric field, the electric dipole experiences no net forces but a torque $\vec{\tau} = \vec{p} \times \vec{E}$.

(1) S2, S3 and S4 (2) S3 and S4

(3) S2 and S3 (4) all four

ES0180

28. A hollow spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q. A charge –q is placed at the centre of the sphere. The surface charge densities on the inner and outer surfaces of the sphere will be respectively :-

(1) $\dfrac{q}{4\pi r_1^2}$ and $\dfrac{q}{4\pi r_2^2}$

(2) $\dfrac{-q}{4\pi r_1^2}$ and $\dfrac{Q+q}{4\pi r_2^2}$

(3) $\dfrac{q}{4\pi r_1^2}$ and $\dfrac{Q-q}{4\pi r_2^2}$

(4) 0 and $\dfrac{Q-q}{4\pi r_2^2}$

ES0181

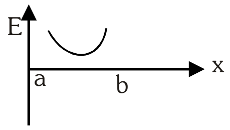
29. An electron travels a distance of 0.10 m perpendicular to an electric field of intensity 3200 V/m, entering with a velocity 4×10^7 m/s. What is the deviation in its path ?

(1) 1.76 mm. (2) 17.6 mm.

(3) 176 mm. (4) 0.176 mm.

ES0182

30. Two point charges a & b whose magnitudes are same are positioned at a certain distance from each other; a is at origin. Graph is drawn between electric field strength E and distance x from a. E is taken positive if it is along the line joining from a to b



(1) a is positive, b is negative

(2) a & b both are positive

(3) a & b both are negative

(4) a is negative, b is positive

ES0183

EXERCISE-III (Analytical Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**3**	**4**	**2**	**1**	**2**	**2**	**1**	**2**	**4**	**1**	**2**	**3**	**2**	**2**	**3**
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	**3**	**4**	**3**	**2**	**3**	**1**	**1**	**2**	**3**	**1**	**4**	**4**	**3**	**1**	**1**