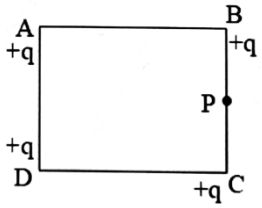
ELECTROSTATICS

1. Two identical balls each having a density 1.6 gcm^{-3} are suspended from a common point by two insulating strings of equal length. Both the balls have equal mass and charge. In equilibrium each string makes an angle 30° with vertical. Now both the balls are immersed in a liquid of density 0.8 gem^{-3}, but the angle does not change. The dielectric constant of the liquid is -
(a) 1 (b) 2
(c) 3 (d) 4

2. Four charges +q each are located at the vertices of square ABCD of side a as shown in figure. Find the electric field E at the midpoint of side BC -

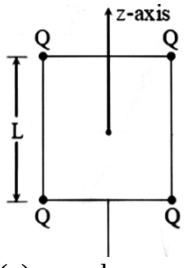


(a) $\frac{4}{5\sqrt{5}\pi\epsilon_0}\frac{a^2}{q^2}$ (b) $\frac{4}{5\sqrt{5}\pi\epsilon_0}\frac{q^2}{a^2}$
(c) 0 (d) none of the above

3. Two parallel infinitely long lines of charge having charge per unit length as λ_1 and λ_2 are located
in air at a distance "a" from each other. The force per unit length between them is-
(a) $\frac{\lambda_1\lambda_2}{4\varepsilon_0}$ (b) $\frac{\lambda_1\lambda_2}{2a\varepsilon_0}$
(c) $\frac{\lambda_1\lambda_2}{2\pi\varepsilon_0 a}$ (d) $\frac{\lambda_1\lambda_2}{4a\varepsilon_0}$

4. Charge Q is distributed to two different metallic spheres having radius R and 2R such that both spheres have equal surface charge density, then charge on larger sphere is-
(a) $\frac{4Q}{5}$ (b) $\frac{Q}{5}$
(c) $\frac{3Q}{5}$ (d) $\frac{5Q}{4}$

5. 'Four point +ve charges of samp magnitude (Q) are placed at four corners of a rigid square frame as shown in figure. The plane of the frame is perpendicular to z-axis. If a –ve point charge is placed at ,a distance z away from the above frame (z << L). Then -



(a) –ve charge oscillates along the z-axis
(b) it moves away from the frame
(c) it moves slowly towards the frame and stays in the plane of the frame
(d) it passes through the frame only once

6. A body can be negatively charged by
(a) giving excess of electrons to it
(b) removing some electrons from it
(c) giving some protons to it
(d) removing some neutrons from it

7. The electric charge in uniform motion produces-
(a) an electric field only
(b) a magnetic field only
(c) both electric and magnetic fields
(d) neither electric nor magnetic fields

8. A charge q is placed at the mid-point of the line joining two equal charges Q. The system of three charges will be in equilibrium when q has the value -
(a) Q/4 (b) Q/2
(c) –Q/4 (d) –Q/2

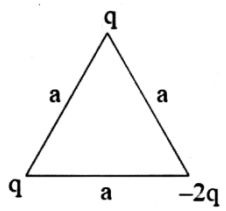
9. Two metallic spheres of same mass are given equal and opposite charges, then-
(a) the mass of positively charged sphere increases
(b) the mass of both remains the same
(c) the mass of negatively charged sphere increases
(d) the mass of both spheres increases

10. If a body has a charge of 10^{-12} coulomb -
(a) the body has 6.25×10^6 excess of electrons
(b) the body has 625×10^6 excess of electrons
(c) the body has 6.25×10^6 deficiency of electrons
(d) the body has 6.25×10^3 deficiency of electrons

11. Two unlike charges of the same magnitude Q are placed at a distance d. The intensity of the electric field at the middle point in the line joining the two charge is -
(a) zero (b) $\frac{8Q}{4\pi\varepsilon_0 d^2}$
(c) $\frac{6Q}{4\pi\varepsilon_0 d^2}$ (d) $\frac{4Q}{4\pi\varepsilon_0 d^2}$

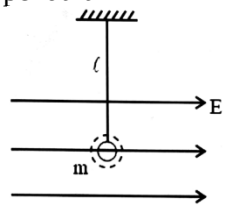
12. Three charges each of 5×10^{-6} coulomb are placed at three corners of an equilateral triangle of side 10 cm. The force exerted on another charge of 1μC placed at the centre of the triangle in newton will be -
(a) 13.5 (b) 4.5
(c) 6.75 (d) zero

13. Find the net force on –2q -



(a) $\frac{\sqrt{3}kq^2}{a^2}$ (b) $\frac{2\sqrt{3}kq^2}{a^2}$
(c) zero (d) none

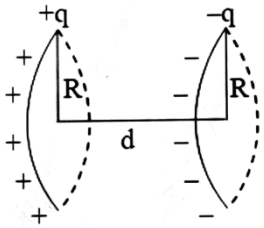
14. The time period of SHM performed by the simple pendulum -



(a) $T = 2\pi\sqrt{l/g}$ (b) $T = 2\pi\sqrt{\frac{l}{g-qE/m}}$
(c) $T = 2\pi\sqrt{\frac{l}{g^2+(qE/m)^2}}$ (d) None

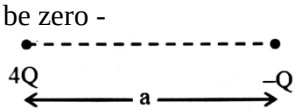
15. In any conductor-
(i) All the free electrons are on the surface
(ii) All the positive ions are at the surface
(iii) All the excess charge and the free electrons in the conductor is at the surface of conductor
(iv) All the excess charge and the positive ions are at the surface
(a) only (i) is correct
(b) (i) & (iv) are correct
(c) all the above are correct
(d) none of the above is correct

16. Two thin rings each of radius R are placed at a distance 'd' apart. The charges on the rings are +q and –q. The potential difference between their centres will be -



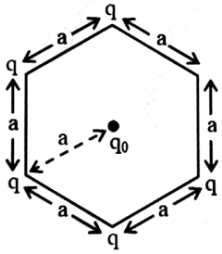
(a) $\frac{qR}{4\pi\varepsilon_0 d^2}$ (b) $\frac{q}{2\pi\varepsilon_0}\left[\frac{1}{R}-\frac{1}{\sqrt{R^2+d^2}}\right]$
(c) zero (d) $\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{R}-\frac{1}{\sqrt{R^2+d^2}}\right]$

17. The position of the point where net electric field will be zero -



(a) (2a)m from 4Q
(b) a/2 m from –Q
(c) 1m from 4Q
(d) Neutral point not possible

18. Calculate the net force acting on q_0-



(a) $\frac{kqq_0}{\sqrt{2}a^2}$ (b) $\frac{kqq_0}{(a/2)^2}$
(c) zero (d) $\frac{kqq_0}{a^2}$

19. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals -
(a) $-2\sqrt{2}$ (b) –1
(c) 1 (d) $-\frac{1}{\sqrt{2}}$

20. The potential in a region is given by V = 10 – 7x volt where x is in metres. The magnitude and direction of the electric field at x = 3 m is-
(a) –11 N/C in the positive x-direction
(b) 11 N/C in the positive x-direction
(c) 7 N/C in the negative x-direction
(d) 7 N/C in the positive x-direction

21. A long string with charge per unit length λ passes through a cube of length *l*. The maximum flux through the cube will be -
(a) $\frac{\lambda l}{\varepsilon_0}$ (b) $\frac{\sqrt{2}\lambda l}{\varepsilon_0}$
(c) $\frac{\sqrt{3}\lambda l}{\varepsilon_0}$ (d) $\frac{2\lambda l}{\varepsilon_0}$

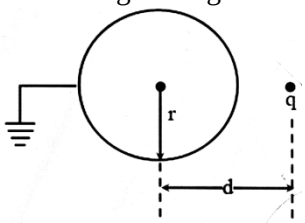
22. Electric charges q, q and –2q are placed at the corners of an equilateral triangle of side 'a'. The magnitude of electric dipole moment of the system is
(a) qa (b) 2 qa
(c) $\sqrt{3}$ qa (d) 4qa

23. Three identical charges are placed at corners of an equilateral triangle of side *l*. If force between any two charges is F, the work required to double the dimensions of triangle is -
(a) –3 F*l* (b) 3 F*l*
(c) (–3/2) F*l* (d) (3/2) F*l*

24. A point charge is brought in an electric field. The electric field at a nearby point:
(a) will increase if the charge is positive
(b) will decrease if the charge is negative
(c) may increase if the charge is positive

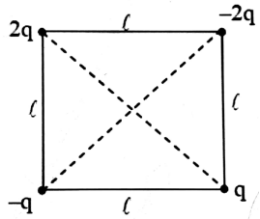
(d) none

25. In the given fig. the charge appears on the sphere is -



(a) q (b) $\frac{qd}{r}$
(c) $-\frac{qr}{d}$ (d) zero

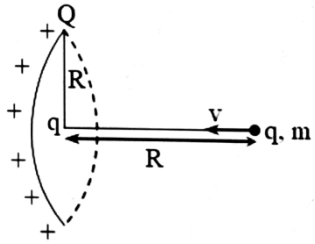
26. The electric field at the centre of square of side I by the system of given charges will be -



(a) $\frac{2Kq}{l^2}$ (b) $\frac{2\sqrt{2}Kq}{l^2}$
(c) $\frac{\sqrt{2}Kq}{l^2}$ (d) None of these

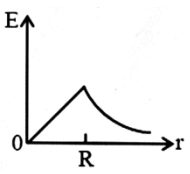
27. The electric potential at a point in an electric field is given by V = $\frac{81}{r}$ volt, where r is the magnitude of the position vector of that point. Then the electric field at a point whose position vector is
$\vec{r} = \hat{\imath} + \hat{\jmath} + \hat{k}$ metre is-
(a) $9\sqrt{3}\,(\hat{\imath} + \hat{\jmath} + \hat{k})$ volt/m
(b) $3(\hat{\imath} + \hat{\jmath} + \hat{k})$ volt/m
(c) $81(\hat{\imath} + \hat{\jmath} + \hat{k})$ volt/m
(d) none of the above

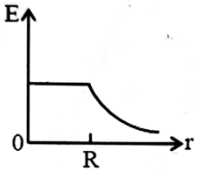
28. Calculate the minimum value 'v' with which q should be projected so that it just reaches the centre of the ring -

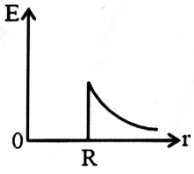


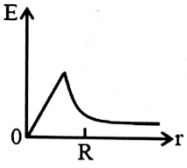
(a) v = $\sqrt{\frac{kQq}{mR}\left(2-\sqrt{2}\right)}$ (b) v = $\sqrt{\frac{kQq}{mR}\left(\sqrt{2}-2\right)}$
(c) v = $\sqrt{\frac{kQq}{mR}}$ (d) v = $\sqrt{\frac{kQq}{\sqrt{2}mR}\left(1-\sqrt{2}\right)}$

29. For a uniformly charged conducting sphere of radius R which of following shows a correct graph between the electric field intensity and the distance from the centre of sphere -

(a) 

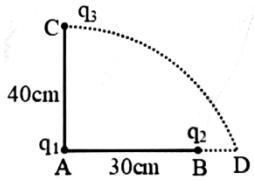
(b) 

(c) 

(d) 

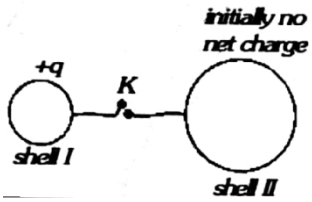
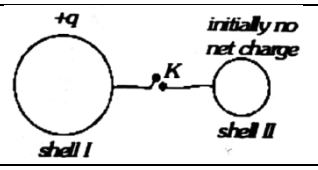
30. Two equal and oppositely charged metal plates have densities ± σ. These are separated by a distance d. Then, the field outside these plates is
(a) $\frac{\sigma}{\varepsilon_0}$ (b) $\frac{2\sigma}{\varepsilon_0}$
(c) $\frac{\sigma}{2\varepsilon_0}$ (d) zero

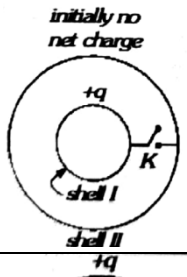
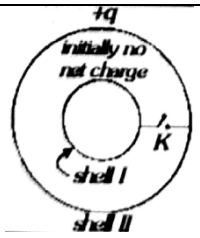
31. Two charges q_1 and q_2 are placed 30 cm apart, as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in the potential energy of the system is $\frac{q_3}{4\pi\epsilon_0}$ k, where k is-



(a) $8q_1$ (b) $6q_1$
(c) $8q_2$ (d) $6q_2$

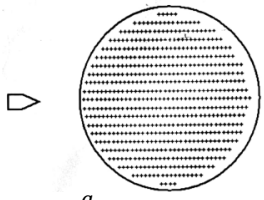
32. Column-I gives certain situation^ involving two thin conducting shells connected by a conducting wire via a key K. In all situations one sphere has net charge +q and other sphere has no net charge. After the key K is pressed,
column-II gives some resulting effect.

Column–I	Column–II
(A) 	(P) Charge flows through connecting wire
(B) 	(Q) Potential energy of system of spheres decreases

(C) 	(R) No heat is produced
(D) 	(S) The sphere I has no charge after equilibrium is reached

(a) (A)→(P,Q), (B)→(P,Q), (C)→(P,Q,S), (D)→(R,S)
(b) (A)→(P), (B)→(P,R), (C)→(P,Q), (D)→(R,S)
(c) (A)→(P,S), (B)→(P,Q), (C)→(Q,S), (D)→(Q,S)
(d) NONE

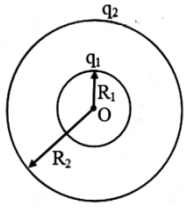
33. A bullet of mass m and charge q is fired towards a solid uniformly charged sphere of radius R and total charge +q. If it strikes the surface of sphere with speed u, find the minimum value of u so; that it can penetrate through the sphere. (Neglect all resistance forces or friction acting on bullet except electrostatic forces)



(a) $\frac{q}{\sqrt{2\pi\varepsilon_0 mR}}$ (b) $\frac{q}{\sqrt{4\pi\varepsilon_0 mR}}$
(c) $\frac{q}{\sqrt{8\pi\varepsilon_0 mR}}$ (d) $\frac{\sqrt{3}q}{\sqrt{4\pi\varepsilon_0 mR}}$

34. On a semicircular ring of radius R charge Q is uniformly distributed over it. The force on a point charge q placed at the centre of semicircle is -
(a) $\frac{Qq}{2\pi\epsilon_0 R^2}$ (b) $\frac{Qq}{4\pi\epsilon_0 R^2}$
(c) $\frac{Qq}{2\pi^2\epsilon_0 R^2}$ (d) $\frac{Qq}{4\pi^2\epsilon_0 R^2}$

35. Two spherical shells shown in figure have uniformly distributed charge q_1 and q_2 ,r is distance from common centre consider the following.
(a) E_1 = Electric field for $r < R_1$,
(b) E_2 = Electric field for $R_1 < r < R_2$
(c) V_1 = Electric potential for $r < R_1$
(d) V_2 = Electric potential for $R_1 < r < R_2$
then match the following columns.

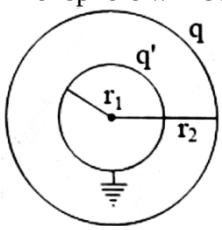


Column-I	Column-II
(A) E_1	(P) is constant for q_2 and vary for
(B) V_1	(Q) is zero for q_2 and vary for q_1
(C) V_2	(R) its constant
(D) E_2	(S) is zero

(a) A→P, B→S, C→P, D→Q
(b) A→S, B→R, C→P, D→Q
(c) A→S, B→R, C→Q, D→P
(d) A→S, B→P, C→R, D→Q

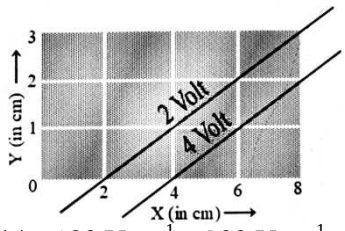
36. Four equal charges of charge q are placed at corner of a square of side a. Potential energy of the whole system is-
(a) $\frac{4kq^2}{a}$ (b) $\frac{4kq^2}{a}\left(1-\frac{1}{2\sqrt{2}}\right)$
(c) $\frac{1}{2\sqrt{2}}\frac{kq^2}{a}$ (d) $\frac{kq^2}{a}\left(4-\frac{1}{2\sqrt{2}}\right)$

37. Two concentric 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)

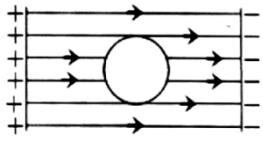


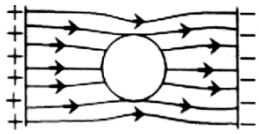
(a) q (b) –q
(c) –q $\frac{r_1}{r_2}$ (d) zero

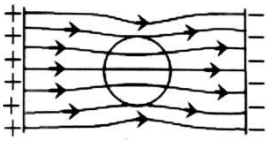
38. The figure shows two equipotential lines in XY-plane for an electric field. The scales are marked. The X-component E_x and Y-component E_y of the electric field in the space between these equipotential lines are respectively-

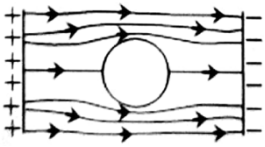


(a) +100 V m^{-1}, –200 V m^{-1}
(b) +200 V m^{-1}, +100 V m^{-1}
(c) –100 V m^{-1}, +200 V m^{-1}
(d) –200 V m^{-1}, –100 V m^{-1}

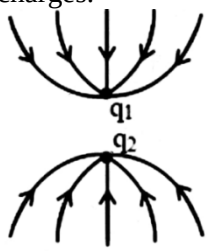
39. An uncharged metal sphere is placed between two equal and oppositely charged metal plates. The nature of lines of force will be-
(a) 

(b) 

(c) 

(d) 

40. In the adjoining figure, the electric field lines for charges q_1 and q_2 are shown. Identify the sign of the charges:



(a) both negative
(b) upper charge is negative and lower is positive
(c) both positive
(d) upper charge is positive and lower is negative

41. A charge q is located at the centre of a cube the electric flux through any face is:

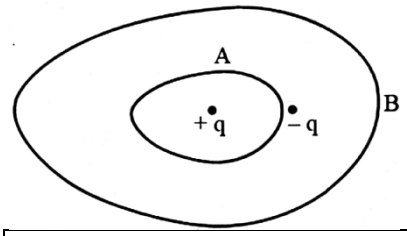
(a) $\frac{4\pi q}{6(4\pi\varepsilon_0)}$ (b) $\frac{\pi q}{6(4\pi\varepsilon_0)}$
(c) $\frac{q}{6(4\pi\varepsilon_0)}$ (d) $\frac{2\pi q}{6(4\pi\varepsilon_0)}$

42. A uniformly charged and infinitely long line having a linear charge density 'λ' is placed at a normal distance y from a point o. Consider a sphere of radius R with 0 as centre and R > y. Electric flux through the surface of the sphere is-

(a) zero (b) $\frac{2\lambda R}{\varepsilon_0}$
(c) $\frac{2\lambda\sqrt{R^2-y^2}}{\varepsilon_0}$ (d) $\frac{\lambda\sqrt{R^2-y^2}}{\varepsilon_0}$

43. Under the influence of the Coulomb field of charge +Q, a charge –q is moving around it in an elliptical orbital. Find out the correct statement(s).
(a) The angular momentum of the charge –q is constant
(b) The linear momentum of the charge –q is constant
(c) The angular velocity of the charge –q is constant
(d) The linear speed of the charge –q is constant

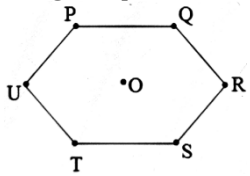
44. Consider the figure.



Column-I	Column-II
(A) Electric flux through A	(P) > 0
(B) Electric flux through B	(Q) = 0
(C) Electric field inside A	(R) < 0
(D) Electric field inside B	(S) None

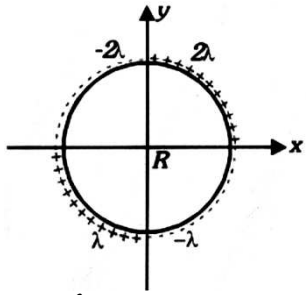
(a) (A)→(Q), (B)→(S), (C)→(R), (D)→(P)
(b) (A)→(S), (B)→(Q), (C)→(P), (D)→(R)
(c) (A)→(P), (B)→(Q), (C)→(P), (D)→(Q)
(d) (A)→(S), (B)→(R), (C)→(Q), (D)→(P)

45. Six charges of equal magnitude ar6 placed at six corners of a regular hexagon. Find arrangement the charges in order PQRSTU which produce double electric field as compared to electric filed produce by single charges +q at R



(a) + + + – – – (b) + – + – + –
(c) – + + – + – (d) – + + + – –

46. The charge per unit length of the four quadrant of the ring is 2λ, –2λ, λ and –λ respectively. The electric field at the centre is:



(a) $\frac{-\lambda}{2\pi\varepsilon_0 R}\hat{\imath}$ (b) $\frac{\lambda}{2\pi\varepsilon_0 R}\hat{\jmath}$
(c) $\frac{\sqrt{2}\lambda}{4\pi\varepsilon_0 R}\hat{\imath}$ (d) None

47. An electric dipole is placed at the origin and is directed along the x-axis. At a point P, far away from the dipole, the electric field is parallel to the y-axis. OP makes an angle θ with the x- axis.

(a) $\tan\theta = \sqrt{3}$ (b) $\tan\theta = \sqrt{2}$
(c) $\theta = 45°$ (d) $\tan\theta = \frac{1}{\sqrt{2}}$

48. A solid sphere of radius R is charged uniformly. At what distance from its surface is the electrostatic potential half of the potential at the centre?

(a) R (b) R/2
(c) R/3 (d) 2R

49. A nonconducting ring of radius 0.5 m carries a total charge of 1.11×10^{-10} C distributed non- uniformly on its circumference, producing an electric field everywhere in space. The value of the line integral $\int_{t=\infty}^{t=0} -E.dl$ ($l = 0$ being the centre of the ring) in volts is:
(a) +2 (b) –1
(c) –2 (d) 0

50. Two Identical pendulums, A and B, are suspended from the same point. The bobs are given positive charges, with A having more charge than B. They diverge and reach equilibrium with A and B making angles θ_1 and θ_2 with the vertical respectively.
(a) $\theta_1 > \theta_2$ (b) $\theta_1 < \theta_2$
(c) $\theta_1 = \theta_2$ (d) None of These