15 Electric Charges and Fields

Conceptual MCQs

1. Two charges are at a distance d apart. If a copper plate of thickness $\frac{d}{2}$ is kept between them, then effective force will be

(a) F/2 (b) $\sqrt{2}$ F (c) 2F (d) zero

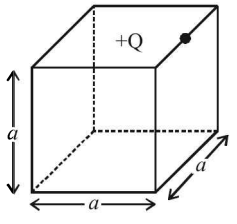
2. An electric dipole is placed in a uniform electric field. The dipole will experience

(a) a force that will displace it in the direction of the field
(b) a force that will displace it in a direction opposite to the field.
(c) a torque which will rotate it without displacement
(d) a torque which will rotate it and a force that will displace it

3. Two parallel large thin metal sheets have equal surface charge densities ($\sigma = 26.4 \times 10^{-12}$ C/m^2) of opposite signs. The electric field between these sheets is

(a) 1.5 N/C (b) 1.5×10^{-10} N/C
(c) 3 N/C (d) 3×10^{-10} N/C

4. In figure + Q charge is located at one of the edge of the cube, then electric flux through cube due to + Q charge is



(a) $\frac{+Q}{\epsilon_0}$ (b) $\frac{+Q}{2\,\epsilon_0}$ (c) $\frac{+Q}{4\,\epsilon_0}$ (d) $\frac{+Q}{8\,\epsilon_0}$

5. A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is

(a) qEy^2 (b) qE^2 y (c) qEy (d) q^2 Ey

6. The electric field due to an extremely short dipole at distance r from it is proportional to

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

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

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

8. If the electric field is given by $(5\hat{i} + 4\hat{j} + 9\hat{k})$. The electric flux through a surface of area 20 units lying in the Y-Z plane will be

(a) 100 units (b) 80 units
(c) 180 units (d) 20 units

9. Two identical conductors of copper and aluminium are placed in an identical electric fields. The magnitude of induced charge in the aluminium will be

(a) zero (b) greater than in copper
(c) equal to that in copper (d) less than in copper

10. A total charge Q is broken in two parts Q_1 and Q_2 and they are placed at a distance R from each other. The maximum force of repulsion between them will occur when

(a) $Q_2 = \frac{Q}{R}, Q_1 = Q - \frac{Q}{R}$ (b) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{2Q}{3}$

(c) $Q_2 = \frac{Q}{4}, Q_1 = \frac{3Q}{4}$ (d) $Q_1 = \frac{Q}{2}, Q_2 = \frac{Q}{2}$

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

(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$

(c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$ (d) $\frac{4\pi\varepsilon_0 Fd^2}{q^2}$

12. A glass rod rubbed with silk is used to charge a gold leaf electroscope and the leaves are observed to diverge. The electroscope thus charged is exposed to X-rays for a short period. Then

(a) the divergence of leaves will not be affected

(b) the leaves will diverge further

(c) the leaves will collapse

(d) the leaves will melt

13. A cube of side 'b' has a charge q at each of its vertices. The electric field at the centre of the cube is

(a) $\frac{4q}{3\pi \in_0 b^2}$ (b) $\frac{3q}{4\pi \in_0 b^2}$

(c) $\frac{2q}{\pi \in_0 b^2}$ (d) Zero

14. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

(a) increase four times (b) be reduced to half

(c) remain the same (d) be doubled

15. The charges on two spheres are +7μC and –5μC respectively. They experience a force F. If each of them is given and additional charge of –2μC, the new force of attraction will be

(a) F (b) F / 2 (c) $F/\sqrt{3}$ (d) 2F

Application Based MCQs

16. Three point charges Q_1, Q_2, Q_3 are placed equally spaced along a straight line. Q_2 and Q_3 are equal in magnitude but opposite in sign. If the net force on Q_3 is zero. The value of Q_1 is

(a) $Q_1 = 4(Q_3)$ (b) $Q = 2(Q_3)$

(c) $Q_1 = \sqrt{2}(Q_3)$ (d) $Q_1 = |Q_3|$

17. Two equally charged, identical metal spheres A and B repel each other with a force 'F'. The spheres are kept fixed with a distance 'r' between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the mid point of the line joining A and B. The magnitude of the net electric force on C is

(a) F (b) $\frac{3F}{4}$ (c) $\frac{F}{2}$ (d) $\frac{F}{4}$

18. Two spheres A and B of radius 4 cm and 6 cm are given charges of 80 μC and 40 μC respectively. If they are connected by a fine wire, the amount of charge flowing from one to the other is

(a) 20 μC from A to B (b) 16 μC from A to B

(c) 32 μC from B to A (d) 32 μC from A to B

19. The electric field intensity just sufficient to balance the earth's gravitational attraction on an electron will be: (given mass and charge of an electron respectively are 9.1×10^{-31}kg and 1.6×10^{-19}C)

(a) -5.6×10^{-11}N/C (b) -4.8×10^{-15}N/C

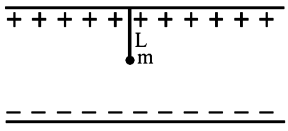
(c) -1.6×10^{-19}N/C (d) -3.2×10^{-19}N/C

20. A pendulum bob of mass m carrying a charge q is at rest with its string making an angle θ with the vertical in a uniform horizontal electric field E. The tension in the string is

(a) $\frac{mg}{\sin\theta}$ and $\frac{qE}{\cos\theta}$ (b) $\frac{mg}{\cos\theta}$ and $\frac{qE}{\sin\theta}$

(c) $\frac{qE}{mg}$ (d) $\frac{mg}{qE}$

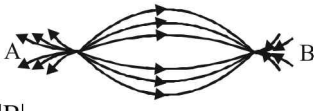
21. A small sphere carrying a charge 'q' is hanging in between two parallel plates by a string of length L. Time period of pendulum is T_0. When parallel plates are charged, the time period changes to T. The ratio T/T_0 is equal to



(a) $\left(\frac{g+\frac{qE}{m}}{g}\right)^{1/2}$ (b) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{3/2}$

(c) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{1/2}$ (d) None of these

22. The spatial distribution of electric field due to charges (A, B) is shown in figure. Which one of the following statements is correct ?



(a) A is +ve and B –ve, |A| > |B|

(b) A is –ve and B +ve, |A| = |B|

(c) Both are +ve but A > B

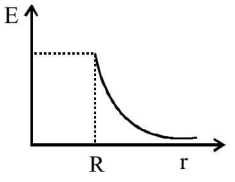
(d) Both are –ve but A > B

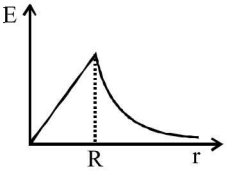
23. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2 then the electric charge inside the surface will be

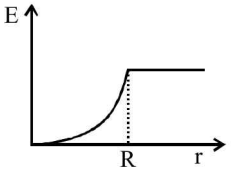
(a) $(\phi_1+\phi_2)\varepsilon_0$ (b) $(\phi_2-\phi_1)\varepsilon_0$

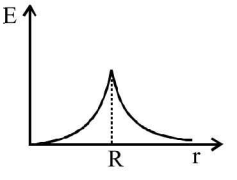
(c) $(\phi_1-\phi_2)/\varepsilon_0$ (d) $(\phi_2-\phi_1)/\varepsilon_0$

24. Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the spherical conductor ?

(a) 

(b) 

(c) 

(d) 

25. A pendulum bob of mass 30.7×10^{-6} kg carrying a charge 2×10^{-8} C is at rest in a horizontal uniform electric field of 20000 V/m. The tension in the thread of the pendulum is $(g = 9.8\ m/s^2)$

(a) 3×10^{-4} N (b) 4×10^{-4} N

(c) 5×10^{-4} N (d) 6×10^{-4} N

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

(a) 3 N/C (b) 4 N/C

(c) 5 N/C (d) 20 N/C

27. A ring of radius r carries a charge Q uniformly distributed over its length. A charge q is placed at its centre will experience a force equal to

(a) $\dfrac{qQ}{4\pi\varepsilon_0 r^2}$ (b) $\dfrac{qQ}{8\pi\varepsilon_0 r^3}$

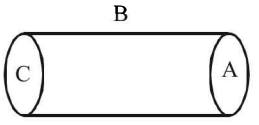
(c) Zero (d) None of these

28. Two point dipoles $p\hat{k}$ and $\dfrac{p}{2}\hat{k}$ are located at (0, 0, 0) and (1, 0, 2) respectively. The resultant electric field due to the two dipoles at the point (1, 0, 0) is

(a) $\dfrac{9p}{32\pi\in_0}\hat{k}$ (b) $\dfrac{-7p}{32\pi\in_0}\hat{k}$

(c) $\dfrac{7p}{32\pi\in_0}\hat{k}$ (d) None of these

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



(a) $\dfrac{q}{2\varepsilon_0}$ (b) $\dfrac{\phi}{3}$

(c) $\left(\dfrac{q}{\varepsilon_0}-\phi\right)$ (d) $\dfrac{1}{2}\left(\dfrac{q}{\varepsilon_0}-\phi\right)$

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

(a) negative and distributed uniformly over the surface of the sphere

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

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

(d) zero

31. A small electric dipole is placed at origin with its dipole moment directed along positive X-axis. The direction of electric field at point $(2, 2\sqrt{2}, 0)$ is

(a) Along negative Z-axis (b) Along Z-axis

(c) Along negative Y-axis (d) Along positive Y-axis

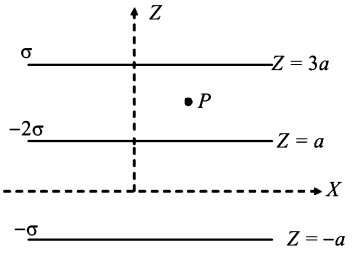
32. Three infinitely long charge sheets are placed as shown in figure. The electric field at point P is

(a) $\dfrac{2\sigma}{\varepsilon_0}\hat{k}$

(b) $\dfrac{4\sigma}{\varepsilon_0}\hat{k}$

(c) $-\dfrac{2\sigma}{\varepsilon_0}\hat{k}$

(d) $-\dfrac{4\sigma}{\varepsilon_0}\hat{k}$



33. Two small similar metal spheres A and B having charges 4q and – 4q, when placed at a certain distance apart, exert an electric force F on each other. When another identical uncharged sphere C, first touched with A then with B and then removed to infinity, the force of interaction between A and B for the same separation will be

(a) F/2 (b) F/8

(c) F/16 (d) F/32

34. An oil drop of radius r and density ρ is held stationary in a uniform vertically upwards electric field 'E'. If ρ_0 (< ρ) is the density of air and e is quanta of charge, then the drop has–

(a) $\frac{4\pi r^3 (\rho-\rho_0) g}{3eE}$ excess electrons

(b) $\frac{4\pi r^2 (\rho-\rho_0) g}{eE}$ excess electrons

(c) deficiency of $\frac{4\pi r^3 (\rho-\rho_0) g}{3eE}$ electrons

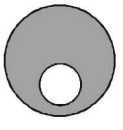
(d) deficiency of $\frac{4\pi r^2 (\rho-\rho_0) g}{eE}$ electrons

35. Three concentric metallic spherical shells of radii R, $2R$, $3R$, are given charges Q_1, Q_2, Q_3, respectively. It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, $Q_1 : Q_2 : Q_3$, is

(a) 1 : 2 : 3 (b) 1 : 3 : 5

(c) 1 : 4 : 9 (d) 1 : 8 : 18

36. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume in the figure. The electric field inside the emptied space is



(a) Zero everywhere

(b) Non-zero and uniform

(c) Non-uniform

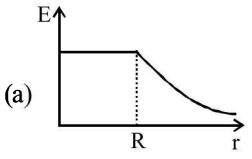
(d) Zero only at its centre

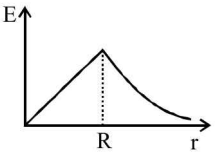
37. Two identical conducting spheres carrying different charges attract each other with a force F when placed in air medium at a distance 'd' apart. The spheres are brought into contact and then taken to their original positions. Now the two spheres repel each other with a force whose magnitude is equal to that of the initial attractive force. The ratio between initial charges on the spheres is

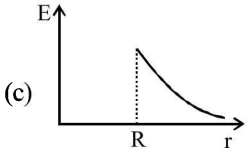
(a) $-(3+\sqrt{8})$ only (b) $(-3+\sqrt{8})$ only

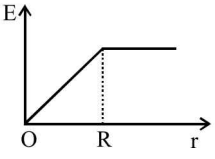
(c) $-(3+\sqrt{8})$ or $(-3+\sqrt{8})$ (d) $+\sqrt{3}$

38. The electric field due to a uniformly charged sphere of radius R as a function of the ditance from its centre is represented graphically by

(a) 

(b) 

(c) 

(d) 

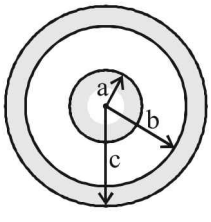
39. The force between two charges 0.06 m apart is 5 N. If each charge is moved towards other by 0.01 m, then the force between them will become

(a) 7.20N (b) 11.25N (c) 22.50N (d) 45.00N

40. A solid conducting sphere of radius a has a net positive charge 2Q. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge – Q. The surface charge density on the inner and outer surfaces of the spherical shell will be

(a) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$



(c) $0, \frac{Q}{4\pi c^2}$

(d) None of these

Skill Based MCQs

41. Two equal negative charge –q are fixed at the fixed points (0, a) and (0, –a) on the Y-axis. A positive charge Q is released from rest at the point (2a, 0) on the X-axis. The charge Q will

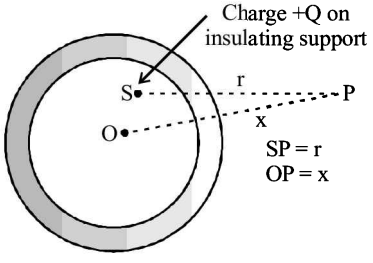
(a) Execute simple harmonic motion about the origin

(b) Move to the origin and remain at rest

(c) Move to infinity

(d) Execute oscillatory but not simple harmonic motion

42. The adjacent diagram shows a charge +Q held on an insulating support S and enclosed by a hollow spherical conductor. O represents the centre of the spherical conductor and P is a point such that OP = x and SP = r. The electric field at point P will be



(a) $\frac{Q}{4\pi\varepsilon_0 x^2}$ (b) $\frac{Q}{4\pi\varepsilon_0 r^2}$

(c) 0 (d) None of these

43. A solid sphere of radius R_1 and volume charge density $\rho = \frac{\rho_0}{r}$ is enclosed by a hollow sphere of radius R_2 with negative surface charge density σ, such that the total charge in the system is zero. ρ_0 is a positive constant and r is the distance from the centre of the sphere. The ratio R_2/R_1 is

(a) σ/ρ_0 (b) $\sqrt{2\sigma/\rho_0}$

(c) $\sqrt{\rho_0/2\sigma}$ (d) ρ_0/σ

44. Three point charges +q, –2q and +q are placed at points (x = 0, y = a, z = 0), (x = 0, y = 0, z = 0) and (x = a, y = 0, z = 0) respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are

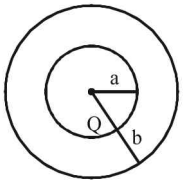
(a) $\sqrt{2}$qa along the line joining points (x = 0, y = 0, z = 0) and (x = a, y = a, z = 0)

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

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

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

45. The region between two concentric spheres of radii '*a*' and '*b*' respectively (see figure), has volume charge density $\rho = \frac{A}{r}$, where *A* is a constant and *r* is the distance from the centre. At the centre of the spheres is a point charge *Q*. The value of *A* such that the electric field in the region between the spheres will be constant, is



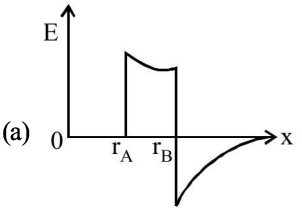
(a) $\frac{Q}{2\pi(b^2-a^2)}$ (b) $\frac{2Q}{\pi(a^2-b^2)}$

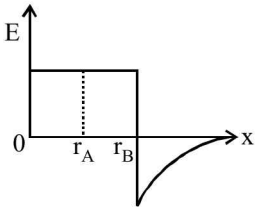
(c) $\frac{2Q}{\pi a^2}$ (d) $\frac{Q}{2\pi a^2}$

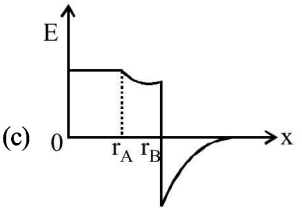
46. A solid sphere of radius *R* has a charge *Q* distributed in its volume with a charge density $\rho = \kappa r^a$, where κ and *a* are constants and *r* is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that at *r* = *R*, find the value of *a*.

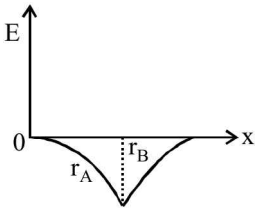
(a) 2 (b) 3 (c) 5 (d) 6

47. Two concentric conducting thin spherical shells A and B having radii r_A and r_B ($r_B > r_A$) are charged to Q_A and $-Q_B$ ($|Q_B| > Q_A|$). The electrical field along a line passing through the centre is

(a) 

(b) 

(c) 

(d) 

48. An infinite number of charges, each of charge 1 μC, are placed on the x-axis with co-ordinates $x = 1, 2, 4, 8, ...\infty$. If a charge of 1 C is kept at the origin, then what is the net force acting on 1 C charge?

(a) 9000N (b) 12000N (c) 24000N (d) 36000N

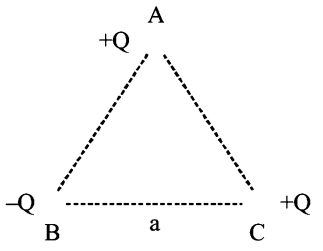
49. Three charges are placed at the vertices of an equilateral triangle of side 'a' as shown in the following figure. The force experienced by the charge placed at the vertex A in a direction normal to BC is

(a) $Q^2/(4\pi\varepsilon_0 a^2)$

(b) $-Q^2/(4\pi\varepsilon_0 a^2)$

(c) Zero

(d) $Q^2/(2\pi\varepsilon_0 a^2)$



50. Equal charges q are placed at the four corners A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be

(a) $\dfrac{3q^2}{4\pi\varepsilon_0 a^2}$

(b) $\dfrac{4q^2}{4\pi\varepsilon_0 a^2}$

(c) $\left(\dfrac{1+2\sqrt{2}}{2}\right)\dfrac{q^2}{4\pi\varepsilon_0 a^2}$

(d) $\left(2+\dfrac{1}{\sqrt{2}}\right)\dfrac{q^2}{4\pi\varepsilon_0 a^2}$

ANSWER KEY

Conceptual MCQs																		
1	(d)	**3**	(c)	**5**	(c)	**7**	(d)	**9**	(c)	**11**	(c)	**13**	(d)	**15**	(a)			
2	(c)	**4**	(c)	**6**	(c)	**8**	(a)	**10**	(d)	**12**	(b)	**14**	(c)					
Application Based MCQs																		
16	(a)	**19**	(a)	**22**	(a)	**25**	(c)	**28**	(b)	**31**	(d)	**34**	(c)	**37**	(c)	**40**	(a)	
17	(a)	**20**	(b)	**23**	(b)	**26**	(d)	**29**	(d)	**32**	(c)	**35**	(b)	**38**	(b)			
18	(d)	**21**	(c)	**24**	(a)	**27**	(c)	**30**	(d)	**33**	(b)	**36**	(b)	**39**	(b)			
Skill Based MCQs																		
41	(d)	**42**	(a)	**43**	(c)	**44**	(a)	**45**	(d)	**46**	(a)	**47**	(a)	**48**	(b)	**49**	(c)	**50**	(c)