Critical Thinking

Objective Questions

1. 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 **[IIT 1984; Bihar MEE 1995; MP PMT 1996]**

   (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

2. An electric line of force in the xy plane is given by equation $x^2 + y^2 = 1$. A particle with unit positive charge, initially at rest at the point $x = 1, y = 0$ in the xy plane **[IIT 1988]**

   (a) Not move at all

   (b) Will move along straight line

   (c) Will move along the circular line of force

   (d) Information is insufficient to draw any conclusion

3. A positively charged ball hangs from a silk thread. We put a positive test charge q_0 at a point and measure F/q_0, then it can be predicted that the electric field strength E **[CPMT 1990]**

   (a) $> F/q_0$ (b) $= F/q_0$

   (c) $< F/q_0$ (d) Cannot be estimated

4. 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 **[MP PMT 1995]**

   (a) $\frac{Q}{2\pi\varepsilon_0 R}$ (b) $\frac{3Q}{2\pi\varepsilon_0 R}$

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

5. If on the concentric hollow spheres of radii r and $R(> r)$ the charge Q is distributed such that their surface densities are same then the potential at their common centre is **[IIT 1981; MP PMT 2003]**

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

   (c) Zero (d) $\frac{Q(R + r)}{4\pi\varepsilon_0 (R^2 + r^2)}$

6. Two equal charges q of opposite sign separated by a distance $2a$ constitute an electric dipole of dipole moment p. If P is a point at a distance r from the centre of the dipole and the line joining the centre of the dipole to this point makes an angle θ with the axis of the dipole, then the potential at P is given by $(r >> 2a)$ (Where $p = 2qa$) **[MP PET 1997]**

   (a) $V = \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$ (b) $V = \frac{p\cos\theta}{4\pi\varepsilon_0 r}$

   (c) $V = \frac{p\sin\theta}{4\pi\varepsilon_0 r}$ (d) $V = \frac{p\cos\theta}{2\pi\varepsilon_0 r^2}$

7. A point charge q is placed at a distance $a/2$ directly above the centre of a square of side a. The electric flux through the square is **[MP PMT 1997; AMU 1999]**

   (a) $\frac{q}{\varepsilon_0}$ (b) $\frac{q}{\pi\varepsilon_0}$

   (c) $\frac{q}{4\varepsilon_0}$ (d) $\frac{q}{6\varepsilon_0}$

8. Two infinitely long parallel wires having linear charge densities λ_1 and λ_2 respectively are placed at a distance of R metres. The force per unit length on either wire will be $\left(K = \frac{1}{4\pi\varepsilon_0}\right)$ **[MP PMT/PET 1998; DPMT 2000]**

   (a) $K\frac{2\lambda_1\lambda_2}{R^2}$ (b) $K\frac{2\lambda_1\lambda_2}{R}$

   (c) $K\frac{\lambda_1\lambda_2}{R^2}$ (d) $K\frac{\lambda_1\lambda_2}{R}$

9. Two identical thin rings each of radius R meters are coaxially placed at a distance R meters apart. If Q_1 coulomb and Q_2 coulomb are respectively the charges uniformly spread on

the two rings, the work done in moving a charge q from the centre of one ring to that of other is

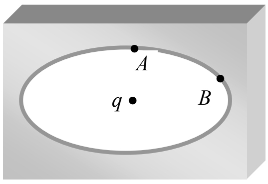
[MP PMT 1999; AMU (Engg.) 1999]

(a) Zero (b) $\frac{q(Q_1-Q_2)(\sqrt{2}-1)}{\sqrt{2}.4\pi\varepsilon_0 R}$

(c) $\frac{q\sqrt{2}(Q_1+Q_2)}{4\pi\varepsilon_0 R}$ (d) $\frac{q(Q_1+Q_2)(\sqrt{2}+1)}{\sqrt{2}.4\pi\varepsilon_0 R}$

10. An ellipsoidal cavity is carved within a perfect conductor. A positive charge q is placed at the centre of the cavity. The points A and B are on the cavity surface as shown in the figure. Then

[IIT-JEE (Screening) 1999]



(a) Electric field near A in the cavity = Electric field near B in the cavity

(b) Charge density at $A =$ Charge density at B

(c) Potential at $A =$ Potential at B

(d) Total electric field flux through the surface of the cavity is q/ε_0

11. A charge $+q$ is fixed at each of the points $x = x_0, x = 3x_0, x = 5x_0$ ..... infinite, on the $x-$axis and a charge $-q$ is fixed at each of the points $x = 2x_0, x = 4x_0, x = 6x_0$,..... infinite. Here x_0 is a positive constant. Take the electric potential at a point due to a charge Q at a distance r from it to be $Q/(4\pi\varepsilon_0 r)$. Then, the potential at the origin due to the above system of charges is

[IIT 1998]

(a) 0 (b) $\frac{q}{8\pi\varepsilon_0 x_0 \ln 2}$

(c) ∞ (d) $\frac{q \ln 2}{4\pi\varepsilon_0 x_0}$

12. A positively charged thin metal ring of radius R is fixed in the $xy-$plane with its centre at the O. A negatively charged particle P is released from rest at the point $(0, 0, z_0)$, where $z_0 > 0$. Then the motion of P is

[IIT 1998]

(a) Periodic for all values of z_0 satisfying $0 < z_0 < \infty$

(b) Simple harmonic for all values of satisfying $0 < z_0 < R$

(c) Approximately simple harmonic provided $z_0 << R$

(d) Such that P crosses O and continues to move along the negative $z-$axis towards $z = -\infty$

13. A non-conducting solid sphere of radius R is uniformly charged. The magnitude of the electric field due to the sphere at a distance r from its centre

[IIT-JEE 1998; DPMT 2000]

(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 $r = R$

14. A non-conducting ring of radius $0.5\,m$ carries a total charge of $1.11\times10^{-10}\,C$ distributed non-uniformly on its circumference producing an electric field $\vec{E}$ everywhere in space. The value of the line integral $\int_{l=\infty}^{l=0} -\vec{E}.\vec{dl}$ $(l = 0$ being centre of the ring) in volt is **[IIT 1997 Cancelled]**

(a) + 2 (b) – 1

(c) – 2 (d) Zero

15. A negatively charged plate has charge density of $2\times10^{-6}\,C/m^2$. The initial distance of an electron which is moving toward plate, cannot strike the plate, if it is having energy of $200\,eV$

[RPET 1997]

(a) $1.77\,mm$ (b) $3.51\,mm$

(c) $1.77\,cm$ (d) $3.51\,cm$

16. The charge on $500\,cc$ of water due to protons will be

[RPET 1997]

(a) $6.0\times10^{27}\,C$ (b) $2.67\times10^{7}\,C$

(c) $6\times10^{23}\,C$ (d) $1.67\times10^{23}\,C$

17. Electric potential is given by

$$V = 6x - 8xy^2 - 8y + 6yz - 4z^2$$

Then electric force acting on $2C$ point charge placed on origin will be **[RPET 1999]**

(a) $2N$ (b) $6N$

(c) $8N$ (d) $20\,N$

18. The electric field in a region is radially outward with magnitude $E = A\gamma_0$. The charge contained in a sphere of radius γ_0 centered at the origin is **[AMU 1999]**

(a) $\frac{1}{4\pi\varepsilon_0} A\gamma_0^3$ (b) $4\pi\varepsilon_0 A\gamma_0^3$

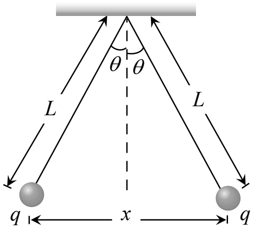
(c) $\frac{4\pi\varepsilon_0 A}{\gamma_0}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{A}{\gamma_0^3}$

19. Charge q is uniformly distributed over a thin half ring of radius R. The electric field at the centre of the ring is **[Roorkee 1999]**

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

(c) $\frac{q}{4\pi\varepsilon_0 R^2}$ (d) $\frac{q}{2\pi\varepsilon_0 R^2}$

20. In the given figure two tiny conducting balls of identical mass m and identical charge q hang from non-conducting threads of equal length L. Assume that θ is so small that $\tan\theta \approx \sin\theta$, then for equilibrium x is equal to **[AMU 2000]**



(a) $\left(\frac{q^2 L}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$ (b) $\left(\frac{qL^2}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

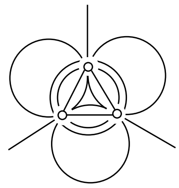
(c) $\left(\frac{q^2 L^2}{4\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$ (d) $\left(\frac{q^2 L}{4\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

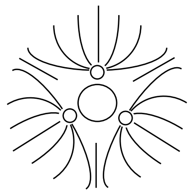
21. Consider two points 1 and 2 in a region outside a charged sphere. Two points are not very far away from the sphere. If E and V represent the electric field vector and the electric potential, which of the following is not possible **[AMU 2001]**

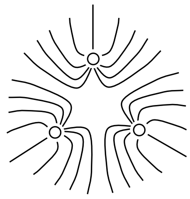
(a) $|\vec{E}_1| = |\vec{E}_2|,\ V_1 = V_2$ (b) $\vec{E}_1 \neq \vec{E}_2,\ V_1 \neq V_2$

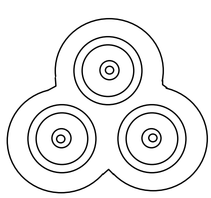
(c) $\vec{E}_1 \neq \vec{E}_2,\ V_1 = V_2$ (d) $|\vec{E}_1| = |\vec{E}_2|,\ V_1 \neq V_2$

22. Three positive charges of equal value q are placed at the vertices of an equilateral triangle. The resulting lines of force should be sketched as in **[IIT-JEE (Screening) 2001]**

(a) 

(b) 

(c) 

(d) 

23. 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 **[IIT-JEE (Screening) 2001]**

(a) $V_A < V_B$ (b) $V_A > V_B$

(c) $V_A < V_C$ (d) $V_A > V_C$

24. There is a uniform electric field of strength $10^3\ V/m$ along y-axis. A body of mass 1g and charge $10^{-6}C$ is projected into the field from origin along the positive x-axis with a velocity 10m/s. Its speed in m/s after 10s is (Neglect gravitation) **[EAMCET 2001]**

(a) 10 (b) $5\sqrt{2}$

(c) $10\sqrt{2}$ (d) 20

25. The electric potential at a point (x, y) in the $x-y$ plane is given by $V = -kxy$. The field intensity at a distance r from the origin varies as **[UPSEAT 2002]**

(a) r^2 (b) r

(c) $\frac{1}{r}$ (d) $\frac{1}{r^2}$

26. Two equal charges are separated by a distance d. A third charge placed on a perpendicular bisector at x distance will experience maximum coulomb force when **[MP PET 2002]**

(a) $x=\frac{d}{\sqrt{2}}$ (b) $x=\frac{d}{2}$

(c) $x=\frac{d}{2\sqrt{2}}$ (d) $x=\frac{d}{2\sqrt{3}}$

27. Two equal point charges are fixed at $x=-a$ and $x=+a$ on the x-axis. Another point charge Q is placed at the origin. The Change in the electrical potential energy of Q, when it is displaced by a small distance x along the x-axis, is approximately proportional to **[IIT-JEE (Screening) 2002]**

(a) x (b) x^2

(c) x^3 (d) $1/x$

28. An elementary particle of mass m and charge $+e$ is projected with velocity v at a much more massive particle of charge Ze, where $Z>0$. What is the closest possible approach of the incident particle **[Orissa JEE 2002]**

(a) $\frac{Ze^2}{2\pi\varepsilon_0 mv^2}$ (b) $\frac{Ze}{4\pi\varepsilon_0 mv^2}$

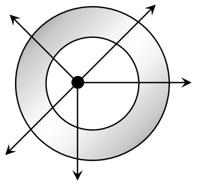
(c) $\frac{Ze^2}{8\pi\varepsilon_0 mv^2}$ (d) $\frac{Ze}{8\pi\varepsilon_0 mv^2}$

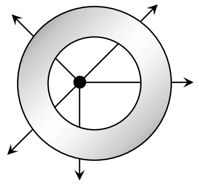
29. An electric dipole is situated in an electric field of uniform intensity E whose dipole moment is p and moment of inertia is I. If the dipole is displaced slightly from the equilibrium position, then the angular frequency of its oscillations is **[MP PET 2003]**

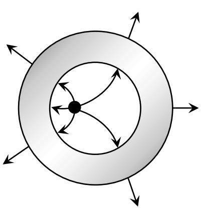
(a) $\left(\frac{pE}{I}\right)^{1/2}$ (b) $\left(\frac{pE}{I}\right)^{3/2}$

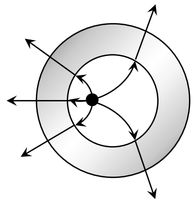
(c) $\left(\frac{I}{pE}\right)^{1/2}$ (d) $\left(\frac{p}{IE}\right)^{1/2}$

30. A metallic shell has a point charge 'q' kept inside its cavity. Which one of the following diagrams correctly represents the electric lines of forces **[IIT-JEE (Screening) 2003]**

(a) 

(b) 

(c) 

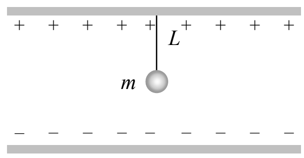
(d) 

31. An infinite number of electric charges each equal to 5 *nano-coulomb* (magnitude) are placed along X-axis at $x=1\,cm$, $x=2\,cm$, $x=4\,cm$ $x=8\,cm$ ………. and so on. In the setup if the consecutive charges have opposite sign, then the electric field in *Newton/Coulomb* at $x=0$ is $\left(\frac{1}{4\pi\varepsilon_0}=9\times10^9\,N-m^2/c^2\right)$

(a) 12×10^4 (b) 24×10^4

(c) 36×10^4 (d) 48×10^4

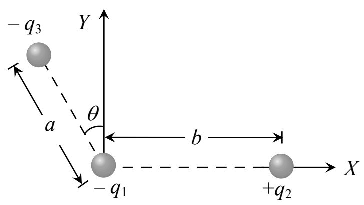
32. A small sphere carrying a charge 'q' is hanging in between two parallel plates by a string of length L. Time period of pendulum is T_0. When parallel plates are charged, the time period changes to T. The ratio T/T_0 is equal to **[UPSEAT 2003]**



(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

33. 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



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

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

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

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

34. A solid conducting sphere having a charge Q is surrounded by an uncharged concentric conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of $-3Q$, the new potential difference between the same two surfaces is

[IIT 1989]

(a) V (b) $2V$

(c) $4V$ (d) $-2V$

35. Two point charges $+q$ and $-q$ are held fixed at $(-d, 0)$ and $(d, 0)$ respectively of a (X, Y) coordinate system. Then

[IIT 1995]

(a) E at all points on the $Y-$axis is along $\hat{i}$

(b) The electric field $\vec{E}$ at all points on the $X-$axis has the same direction

(c) Dipole moment is $2qd$ directed along $\hat{i}$

(d) Work has to be done in bringing a test charge from infinity to the origin

36. A point charge of 40 stat coulomb is placed 2 *cm* in front of an earthed metallic plane plate of large size. Then the force of attraction on the point charge is

(a) 100 *dynes* (b) 160 *dynes*

(c) 1600 *dynes* (d) 400 *dynes*

37. A piece of cloud having area $25 \times 10^6 m^2$ and electric potential of 10^5 volts. If the height of cloud is $0.75 km$, then energy of electric field between earth and cloud will be

[RPET 1997]

(a) $250 J$ (b) $750 J$

(c) $1225 J$ (d) $1475 J$

38. Two point charges $(+Q)$ and $(-2Q)$ are fixed on the X-axis at positions a and $2a$ from origin respectively. At what positions on the axis, the resultant electric field is zero

[MP PET 2001]

(a) Only $x = \sqrt{2}a$ (b) Only $x = -\sqrt{2}a$

(c) Both $x = \pm\sqrt{2}a$ (d) $x = \frac{3a}{2}$ only

39. Six charges, three positive and three negative of equal magnitude are to be placed at the vertices of a regular hexagon such that the electric field at O is double the electric field when only one positive charge of same magnitude is placed at R. Which of the following arrangements of charges is possible for P, Q, R, S, T and U respectively

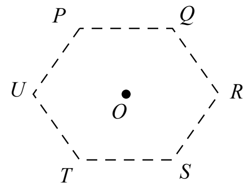
[IIT-JEE (Screening) 2004]

(a) $+, -, +, -, -, +$

(b) $+, -, +, -, +, -$

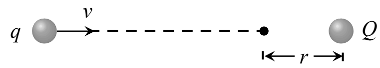
(c) $+, +, -, +, -, -$

(d) $-, +, +, -, +, -$



40. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q were given a speed $2v$, the closest distances of approach would be

[AIEEE 2004]



(a) r (b) $2r$

(c) $r/2$ (d) $r/4$

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

[AIEEE 2004]

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

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

42. A parallel plate air capacitor has a capacitance of $100 \mu\mu F$. The plates are at a distance d apart. If a slab of thickness $t (t \le d)$ and dielectric constant 5 is introduced between the parallel plates, then the capacitance will be **[MP PMT 2003]**

(a) $50 \mu\mu F$ (b) $100 \mu\mu F$

(c) $200 \mu\mu F$ (d) $500 \mu\mu F$

43. A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at $x = 0$ and positive plate is at $x = 3d$. The slab is equidistant from the plates. The capacitor is given some charge. As one goes from 0 to $3d$

[IIT-JEE 1998]

(a) The magnitude of the electric field remains the same

(b) The direction of the electric field remains the same

(c) The electric potential increases continuously

(d) The electric potential increases at first, then decreases and again increases

44. Capacitance of a capacitor made by a thin metal foil is $2\mu F$. If the foil is folded with paper of thickness $0.15 mm$, dielectric constant of paper is 2.5 and width of paper is $400 mm$, then length of foil will be **[RPET 1997]**

(a) $0.34\ m$ (b) $1.33\ m$

(c) $13.4\ m$ (d) $33.9\ m$

45. A parallel plate capacitor is charged to a potential difference of 50 *V*. It is discharged through a resistance. After 1 second, the potential difference between plates becomes 40 *V*. Then **[Roorkee 1999]**

(a) Fraction of stored energy after 1 second is 16/25

(b) Potential difference between the plates after 2 seconds will be 32 *V*

(c) Potential difference between the plates after 2 seconds will be 20 *V*

(d) Fraction of stored energy after 1 second is 4/5

46. A parallel plate capacitor is connected to a battery. The plates are pulled apart with a uniform speed. If *x* is the separation between the plates, the time rate of change of electrostatic energy of capacitor is proportional to **[CPMT 2002]**

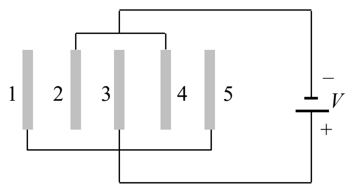
(a) x^{-2} (b) x

(c) x^{-1} (d) x^2

47. Five identical plates each of area A are joined as shown in the figure. The distance between the plates is *d*. The plates are connected to a potential difference of $V\,volts$. The charge on plates 1 and 4 will be **[IIT 1984]**

(a) $\frac{\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$

(b) $\frac{\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$



(c) $\frac{\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

(d) $\frac{-\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

48. To form a composite $16\mu F, 1000 V$ capacitor from a supply of identical capacitors marked $8\mu F, 250 V$, we require a minimum number of capacitors **[MP PET 1996; AIIMS 2000]**

(a) 40 (b) 32

(c) 8 (d) 2

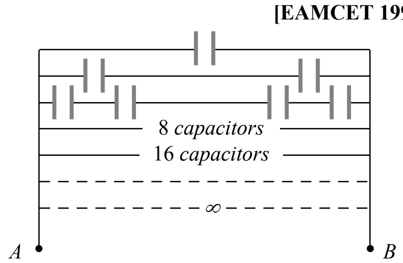
49. An infinite number of identical capacitors each of capacitance $1\mu F$ are connected as in adjoining figure. Then the equivalent capacitance between A and B is **[EAMCET 1990]**

(a) $1\mu F$

(b) $2\mu F$

(c) $\frac{1}{2}\mu F$

(d) ∞

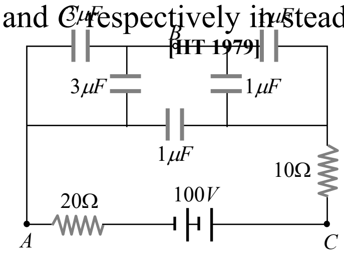


50. Two condensers of capacities $2C$ and *C* are joined in parallel and charged upto potential *V*. The battery is removed and the condenser of capacity *C* is filled completely with a medium of dielectric constant *K*. The p.d. across the capacitors will now be **[IIT 1988]**

(a) $\frac{3V}{K+2}$ (b) $\frac{3V}{K}$

(c) $\frac{V}{K+2}$ (d) $\frac{V}{K}$

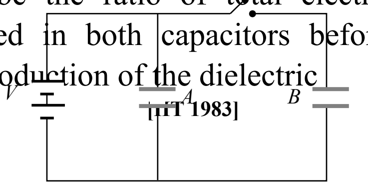
51. In the figure below, what is the potential difference between the point *A* and *B* and between *B* and *C* respectively in steady state **[IIT 1979]**



(a) $V_{AB} = V_{BC} = 100\ V$ (b) $V_{AB} = 75\ V, V_{BC} = 25\ V$

(c) $V_{AB} = 25\ V, V_{BC} = 75\ V$ (d) $V_{AB} = V_{BC} = 50\ V$

52. Figure given below shows two identical parallel plate capacitors connected to a battery with switch S closed. The switch is now opened and the free space between the plate of capacitors is filled with a dielectric of dielectric constant 3. What will be the ratio of total electrostatic energy stored in both capacitors before and after the introduction of the dielectric **[IIT 1983]**



(a) 3 : 1

(b) 5 : 1

(c) 3 : 5

(d) 5 : 3

53. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance $2C$ is connected to another battery and is charged to potential difference $2V$. The charging batteries are now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration is **[IIT 1995]**

(a) Zero (b) $\frac{25CV^2}{6}$

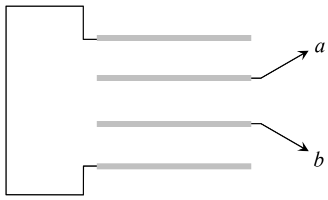
(c) $\frac{3CV^2}{2}$ (d) $\frac{9CV^2}{2}$

54. Condenser A has a capacity of $15\mu F$ when it is filled with a medium of dielectric constant 15. Another condenser B has a capacity of $1\mu F$ with air between the plates. Both are charged separately by a battery of $100\ V$. After charging, both are connected in parallel without the battery and the dielectric medium being removed. The common potential now is **[MNR 1994]**

(a) $400V$ (b) $800\ V$

(c) $1200\ V$ (d) $1600\ V$

55. Four metallic plates each with a surface area of one side A are placed at a distance d from each other. The plates are connected as shown in the circuit diagram. Then the capacitance of the system between a and b is



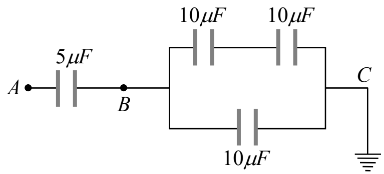
(a) $\frac{3\varepsilon_0 A}{d}$

(b) $\frac{2\varepsilon_0 A}{d}$

(c) $\frac{2\varepsilon_0 A}{3d}$

(d) $\frac{3\varepsilon_0 A}{2d}$

56. In the given circuit if point C is connected to the earth and a potential of $+2000\ V$ is given to the point A, the potential at B is **[MP PET 1997; Pb. PET 2003]**



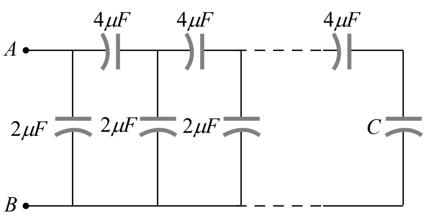
(a) $1500\ V$

(b) $1000\ V$

(c) $500\ V$

(d) $400\ V$

57. A finite ladder is constructed by connecting several sections of $2\mu F, 4\mu F$ capacitor combinations as shown in the figure. It is terminated by a capacitor of capacitance C. What value should be chosen for C such that the equivalent capacitance of the ladder between the points A and B becomes independent of the number of sections in between **[MP PMT 1999; KCET (Engg./Med.) 1999]**



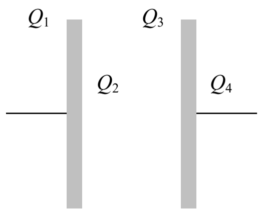
(a) $4\mu F$

(b) $2\mu F$

(c) $18\mu F$

(d) $6\mu F$

58. In an isolated parallel plate capacitor of capacitance C, the four surface have charges Q_1, Q_2, Q_3 and Q_4 as shown. The potential difference between the plates is **[IIT-JEE 1999]**



(a) $\frac{Q_1 + Q_2 + Q_3 + Q_4}{2C}$

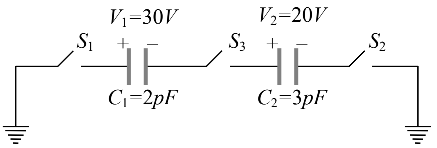
(b) $\frac{Q_2 + Q_3}{2C}$

(c) $\frac{Q_2 - Q_3}{2C}$

(d) $\frac{Q_1 + Q_4}{2C}$

59. For the circuit shown, which of the following statements is true

[IIT-JEE 1999; UPSEAT 2003]



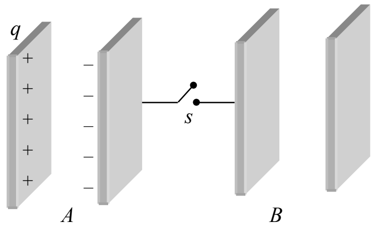
(a) With S_1 closed, $V_1 = 15\ V,\ V_2 = 20\ V$

(b) With S_3 closed $V_1 = V_2 = 25\,V$

(c) With S_1 and S_2 closed $V_1 = V_2 = 0$

(d) With S_1 and S_3 closed, $V_1 = 30\ V,\ V_2 = 20\ V$

60. Consider the situation shown in the figure. The capacitor A has a charge q on it whereas B is uncharged. The charge appearing on the capacitor B a long time after the switch is closed is **[IIT-JEE (Screening) 2001]**



(a) Zero (b) $q/2$

(c) q (d) $2q$

61. A capacitor of capacitance $C_1 = 1\mu F$ can with stand maximum voltage $V_1 = 6kV$ (*kilo-volt*) and another capacitor of capacitance $C_2 = 3\mu F$ can withstand maximum voltage $V_2 = 4\ kV$. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of **[MP PET 2001]**

(a) $4\,kV$ (b) $6\,kV$

(c) $8\,kV$ (d) $10\,kV$

62. In the given figure each plate of capacitance C has partial value of charge

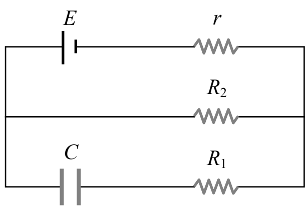
[MP PMT 2003]

(a) CE

(b) $\frac{CER_1}{R_2 - r}$

(c) $\frac{CER_2}{R_2 + r}$

(d) $\frac{CER_1}{R_1 - r}$



63. The plates of a capacitor are charged to a potential difference of 320 *volts* and are then connected across a resistor. The potential difference across the capacitor decays exponentially with time. After 1 *second* the potential difference between the plates of the capacitor is 240 *volts*, then after 2 and 3 *seconds* the potential difference between the plates will be **[MP PET 1996]**

(a) 200 and 180 V (b) 180 and 135 V

(c) 160 and 80 V (d) 140 and 20 V

64. The plates of a parallel plate condenser are pulled apart with a velocity v. If at any instant their mutual distance of separation is d, then the magnitude of the time of rate of change of capacity depends on d as follows

[MP PET 1991]

(a) $\frac{1}{d}$ (b) $\frac{1}{d^2}$

(c) d^2 (d) d

65. A fully charged capacitor has a capacitance 'C'. It is discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity 's' and mass 'm'. If the temperature of the block is raised by 'ΔT', the potential difference 'V' across the capacitance is

[AIEEE 2005]

(a) $\frac{ms\Delta T}{C}$ (b) $\sqrt{\frac{2ms\Delta T}{C}}$

(c) $\sqrt{\frac{2mC\Delta T}{s}}$ (d) $\frac{mC\Delta T}{s}$

66. A network of four capacitors of capacity equal to $C_1 = C,\ C_2 = 2C,\ C_3 = 3C$ and $C_4 = 4C$ are conducted in a battery as shown in the figure. The ratio of the charges on C_2 and C_4 is

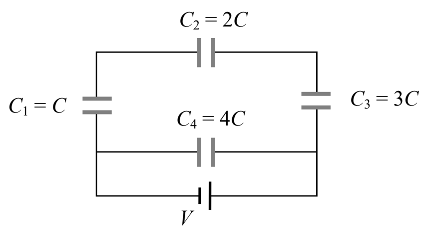
[CBSE PMT 2005]

(a) $\frac{22}{3}$

(b) $\frac{3}{22}$

(c) $\frac{7}{4}$

(d) $\frac{4}{7}$



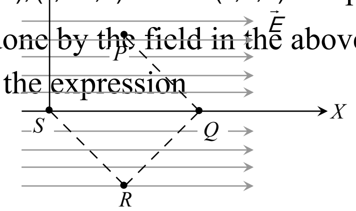
67. A 4 μF capacitor, a resistance of 2.5 $M\Omega$ is in series with 12 V battery. Find the time after which the potential difference across the capacitor is 3 times the potential difference across the resistor. [Given ln(2)= 0.693] **[IIT-JEE (Screening) 2005]**

(a) 13.86 *s* (b) 6.93 *s*

(c) 7 *s* (d) 14 *s*

GQ Graphical Questions

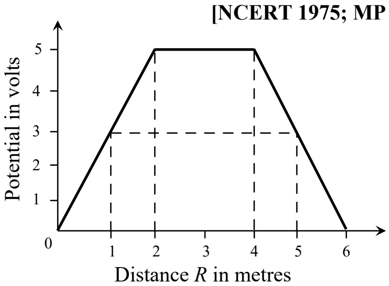
1. Point charge q moves from point P to point S along the path $PQRS$ (figure shown) in a uniform electric field E pointing coparallel to the positive direction of the $X-$axis. The coordinates of the points P, Q, R and S are $(a, b, 0)$, $(2a, 0, 0)$, $(a, -b, 0)$ and $(0, 0, 0)$ respectively. The work done by the field in the above process is given by the expression **[IIT 1989]**



(a) qEa (b) $-qEa$

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

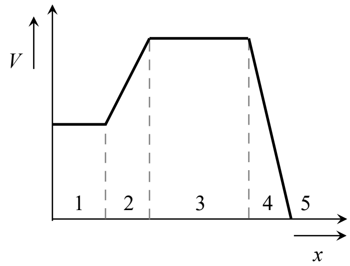
2. The variation of potential with distance R from a fixed point is as shown below. The electric field at $R = 5\,m$ is **[NCERT 1975; MP PMT 2003]**



(a) $2.5\ volt/m$ (b) $-2.5\ volt/m$

(c) $2/5\ volt/m$ (d) $-2/5\ volt/m$

3. The figure gives the electric potential V as a function of distance through five regions on x-axis. Which of the following is true for the electric field E in these regions **[AMU 2000]**



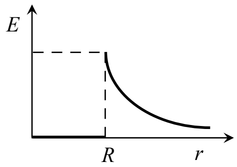
(a) $E_1 > E_2 > E_3 > E_4 > E_5$

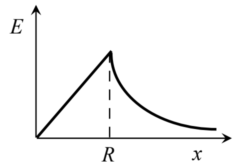
(b) $E_1 = E_3 = E_5$ and $E_2 < E_4$

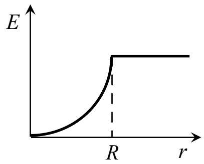
(c) $E_2 = E_4 = E_5$ and $E_1 < E_3$

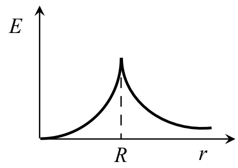
(d) $E_1 < E_2 < E_3 < E_4 < E_5$

4. 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 sphere **[AMU 2001]**

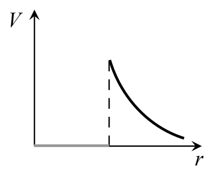
(a) 

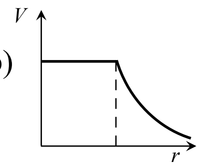
(b) 

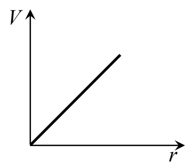
(c) 

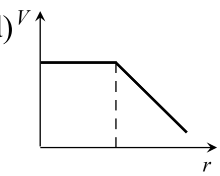
(d) 

5. In a hollow spherical shell potential (V) changes with respect to distance (r) from centre

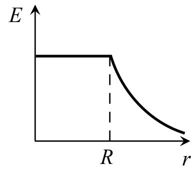
(a) 

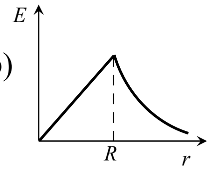
(b) 

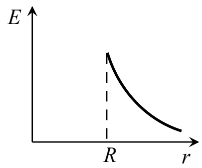
(c) 

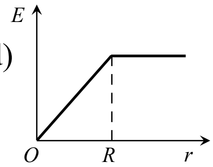
(d) 

6. The electric field due to a uniformly charged sphere of radius R as a function of the distance from its centre is represented graphically by **[AIIMS 2004]**

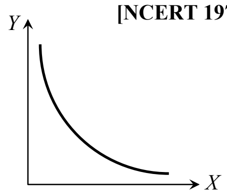
(a) 

(b) 

(c) 

(d) 

7. What physical quantities may X and Y represent ? (Y represents the first mentioned quantity) **[NCERT 1978; MP PMT 2003]**



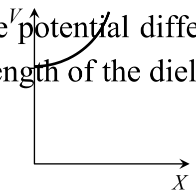
(a) Pressure *v/s* temperature of a given gas (constant volume)

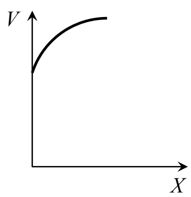
(b) Kinetic energy *v/s* velocity of a particle

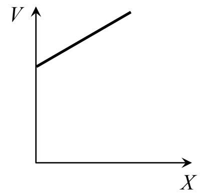
(c) Capacitance *v/s* charge to give a constant potential

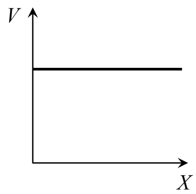
(d) Potential *v/s* capacitance to give a constant charge

8. Between the plates of a parallel plate capacitor a dielectric plate is introduced just to fill the space between the plates. The capacitor is charged and later disconnected from the battery. The dielectric plate is slowly drawn out of the capacitor parallel to the plates. The plot of the potential difference across the plates and the length of the dielectric plate drawn out is **[MP PET 1997]**

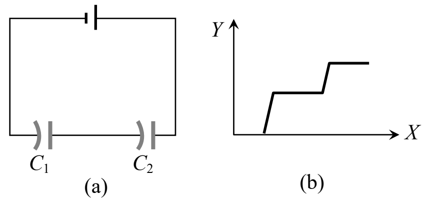
(a) 

(b) 

(c) 

(d) 

9. Figure (a) shows two capacitors connected in series and joined to a battery. The graph in figure (b) shows the variation in potential as one moves from left to right on the branch containing the capacitors, if **[MP PMT 1999]**



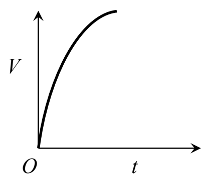
(a) $C_1 > C_2$

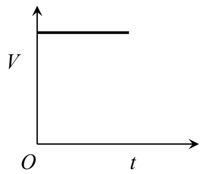
(b) $C_1 = C_2$

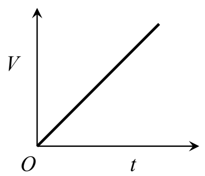
(c) $C_1 < C_2$

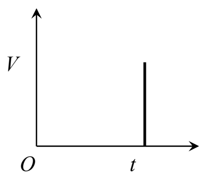
(d) The information is not sufficient to decide the relation between C_1 and C_2

10. During charging a capacitor variation of potential V of the capacitor with time t is shown as **[MP PET 2003]**

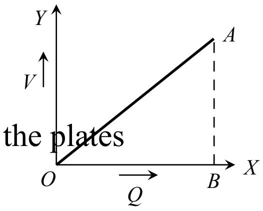
(a) 

(b) 

(c) 

(d) 

11. Change Q on a capacitor varies with voltage V as shown in the figure, where Q is taken along the X-axis and V along the Y-axis. The area of triangle OAB represents **[Kerala (Engg.) 2001]**



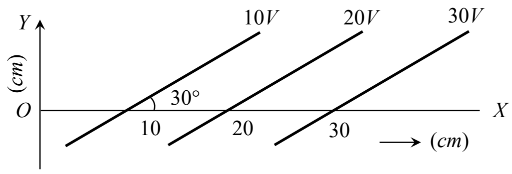
(a) Capacitance

(b) Capacitive reactance

(c) Magnetic field between the plates

(d) Energy stored in the capacitor

12. Equipotential surfaces are shown in figure. Then the electric field strength will be



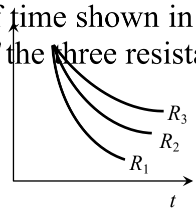
(a) 100 Vm^{-1} along X-axis

(b) 100 Vm^{-1} along Y-axis

(c) 200 Vm^{-1} at an angle 120° with X-axis

(d) 50 Vm^{-1} at an angle 120° with X-axis

13. Three identical capacitors are given a charge Q each and they are then allowed to discharge through resistance R_1, R_2 and R_3. Their charges, as a function of time shown in the graph below. The smallest of the three resistance is

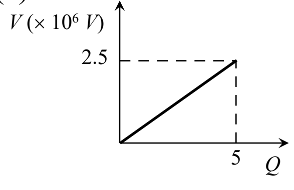


(a) R_3 (b) R_2

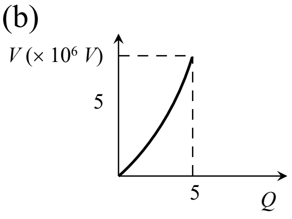
(c) R_1 (d) Cannot be predicted

14. A condenser of $2\mu F$ capacitance is charged steadily from 0 to 5 *Coulomb*. Which of the following graphs correctly represents the variation of potential difference across its plates with respect to the charge on the condenser

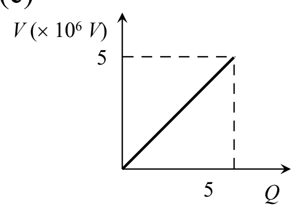
(a)



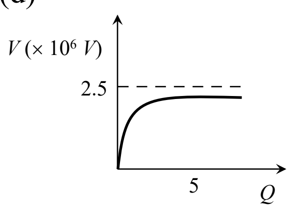
(b)



(c)

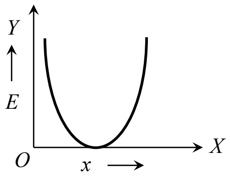


(d)

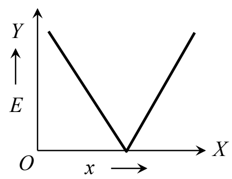


15. Two identical point charges are placed at a separation of d. P is a point on the line joining the charges, at a distance x from any one charge. The field at P is E, E is plotted against x for values of x from close to zero to slightly less than d. Which of the following represents the resulting curve

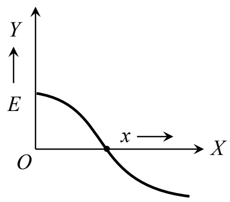
(a)



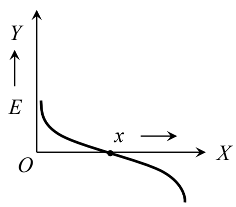
(b)



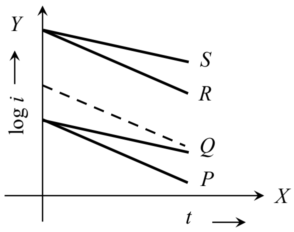
(c)



(d)



16. In an RC circuit while charging, the graph of in i versus time is as shown by the dotted line in the diagram figure, where i is the current. When the value of the resistance is doubled, which of the solid curve best represents the variation of in i versus time **[IIT-JEE (Screening) 2004]**

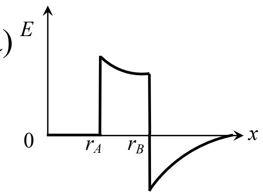


(a) P (b) Q

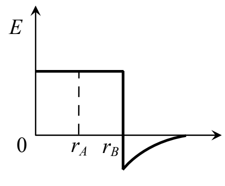
(c) R (d) S

17. 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 **[AIIMS 2005]**

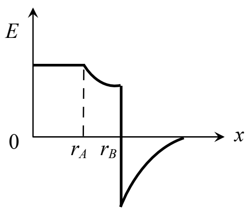
(a)



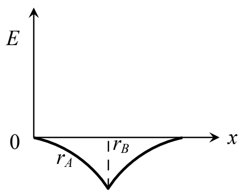
(b)



(c)



(d)



Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : The coulomb force is the dominating force in the universe.
Reason : The coulomb force is weaker than the gravitational force. **[AIIMS 2003]**

2. Assertion : If three capacitors of capacitance $C_1 < C_2 < C_3$ are connected in parallel then their equivalent capacitance $C_p > C_s$
Reason : $\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ **[AIIMS 2002]**

3. Assertion : A metallic shield in form of a hollow shell may be built to block an electric field.
Reason : In a hollow spherical shield, the electric field inside it is zero at every point. **[AIIMS 2001]**

4. Assertion : Electrons move away from a low potential to high potential region.
Reason : Because electrons has negative charge **[AIIMS 1999]**

5. Assertion : If the distance between parallel plates of a capacitor is halved and dielectric constant is made three times, then the capacitor becomes 6 times.
Reason : Capacity of the capacitor does not depend upon the nature of the material. **[AIIMS 1997]**

6. Assertion : A parallel plate capacitor is connected across battery through a key. A dielectric slab of constant K is introduced between the plates. The energy which is stored becomes K times.
Reason : The surface density of charge on the plate remains constant or unchanged. **[AIIMS 1996]**

7. Assertion : Electric lines of force cross each other.
Reason : Electric field at a point superimpose to give one resultant electric field. **[AIIMS 1995]**

8. Assertion : If a proton and an electron are placed in the same uniform electric field. They experience different acceleration.
Reason : Electric force on a test charge is independent of its mass. **[AIIMS 1994]**

9. Assertion : Dielectric breakdown occurs under the influence of an intense light beam.
Reason : Electromagnetic radiations exert pressure.

10. Assertion : When charges are shared between any two bodies, no charge is really lost, but some loss of energy does occur.
Reason : Some energy disappears in the form of heat, sparking *etc*.

11. Assertion : Annihilation of electron and positron is an example of decay of charges.
Reason : In the process of annihilation an electron and a positron combine to give a gamma particle.

12. Assertion : Surface of a symmetrical conductor can be treated as equipotential surface.

Reason : Charges can easily flow in a conductor.

13. Assertion : The capacity of a given conductor remains same even if charge is varied on it.

Reason : Capacitance depends upon nearly medium as well as size and shape of conductor.

14. Assertion : A charged capacitor is disconnected from a battery. Now if its plate are separated farther, the potential energy will fall.

Reason : Energy stored in a capacitor is equal to the work done in charging it.

15. Assertion : Charge is invariant.

Reason : Charge does not depends on speed of frame of reference.

16. Assertion : Mass of ion is slightly differed from its element.

Reason : Ion is formed, when some electrons are removed or added so mass changes.

17. Assertion : Charge is quantized

Reason : Charge, which is less than 1 C is not possible

18. Assertion : If a point charge q is placed in front of an infinite grounded conducting plane surface, the point charge will experience a force.

Reason : This force is due to the induced charge on the conducting surface which is at zero potential.

19. Assertion : The surface charge densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal.

Reason : Surface charge density is equal to charge per unit area.

20. Assertion : Three equal charges are situated on a circle of radius r such that they form on equilateral triangle, then the electric field intensity at the centre is zero.

Reason : The force on unit positive charge at the centre, due to the three equal charges are represented by the three sides of a triangle taken in the same order. Therefore, electric field intensity at centre is zero.

21. Assertion : On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases.

Reason : Electric field is inversely proportional to square of distance from the charge or an electric dipole.

22. Assertion : The whole charge of a conductor cannot be transferred to another isolated conductor.

Reason : The total transfer of charge from one to another is not possible.

23. Assertion : Conductors having equal positive charge and volume, must also have same potential.

Reason : Potential depends only on charge and volume of conductor.

24. Assertion : At a point in space, the electric field points towards north. In the region, surrounding this point the rate of change of potential will be zero along the east and west.

Reason : Electric field due to a charge is the space around the charge.

25. Assertion : A point charge is brought in an electric field. The field at a nearby point will increase, whatever be the nature of the charge.

Reason : The electric field is independent of the nature of charge.

26. Assertion : The force with which one plate of a parallel plate capacitor is attracted towards the other plate is equal to square of surface density per ε per unit area.

Reason : The electric field due to one charged plate of the capacitor at the location of the other is equal to surface density per ε.

27. Assertion : The lightening conductor at the

top of high building has sharp pointed ends.

Reason : The surface density of charge at sharp points is very high resulting in setting up of electric wind.

28. Assertion : Circuit containing capacitors should be handled cautiously even when there is no current.

Reason : The capacitors are very delicate and so quickly break down.

29. Assertion : The tyres of aircraft's are slightly conducting.

Reason : If a conductor is connected to ground, the extra charge induced on conductor will flow to ground.

30. Assertion : A bird perches on a high power line and nothing happens to the bird.

Reason : The level of bird is very high from the ground.

Answers

Charge and Coulombs Law

1	d	2	d	3	b	4	c	5	d
6	b	7	b	8	c	9	c	10	a
11	c	12	c	13	d	14	a	15	a
16	a	17	a	18	d	19	a	20	c
21	c	22	b	23	c	24	b	25	d
26	a	27	a	28	a	29	d	30	c
31	c	32	a	33	b	34	a	35	b
36	d	37	b	38	a	39	a	40	b
41	b	42	c	43	b	44	c	45	c
46	a	47	c	48	a	49	a	50	d
51	c	52	d	53	b	54	c	55	c
56	c	57	b	58	c	59	c	60	c
61	c	62	d	63	b	64	a	65	a
66	d	67	a	`68	d	69	b	70	a
71	a	72	b						

Electric Field and Potential

1	b	2	a	3	d	4	c	5	b
6	a	7	a	8	b	9	d	10	c
11	b	12	b	13	b	14	a	15	c
16	c	17	b	18	d	19	c	20	c
21	b	22	a	23	d	24	b	25	b
26	a	27	c	28	c	29	a	30	c
31	b	32	c	33	b	34	b	35	a
36	c	37	c	38	d	39	c	40	b
41	c	42	c	43	a	44	b	45	d
46	a	47	c	48	d	49	d	50	a
51	c	52	d	53	a	54	b	55	a
56	b	57	a	58	c	59	c	60	c
61	d	62	a	63	a	64	b	65	a
66	a	67	b	68	c	69	b	70	c
71	a	72	b	73	d	74	c	75	a
76	d	77	c	78	c	79	a	80	b
81	a	82	a	83	b	84	d	85	b
86	c	87	b	88	b	89	c	90	a
91	d	92	c	93	b	94	b	95	c
96	b	97	a	98	b	99	c	100	a
101	d	102	b	103	a,d	104	b	105	b
106	c	107	c	108	b	109	c	110	c
111	c	112	c	113	c	114	a	115	c
116	a	117	c	118	d	119	d	120	a
121	b	122	a	123	c	124	c	125	a
126	b	127	a	128	a	129	a	130	a
131	d	132	c	133	c	134	b	135	a
136	a	137	b	138	b	139	c	140	c
141	d	142	c	143	d	144	c	145	b
146	c	147	c	148	c	149	d	150	d
151	c	152	c	153	a	154	b	155	b
156	b	157	d	158	a	159	c	160	d
161	c	162	d	163	a	164	b	165	b
166	a	167	d	168	b	169	b	170	a
171	c	172	b	173	a	174	a	175	a
176	c	177	a	178	c	179	d	180	a
181	a	182	c	183	a	184	a	185	b
186	c	187	a	188	b	189	c	190	b
191	c	192	a	193	a	194	c	195	b
196	c	197	b	198	a	199	a	200	b
201	c	202	d	203	b	204	c	205	a
206	c	207	d	208	b	209	b	210	b

Electric Dipole

1	c	2	d	3	b	4	d	5	a
6	b	7	d	8	d	9	b	10	b
11	c	12	c	13	b	14	c	15	b
16	b	17	d	18	b	19	d	20	d
21	d	22	c	23	a	24	a	25	a
26	d	27	d	28	c	29	b	30	b
31	c	32	d	33	a	34	b	35	a
36	a	37	b	38	c	39	c		

Electric Flux and Gauss's Law

1	d	2	c	3	a	4	b	5	c
6	a	7	d	8	a	9	c	10	b
11	d	12	b	13	c	14	b	15	b
16	d	17	d	18	a	19	b	20	a
21	b	22	c	23	b	24	c	25	b
26	a	27	c	28	c				

Capacitance

1	c	2	c	3	a	4	a	5	d
6	ad	7	c	8	b	9	b	10	c
11	c	12	a	13	b	14	d	15	c
16	d	17	a	18	d	19	b	20	b
21	b	22	b	23	d	24	a	25	b
26	d	27	c	28	b	29	c	30	b
31	b	32	a	33	c	34	d	35	c
36	a	37	a	38	d	39	d	40	c
41	c	42	b	43	b	44	a	45	d
46	d	47	c	48	b	49	c	50	a
51	b	52	a	53	b	54	a	55	d
56	c	57	d	58	c	59	b	60	c
61	a	62	b	63	d	64	b	65	d
66	d	67	b	68	c	69	d	70	d
71	a	72	c	73	b	74	c	75	a
76	d	77	b	78	c	79	d	80	a
81	d	82	a	83	c	84	c	85	c
86	a	87	c	88	a	89	b	90	d
91	a	92	b	93	d	94	b	95	c
96	c	97	c	98	c	99	a	100	b
101	b	102	a	103	c	104	b	105	a
106	a	107	b	108	d	109	d	110	a
111	c	112	d	113	c	114	a, b	115	a
116	c	117	b	118	d	119	b	120	a
121	d	122	d	123	d	124	c	125	a
126	a	127	b	128	c	129	b	130	d
131	b	132	c	133	a	134	a	135	b
136	c	137	c	138	d	139	a	140	d
141	d	142	d	143	c	144	c	145	d
146	d	147	c	148	a	149	a	150	d
151	a	152	c	153	b	154	c	155	b
156	b	157	b	158	c	159	d	160	a
161	b	162	b	163	a	164	b	165	b
166	b	167	d	168	b	169	d	170	a
171	c	172							

Grouping of Capacitor

1	d	2	a	3	c	4	a	5	a
6	c	7	c	8	d	9	b	10	d
11	d	12	a	13	b	14	c	15	c
16	b	17	b	18	b	19	c	20	c
21	c	22	c	23	a	24	c	25	d
26	a	27	a	28	c	29	b	30	c
31	c	32	a	33	d	34	b	35	b
36	d	37	c	38	d	39	b	40	b
41	d	42	c	43	a	44	d	45	d
46	d	47	c	48	a	49	d	50	b
51	a	52	a	53	b	54	b	55	d
56	b	57	a	58	a	59	d	60	c
61	c	62	b	63	c	64	c	65	b
66	c	67	d	68	b	69	c	70	c
71	d	72	d	73	a	74	a	75	a
76	b	77	c	78	b	79	d	80	a
81	d	82	d	83	b	84	b	85	b
86	b	87	b	88	b	89	d	90	a
91	d	92	d	93	c	94	a	95	b
96	b	97	d	98	d	99	c	100	d
101	b	102	b	103	b	104	a	105	b
106	c	107	d	108	b	109	d	110	a
111	c	112	c	113	a	114	b	115	a
116	c	117	c	118	d	119	c	120	b
121	b	122	d	123	b	124	d	125	d
126	d	127	c						

Critical Thinking Questions

1	d	2	c	3	a	4	c	5	d
6	a	7	d	8	b	9	b	10	cd
11	d	12	ac	13	ac	14	a	15	a
16	b	17	d	18	b	19	a	20	a
21	d	22	c	23	b	24	c	25	b
26	c	27	b	28	a	29	a	30	c
31	c	32	c	33	c	34	a	35	a
36	a	37	d	38	b	39	d	40	d
41	b	42	c	43	bc	44	d	45	ab
46	a	47	c	48	b	49	b	50	a
51	c	52	c	53	c	54	b	55	d
56	c	57	a	58	c	59	d	60	a
61	c	62	c	63	b	64	b	65	b
66	b	67	a						

Graphical Questions

1	b	2	a	3	b	4	a	5	b
6	b	7	d	8	b	9	c	10	a
11	d	12	c	13	c	14	a	15	d
16	b	17	a						

Assertion and Reason

1	d	2	c	3	a	4	a	5	b
6	c	7	e	8	b	9	b	10	b
11	e	12	a	13	a	14	e	15	a
16	a	17	c	18	a	19	b	20	a
21	d	22	d	23	d	24	b	25	d
26	d	27	a	28	c	29	b	30	c

Answers and Solutions

Charge and Coulombs Law

1. (d) Coulomb's law is used to calculate the force between charges.

2. (d) $F \propto \frac{1}{r^2}$; so when r is halved the force becomes four times.

3. (b) The same force will act on both bodies although their directions will be different.

4. (c) The force will still remain $\frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

5. (d) Gravitational force between electrons $F_G = \frac{G(m_e)^2}{r^2}$

   Electrostatics force between electrons

   $F_e = k.\frac{e^2}{r^2}$

   $\frac{F_G}{F_e} = \frac{G(m_e)^2}{k.e^2} = \frac{6.67 \times 10^{-11} \times (9.1 \times 10^{-31})^2}{9 \times 10^9 \times (1.6 \times 10^{-19})^2} = 2.39 \times 10^{-43}$

6. (b) $F_a = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}, F_b = \frac{q_1 q_2}{K 4\pi\varepsilon_0 r^2} \Rightarrow F_a : F_b = K : 1$

7. (b) Due to mutual repulsion of charges distributed on the surface of bubble.

8. (c) We put a unit positive charge at O. Resultant force due to the charge placed at A and C is zero and resultant charge due to B and D is towards D along the diagonal BD.

9. (c) Surface charge density $\sigma = \frac{q}{A}$

10. (a) Excess of electron gives the negative charge on body.

11. (c) All other charges are its integral multiple.

12. (c) Gravitational force and nuclear force both are attractive in nature.

13. (d) $Q_1 + Q_2 = Q$ ..... (i) and $F = k\frac{Q_1 Q_2}{r^2}$ .....(ii)

    From (i) and (ii) $F = \frac{kQ_1(Q - Q_1)}{r^2}$

    For F to be maximum $\frac{dF}{dQ_1} = 0 \Rightarrow Q_1 = Q_2 = \frac{Q}{2}$

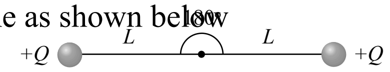
14. (a) The force between $4q$ and q; $F_1 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{4q \times q}{l^2}$

    The force between Q and q; $F_2 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q \times q}{(l/2)^2}$

    We want $F_1 + F_2 = 0$ or $\frac{4q^2}{l^2} = -\frac{4Qq}{l^2} \Rightarrow Q = -q$

15. (a) The charge given to a sphere will be distributed uniformly over the surface.

16. (a) The position of the balls in the satellite will become as shown below



    Thus angle $\theta = 180°$ and Force $= \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q^2}{(2L)^2}$

17. (a) $F = \frac{kQ^2}{r^2} = 9 \times 10^9 \times 1^2 \times \frac{1}{(1000)^2} = 9 \times 10^3 N$

18. (d) Resultant charges after adding the $-2C$ be $(-2+2) = 0$ and $(-2+6) = +4C \Rightarrow F = \frac{k\,Q_1 Q_2}{r^2} = k \times \frac{0 \times 4}{r^2} = 0$

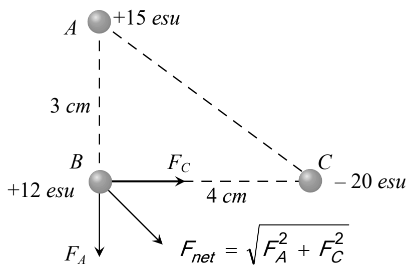
19. (a) $\varepsilon = K\varepsilon_0 = 81 \times 8.854 \times 10^{-12} = 7.17 \times 10^{-10}$ *MKS units*

20. (c) Because in case of metallic sphere either solid or hollow, the charge will reside on the surface of the sphere. Since both spheres have same surface area, so they can hold equal maximum charge.

21. (c) For providing path to charge induced on the surface of the carriers which take inflammable material.

22. (b) $F_{12} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{a^2}$ and $F_{13} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{(a\sqrt{2})^2} \Rightarrow \frac{F_{12}}{F_{13}} = 2$

23. (c) Net force on B $F_{net} = \sqrt{F_A^2 + F_C^2}$



    $F_A = \frac{15 \times 12}{(3)^2} = 20$ *dyne*, $F_C = \frac{12 \times 20}{(4)^2} = 15$ *dyne*

    $\Rightarrow F_{net} = \sqrt{F_A^2 + F_C^2} = \sqrt{(20)^2 + (15)^2} = 25$ *dyne*