18. Electrostatics – Multiple Choice Questions

1. Charge and Coulomb's Law

1. A solid spherical conductor of radius R has a spherical cavity of radius $a\,(a < R)$ at its centre. A charge $+Q$ is kept at the center. The charge at the inner surface, outer and at a position $r\,(a < r < R)$ are respectively

(a) $+Q, -Q, 0$ (b) $-Q, +Q, 0$

(c) $0, -Q, 0$ (d) $+Q, 0, 0$

2. There are two metallic spheres of same radii but one is solid and the other is hollow, then

(a) Solid sphere can be given more charge

(b) Hollow sphere can be given more charge

(c) They can be charged equally (maximum)

(d) None of the above

3. When 10^{19} electrons are removed from a neutral metal plate, the electric charge on it is

(a) $-1.6\,C$ (b) $+1.6\,C$

(c) $10^{+19}\,C$ (d) $10^{-19}\,C$

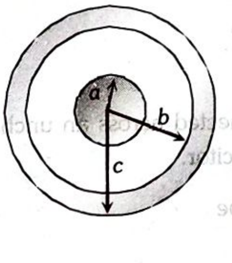
4. A solid conducting sphere of radius a has a net positive charge $2Q$. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge $-Q$. The surface charge density on the inner and outer surfaces of the spherical shell will be

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

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

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

(d) None of the above



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

(a) Binds the electrons of an atom to its nucleus

(b) Binds the protons and neutrons in the nucleus of an atom

(c) Binds atoms together to form molecules

(d) Binds atoms and molecules together to form solids

6. A conductor has been given a charge $-3\times10^{-7}\,C$ by transferring electron. Mass increase (in kg) of the conductor and the number of electrons added to the conductor are respectively

(a) 2×10^{-16} and 2×10^{31} (b) 5×10^{-31} and 5×10^{19}

(c) 3×10^{-19} and 9×10^{16} (d) 2×10^{-18} and 2×10^{12}

7. Five balls numbered 1 to 5 are suspended using separate threads. Pairs (1, 2), (2, 4) and (4, 1) show electrostatic attraction, while pair (2, 3) and (4, 5) show repulsion. Therefore ball 1 must be

(a) Positively charged (b) Negatively charged

(c) Neutral (d) Made of metal

8. A conducting sphere of radius R, and carrying a charge q is joined to a conducting sphere of radius $2R$, and carrying a charge $-2q$. The charge flowing between them will be

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

(c) q (d) $\dfrac{4q}{3}$

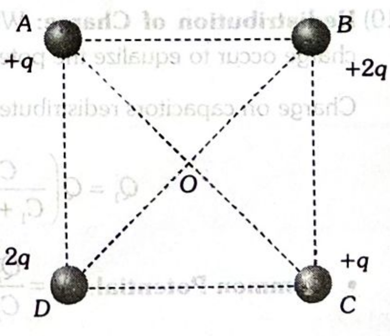
9. Two equal point charges each of $3\,\mu C$ are separated by a certain distance in metres. If they are located at $(\hat{i}+\hat{j}+\hat{k})$ and $(2\hat{i}+3\hat{j}+3\hat{k})$, then the electrostatic force between them is

(a) $9\times10^{3}N$ (b) $9\times10^{-3}N$

(c) $10^{-3}N$ (d) $9\times10^{-2}N$

(e) $3\times10^{-3}N$

10. Four charges are arranged at the corners of a square $ABCD$, as shown in the adjoining figure. The force on the charge kept at the centre O is



(a) Zero (b) Along the diagonal AC

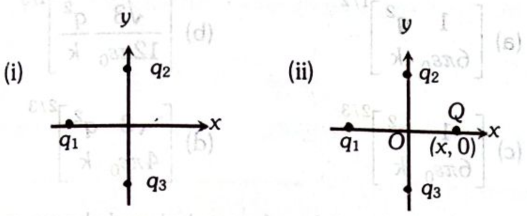
(c) Along the diagonal BD (d) Perpendicular to side AB

11. Two point charges $+3\mu C$ and $+8\mu C$ repel each other with a force of $40N$. If a charge of $-5\mu C$ is added to each of them, then the force between them will become

(a) $-10N$ (b) $+10N$

(c) $+20N$ (d) $-20N$

12. In figure two positive charges q_2 and q_3 fixed along the y-axis, exert a net electric force in the + x-direction on a charge q_1 fixed along the x-axis. If a positive charge Q is added at $(x, 0)$, the force on q_1



(a) Shall increase along the positive x-axis
(b) Shall decrease along the positive x-axis
(c) Shall point along the negative x-axis
(d) Shall increase but the direction changes because of the intersection of Q with q_2 and q_1

13. Electric charges of $1\mu C, -1\mu C$ and $2\mu C$ are placed in air at the corners A, B and C respectively of an equilateral triangle ABC having length of each side 10 cm. The resultant force on the charge at C is

(a) 0.9 N (b) 1.8 N
(c) 2.7 N (d) 3.6 N

14. Three charges each of magnitude q are placed at the corners of an equilateral triangle, the electrostatic force on the charge placed at the center is (each side of triangle is L)

(a) Zero (b) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{L^2}$
(c) $\frac{1}{4\pi\varepsilon_0}\frac{3q^2}{L^2}$ (d) $\frac{1}{12\pi\varepsilon_0}\frac{q^2}{L^2}$

15. Two identical conducting spheres carry identical charges. If the spheres are set at a certain distance apart, they repel each other with a force F. A third conducting sphere, identical to the other two, but initially uncharged, is then touched to one sphere, and then into the other before being removed. The force between the original two spheres is now

(a) $\frac{F}{2}$ (b) $\frac{F}{4}$
(c) $\frac{3F}{4}$ (d) $\frac{3F}{8}$

16. Two charges $+6\mu C$ and $+15\mu C$ are placed along the x–axis at $x=0$ and $x=2$ m respectively A negative charge is placed between them such that the resultant force on it is zero. The negative charge is placed at

(a) $x = 0.775m$
(b) $x = 1.2m$
(c) $x = 0.5m$
(d) Position depends on the amount of charge

17. 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) $+\sqrt{3}$
(e) $-\sqrt{8}$

18. Charges $4Q$, q and Q and placed along x-axis at positions $x=0, x=l/2$ and $x=l$, respectively. Find the value of q so that force on charge Q is zero

(a) Q (b) $Q/2$
(c) $-Q/2$ (d) $-Q$

19. Two small conducting spheres of equal radius have charges $+10\mu C$ and $-20\mu C$ respectively and placed at a distance R from each other experience force F_1. If they are brought in contact and separated to the same distance, they experience force F_2. The ratio of F_1 to F_2 is

(a) 1 : 8 (b) – 8 : 1
(c) 1 : 2 (d) – 2 : 1

20. Two particles of equal mass m and charge q are placed at a distance of 16 cm. They do not experience any force. The value of $\frac{q}{m}$ is

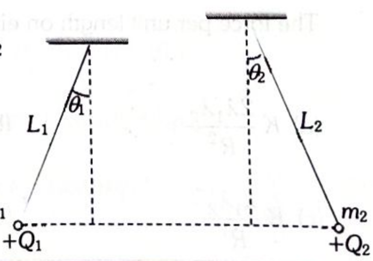
(a) l (b) $\sqrt{\frac{\pi\varepsilon_0}{G}}$
(c) $\sqrt{\frac{G}{4\pi\varepsilon_0}}$ (d) $\sqrt{4\pi\varepsilon_0 G}$

21. 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) 9000 N (b) 12000 N
(c) 24000 N (d) 36000 N

22. Two small spheres of masses m_1 and m_2 are suspended by weightless insulating threads of lengths L_1 and L_2. The spheres carry charges Q_1 and Q_2 respectively. The spheres are suspended such that they are in level with one another and the threads are inclined to the vertical at angles of θ_1 and θ_2 as shown. Which one of the following conditions is essential, if $\theta_1 = \theta_2$

(a) $m_1 \neq m_2$ but $Q_1 = Q_2$
(b) $m_1 = m_2$
(c) $Q_1 = Q_2$
(d) $L_1 = L_2$



23. The line AA' is on a charged infinite conducting plane which is perpendicular to the plane of the paper. The plane has a surface density of charge σ and B is a ball of mass m with a like charge magnitude q. B is connected by a string from a point on the line AA'. The tangent of the angle (θ) formed between the line AA' and the string is

(a) $\frac{q\sigma}{2\varepsilon_0 mg}$ (b) $\frac{q\sigma}{4\pi\varepsilon_0 mg}$

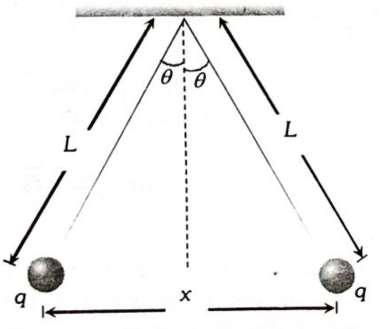
(c) $\frac{q\sigma}{2\pi\varepsilon_0 mg}$ (d) $\frac{q\sigma}{\varepsilon_0 mg}$

24. Two small metal balls of different mass m_1 and m_2 are connected by strings of equal length to a fixed point. When the balls are given charges, the angles that the two strings make with the vertical are $30°$ and $60°$, respectively. The ratio m_1/m_2 is close to

(a) 1.7 (b) 3.0

(c) 0.58 (d) 2.0

25. 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



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

26. 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 $\left(K = \frac{1}{4\pi\varepsilon_0}\right)$

(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) $K\frac{\lambda_1\lambda_2}{R}$

27. Three equal charge $+q$ are placed at the three vertices of an equilateral triangle centered at the origin. They are held in equilibrium by a restoring force of magnitude $F(r) = kr$ directed towards the origin. Where k is a constant? What is the distance of the three charges from the origin?

(a) $\left[\frac{1}{6\pi\varepsilon_0}\frac{q^2}{k}\right]^{1/2}$ (b) $\left[\frac{\sqrt{3}}{12\pi\varepsilon_0}\frac{q^2}{k}\right]^{1/3}$

(c) $\left[\frac{1}{6\pi\varepsilon_0}\frac{q^2}{k}\right]^{2/3}$ (d) $\left[\frac{\sqrt{3}}{4\pi\varepsilon_0}\frac{q^2}{k}\right]^{2/3}$

28. Two identical particles of mass 'm' and charge q are shot at each other form a very great distance with an initial speed v. The distance of closest approach of these charges is

(a) $\frac{q^2}{8\pi\varepsilon_0 mv^2}$ (b) $\frac{q^2}{4\pi\varepsilon_0 mv^2}$

(c) $\frac{q^2}{2\pi\varepsilon_0 mv^2}$ (d) 0

29. The surface of a planet is found to be uniformly charged. When a particle of mass m and no charge is thrown at an angle from the surface of the planet, it has a parabolic trajectory as in projectile motion with horizontal range L. A particle of mass m and charge q, with the same initial conditions has a range $L/2$. The range of particle of mass m and charge $2q$ with the same initial conditions is

(a) L (b) $L/2$

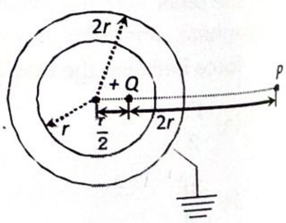
(c) $L/3$ (d) $L/4$

30. At a distance ℓ from a uniformly charged long wire a charged particle is thrown radially outward with a velocity u in the direction perpendicular to the wire. When the particle reaches a distance 2ℓ from the wire its speed is found to be $\sqrt{2}u$. The magnitude of the velocity, when it is a distance 4ℓ away from the wire, is (ignore gravity)

(a) $\sqrt{3}\,u$ (b) $2u$

(c) $2\sqrt{2}\,u$ (d) $4u$

31. Consider an initially neutral hollow conducting spherical shell with inner radius r and outer radius $2r$. A point charge $+Q$ is now placed inside the shell at a distance $r/2$ from the centre. The shell is then grounded by connecting the outer surface to the earth. P is an external point at a distance $2r$ from the point charge $+Q$ as shown in the figure.

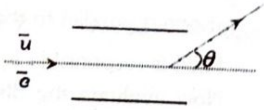


The magnitude of the force on a test charge $+q$ placed at P will be

(a) $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{4r^2}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{9qQ}{100r^2}$

(c) $\frac{1}{4\pi\varepsilon_0}\frac{4qQ}{25r^2}$ (d) 0

32. An electron enters a parallel plate capacitor with horizontal speed μ and is found to deflect by angle θ on leaving the capacitor as shown. It is found that $\tan\theta = 0.4$ and gravity is negligible. If the initial horizontal speed is doubled, then $\tan\theta$ will be



(a) 0.1 (b) 0.2

(c) 0.8 (d) 1.6

2. Electric Field and Potential

1. The electric field inside a spherical shell of uniform surface charge density is

(a) Zero

(b) Constant, less than zero

(c) Directly proportional to the distance from the centre

(d) None of the above

2. An electron and a proton are in a uniform electric field, the ratio of their accelerations will be

(a) Zero

(b) Unity

(c) The ratio of the masses of proton and electron

(d) The ratio of the masses of electron and proton

3. A proton and an electron are placed in a uniform electric field

(a) The electric forces acting on them will be equal

(b) The magnitude of the forces will be equal

(c) Their accelerations will be equal

(d) The magnitude of their accelerations will be equal

4. The number of electrons to be put on a spherical conductor of radius $0.1\,m$ to produce an electric field of $0.036\,N/C$ just above its surface is

(a) 2.7×10^5 (b) 2.6×10^5

(c) 2.5×10^5 (d) 2.4×10^5

5. The electric field near a conducting surface having a uniform surface charge density σ is given by

(a) $\frac{\sigma}{\varepsilon_0}$ and is parallel to the surface

(b) $\frac{2\sigma}{\varepsilon_0}$ and is parallel to the surface

(c) $\frac{\sigma}{\varepsilon_0}$ and is normal to the surface

(d) $\frac{2\sigma}{\varepsilon_0}$ and is normal to the surface

6. A point dipole is located at the origin in some orientation. The electric field at the point (10 cm, 10 cm) on the x-y plane is measured to have a magnitude $1.0\times10^{-3}\,V/m$. What will be the magnitude of the electric field at the point $(20\,cm, 20\,cm)$

(a) $5.0\times10^{-4}\,V/m$

(b) $2.5\times10^{-4}\,V/m$

(c) It will depend on the orientation of the dipole

(d) $1.25\times10^{-4}\,V/m$

7. The distance between a proton and electron both having a charge 1.6×10^{-19} *coulomb*, of a hydrogen atom is 10^{-10} *metre*. The value of intensity of electric field produced on electron due to proton will be

(a) $2.304\times10^{-10}\,N/C$ (b) $14.4\,V/m$

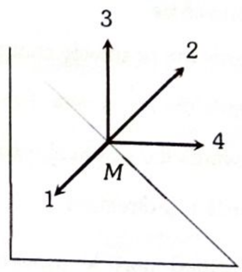
(c) $16\,V/m$ (d) $1.44\times10^{11}\,N/C$

8. Two point charges of $20\mu C$ and $80\mu C$ are 10cm apart. Where will the electric field strength be zero on the line joining the charges from $20\mu C$ charge

(a) 0.1cm (b) 0.04 cm

(c) 0.033 cm (d)0.33 cm

9. Three identical point charges, as shown are placed at the vertices of an isosceles right-angled triangle. Which of the numbered vectors coincides in direction with the electric field at the mid-point M of the hypotenuse



(a) 1 (b) 2

(c) 3 (d) 4

10. Two charges $+5\mu C$ and $+10\mu C$ are placed 20 cm apart. The net electric field at the mid-Point between the two charges is

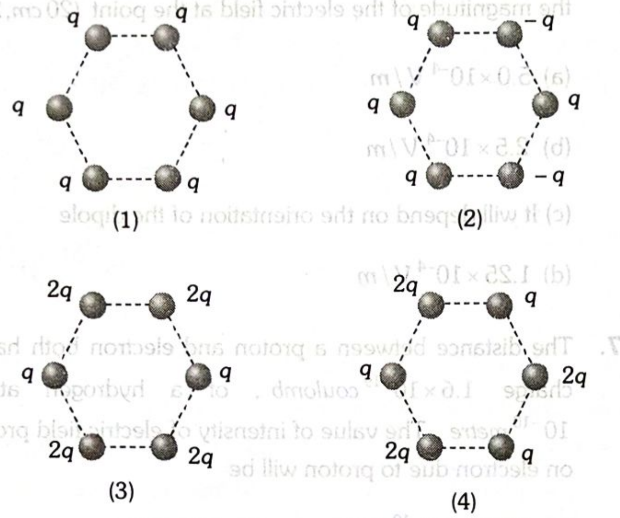
(a) 4.5×10^6 N/C directed towards $+5\mu C$

(b) 4.5×10^6 N/C directed towards $+10\mu C$

(c) 13.5×10^6 N/C directed towards $+5\mu C$

(d) 13.5×10^6 N/C directed towards $+10\mu C$

11. Figures below show regular hexagons, with charges at the vertices. In which of the following cases the electric field at the centre is not zero



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

12. An electron enters in an electric field with its velocity in the direction of the electric lines of force. Then
(a) The path of the electron will be a circle
(b) The path of the electron will be a parabola
(c) The velocity of the electron will decrease
(d) The velocity of the electron will increase

13. Two infinite parallel metal planes, contain electric charges with charge densities $+\sigma$ and $-\sigma$ respectively and they are separated by a small distance in air. If the permittivity of air is ε_0 then the magnitude of the field between the two planes with its direction will be
(a) σ / ε_0 towards the positively charged plane
(b) σ / ε_0 towards the negatively charged plane
(c) $\sigma / (2\varepsilon_0)$ towards the positively charged plane
(d) 0 and towards any direction

14. A positively charged particle moving along x-axis with a certain velocity enters a uniform electric field directed along positive y-axis. Its
(a) Vertical velocity changes but horizontal velocity remains constant
(b) Horizontal velocity changes but vertical velocity remains constant
(c) Both vertical and horizontal velocities change
(d) Neither vertical nor horizontal velocity changes

15. A conducting sphere of radius R=20 cm is given a charge Q=16μC. What is $\vec{E}$ at centre
(a) $3.6\times10^6\ N/C$ (b) $1.8\times10^6\ N/C$
(c) Zero (d) $0.9\times10^6\ N/C$

16. An electron moving with the speed $5\times10^6\ m$ per sec is shooted parallel to the electric field of intensity $1\times10^3\ N/C$. Field is responsible for the retardation of motion of electron. Now evaluate the distance travelled by the electron before coming to rest for an instant (mass of $e = 9\times10^{-31} Kg$. charge $= 1.6\times10^{-19} C$)
(a) 7 m (b) 0.7 mm
(c) 7 cm (d) 0.7 cm

17. If an insulated non-conducting sphere of radius R has charge density ρ. The electric field at a distance r from the centre of sphere ($r < R$) will be
(a) $\frac{\rho R}{3\varepsilon_0}$ (b) $\frac{\rho r}{\varepsilon_0}$
(c) $\frac{\rho r}{3\varepsilon_0}$ (d) $\frac{3\rho R}{\varepsilon_0}$

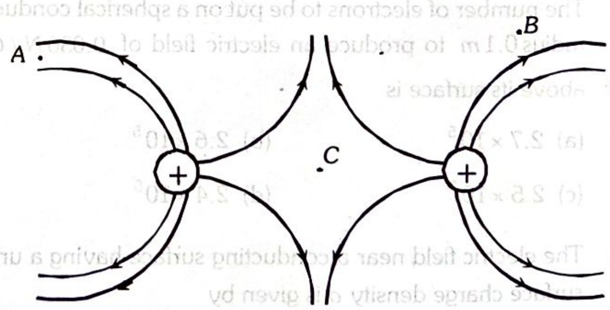
18. The wrong statement about electric lines of force is
(a) These originate from positive charge and end on negative charge
(b) They do not intersect each other at a point
(c) They have the same form for a point charge and a sphere
(d) They have physical existence

19. An infinite line charge produce a field of $7.182\times10^8\ N/C$ at a distance of 2 cm. The linear charge density is

[MH CET 2004; Similar GUJCET 2014]

(a) $7.27\times10^{-4}\ C/m$ (b) $7.98\times10^{-4}\ C/m$
(c) $7.11\times10^{-4}\ C/m$ (d) $7.04\times10^{-4}\ C/m$

20. The figure below shows the electric field lines due to two positive charges. The magnitudes E_A, E_B and E_C of the electric fields at points A, B and C respectively are related as



(a) $E_A > E_B > E_C$ (b) $E_B > E_A > E_C$
(c) $E_A = E_B > E_C$ (d) $E_A > E_B = E_C$

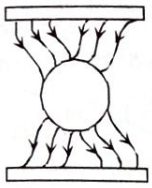
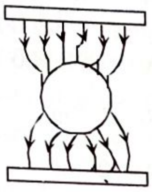
21. Under the action of a given coulombic force the acceleration of an electron is $2.5\times10^{22} m/s^2$. Then the magnitude of the acceleration of a proton under the action of same force is nearly
(a) $1.6\times10^{-19} m/s^2$ (b) $9.1\times10^{31} m/s^2$
(c) $1.5\times10^{19} m/s^2$ (d) $1.6\times10^{27} m/s^2$

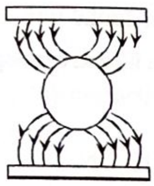
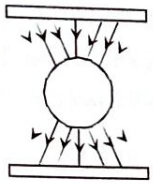
22. An electron initially at rest falls a distance of 1.5 cm in a uniform electric field of magnitude $2\times10^4\,N/C$. The time taken by the electron to fall this distance is

(a) $1.3\times10^2 s$ (b) $2.1\times10^{-12} s$

(c) $1.6\times10^{-10} s$ (d) $2.9\times10^{-9} s$

23. A metallic sphere is kept in between two oppositely charged plate. The most appropriate representation of the field lines is

(a)  (b) 

(c)  (d) 

24. A point charge $+q$ is placed at a distance d from an isolated conducting plane. The field at a point P on the other side of the plane is

(a) Directed perpendicular to the plane and away from the plane

(b) Directed perpendicular to the plane but towards the plane

(c) Directed radially away from the point charge

(d) Directed radially towards the point charge

25. A point positive charge is brought near an isolated conducting sphere (figure). The electric field is best given by

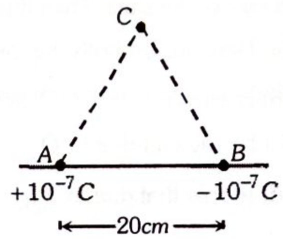
(a) 

(b) 

(c) 

(d) 

26. Two point charges $+10^{-7}C$ and $-10^{-7}C$ are placed at A and B, 20 cm apart as shown in the figure. Calculate the electric field at C, 20 cm apart from both A and B



(a) $1.5\times10^{-5} N/C$

(b) $2.2\times10^{4} N/C$

(c) $3.5\times10^{6} N/C$

(d) $3.0\times10^{5} N/C$

27. A rod lies along the x-axis with one end at the origin and the other at $x\to\infty$. It carries a uniform charge $\lambda\,C/m$. The electric field at the point $x=-a$ on the axis will be

(a) $\vec{E}=\dfrac{\lambda}{4\pi\varepsilon_0 a}(-\hat{i})$ (b) $\vec{E}=\dfrac{\lambda}{4\pi\varepsilon_0 a}(\hat{i})$

(c) $\vec{E}=\dfrac{\lambda}{2\pi\varepsilon_0 a}(-\hat{i})$ (d) $E=\dfrac{\lambda}{2\pi\varepsilon_0 a}(\hat{i})$

28. An $\alpha-$particle of mass $6.4\times10^{-27}\,kg$ and charge $3.2\times10^{-19}\,C$ is situated in a uniform electric field of $1.6\times10^5\,Vm^{-1}$. The velocity of the particle at the end of $2\times10^{-2}\,m$ path when it starts from rest is

(a) $2\sqrt{3}\times10^5\,ms^{-1}$ (b) $8\times10^5\,ms^{-1}$

(c) $16\times10^5\,ms^{-1}$ (d) $4\sqrt{2}\times10^5\,ms^{-1}$

29. Two charges each equal to $\eta q(\eta^{-1}<\sqrt{3})$ are placed at the corners of an equilateral triangle of side a. The electric field at the third corner is E_3 then (where $E_0=q/4\pi\varepsilon_0 a^2$)

(a) $E_3=E_0$ (b) $E_3<E_0$

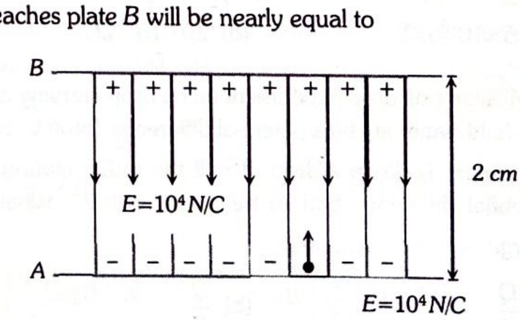
(c) $E_3>E_0$ (d) $E_3\geq E_0$

30. The distance between charges $5\times10^{-11}C$ and $-2.7\times10^{-11}C$ is 0.2 m. The distance at which a third charge should be placed in order that it will not experience any force along the line joining the two charges is

(a) 0.44 m (b) 0.65 m

(c) 0.554 m (d) 0.350 m

31. An electron is released from the bottom plate A as shown in the figure ($E=10^4\,N/C$). The velocity of the electron when it reaches plate B will be nearly equal to



(a) $0.85\times10^7\,m/s$ (b) $1.0\times10^7\,m/s$

(c) $1.25\times10^7\,m/s$ (d) $1.65\times10^7\,m/s$

32. A charge $+q$ is placed some where inside the cavity of a thick conducting spherical shell of inner radius R_1 and outer radius R_2. A charge Q is placed at a distance $r > R_2$ from the centre of the shell. Then the electric field in the hollow cavity

(a) Depends on both $+q$ and Q

(b) Is zero

(c) Is only that due to Q

(d) Is only that due to $+q$

33. 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

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

(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

35. Two equal negative charges $-q$ are fixed at points (0, *a*) and (0, -*a*) on the Y-axis. A positive charge '*q*' is released from rest at the point (*x*<<*a*) on the *x*-axis. What is the frequency of motion

(a) $\sqrt{\frac{2q^2}{4\pi\varepsilon_0 ma^3}}$ (b) $\sqrt{\frac{4q^2}{2\pi\varepsilon_0 ma^3}}$

(c) $\sqrt{\frac{q^2}{2\pi\varepsilon_0 ma^3}}$ (d) $\sqrt{\frac{q^2}{\pi\varepsilon_0 ma^3}}$

36. A charged particle of mass $5\times10^{-5} kg$ is held stationary in space by placing it in an electric field of strength $10^7 NC^{-1}$ directed vertically downwards. The charge on the particle is

(a) $-20\times10^{-5}\mu C$ (b) $-5\times10^{-5}\mu C$

(c) $5\times10^{-5}\mu C$ (d) $20\times10^{-5}\mu C$

37. In Millikan's oil drop experiment an oil drop carrying a charge Q is held stationary by a potential difference $2400\,V$ between the plates. To keep a drop of half the radius stationary the potential difference had to be made $600\,V$. What is the charge on the second drop

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

(c) Q (d) $\frac{3Q}{2}$

38. A charged water drop whose radius is $0.1\,\mu m$ is in equilibrium in an electric field. If charge on it is equal to charge of an electron, then intensity of electric field will be ($g = 10\,ms^{-1}$)

(a) $1.61\,N/C$ (b) $26.2\,N/C$

(c) $262\,N/C$ (d) $1610\,N/C$

39. An oil drop having charge 2*e* is kept stationary between two parallel horizontal plates 2.0 *cm* apart when a potential difference of 12000 volts is applied between them. If the density of oil is 900 *kg/m*^{3}, the radius of the drop will be

(a) $2.0\times10^{-6} m$ (b) $1.7\times10^{-6} m$

(c) $1.4\times10^{-6} m$ (d) $1.1\times10^{-6} m$

40. A pendulum bob of mass $30.7\times10^{-6}\ kg$ and carrying a charge $2\times10^{-8}\ C$ 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) $3\times10^{-4}\ N$ (b) $4\times10^{-4}\ N$

(c) $5\times10^{-4}\ N$ (d) $6\times10^{-4}\ N$

41. The work done in bringing a unit positive charge from infinite distance to a point at distance *x* from a positive charge *Q* is *W*. Then the potential ϕ at that point is

(a) $\frac{WQ}{x}$ (b) W

(c) $\frac{W}{x}$ (d) WQ

42. The top of the atmosphere is at about 400 *kV* with respect to the surface of the earth, corresponding to an electric field that decreases with altitude. Near the surface of the earth, the field is about 100 Vm^{-1}. Still, we do not get an electric shock as we step out of our house into the open house because (assume the house to be a steel cage so that there is no field inside)

(a) There is a potential difference between our body and the ground

(b) 100 Vm^{-1} is not a high electric field so that we do not feel the shock

(c) Our body and the ground forms an Equipotential surface

(d) The atmosphere is not a conductor

43. If a charged spherical conductor of radius 10 *cm* has potential V at a point distant $5\,cm$ from its centre, then the potential at a point distant 15 *cm* from the centre will be

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

(c) $\frac{3}{2}V$ (d) $3V$

44. Two charges of $4\mu C$ each are placed at the corners A and B of an equilateral triangle of side length 0.2 m in air. The electric potential at C is $\left[\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \frac{N\text{-}m^2}{C^2}\right]$

(a) $9\times10^4\,V$ (b) $18\times10^4\,V$

(c) $36\times10^4\,V$ (d) $36\times10^{-4}\,V$

45. Two electric charges $12\mu C$ and $-6\mu C$ are placed 20 cm apart in air. There will be a point P on the line joining these charges and outside the region between them, at which the electric potential is zero. The distance of P from $-6\mu C$ charge is

(a) 0.10 m (b) 0.15 m

(c) 0.20 m (d) 0.25 m

46. Two point charges $-q$ and $+q$ are located at points $(0,0\,-a)$ and $(0,\,0a)$, respectively. The potential at a point $(0,0,z)$ where $z > a$ is

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

(c) $\frac{2qa}{4\pi\varepsilon_0(z^2-a^2)}$ (d) $\frac{2qa}{4\pi\varepsilon_0(z^2+a^2)}$

47. What is not true for equipotential surface for uniform electric field

(a) Equipotential surface is flat

(b) Equipotential surface is spherical

(c) Electric lines are perpendicular to equipotential surface

(d) Work done is zero

48. A regular hexagon of side 'a' has a charge Q at each vertex. Potential at the centre of the hexagon is $\left(K = \frac{1}{4\pi\,\varepsilon_0}\right)$

(a) Zero (b) $\frac{KQ}{a}$ Volts

(c) $12\frac{KQ}{a}$ (d) $6\frac{KQ}{a}$

49. In identical mercury droplets charged to the same potential V coalesce to form a single bigger drop. The potential of new drop will be

(a) $\frac{V}{n}$ (b) nV

(c) nV^2 (d) $n^{2/3}V$

50. Two insulated charged conducting spheres of radii 20 cm and 15 cm respectively and having an equal charge of 10 C are connected by a copper wire and then they are separated. Then

(a) Both the spheres will have the same charge of 10 C

(b) Surface charge density on the 20 cm sphere will be greater than that on the 15 cm sphere

(c) Surface charge density on the 15 cm sphere will be greater than that on the 20 cm sphere

(d) Surface charge density on the two spheres will be equal

51. Two charged spherical conductors of radii R_1 and R_2 are connected by a wire. Then the ratio of surface charge densities of the spheres σ_1/σ_2 is

(a) $\frac{R_1}{R_2}$ (b) $\frac{R_2}{R_1}$

(c) $\sqrt{\left(\frac{R_1}{R_2}\right)}$ (d) $\frac{R_1^2}{R_2^2}$

(e) $\frac{R_2^2}{R_1^2}$

52. A small conducting sphere of radius r is lying concentrically inside a bigger hollow conducting sphere of radius R. The bigger and smaller spheres are charged with Q and q ($Q>q$) and are insulated from each other. The potential difference between the spheres will be

(a) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}-\frac{Q}{R}\right)$ (b) $\frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R}+\frac{q}{r}\right)$

(c) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}-\frac{q}{R}\right)$ (d) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{R}-\frac{Q}{r}\right)$

53. Two conducting spheres of radii 3 cm and 1 cm are separated by a distance of 10 cm in free space. If the spheres are charged to same potential of 10 V each, the force of repulsion between them is

(a) $\left(\frac{1}{3}\right)\times10^{-9}\,N$ (b) $\left(\frac{2}{9}\right)\times10^{-9}\,N$

(c) $\left(\frac{1}{9}\right)\times10^{-9}\,N$ (d) $\left(\frac{4}{3}\right)\times10^{-9}\,N$

(e) $\left(\frac{2}{3}\right)\times10^{-9}\,N$

54. Consider three concentric metallic spheres A, B and C of radii a, b, c respectively where $a < b < c$. A and B are connected whereas C is grounded. The potential of the middle sphere B is raised to V then the charge on the sphere C is

(a) $-4\pi\varepsilon_0 V \frac{bc}{c-b}$ (b) $+4\pi\varepsilon_0 V \frac{bc}{c-b}$

(c) $-4\pi\varepsilon_0 V \frac{ac}{c-a}$ (d) Zero

55. Two plates are $2\,cm$ apart, a potential difference of $10\ volt$ is applied between them, the electric field between the plates is

(a) $20\ N/C$ (b) $500\ N/C$

(c) $5\ N/C$ (d) $250\ N/C$

56. A charge of $5\,C$ experiences a force of $5000\,N$ when it is kept in a uniform electric field. What is the potential difference between two points separated by a distance of $1\,cm$

(a) $10\ V$ (b) $250\ V$

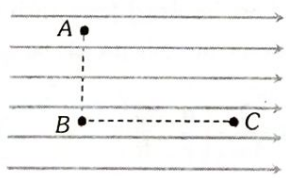
(c) $1000\ V$ (d) $2500\ V$

57. Ten electrons are equally spaced and fixed around a circle of radius R. Relative to $V = 0$ at infinity, the electrostatic potential V and the electric field E at the centre C are

(a) $V \neq 0$ and $\vec{E} \neq 0$ (b) $V \neq 0$ and $\vec{E} = 0$

(c) $V = 0$ and $\vec{E} = 0$ (d) $V = 0$ and $\vec{E} \neq 0$

58. Figure shows three points A, B and C in a region of uniform electric field $\vec{E}$. The line AB is perpendicular and BC is parallel to the field lines. Then which of the following holds good. Where V_A, V_B and V_C represent the electric potential at points A, B and C respectively



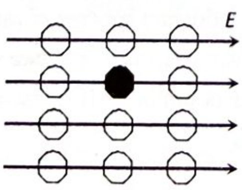
(a) $V_A = V_B = V_C$

(b) $V_A = V_B > V_C$

(c) $V_A = V_B < V_C$

(d) $V_A > V_B = V_C$

59. There is a uniform electric field of intensity E which is as shown. How many labelled points have the same electric potential as the fully shaded point



(a) 2

(b) 3

(c) 8

(d) 11

60. The electric potential V is given as a function of distance x (metre) by $V = (5x^2 + 10x - 9)\,volt$. Value of electric field at $x = 1$ is

(a) $-20\ V/m$ (b) $6\ V/m$

(c) $11\ V/m$ (d) $-23\ V/m$

61. 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

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

62. The electric field in a certain region is given by $\vec{E} = 5\hat{i} - 3\hat{j}\,kV/m$. The potential difference $V_B - V_A$ between points A and B, having coordinates $(4, 0, 3)m$ and $(10, 3, 0)m$ respectively, is equal to

(a) $21\,kV$ (b) $-21\,kV$

(c) $39\,kV$ (d) $-39\,kV$

63. Two small spheres each carrying a charge q are placed r meter apart. If one of the sphere is taken around the other one in a circular path of radius r, the work done will be equal to

(a) Force between them $\times r$

(b) Force between them $\times 2\pi r$

(c) Force between them $/2\pi r$

(d) Zero

64. If E is the electric field intensity of an electrostatic field, then the electrostatic energy density is proportional to

(a) E (b) E^2

(c) $1/E^2$ (d) E^3

65. Two positive point charges of $12\mu C$ and $8\mu C$ are $10 cm$ apart. The work done in bringing them 4 cm closer is

(a) 5.8 J (b) 5.8 eV

(c) 13 J (d) 13 eV

66. If an electron moves from rest from a point at which potential is 50 volt to another point at which potential is 70 volt, then its kinetic energy in the final state will be

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

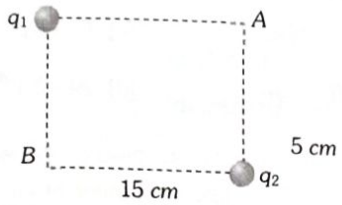
(c) 1 N (d) 1 $dyne$

67. An electron of mass m and charge e is accelerated from rest through a potential difference V in vacuum. The final speed of the electron will be

(a) $V\sqrt{e/m}$ (b) $\sqrt{eV/m}$

(c) $\sqrt{2eV/m}$ (d) $2eV/m$

68. In the rectangle, shown below, the two corners have charges $q_1=-5\mu C$ and $q_2=+2.0\mu C$. The work done in moving a charge $+3.0\mu C$ from B to A is (take $1/4\pi\varepsilon_0=10^{10}\ N\text{-}m^2/C^2$)



(a) 2.8 J (b) 3.5 J

(c) 4.5 J (d) 5.5 J

69. Identify the WRONG statement

(a) The electrical potential energy of a system of two protons shall increase if the separation between the two is decreased

(b) The electrical potential energy of a proton electron system will increase if the separation between the two is decreased

(c) The electrical potential energy of a proton electron system will increase if the separation between the two is increased

(d) The electrical potential energy of system of two electrons shall increase if the separation between the two is decreased

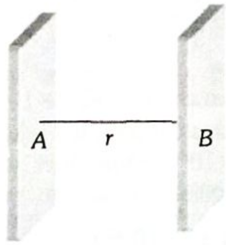
70. There are two equipotential surfaces as shown in figure. The distance between them is r. The charge of $-q$ coulomb is taken from the surface A to B, the resultant work done will be

(a) $W = \frac{1}{4\pi\varepsilon_o}\frac{q}{r}$

(b) $W = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

(c) $W = -\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

(d) W = zero



71. A soap bubble is given a negative charge, then its radius

(a) Decreases

(b) Increases

(c) Remains unchanged

(d) Nothing can be predicted as information is insufficient

72. A point charge is surrounded symmetrically by six identical charges at distance r as shown in the figure. How much work is done by the forces of electrostatic repulsion when the point charge q at the centre is removed at infinity

(a) Zero

(b) $6q^2/4\pi\varepsilon_0 r$

(c) $q^2/4\pi\varepsilon_0 r$

(d) $12q^2/4\pi\varepsilon_0 r$

73. A positively charged particle is released from rest in an uniform electric field. The electric potential energy of the charge

(a) Remains a constant because the electric field is uniform

(b) Increases because the charge moves along the electric field

(c) Decreases because the charge moves along the electric field

(d) Decreases because the charge moves opposite to the electric field

74. A particle A has charge $+q$ and a particle B has charge $+4q$ with each of them having the same mass m. When allowed to fall from rest through the same electric potential difference, the ratio of their speed $\frac{v_A}{v_B}$ will become

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

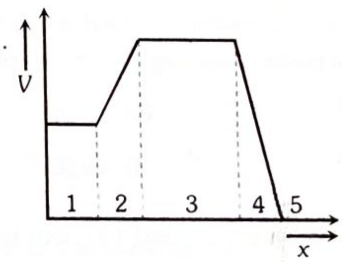
(c) 1 : 4 (d) 4 : 1

75. Consider a spherical shell of radius R with a total charge $+q$ uniformly spread on its surface (centre of the shell lies at the origin $x = 0$). Two point charge, $+q$ and $-q$ are brought, one after the other, from far away and placed at $x = -a/2$ and $+a/2 (a < R)$, respectively. Magnitude of the work done in this process is

(a) $\frac{(Q+q)^2}{4\pi\varepsilon_0 a}$ (b) Zero

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

76. 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



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

77. An electron falls through a small distance in a uniform electric field of magnitude $2\times10^4\ NC^{-1}$. The direction of the field is reversed keeping the magnitude unchanged and a proton falls through the same distance. The time of fall will be

(a) Same in both cases

(b) More in the case of an electron

(c) More in the case of proton

(d) Independent of charge

3. Electric Dipole

1. A given charge is situated at a certain distance from an electric dipole in the end-on position experiences a force F. If the distance of the charge is doubled, the force acting on the charge will be

(a) $2F$ (b) $F/2$

(c) $F/4$ (d) $F/8$

2. The ratio of electric field and potential (E/V) at midpoint of electric dipole, for which separation is l

(a) $1/l$ (b) l

(c) $2/l$ (d) None of these

3. The electric field due to an electric dipole at a distance r from its centre in axial position is E. If the dipole is rotated through an angle of $90°$ about its perpendicular axis, the electric field at the same point will be

(a) E (b) $E/4$

(c) $E/2$ (d) $2E$

4. An electric dipole coincides on Z-axis and its mid point is on origin of the co-ordinate system. The electric field at an axial point at a distance z from origin is $\vec{E}_{(z)}$ and electric field at an equatorial point at a distance y from origin is $\vec{E}_{(y)}$ Here $z = y >> a$, so $\left|\frac{\vec{E}_{(z)}}{\vec{E}_{(y)}}\right| = ...$

(a) 1 (b) 4

(c) 3 (d) 2

5. A water molecule has an electric dipole moment 6.4×10^{-30} cm when it is in vapour state. The distance in metre between the centre of positive and negative charge of the molecule is

(a) 4×10^{-10} (b) 4×10^{-11}

(c) 4×10^{-12} (d) 4×10^{-13}

6. The distance between H^+ and Cl^- ions in HCl molecule is 1.28 Å. What will be the potential due to this dipole at a distance of 12 Å on the axis of dipole

(a) 0.13 V (b) 1.3 V

(c) 13 V (d) 130 V

7. Two electric dipoles of moment p and $64\ p$ are placed in opposite direction on a line at a distance of 25 cm. The electric field will be zero at point between the dipoles whose distance from the dipole of moment p is

(a) 5 cm (b) $\frac{25}{9}$ cm

(c) 10 cm (d) $\frac{4}{13}$ cm

8. An electric dipole consisting of two opposite charges of $2 \times 10^{-6}\ C$ each separated by a distance of 3 cm is placed in an electric field of $2 \times 10^5\ N/C$. The maximum torque on the dipole will be

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

(c) $24 \times 10^{-1}\ Nm$ (d) $24 \times 10^{-3}\ Nm$

9. A sample of HCl gas is placed in an electric field of $3 \times 10^4\ NC^{-1}$. The dipole moment of each HCl molecule is $6 \times 10^{-30}\ c \times m$. The maximum torque that can act on a molecule is

(a) $2 \times 10^{-34}\ C^2 N^{-1} m$ (b) $2 \times 10^{-34}\ Nm$

(c) $18 \times 10^{-26}\ Nm$ (d) $0.5 \times 10^{34}\ C^{-2} N^{-1} m^{-1}$

10. An electric dipole of moment $\mathbf{p}$ is placed in the position of stable equilibrium in uniform electric field of intensity $\mathbf{E}$. It is rotated through an angle θ from the initial position. The potential energy of electric dipole in the final position is

(a) $pE\cos\theta$ (b) $pE\sin\theta$

(c) $pE(1-\cos\theta)$ (d) $-pE\cos\theta$

11. A dipole of electric dipole moment p is placed in a uniform electric field of strength E. If θ is the angle between positive directions of p and E, then the potential energy of the electric dipole is largest when θ is

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

(c) π (d) Zero

(e) $\frac{2}{3}\pi$

12. Two charges $+3.2\times10^{-19}C$ and $-3.2\times10^{-9}C$ kept 2.4 Å apart forms a dipole. If it is kept in uniform electric field of intensity 4×10^5 $volt/m$ then what will be its electrical energy in equilibrium

(a) $+3\times10^{-23} J$ (b) $-3\times10^{-23} J$

(c) $-6\times10^{-23} J$ (d) $-2\times10^{-23} J$

13. Consider the following statements about electric dipole and select the correct ones

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

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

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

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

(a) S2, S3 and S4 (b) S3 and S4

(c) S2 and S3 (d) All four

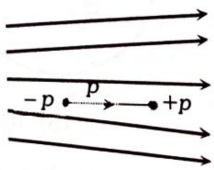
14. An electric dipole of length 1 cm is placed with the axis making an angle of 30° to an electric field of strength $10^4\ NC^{-1}$. If it experiences a torque of $10\sqrt{2}\ Nm$, the potential energy of the dipole is

(a) 0.245 J (b) 2.45 J

(c) 0.0245 J (d) 245.0 J

(e) 24.5 J

15. Figure shows electric field lines in which an electric dipole P is placed as shown. Which of the following statements is correct?



(a) The dipole will not experience any force

(b) The dipole will experience a force towards right

(c) The dipole will experience a force towards left

(d) The dipole will experience a force upwards

16. A point electric dipole placed at the origin has a potential given by $V(r,\theta) = \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$ where θ is the angle made by the position vector with the direction of the dipole. Then

(a) Since the potential vanishes at $\theta = \frac{\pi}{2}$, the electric field is zero

(b) The electric field everywhere on the $\theta = \frac{\pi}{2}$ plane is parallel to the plane

(c) The electric field everywhere on the $\theta = \frac{\pi}{2}$ plane is perpendicular to the plane

(d) The electric field vanishes on the $\theta = 0$ line

4. Electric Flux and Gauss's Law

1. The S.I. unit of electric flux is

(a) Weber (b) Newton per coulomb

(c) Volt × metre (d) Joule per coulomb

2. The inward and outward electric flux for a closed surface in units of $N\text{-}m^2/C$ are respectively 8×10^3 and 4×10^3. Then the total charge inside the surface is [where ε_0 = permittivity constant]

(a) $4\times10^3\ C$ (b) $-4\times10^3\ C$

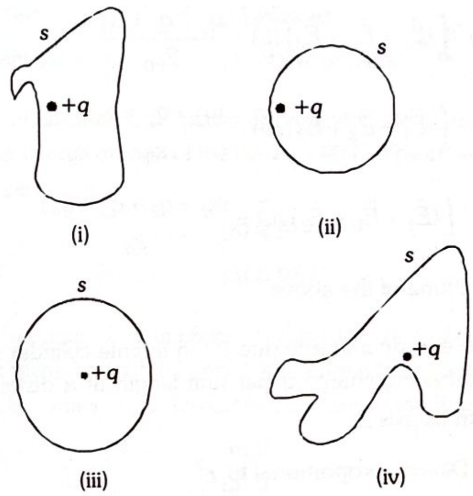
(c) $\frac{(-4\times10^3)}{\varepsilon}\ C$ (d) $-4\times10^3\varepsilon_0\ C$

3. In a region, the intensity of an electric field is given by $\vec{E} = 2\hat{i}+3\hat{j}+\hat{k}$ in NC^{-1}. The electric flux through a surface $\vec{S} = 10\hat{i}\ m^2$ in the region is

(a) 5 Nm^2C^{-1} (b) 10 Nm^2C^{-1}

(c) 15 Nm^2C^{-1} (d) 20 Nm^2C^{-1}

4. The electric flux through the surface



(a) In Fig. (iv) is the largest

(b) In Fig. (iii)is the least

(c) In Fig. (ii) is same as Fig. (iii) but is smaller than Fig. (iv)

(d) Is the same for all the figures

5. A charge q is placed at the centre of the open end of cylindrical vessel. The flux of the electric field through the surface of the vessel is

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

(c) $\frac{q}{2\varepsilon_0}$ (d) $\frac{2q}{\varepsilon_0}$

6. It is not convenient to use a spherical Gaussian surface to find the electric field due to an electric dipole using Gauss's theorem because

(a) Gauss's law fails in this case

(b) This problem does not have spherical symmetry

(c) Coulomb's law is more fundamental than Gauss's law

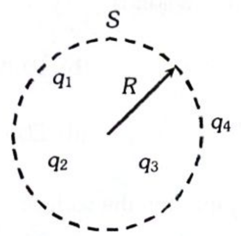
(d) Spherical Gaussian surface will alter the dipole moment

7. Which of the following will represent coulomb's law?

(a) $\oint \vec{E}.d\vec{S} = \frac{q}{\varepsilon_0}$ (b) $\oint \vec{E}.d\vec{l} = 0$

(c) $\oint \vec{H}.d\vec{S} = 0$ (d) $\oint \vec{H}.d\vec{l} = \mu_0 I$

8. q_1, q_2, q_3 and q_4 are point charges located at points as shown in the figure and S is a spherical Gaussian surface of radius R. Which of the following is true according to the Gauss's law



(a) $\oint_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3).d\vec{A} = \frac{q_1 + q_2 + q_3}{2\varepsilon_0}$

(b) $\int_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3).d\vec{A} = \frac{(q_1 + q_2 + q_3)}{\varepsilon_0}$

(c) $\int_s (\vec{E}_1 + \vec{E}_2 + \vec{E}_3).d\vec{A} = \frac{(q_1 + q_2 + q_3 + q_4)}{\varepsilon_0}$

(d) None of the above

9. The electric intensity due to an infinite cylinder of radius R and having charge q per unit length at a distance $r(r > R)$ from its axis is

(a) Directly proportional to r^2

(b) Directly proportional to r^3

(c) Inversely proportional to r

(d) Inversely proportional to r^2

10. What about Gauss theorem is not incorrect?

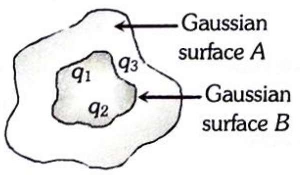
(a) It can be derived by using Coulomb's Law

(b) It is valid for conservative field obeys inverse square root law

(c) Gauss theorem is not applicable in gravitation

(d) (a) and (b) both

11. The electric flux for Gaussian surface A that enclose the charged particles in free space is (given $q_1 = -14\ nC$, $q_2 = 78.85\ nC$, $q_3 = -56\ nC$)



(a) $10^3\ Nm^2\ C^{-1}$ (b) $10^3\ CN^{-1}\ m^{-2}$

(c) $6.32 \times 10^3\ Nm^2\ C^{-1}$ (d) $6.32 \times 10^3\ CN^{-1}\ m^{-2}$

12. A point charge causes an electric flux of $-1.0 \times 10^3\ Nm^2C^{-1}$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. If the radius of the Gaussian surface were three times, how much flux would pass through the surface

(a) $3.0 \times 10^3 Nm^2/C$ (b) $-1.0 \times 10^3 Nm^2/C$

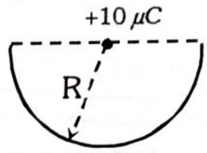
(c) $-3.0 \times 10^3 Nm^2/C$ (d) $-2.0 \times 10^3 Nm^2/C$

13. 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

(a) q/ε_0 (b) $q/\pi\varepsilon_0$

(c) $q/4\varepsilon_0$ (d) $q/6\varepsilon_0$

14. A charge $10\ \mu C$ is placed at the centre of a hemisphere of radius $R = 10\,cm$ as shown. The electric flux through the hemisphere (in MKS units) is



(a) 20×10^5 (b) 10×10^5

(c) 6×10^5 (d) 2×10^5

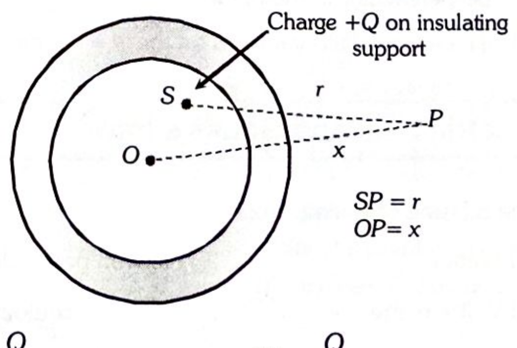
15. The total electric flux through a cube when a charge $8q$ is placed at one corner of the cube is

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

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

(e) $\frac{q}{\varepsilon_0}$

16. 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) $\frac{Q}{4\pi\varepsilon_0 r^2}$

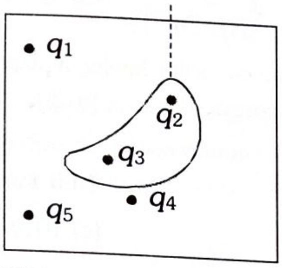
(c) 0 (d) None of the above

17. Gauss law of gravitation is

(a) $\oint \vec{g} \cdot \vec{ds} = m$ (b) $\int \vec{g} \cdot \vec{ds} = Gm$

(c) $\int \vec{g} \cdot \vec{ds} = -4\,G\pi m$ (d) All the above

18. Five charges q_1, q_2, q_3, q_4, and q_5 are fixed at their positions as shown in Figure, S is a Gaussian surface. The Gauss' law is given by $\int_s E.dS = \frac{q}{\varepsilon_0}$. Which of the following statements is correct?



(a) E on the LHS of the above equation will have a contribution from q_1, q_5 and q_1, q_5 and q_3 while q on the RHS will have a contribution from q_2 and q_4 only

(b) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_4 only

(c) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_1, q_3 and q_5 only

(d) Both E on the LHS and q on the RHS will have contributions from q_2 and q_4 only

19. Consider a cube of uniform charge density ρ. The ratio of electrostatic potential at the centre of the cube to that at one of the corners of the cube is

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

(c) $\sqrt{2}$ (d) 1

5. Capacitance

1. The potential to which a conductor is raised, depends on

(a) The amount of charge

(b) Geometry and size of the conductor

(c) Both (a) and (b)

(d) None of these

2. A $500\,\mu F$ capacitor is charged at a steady rate of $100\,\mu C/\text{second}$. The potential difference across the capacitor will be 10 V after an interval of

(a) 5 sec (b) 25 sec

(c) 20 sec (d) 50 sec

3. 64 drops each having the capacity C and potential V are combined to form a big drop. If the charge on the small drop is q, then the charge on the big drop will be

(a) $2q$ (b) $4q$

(c) $16q$ (d) $64q$

4. A parallel plate capacitor is charged. If the plates are pulled apart

(a) The capacitance increases

(b) The potential difference increases

(c) The total charge increases

(d) The charge and potential difference remain the same

5. If the charge on a capacitor is doubled, the value of its capacitance C will be

(a) Doubled (b) Halved

(c) Remain the same (d) None of these

6. The potentials of the two plates of capacitor are $+10V$ and $-10\,V$. The charge on one of the plates is 40 C. The capacitance of the capacitor is

(a) 2 F (b) 4 F

(c) 0.5 F (d) 0.25 F

7. An air filled parallel plate capacitor has capacity C. If distance between plates is doubled and it is immersed in a liquid then capacity becomes twice. Dielectric constant of the liquid is

(a) 1 (b) 2

(c) 3 (d) 4

8. The potential energy of a charged parallel plate capacitor is U_0. if a slab of dielectric constant k is inserted between the plates, then the new potential energy will be

(a) $\frac{U_0}{k}$ (b) $U_0 k^2$

(c) $\frac{U_0}{k^2}$ (d) U_0^2

9. A parallel plate condenser has a capacitance $50\mu F$ in air and $110\mu F$ when immersed in an oil. The dielectric constant 'k' of the oil is

(a) 0.45 (b) 0.55

(c) 1.10 (d) 2.20

10. A parallel plate capacitor is charged to a potential difference of 50 volts. It is then discharged through a resistance for 2 seconds and its potential drops by 10 volts. Calculate the fraction of energy stored in the capacitance

(a) 0.14 (b) 0.25

(c) 0.50 (d) 0.64

11. Consider a parallel plate capacitor with plates 20 cm by 20 cm and separated by 2 mm. The dielectric constant of the material between the plates is 5. The plates are connected to a voltage source of 500 V. The energy density of the field between the plates will be close to

(a) $2.65\,J/m^3$ (b) $1.95\,J/m^3$

(c) $1.38\,J/m^3$ (d) $0.69\,J/m^3$

12. C, V, U and Q are capacitance, potential difference, energy stored and charge of parallel plate capacitor respectively. The quantities that increases when a dielectric slab is introduced between the plates without disconnecting the battery are

(a) V and C (b) V and U

(c) U and Q (d) V and Q

(e) U but not Q

13. There is an air filled $1pF$ parallel plate capacitor. When the plate separation is doubled and the space is filled with wax, the capacitance increases to $2pF$. The dielectric constant of wax is

(a) 2 (b) 4

(c) 6 (d) 8

14. A parallel plate capacitor has a plate area of 50 cm^2 and plate separation of 1.0 cm. A potential difference of 200 $volt$ is applied across the plates with air as the dielectric between plates. The battery is then disconnected and a piece of bakelite of dielectric constant 4.8 inserted which fills the complete volume between the plates. The capacitance before and after inserting bakelite are respectively

(a) $44pF$; $211.2pF$ (b) $4.4pF$; $211.2pF$

(c) $4.4pF$; $21.12pF$ (d) $21.12pF$; $44pF$

15. The capacity of a condenser in which a dielectric of dielectric constant 5 has been used, is C. If the dielectric is replaced by another with dielectric constant 20, the capacity will become

(a) $C/4$ (b) $4C$

(c) $C/2$ (d) $2C$

16. In a parallel-plate capacitor with plate area A and charge Q, the force on one plate because of the charge on the other is equal to

(a) $\frac{Q^2}{\varepsilon_0 A^2}$ (b) $\frac{Q^2}{2\varepsilon_0 A^2}$

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

17. The capacitance of a parallel plate capacitor with air as medium is $3\mu F$. With the introduction of a dielectric medium between the plates, the capacitance becomes $15\mu F$. The permittivity of the medium is

(a) 5 (b) 15

(c) $0.44\times10^{-10}\ C^2N^{-1}m^{-2}$ (d) $8.854\times10^{-11}\ C^2N^{-1}m^{-2}$

18. When a dielectric material is introduced between the plates of a charged condenser then electric field between the plates

(a) Decreases (b) Increases

(c) Remain constant (d) First (b) then (a)

19. A variable condenser is permanently connected to a 100 V battery. If the capacity is changed from $2\mu F$ to $10\mu F$, then change in energy is equal to

(a) $2\times10^{-2}\ J$ (b) $2.5\times10^{-2}\ J$

(c) $3.5\times10^{-2}\ J$ (d) $4\times10^{-2}\ J$

20. A parallel plate capacitor having a plate separation of 2 mm is charged by connecting it to a 300 V supply. The energy density is

(a) 0.01 J/m^3 (b) 0.1 J/m^3

(c) 1.0 J/m^3 (d) 10 J/m^3

21. A charge of $40\mu C$ is given to a capacitor having capacitance $C=10\mu F$. The stored energy in ergs is

(a) 80×10^{-6} (b) 800

(c) 80 (d) 8000

22. The electric field between the plates of a parallel plate capacitor when connected to a certain battery is E_0. If the space between the plates of the capacitor is filled by introducing a material of dielectric constant k without disturbing the battery connections, the field between the plates shall be

(a) kE_0 (b) E_0

(c) $\frac{E_0}{k}$ (d) None of the above

23. Putting a dielectric substance between two plates of condenser, capacity, potential and potential energy respectively

(a) Increase, decrease, decrease

(b) Decrease, increase, increase

(c) Increase, increase, increase

(d) Decrease, decrease, decrease

24. On increasing the plate separation of a charged condenser, the energy

(a) Increases (b) Decreases

(c) Remains unchanged (d) Becomes zero

25. A parallel plate capacitor of capacity C_0 is charged to a potential V_0

(i) The energy stored in the capacitor when the battery is disconnected and the separation is doubled E_1

(ii) The energy stored in the capacitor when the charging battery is kept connected and the separation between the capacitor plates is doubled is E_2. Then E_1/E_2 value is

(a) 4 (b) 3/2

(c) 2 (d) 1/2

26. Force of attraction between the plates of a parallel plate capacitor is

(a) $\frac{q^2}{2\varepsilon_0 AK}$ (b) $\frac{q^2}{\varepsilon_0 AK}$

(c) $\frac{q}{2\varepsilon_0 A}$ (d) $\frac{q^2}{2\varepsilon_0 A^2 K}$

27. The force between the plates of a parallel plate capacitor of capacitance C and distance of separation of the plates d with a potential difference V between the plates, is

(a) $\frac{CV^2}{2d}$ (b) $\frac{C^2V^2}{2d^2}$

(c) $\frac{C^2V^2}{d^2}$ (d) $\frac{V^2d}{C}$

28. Eight drops of mercury of equal radii possessing equal charges combine to form a big drop. Then the capacitance of bigger drop compared to each individual small drop is

(a) 8 times (b) 4 times

(c) 2 times (d) 32 times

29. Two conducting spheres of radii R_1 and R_2 having charges Q_1 and Q_2 respectively are connected to each other. There is

(a) No change in the energy of the system

(b) An increase in the energy of the system

(c) Always a decrease in the energy of the system

(d) A decrease in the energy of the system unless $Q_1R_2 = Q_2R_1$

30. Two spherical conductors A and B of radius a and b $(b > a)$ are placed in air concentrically B is given charge $+Q$ *coulomb* and A is grounded. The equivalent capacitance of these is

(a) $4\pi\varepsilon_0 \frac{ab}{b-a}$ (b) $4\pi\varepsilon_0 (a+b)$

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

31. A spherical condenser has inner and outer spheres of radii a and b respectively. The space between the two is filled with air. The difference between the capacities of two condensers formed when outer sphere is earthed and when inner sphere is earthed will be

(a) Zero (b) $4\pi\varepsilon_0 a$

(c) $4\pi\varepsilon_0 b$ (d) $4\pi\varepsilon_0 a\left(\frac{b}{b-a}\right)$

32. A capacitor is charged by using a battery which is then disconnected. A dielectric slab is then slipped between the plates, which results in

(a) Reduction of charge on the plates and increase of potential difference across the plates

(b) Increase in the potential difference across the plate, reduction in stored energy, but no change in the charge on the plates

(c) Decrease in the potential difference across the plates, reduction in the stored energy, but no change in the charge on the plates

(d) None of the above

33. A parallel plate capacitor is charged fully using a battery. Then without disconnecting the battery, the plates are moved further apart. Then,

(a) The charge on the capacitor increase

(b) The voltage difference between the plates decreases

(c) The capacitance increase

(d) The electrostatic energy stored in the capacitor decreases

34. A parallel plate capacitor without any dielectric within its plates, has a capacitance C, and is connected to a battery of emf V. The battery is disconnected and the plates of the capacitor are pulled apart until the separation between the plates is doubled. What is the work done by the agent pulling the plates apart, in this process?

(a) $\frac{1}{2}CV^2$ (b) $\frac{3}{2}CV^2$

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

35. An air capacitor of capacity $C = 10\mu F$ is connected to a constant voltage battery of $12\ V$. Now the space between the plates is filled with a liquid of dielectric constant 5. The charge that flows now from battery to the capacitor is

(a) $120\mu C$ (b) $699\mu C$

(c) $480\mu C$ (d) $24\mu C$

36. If a slab of insulating material $4\times10^{-3}m$ thick is introduced between the plates of a parallel plate capacitor, the separation between plates has to be increased by $3.5\times10^{-3}m$ to restore the capacity to original value. The dielectric constant of the material will be

(a) 6 (b) 8

(c) 10 (d) 12

37. In a capacitor of capacitance $20\mu F$, the distance between the plates is $2mm$. If a dielectric slab of width $1mm$ and dielectric constant 2 is inserted between the plates, then the new capacitance is

(a) $2\mu F$ (b) $15.5\mu F$

(c) $26.6\mu F$ (d) $32\mu F$

38. A parallel plate capacitor has a plate separation of 0.01 *mm* and use a dielectric (whose dielectric strength is 19 *KV/mm*) as an insulator. The maximum potential difference that can be applied to the terminals of the capacitor is

(a) 190 *V* (b) 290 *V*

(c) 95 *V* (d) 350 *V*

39. A parallel plate capacitor has plate area *A* and separation *d*. It is charged to a potential difference V_0. The charging battery is disconnected and the plates are pulled apart to three times the initial separation. The work required to separate the plates is

(a) $\frac{3\varepsilon_0 A V_0^2}{d}$ (b) $\frac{\varepsilon_0 A V_0^2}{2d}$

(c) $\frac{\varepsilon_0 A V_0^2}{3d}$ (d) $\frac{\varepsilon_0 A V_0^2}{d}$

40. If *n* drops, each of capacitance *C*, coalesce to form a single big drop, then the ratio of the energy stored in the big drop to that in each small drop will be

(a) $n : 1$ (b) $n^{1/3} : 1$

(c) $n^{5/3} : 1$ (d) $n^2 : 1$

41. Capacitance of a parallel plate capacitor becomes 4/3 times its original value if a dielectric slab of thickness $t = d/2$ is inserted between the plates (*d* is the separation between the plates). The dielectric constant of the slab is

(a) 8 (b) 4

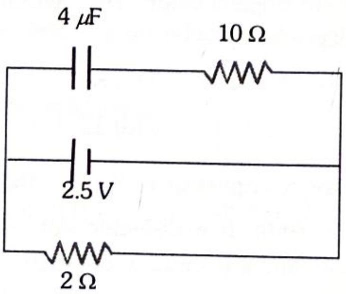
(c) 6 (d) 2

42. 64 identical spheres of charge *q* and capacitance *C* each are combined to form a large sphere. The charge and capacitance of the large sphere is

(a) $64q, C$ (b) $16q, 4C$

(c) $64q, 4C$ (d) $16q, 64C$

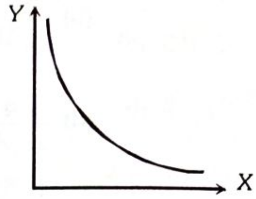
43. A capacitor of $4\,\mu F$ is connected as shown in the circuit. The internal resistance of the battery is $0.5\,\Omega$. The amount of charge on the capacitor plates will be



(a) 0 (b) 4 μC

(c) 16 μC (d) 8 μC

44. What physical quantities may *X* and *Y* represent? (*Y* represents the first mentioned quantity)



(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

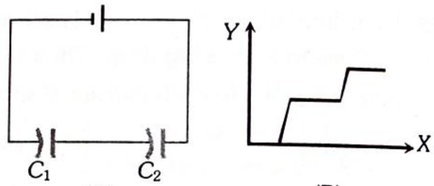
(d) Potential *v/s* capacitance to give a constant charge

45. 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

(a) $C_1 > C_2$

(b) $C_1 = C_2$

(c) $C_1 < C_2$

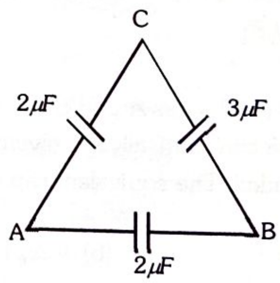


(A) (B)

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

6. Grouping of Capacitors

1. Three capacitors are connected in the arms of a triangle *ABC* as shown in figure 5 V is applied between *A* and *B*. The voltage between *B* and *C* is



(a) 2 V (b) 1 V

(c) 3 V (d) 1.5 V

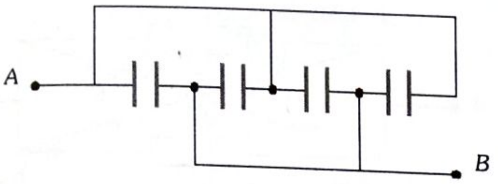
(e) 0.5 V

2. Two capacitors connected in parallel having the capacities C_1 and C_2 are given '*q*' charge, which is distributed among them. The ratio of the charge on C_1 and C_2 will be

(a) $\frac{C_1}{C_2}$ (b) $\frac{C_2}{C_1}$

(c) $C_1 C_2$ (d) $\frac{1}{C_1 C_2}$

3. Four condensers are joined as shown in the adjoining figure. The capacity of each is $8\mu F$. The equivalent capacity between the points A and B will be



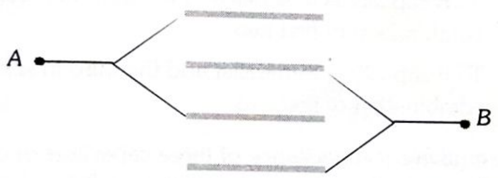
(a) $32\mu F$

(b) $2\mu F$

(c) $8\mu F$

(d) $16\mu F$

4. Four plates of the same area of cross-section are joined as shown in the figure. The distance between each plate is d. The equivalent capacity across A and B will be

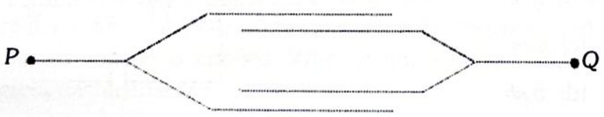


(a) $\frac{2\varepsilon_0 A}{d}$ (b) $\frac{3\varepsilon_0 A}{d}$

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

5. Four metallic plates each of surface area (of one side) A, are placed at a distance d apart from each other. The two plates are connected to a point P and the two inner plates to another point Q as shown in figure:

Then the capacitance of the system is



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

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

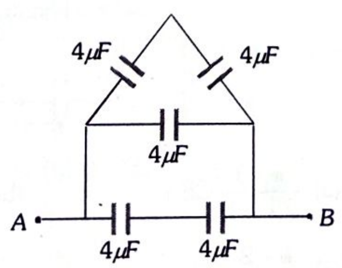
6. Equivalent capacitance between A and B is

(a) $8\ \mu F$

(b) $6\ \mu F$

(c) $26\ \mu F$

(d) $10/3\ \mu F$



7. Three capacitors of capacitance $3\ \mu F$ are connected in a circuit. Then their maximum and minimum capacitances will be

(a) $9\ \mu F$, $1\ \mu F$ (b) $8\ \mu F$, $2\ \mu F$

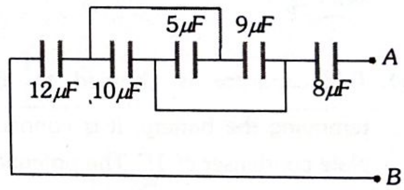
(c) $9\ \mu F$, $0\ \mu F$ (d) $3\ \mu F$, $2\ \mu F$

8. Three capacitors of capacitances $3\mu F, 9\mu F$ and $18\mu F$ are connected once in series and another time in parallel. The ratio of equivalent capacitance in the two cases $\left(\frac{C_s}{C_p}\right)$ will be

(a) 1 : 15 (b) 15 : 1

(c) 1 : 1 (d) 1 : 3

9. The capacities and connection of five capacitors are shown in the adjoining figure. The potential difference between the points A and B is 60 *volts*. Then the equivalent capacity between A and B and the charge on $5\mu F$ capacitance will be respectively



(a) $44\mu F$; $300\mu C$

(b) $16\mu F$; $150\mu C$

(c) $15\mu F$; $200\mu C$

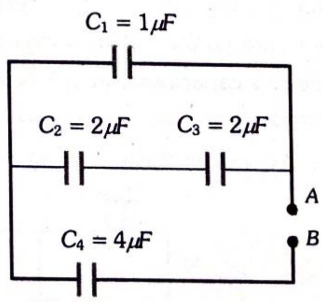
(d) $4\mu F$; $50\mu C$

10. n identical capacitors each of capacitance C when connected in parallel give the effective capacitance 90 μF and when connected in series give 2.5 μF. Then the values of n and C respectively are

(a) 6 and 15 μF (b) 5 and 18 μF

(c) 15 and 6 μF (d) 18 and 5 μF

11. Four capacitors are connected in a circuit as shown in the following figure. Calculate the effective capacitance between the points A and B



(a) $\frac{4}{3}\mu F$ (b) $\frac{24}{5}\mu F$

(c) $9\mu F$ (d) $5\mu F$

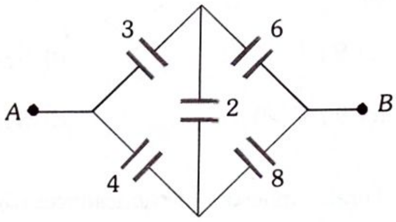
12. Effective capacitance between A and B in the figure shown is (all capacitance are in μF)

(a) 21 μF

(b) 23 μF

(c) $\frac{3}{14}\ \mu F$

(d) $\frac{14}{3}\ \mu F$



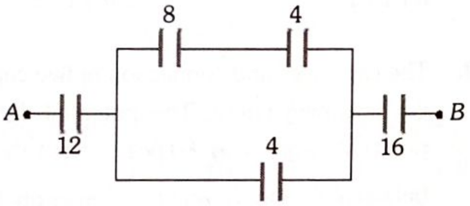
13. What is the equivalent capacitance between A and B in the given figure (all are in farad)

(a) $\frac{13}{18}F$

(b) $\frac{48}{13}F$

(c) $\frac{1}{31}F$

(d) $\frac{240}{71}F$



14. $0.2F$ capacitor is charged to $600\ V$ by a battery. On removing the battery, it is connected with another parallel plate condenser of $1F$. The potential decreases to

(a) 100 *volts*

(b) 120 *volts*

(c) 300 *volts*

(d) 600 *volts*

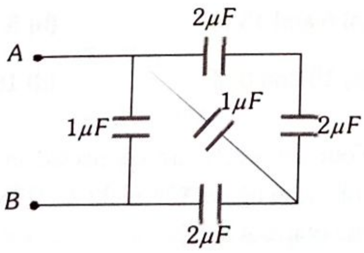
15. The total capacity of the system of capacitors shown in the adjoining figure between the points A and B is

(a) $1\mu F$

(b) $2\mu F$

(c) $3\mu F$

(d) $4\mu F$



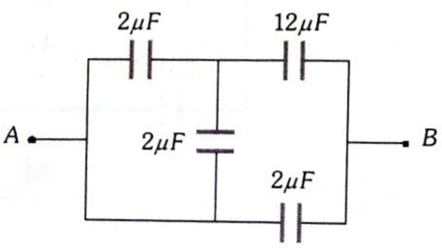
16. Four capacitors are connected in a circuit as shown in the figure. The effective capacitance in μF between points A and B will be

(a) $\frac{28}{9}$

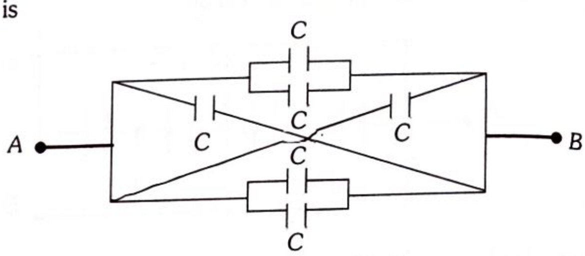
(b) 4

(c) 5

(d) 18



17. Six capacitors each of capacitance of $2\mu F$ are connected as shown in the figure. The effective capacitance between A and B is



(a) $12\mu F$

(b) $8/3\mu F$

(c) $3\mu F$

(d) $6\mu F$

(e) $2/3\mu F$

18. To obtain $3\mu F$ capacity from three capacitors of $2\mu F$ each, they will be arranged

(a) All the three in series

(b) All the three in parallel

(c) Two capacitors in series and the third in parallel with the combination of first two

(d) Two capacitors in parallel and the third in series with the combination of first two

19. The equivalent capacitance of three capacitors of capacitance C_1, C_2 and C_3 are connected in parallel is 12 units and product $C_1.C_2.C_3 = 48$ unit. When the capacitors C_1 and C_2 are connected in parallel, the equivalent capacitance is 6 units. Then the capacitances are

(a) 2, 3, 7

(b) 1.5, 2.5, 8

(c) 1, 5, 6

(d) 4, 2, 6

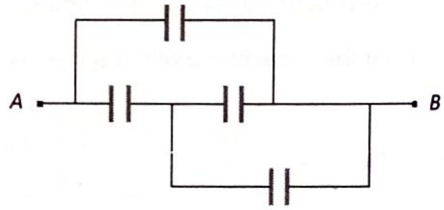
20. In the circuit shown in figure, each capacitor has a capacity of $3\mu F$. The equivalent capacity between A and B is

(a) $\frac{3}{4}\mu F$

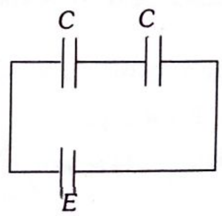
(b) $3\mu F$

(c) $6\mu F$

(d) $5\mu F$



21. Two identical parallel plate capacitor of capacitance C each are connected in series with a battery of *emf*, E as shown, if one of the capacitors is now filled with a dielectric of dielectric constant k, the amount of charge which will flow through the battery is (neglect internal resistance of the battery)



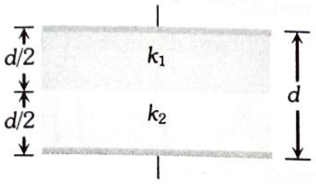
(a) $\frac{k+1}{2(k-1)}CE$

(b) $\frac{k-1}{2(k+1)}CE$

(c) $\frac{k-2}{(k+2)}CE$

(d) $\frac{k+2}{(k-2)}CE$

22. Two dielectric slabs of constant K_1 and K_2 have been filled in between the plates of a capacitor as shown below. What will be the capacitance of the capacitor?



(a) $\frac{2\varepsilon_0 A}{d}(k_1+k_2)$ (b) $\frac{2\varepsilon_0 A}{2}\left(\frac{k_1+k_2}{k_1\times k_2}\right)$

(c) $\frac{2\varepsilon_0 A}{2}\left(\frac{k_1\times k_2}{k_1+k_2}\right)$ (d) $\frac{2\varepsilon_0 A}{d}\left(\frac{k_1\times k_2}{k_1+k_2}\right)$

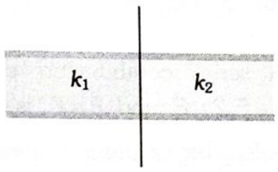
23. A parallel plate capacitor with air as medium between the plates has a capacitance of $10\mu F$. The area of capacitor is divided into two equal halves and filled with two media as shown in the figure having dielectric constant $k_1=2$ and $k_2=4$. The capacitance of the system will now be

(a) $10\mu F$

(b) $20\mu F$

(c) $30\mu F$

(d) $40\mu F$



24. An electric circuit requires a total capacitance of $2\ \mu F$ across a potential of 1000 V. Large number of $1\ \mu F$ capacitances are available each of which would breakdown if the potential is more than 350 V. How many capacitances are required to make the circuit?

(a) 24 (b) 20

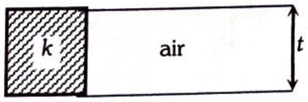
(c) 18 (d) 12

25. A $10\mu F$ capacitor and a $20\mu F$ capacitor are connected in series across a $200\ V$ supply line. The charged capacitors are then disconnected from the line and reconnected with their positive plates together and negative plates together and no external voltage is applied. What is the potential difference across each capacitor

(a) $\frac{400}{9}V$ (b) $\frac{800}{9}V$

(c) $400\ V$ (d) $200\ V$

26. A parallel plate capacitor with air as the dielectric has capacitance C. A slab of dielectric constant k and having the same thickness as the separation between the plates is introduced so as to fill one-fourth of the capacitor as shown in the figure. The new capacitance will be



(a) $(k+3)\frac{C}{4}$ (b) $(k+2)\frac{C}{4}$

(c) $(k+1)\frac{C}{4}$ (d) $\frac{kC}{4}$

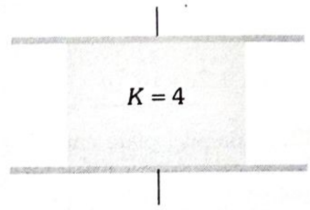
27. Consider a parallel plate capacitor of $10\mu F$ (*micro-farad*) with air filled in the gap between the plates. Now one half of the space between the plates is filled with a dielectric of dielectric constant 4, as shown in the figure. The capacity of the capacitor changes to

(a) $25\ \mu F$

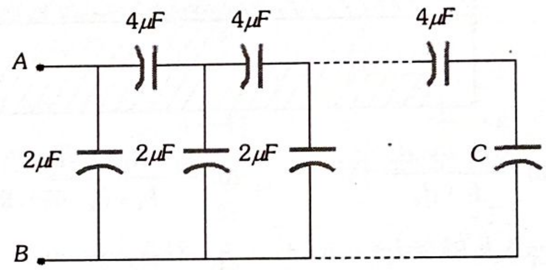
(b) $20\ \mu F$

(c) $40\ \mu F$

(d) $5\ \mu F$



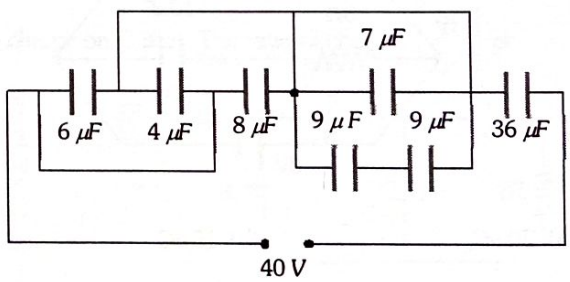
28. A finite ladder is constructed by connecting several sections of $2\mu F, 4\mu F$ capacitor combinations as shown in the figure. It is terminated by a capacitor of capacitance C. What value should be chosen for C such that the equivalent capacitance of the ladder between the points A and B becomes independent of the number of sections in between



(a) $4\mu F$ (b) $2\mu F$

(c) $18\mu F$ (d) $6\mu F$

29. In the following diagram, the charge and potential difference across $8\ \mu F$ capacitance will be respectively



(a) $320\ \mu C, 40\ V$ (b) $420\ \mu C, 50\ V$

(c) $214\ \mu C, 27\ V$ (d) $360\ \mu C, 45\ V$

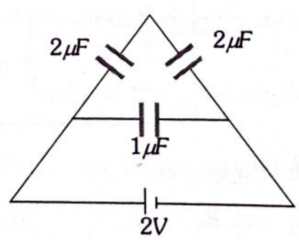
30. The charge on any one of the $2\mu F$ capacitors and $1\mu F$ capacitor will be given respectively (in μC) as

(a) 1, 2

(b) 2, 1

(c) 1, 1

(d) 2, 2

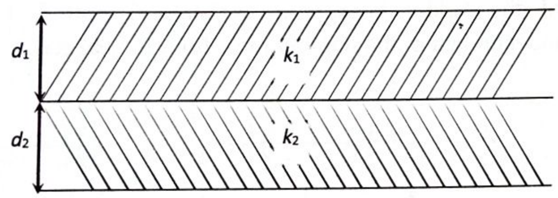


31. Two capacitors, $3\mu F$ and $4\mu F$, are individually charged across a $6V$ battery. After being disconnected from the battery, they are connected together with the negative plate of one attached to the positive plate of the other. What is the final total energy stored?

(a) $1.26\times10^{-4}J$ (b) $2.57\times10^{-4}J$

(c) $1.26\times10^{-6}J$ (d) $2.57\times10^{-6}J$

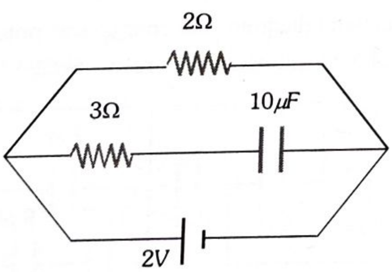
32. A parallel plate capacitor is made of two dielectric blocks in series. One of the blocks has thickness d_1 and dielectric constant k_1 and the other has thickness d_2 and dielectric constant k_2 as shown in figure. This arrangement can be thought as a dielectric slab of thickness $d(=d_1+d_2)$ and effective dielectric constant K. The K is



(a) $\dfrac{k_1d_1+k_2d_2}{d_1+d_2}$ (b) $\dfrac{k_1+d_1+k_2d_2}{k_1+k_2}$

(c) $\dfrac{k_1k_2(d_1+d_2)}{(k_1d_1+k_2d_2)}$ (d) $\dfrac{2k_1k_2}{k_1+k_2}$

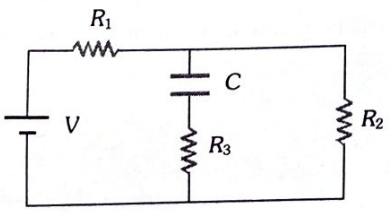
33. The charge on a capacitor of capacitance $10\mu F$ connected as shown in the figure is



(a) $20\mu C$ (b) $15\mu C$

(c) $10\mu C$ (d) Zero

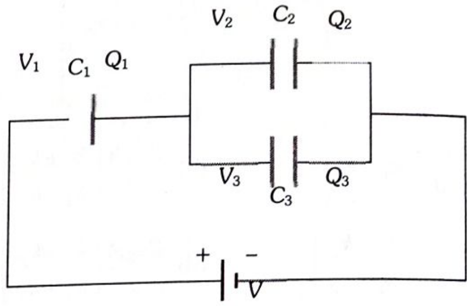
34. In the circuit here, the steady state voltage across capacitor C is a fraction of the battery e.m.f. The fraction is decided by



(a) R_1 only (b) R_1 and R_2 only

(c) R_1 and R_3 only (d) R_1, R_2 and R_3

35. In an adjoining figure are shown three capacitors C_1, C_2 and C_3 joined to a battery. The correct condition will be (Symbols have their usual meanings)



(a) $Q_1=Q_2=Q_3$ and $V_1=V_2=V_3=V$

(b) $Q_1=Q_2+Q_3$ and $V=V_1+V_2+V_3$

(c) $Q_1=Q_2+Q_3$ and $V=V_1+V_2$

(d) $Q_2=Q_3$ and $V_2=V_3$

36. A series combination of three capacitors of capacities $1\mu F, 2\mu F$ and $8\mu F$ is connected to a battery of e.m.f. 13 *volt*. The potential difference across the plates of $2\mu F$ capacitor will be

(a) 1V (b) 8V

(c) 4V (d) $\dfrac{13}{3}V$

37. Choose the incorrect statement from the following: When two identical capacitors are charged individually to different potentials and connected parallel to each other after disconnecting them from the source

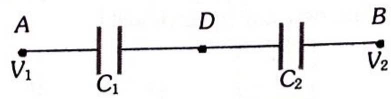
(a) Net charge equals the sum of initial charges

(b) The net energy stored in the two capacitors is less than the sum of the initial individual energies

(c) The net potential difference across them is different from the sum of the individual initial potential difference

(d) The net potential difference across them equals the sum of the individual initial potential differences

38. Two condensers C_1 and C_2 in a circuit are joined as shown in figure. The potential of point A is V_1 and that of B is V_2. The potential of point D will be



(a) $\dfrac{1}{2}(V_1+V_2)$ (b) $\dfrac{C_2V_1+C_1V_2}{C_1+C_2}$

(c) $\dfrac{C_1V_1+C_2V_2}{C_1+C_2}$ (d) $\dfrac{C_2V_1-C_1V_2}{C_1+C_2}$

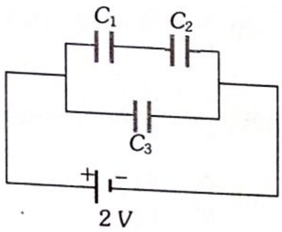
39. Two capacitors $C_1 = 2\mu F$ and $C_2 = 6\mu F$ in series, are connected in parallel to a third capacitor $C_3 = 4\mu F$. This arrangement is then connected to a battery of e.m.f. = 2V, as shown in the figure. How much energy is lost by the battery in charging the capacitors

(a) $22\times10^{-6}\,J$

(b) $11\times10^{-6}\,J$

(c) $\left(\frac{32}{3}\right)\times10^{-6}\,J$

(d) $\left(\frac{16}{3}\right)\times10^{-6}\,J$



40. Two capacitors of capacitances $3\mu F$ and $6\mu F$ are charged to a potential of 12 V each. They are now connected to each other, with the positive plate of each joined to the negative plate of the other. The potential difference across each will be

(a) 6 *volt*
(b) 4 *volt*
(c) 3 *volt*
(d) Zero

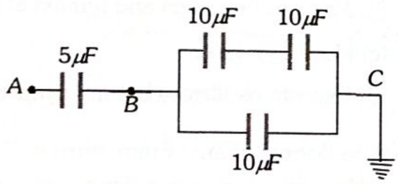
41. In the given circuit if point C is connected to the earth and a potential of $+2000\,V$ is given to the point A, the potential at B is

(a) 1500 V

(b) 1000 V

(c) 500 V

(d) 400 V



42. Two identical capacitors are joined in parallel, charged to a potential V and then separated and then connected in series *i.e.* the positive plate of one is connected to negative of the other

(a) The charges on the free plates connected together are destroyed

(b) The charges on the free plates are enhanced

(c) The energy stored in the system increases

(d) The potential difference in the free plates becomes 2V

43. 100 capacitors each having a capacity of $10\mu F$ are connected in parallel and are charged by a potential difference of 100 *kV*. The energy stored in the capacitors and the cost of charging them, if electrical energy costs 108 *paise per kWh*, will be

(a) 10^7 *joule* and 300 *paise*

(b) 5×10^6 *joule* and 300 *paise*

(c) 5×10^6 *joule* and 150 *paise*

(d) 10^7 *joule* and 150 *paise*

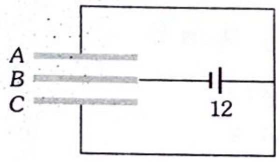
44. Three plates A, B, C each of area $50\,cm^2$ have separation 3mm between A and B and 3mm between B and C The energy stored when the plates are fully charged is

(a) $1.6\times10^{-9}\,J$

(b) $2.1\times10^{-9}\,J$

(c) $5\times10^{-9}\,J$

(d) $7\times10^{-9}\,J$



45. The combination of capacitors with $C_1 = 3\mu F, C_2 = 4\mu F$ and $C_3 = 2\mu F$ is charged by connecting AB to a battery. Consider the following statements

I. Energy stored in C_1 = Energy stored in C_2 + Energy stored in C_3

II. Charge on C_1 = Charge on C_2 + Charge on C_3

III. Potential drop across C_1 = Potential drop across C_2 = Potential drop across C_3

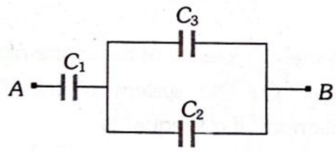
Which of these is/are correct?

(a) I and II

(b) II only

(c) I and III

(d) III only



46. A body of capacity $4\mu F$ is charged to 80 V and another body of capacity $6\mu F$ is charged to 30V. When they are connected the energy lost by $4\mu F$ capacitor is

(a) 7.8 *mJ*
(b) 4.6 *mJ*
(c) 3.2 *mJ*
(d) 2.5 *mJ*

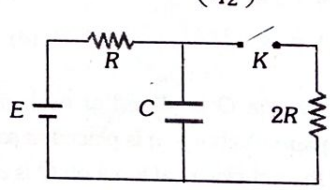
47. In the circuit, shown in fig. 'K' is open. The charge on capacitor C in steady state is q_1. Now key is closed and at steady state, the charge on C is q_2. The ratio of charges $\left(\frac{q_1}{q_2}\right)$ is

(a) $\frac{3}{2}$

(b) $\frac{2}{3}$

(c) 1

(d) $\frac{1}{2}$



7. IIT-JEE/AIEEE

1. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then **[2007]**

(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

2. 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 **[2009]**

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

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

3. Two small spheres each having the charge $+Q$ are suspended by insulating threads of length L from a hook. This arrangement is taken in space where there is no gravitational effect, then the angle between the two suspensions and the tension in each will be **[1986]**

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

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

4. A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium, if q is equal to **[1987]**

(a) $-Q/2$ (b) $-Q/4$

(c) $+Q/4$ (d) $+Q/2$

5. Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is **[2004]**

(a) $F/4$ (b) $3F/4$

(c) $F/8$ (d) $3F/8$

6. 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 **[2009]**

(a) $-2\sqrt{2}$ (b) -1

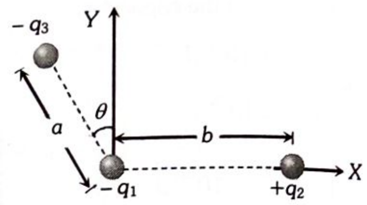
(c) 1 (d) $-\frac{1}{\sqrt{2}}$

7. Two charges, each equal to q, are kept at $x=-a$ and $x=a$ on the x-axis. A particle of mass m and charge $q_0 = \frac{q}{2}$ is placed at the origin. If charge q_0 is given a small displacement ($y \ll a$) along the y-axis, the net force acting on the particle is proportional to **[2013]**

(a) y (b) $-y$

(c) $1/y$ (d) $-1/y$

8. 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 **[2003]**



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

9. 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 **[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) $\frac{Q}{2}(1+2\sqrt{2})$

10. 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 **[1984]**

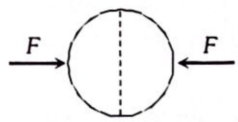
(a) Execute simple harmonic motion about the origin

(b) Move to the origin and remain at rest

(c) Move to infinity

(d) Execute oscillatory but not simple harmonic motion

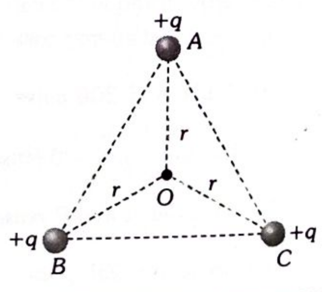
11. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to **[2010]**



(a) $\frac{1}{\varepsilon_0}\sigma^2R^2$ (b) $\frac{1}{\varepsilon_0}\sigma^2R$

(c) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$ (d) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$

12. ABC is an equilateral triangle. Charges $+q$ are placed at each corner. The electric intensity at O will be **[2002]**



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

(b) $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

(c) Zero

(d) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{r^2}$

13. The magnitude of electric field E in the annular region of a charged cylindrical capacitor **[1996]**

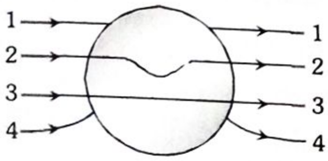
(a) Is same throughout

(b) Is higher near the outer cylinder than near the inner cylinder

(c) Varies as $1/r$, where r is the distance from the axis

(d) Varies as $1/r^2$, where r is the distance from the axis

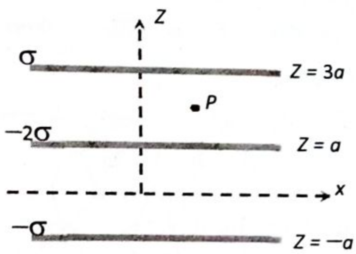
14. A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in figure as **[1996]**



(a) 1 (b) 2

(c) 3 (d) 4

15. Three infinitely long charge sheets are placed as shown in figure. The electric field at point P is **[2005]**



(a) $\frac{2\sigma}{\varepsilon_o}\hat{k}$

(b) $-\frac{2\sigma}{\varepsilon_o}\hat{k}$

(c) $\frac{4\sigma}{\varepsilon_o}\hat{k}$

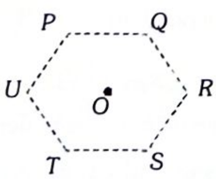
(d) $-\frac{4\sigma}{\varepsilon_o}\hat{k}$

16. A simple pendulum of period T has a metal bob which is negatively charged. If it is allowed to oscillate above a positively charged metal plate, its period will **[2002]**

(a) Remains equal to T (b) Less than T

(c) Greater than T (d) Infinite

17. 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? **[2004]**



(a) +, −, +, −, −, +

(b) +, −, +, −, +, −

(c) +, +, −, +, −, −

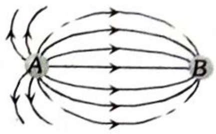
(d) −, +, +, −, +, −

18. Two point charges $+8q$ and $-2q$ are located at $x = 0$ and $x = L$ respectively. The location of a point on the x-axis at which the net electric field due to these two point charges is zero is **[2005]**

(a) $8L$ (b) $4L$

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

19. The spatial distribution of the electric field due to charges (A,B) is shown in figure. Which one of the following statements is correct? **[2010]**



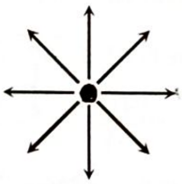
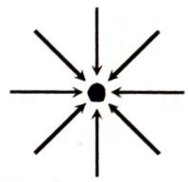
(a) A is $+ve$ and B $-ve$ and $|A|>|B|$

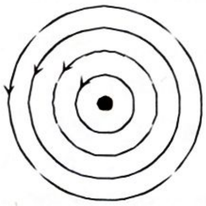
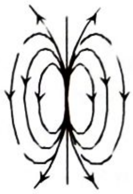
(b) A is $-ve$ and B $+ve$; $|A|=|B|$

(c) Both are $+ve$ but $A > B$

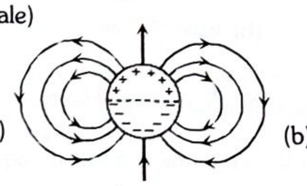
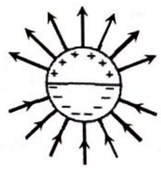
(d) Both are $-ve$ but $A > B$

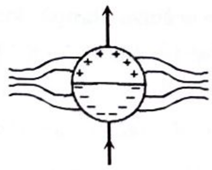
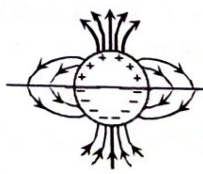
20. Which of the field patterns given below is valid for electric field as well as for magnetic field **[2011]**

(a)  (b) 

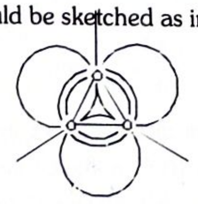
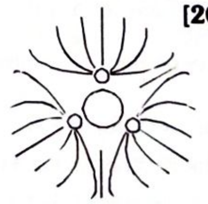
(c)  (d) 

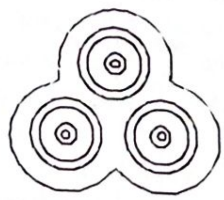
21. A long cylindrical shell carries positive surface charge σ in the upper half negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in (figure are schematic and not drawn to scale) **[2015]**

(a)  (b) 

(c)  (d) 

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 **[2001]**

(a)  (b) 

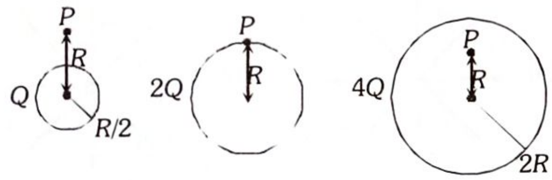
(c)  (d) 

23. An electron of mass m_e initially at rest moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p also initially at rest takes time t_2 to move through an equal distance in this uniform electric field. Neglecting the effect of gravity, the ratio of t_2/t_1 is nearly equal to **[1997]**

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

(c) $(m_e/m_p)^{1/2}$ (d) 1836

24. Charges Q, 2Q and 4Q are uniformly distributed in three dielectric solid spheres 1, 2 and 3 of radii R/2, R and 2R respectively, as shown in figure. If magnitudes of the electric fields at point P at a distance R from the center of spheres 1, 2 and 3 are $E_1 E_2$ and E_3 respectively, then **[2014]**



(a) $E_1 > E_2 > E_3$ (b) $E_3 > E_1 > E_2$

(c) $E_2 > E_1 > E_3$ (d) $E_3 > E_2 > E_1$

25. Let $E_1(r)$, $E_2(r)$ and $E_3(r)$ be the respective electric fields at a distance r from a point charge Q, an infinitely long wire with constant linear charge density λ, and an infinite plane with uniform surface charge density σ. If $E_1(r_0) = E_2(r_0) = E_3(r_0)$ at a given distance r_0, then **[2014]**

(a) $Q = 4\sigma\pi r_0^2$ (b) $r_0 = \frac{\lambda}{2\pi\sigma}$

(c) $E_1(r_0/2) = 2E_2(r_0/2)$ (d) $E_2(r_0/2) = 4E_3(r_0/2)$

26. 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 **[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

27. Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0\left(\frac{5}{4} - \frac{r}{R}\right)$ upto $r = R$, and $\rho(r) = 0$ for $r > R$, where r is the distance from the origin. The electric field at a distance $r(r < R)$ from the origin is given by **[2010]**

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

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

28. Charge q is uniformly distributed over a thin half ring of radius R. The electric field at the centre of the ring is **[2010]**

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

29. 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 **[2007]**

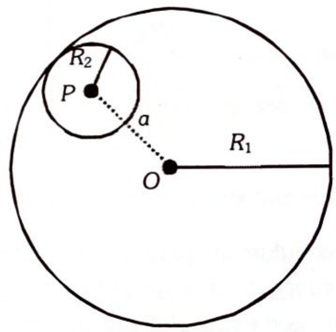
(a) Zero everywhere

(b) Non-zero and uniform

(c) Non-uniform

(d) Zero only at its center

30. Consider a uniform spherical charge distribution of radius R_1 centred at the origin O. In this distribution, a spherical cavity of radius R_2, centred at P with distance $OP = a = R_1 - R_2$ (see figure) is made. If the electric field inside the cavity at position $\vec{r}$ is $\vec{E}(\vec{r})$, then the correct statement(s) is(are) **[2015]**



(a) $\vec{E}$ is uniform, its magnitude is independent of R_2 but its direction depends on $\vec{r}$

(b) $\vec{E}$ is uniform, its magnitude independs of R_2 and its direction depends on $\vec{r}$

(c) $\vec{E}$ is uniform, its magnitude is independent of a but its direction depends on $\vec{a}$

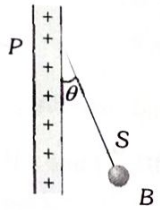
(d) $\vec{E}$ is uniform, and both its magnitude and direction depend on $\vec{a}$

31. A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^a$, 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. **[2009]**

(a) 3 (b) 5

(c) 2 (d) Both (a) and (b)

32. A charged ball B hangs from a silk thread S, which makes an angle θ with a large charged conducting sheet P, as shown in the figure. The surface charge density σ of the sheet is proportional to **[2005]**



(a) $\sin\theta$

(b) $\tan\theta$

(c) $\cos\theta$

(d) $\cot\theta$

33. Two large vertical and parallel metal plates having a separation of 1cm are connected to a DC voltage source of potential difference X. A proton is released at rest midway between the two plates. It is found to move at 45° to the vertical JUST after release. Then X is nearly **[2012]**

(a) 1×10^{-5} V (b) 1×10^{-7} V

(c) 1×10^{-9} V (d) 1×10^{-10} V

34. A thin spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centre of the shell. The electrostatic potential at a point p a distance $R/2$ from the centre of the shell is **[2003]**

(a) $\dfrac{(q+Q)}{4\pi\varepsilon_0}\dfrac{2}{R}$ (b) $\dfrac{2Q}{4\pi\varepsilon_0 R}$

(c) $\dfrac{2Q}{4\pi\varepsilon_0 R}-\dfrac{2q}{4\pi\varepsilon_0 R}$ (d) $\dfrac{2Q}{4\pi\varepsilon_0 R}+\dfrac{q}{4\pi\varepsilon_0 R}$

35. Two thin wire rings each having a radius R are placed at a distance d apart with their axes coinciding. The charges on the two rings are $+q$ and $-q$. The potential difference between the centres of the two rings is **[2005]**

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

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

36. 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 **[1981]**

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

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

37. 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 **[1989]**

(a) V (b) $2V$

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

38. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10 V. The potential at the centre of the sphere is **[1983]**

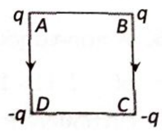
(a) 0 V

(b) 10 V

(c) Same as at point 5 cm away from the surface

(d) Same as at point 25 cm away from the surface

39. Charges are placed on the vertices of a square as shown. Let E be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then **[2007]**



(a) $\vec{E}$ remains unchanged, V changes

(b) Both $\vec{E}$ and V change

(c) $\vec{E}$ and V remains unchanged

(d) $\vec{E}$ changes, V remains unchanged

40. A long, hollow conducting cylinder is kept coaxially inside another long, hollow conducting cylinder of larger radius. Both the cylinders are initially electrically neutral **[2007]**

(a) A potential difference appears between the two cylinders when a charge density is given to the inner cylinder

(b) A potential difference appears between the two cylinders when a charge density is given to the outer cylinder

(c) No potential difference appears between the two cylinders when a uniform line charge is kept along the axis of the cylinders

(d) No potential difference appears between the two cylinders when same charge density is given to both the cylinders

41. The electric potential V at any point O (x, y, z all in metres) in space is given by $V=4x^2$ *volt*. The electric field at the point (1m, 0, 2m) in *volt/metre* is **[1992]**

(a) 8 along negative X–axis (b) 8 along positive X–axis

(c) 16 along negative X–axis (d) 16 along positive Z–axis

42. Assume that an electric field $\vec{E}=30x^2\hat{i}$ exists in space. Then the potential difference V_A-V_O, where V_O is the potential at the origin and V_A the potential at $x=2m$ is **[2014]**

(a) 120 V (b) –120 V

(c) –80 V (d) 80 V

43. 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 **[2001]**

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

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

44. Two spherical conductors A and B of radii 1 *mm* and 2 *mm* are separated by a distance of 5 *cm* and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surfaces of spheres A and B is **[2006]**

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

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

45. The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by $V(x)=20 / (x^2-4)$ *Volts*. The electric field E at $x=4\mu m$ is given by **[2007]**

(a) 5/3 *Volt* / μm and in the $-ve$ x direction

(b) 5/3 *Volt* / μm and in the $+ve$ x direction

(c) 10/9 *Volt* / μm and in the $-ve$ x direction

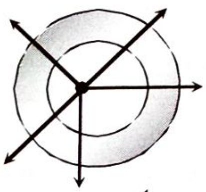
(d) 10/9 *Volt* / μm and in the $+ve$ x direction

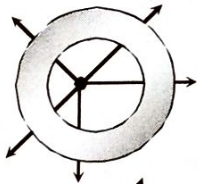
46. A non-conducting ring of radius $0.5\,m$ carries a total charge of $1.11\times10^{-10}\,C$ distributed non-uniformly on its circumference producing an electric field $\vec{E}$ everywhere in space. The value of the line integral $\int_{l=\infty}^{l=0} -\vec{E}.\vec{dl}$ $(l=0$ being centre of the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

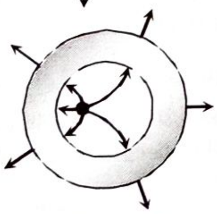
(a) + 2 (b) – 1

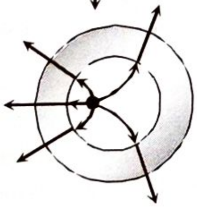
(c) – 2 (d) Zero

47. 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 **[2003]**

(a) 

(b) 

(c) 

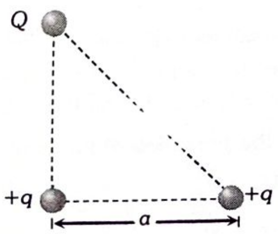
(d) 

48. Two points P and Q are maintained at the potentials of 10 V and –4V, respectively. The work done in moving 100 electrons from P to Q is **[2009]**

(a) $-9.60\times10^{-17}\,J$ (b) $9.60\times10^{-17}\,J$

(c) $-2.24\times10^{-16}\,J$ (d) $2.24\times10^{-16}\,J$

49. Three charges Q, $+q$ and $+q$ are placed at the vertices of a right-angled isosceles triangle as shown. The net electrostatic energy of the configuration is zero if Q is equal to **[2000]**



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

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

(c) $-2q$

(d) $+q$

50. The dimension of (1/2) $\varepsilon_0 E^2$(ε_0 : permittivity of free space; E : electric field) is **[2000]**

(a) MLT^{-1} (b) ML^2T^{-2}

(c) $ML^{-1}T^{-2}$ (d) ML^2T^{-1}

51. Positive and negative point charges of equal magnitude are kept at $\left(0,0,\frac{a}{2}\right)$ and $\left(0,0,\frac{-a}{2}\right)$, respectively. The work done by the electric field when another positive point charge is moved from $(-a, 0, 0)$ to $(0, a, 0)$ is **[2007]**

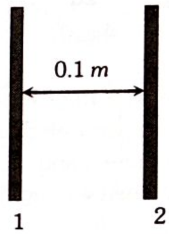
(a) Positive

(b) Negative

(c) Zero

(d) Depends on the path connecting the initial and final positions

52. Two insulating plates are both uniformly charged in such a way that the potential difference between them is $V_2 - V_1 = 20V$. (*i.e.* plate 2 is at a higher potential). The plates are separated by d = $0.1m$ and can be treated as infinitely large. An electron is released from rest on the inner surface of plate 1. What is its speed when it hits plate 2 $(e=1.6\times10^{-19}C,\ m_e=9.11\times10^{-31}kg)$? **[2006]**



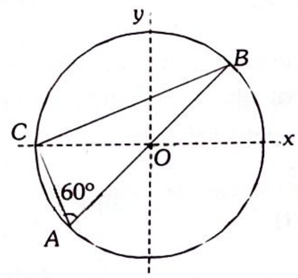
(a) $7.02\times10^{12}\,m/s$

(b) $1.87\times10^{6}\,m/s$

(c) $32\times10^{-19}\,m/s$

(d) $2.65\times10^{6}\,m/s$

53. Consider a system of three charges $\frac{q}{3}, \frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB = 60° **[2008]**



(a) The electric field at point O is $\frac{q}{8\pi\,\varepsilon_0 R^2}$ directed along the negative x-axis

(b) The Potential energy of the system is zero

(c) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\,\varepsilon_0\,R^2}$

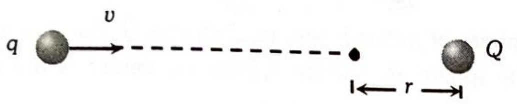
(d) The potential at point O is $\frac{q}{12\pi\varepsilon_0 R}$

54. 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 **[2002]**

(a) x (b) x^2

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

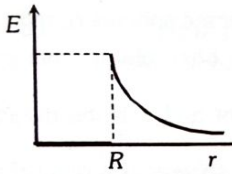
55. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q were given a speed $2v$, the closest distances of approach would be **[2004]**

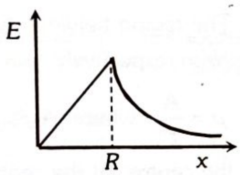


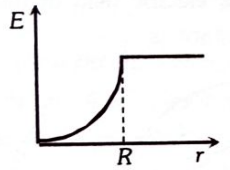
(a) r (b) $2r$

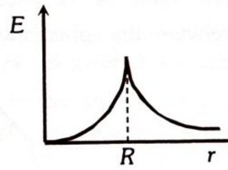
(c) $r/2$ (d) $r/4$

56. 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 **[2008]**

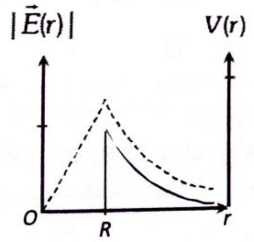
(a)


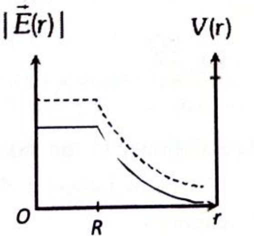
(b)


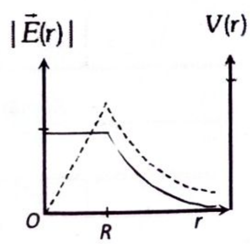
(c)


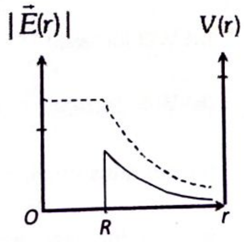
(d)


57. Consider a thin spherical shell of radius R with its centre at the origin, carrying uniform positive surface charge density. The variation of the magnitude of the electric field $|\vec{E}(r)|$ and the electric potential $V(r)$ with the distance r from the centre, is best represented by which graph **[2012]**

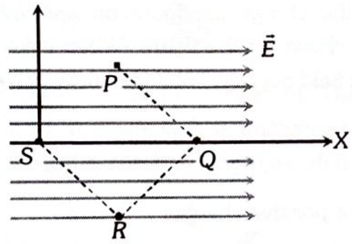
(a)


(b)


(c)


(d)


58. 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 **[1989]**



(a) qEa (b) $-qEa$

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

59. Three concentric metal shells A, B and C of respective radii a, b and c $(a < b < c)$ have surface charge densities $+\sigma, -\sigma$ and $+\sigma$ respectively. The potential of shell B is **[2018]**

(a) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2+b^2}{b}+c\right]$ (b) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-c^2}{b}\right]$

(c) $\frac{\sigma}{\varepsilon_0}\left[\frac{b^2-a^2}{b}+c\right]$ (d) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{b}+c\right]$

60. An electric dipole is kept in non-uniform electric field. It experiences **[2006]**

(a) A force and a torque

(b) A force but not a torque

(c) A torque but not a force

(d) Neither a force nor a torque

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

62. An electric dipole has a fixed dipole moment $\vec{p}$, which makes angle θ with respect to x-axis. When subjected to an electric field $\vec{E}_1 = E\hat{i}$, it experiences a torque $\vec{T}_1 = \tau\hat{k}$. When subjected to another electric field $\vec{E}_2 = \sqrt{3}E_1\hat{j}$ it experiences a torque $\vec{T}_2 = -\vec{T}_1$. The angle θ is **[2017]**

(a) 90° (b) 30°

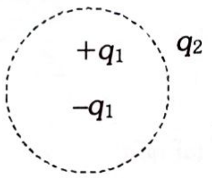
(c) 45° (d) 60°

63. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2 the electric charge inside the surface will be **[2003]**

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

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

64. Consider the charge configuration and spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface the electric field will be due to **[2004]**



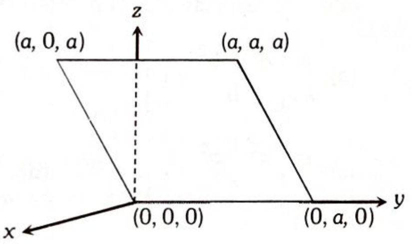
(a) q_2

(b) Only the positive charges

(c) All the charges

(d) $+q_1$ and $-q_1$

65. Consider an electric field $\vec{E} = E_0\,\hat{x}$, where E_0 is a constant. The flux through the shaded area (as shown in the figure) due to this field is **[2011]**



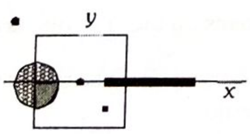
(a) $2E_0a^2$

(b) $\sqrt{2}E_0a^2$

(c) E_0a^2

(d) $\dfrac{E_0a^2}{\sqrt{2}}$

66. A disk of radius $a/4$ having a uniformly distributed charge 6C is placed in the x-y plane with its centre at $(-a/2, 0, 0)$. A rod of length a carrying a uniformly distributed charge 8C is placed on the x-axis from $x = a/4$ to $x = 5a/4$. Two point charges $-7\,C$ and $3C$ are placed at $(a/4, -a/4, 0)$ and $(-3a/4, 3a/4, 0)$, respectively. Consider a cubical surface formed by six surfaces $x = \pm a/2$, $y = \pm a/2$, $z = \pm a/2$. The electric flux through this cubical surface is **[2009]**



(a) $\dfrac{-2C}{\varepsilon_0}$ (b) $\dfrac{2C}{\varepsilon_0}$

(c) $\dfrac{10C}{\varepsilon_0}$ (d) $\dfrac{12C}{\varepsilon_0}$

67. The electrostatic potential inside a charged spherical ball is given by $\phi = ar^2 + b$ where r is the distance from the centre; a, b are constants. Then the charge density inside the ball is **[2011]**

(a) $-24\pi a\varepsilon_0 r$ (b) $-6a\varepsilon_0 r$

(c) $-24\pi a\varepsilon_0$ (d) $-6a\varepsilon_0$

68. Which of the following statement(s) is/are correct? **[2011]**

(a) If the electric field due to a point charge varies as $r^{-2.5}$ instead of r^{-2}, then the Gauss law will still be valid

(b) The Gauss law can be used to calculate the field distribution around an electric dipole

(c) If the electric field between two point charges is zero somewhere, then the sign of the two charges is the same

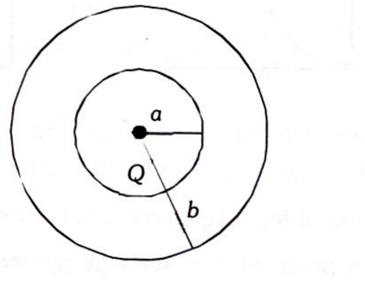
(d) The work done by the external force in moving a unit positive charge from point A at potential V_A to point B at potential V_B is $(V_B - V_A)$

69. Let $P(r) = \dfrac{Q}{\pi R^4}r$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point 'p' inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is **[2009]**

(a) 0 (b) $\dfrac{Q}{4\pi\varepsilon_0 r_1^2}$

(c) $\dfrac{Qr_1^2}{4\pi\varepsilon_0 R^4}$ (d) $\dfrac{Qr_1^2}{3\pi\varepsilon_0 R^4}$

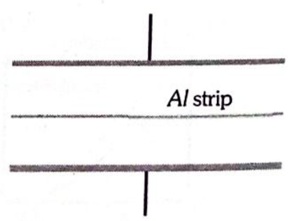
70. The region between two concentric spheres of radii 'a' and 'b', respectively (see figure), has volume charge density $\rho = \dfrac{A}{r}$, where A is a constant and r is the distance from the centre. At the centre of the spheres is a point charge Q. The value of A such that the electric field in the region between the spheres will be constant, is **[2016]**



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

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

71. As shown in the figure, a very thin sheet of aluminium is placed in between the plates of the condenser. Then the capacity **[2003]**



(a) Will increase

(b) Will decrease

(c) Remains unchanged

(d) May increase or decrease

72. A parallel plate condenser with a dielectric of dielectric constant k between the plates has a capacity C and is charged to a potential V *volts*. The dielectric stab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is **[2007]**

(a) $\frac{1}{2}(k-1)CV^2$ (b) $CV^2(k-1)/k$

(c) $(k-1)CV^2$ (d) Zero

73. A parallel plate capacitor is made of two circular plates separated by a distance of 5 mm and with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is $3\times10^4\ V/m$, the charge density of the positive plate will be close to **[2014]**

(a) $6\times10^{-7}\ C/m^2$ (b) $3\times10^{-7}C/m^2$

(c) $3\times10^4 C/m^2$ (d) $6\times10^4 C/m^2$

74. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be **[2007]**

(a) 1 (b) 2

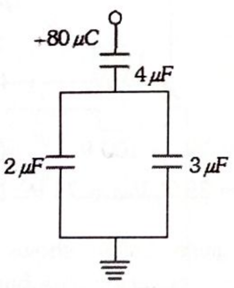
(c) 1/4 (d) 1/2

75. If there are n capacitors in parallel connected to V *volt* source, then the energy stored is equal to **[2002]**

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

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

76. In the given circuit, a charge of $+80\,\mu C$ is given to the upper plate of the $4\mu F$ capacitor. Then in the steady state, the charge on the upper plate of the $3\mu F$ capacitor is **[2012]**



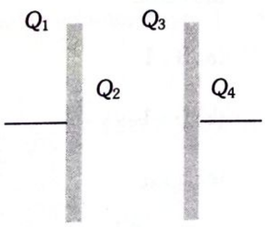
(a) $+32\,\mu C$

(b) $+40\,\mu C$

(c) $+48\,\mu C$

(d) $+80\,\mu C$

77. 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 **[1999]**



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

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

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

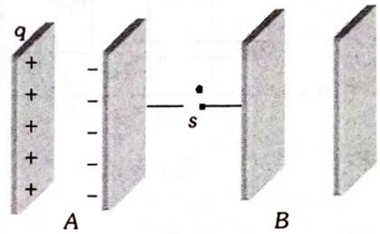
(d) $\frac{Q_1+Q_4}{2C}$

78. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density $0.8g\ cm^{-3}$, the angle remains the same. If density of the material of the sphere is $1.6g\ cm^{-3}$, the dielectric constant of the liquid is **[2010]**

(a) 1 (b) 4

(c) 3 (d) 2

79. 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 **[2001]**



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

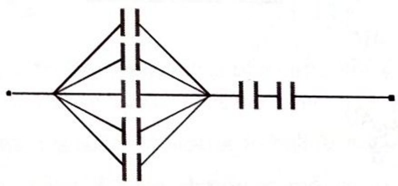
(c) q (d) $2q$

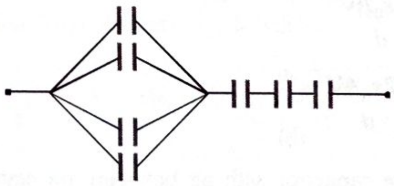
80. A parallel plate capacitor of capacitance 90 pF is connected to a battery of *emf* 20V. If a dielectric material of dielectric constant $K=\frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be **[2018]**

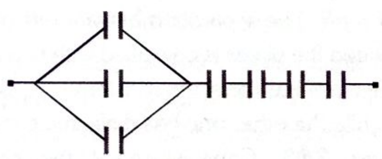
(a) $2.4\,nC$ (b) $0.9\,nC$

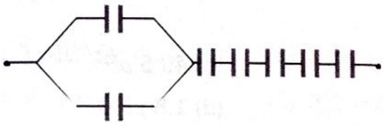
(c) $1.2\,nC$ (d) $0.3\,nC$

81. Seven capacitors each of capacity $2\mu F$ are to be so connected to have a equivalent capacity $\frac{10}{11}\mu F$. Which will be the necessary figure as shown **[1990]**

(a) 

(b) 

(c) 

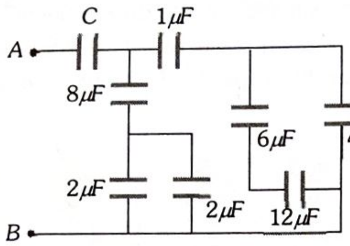
(d) 

82. A parallel plate capacitor is made by stacking n equally spaced plates connected alternately. If the capacitance between any two plates is C then the resultant capacitance is **[2005]**

(a) C (b) nC

(c) $(n-1)\,C$ (d) $(n+1)\,C$

83. In the following circuit, the resultant capacitance between A and B is $1\mu F$. Then value of C is **[1977]**



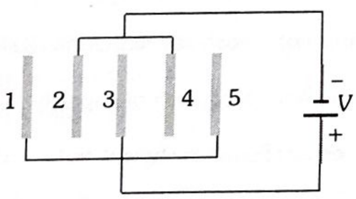
(a) $\frac{32}{11}\,\mu F$

(b) $\frac{11}{32}\,\mu F$

(c) $\frac{23}{32}\,\mu F$

(d) $\frac{32}{23}\,\mu F$

84. 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 **[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) $\frac{\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

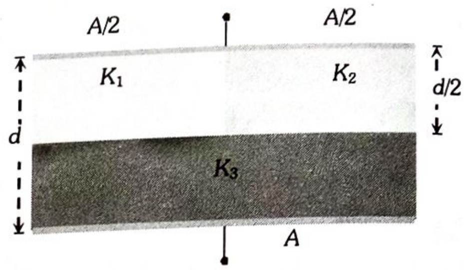
(d) $\frac{-\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$

85. A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is 'd'. The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $k_1 = 3$ and thickness $d/3$ while the other one has dielectric constant $k_2 = 6$ and thickness $2d/3$. Capacitance of the capacitor is now **[2008]**

(a) 45 pF (b) 40.5 pF

(c) 20.25 pF (d) 1.8 pF

86. A parallel plate capacitor of area A, plate separation d and capacitance C is filled with three different dielectric materials having dielectric constants k_1, k_2 and k_3 as shown. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by **[2000]**



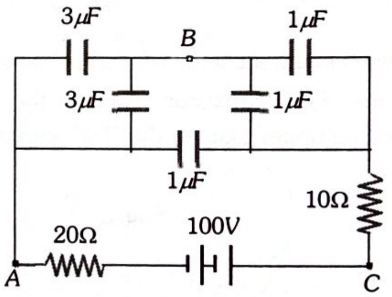
A = Area of plates

87. 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 **[1988]**

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

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

88. In the figure below, what is the potential difference between the points A and B and between B and C respectively in steady state **[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) $V_{AB} = V_{BC} = 50\ V$

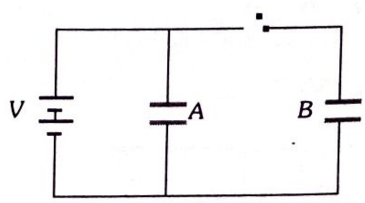
89. Figure given below shows two identical parallel plate capacitors connected to a battery with switch S closed. The switch is now opened and the free space between the plates of capacitors is filled with a dielectric of dielectric constant 3. What will be the ratio of total electrostatic energy stored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

(a) 3 : 1

(b) 5 : 1

(c) 3 : 5

(d) 5 : 3



90. 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 **[1995]**

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

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

91. Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero. Then **[2013]**

(a) $5C_1 = 3C_2$ (b) $3C_1 = 5C_2$

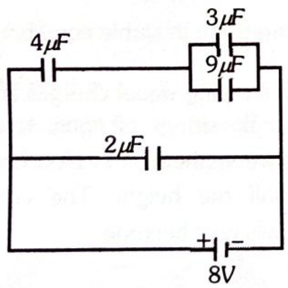
(c) $3C_1 + 5C_2 = 0$ (d) $9C_1 = 4C_2$

92. Two identical capacitors, have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the combined system is **[2002]**

(a) $\frac{1}{4}C(V_1^2 - V_2^2)$ (b) $\frac{1}{4}C(V_1^2 + V_2^2)$

(c) $\frac{1}{4}C(V_1 - V_2)^2$ (d) $\frac{1}{4}C(V_1 + V_2)^2$

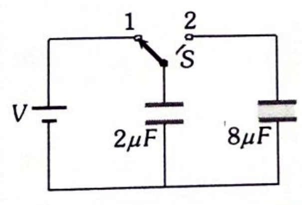
93. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the $4\mu F$ and $9\mu F$ capacitors), at a point distance 30 m from it, would equal **[2016]**



(a) 360 N/C (b) 420 N/C

(c) 480 N/C (d) 240 N/C

94. A $2\mu F$ capacitor is charged as shown in figure. The percentage of its stored energy dissipated after the switch S is turned to position 2 is **[2011]**



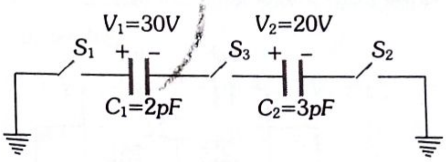
(a) 0%

(b) 20%

(c) 75%

(d) 80%

95. For the circuit shown, which of the following statements is true **[1999]**



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

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

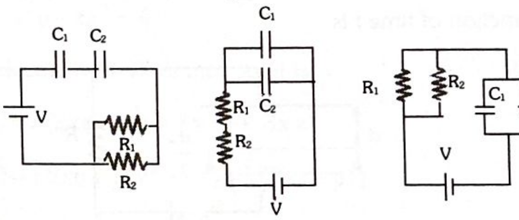
(c) With S_1 and S_2 closed $V_1 = V_2 = 0$

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

96. Given,

$R_1 = 1\Omega$ $C_1 = 2\mu F$

$R_2 = 2\Omega$ $C_2 = 4\mu F$



(I) (II) (III)

The time constants (in μ s) for the circuits, I, II, III, are respectively **[2006]**

(a) 18,18/9,4 (b) 18,4,8/9

(c) 4,8/9,18 (d) 8/9,18,4

97. 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] **[2005]**

(a) 13.86 s (b) 6.93 s

(c) 7 s (d) 14 s

98. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio t_1 / t_2 will be **[2010]**

(a) 2 (b) 1

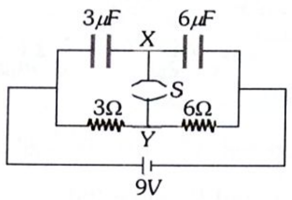
(c) $\frac{1}{2}$ (d) $\frac{1}{4}$

99. A resistor 'R' and $2\mu F$ capacitor in series is connected through a switch to 200 V direct supply. Across the capacitor is a neon bulb that lights up at 120 V. Calculate the value of R to make the bulb light up 5s after the switch has been closed. ($\log_{10} 2.5 = 0.4$) **[2011]**

(a) $1.3 \times 10^4\,\Omega$ (b) $1.7 \times 10^5\,\Omega$

(c) $2.7 \times 10^6\,\Omega$ (d) $3.3 \times 10^7\,\Omega$

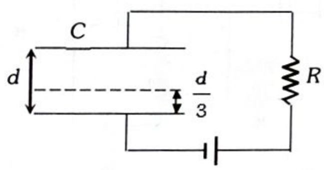
100. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is **[2007]**



(a) 0 (b) 54 μC

(c) 27 μC (d) 81 μC

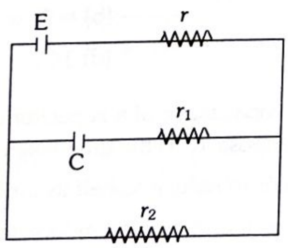
101. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant $k = 2$. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed V, the time constant as a function of time t is **[2008]**



(a) $\frac{6\varepsilon_0 R}{5d + 3Vt}$ (b) $\frac{(15d + 9Vt)\varepsilon_0 R}{2d^2 - 3dVt - 9V^2t^2}$

(c) $\frac{6\varepsilon_0 R}{5d - 3Vt}$ (d) $\frac{(15d - 9Vt)\varepsilon_0 R}{2d^2 + 3dVt - 9V^2t^2}$

102. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be **[2017]**



(a) $CE\frac{r_1}{(r_1 + r)}$ (b) CE

(c) $CE\frac{r_1}{(r_2 + r)}$ (d) $CE\frac{r_2}{(r + r_2)}$

103. A capacitance of $2\mu F$ is required in an electrical circuit across a potential difference of 1.0 kV. A large number of $1\mu F$ capacitors are available which can withstand a potential difference of not more than 300 V. The minimum number of capacitors required to achieve this is **[2017]**

(a) 32 (b) 2

(c) 16 (d) 24

8. NEET/AIPMT

1. When air is replaced by a dielectric medium of constant k, the maximum force of attraction between two charges separated by a distance **[1999]**

(a) Decreases k times (b) Remains unchanged

(c) Increases k times (d) Increases k^{-1} times

2. An electron is moving around the nucleus of a hydrogen atom in a circular orbit of radius r. The coulomb force $\vec{F}$ between the two is (Where $K = \frac{1}{4\pi\varepsilon_0}$) **[2003]**

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

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

3. 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 on an electron) **[2010]**

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

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

4. Point charges $+4q$, $-q$ and $+4q$ are kept on the x–axis at points $x=0$, $x=a$ and $x=2a$ respectively, then **[1992]**

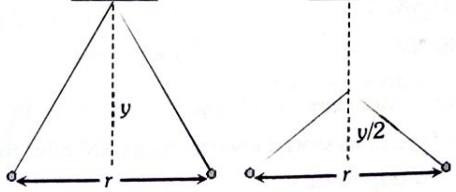
(a) Only q is in stable equilibrium

(b) None of the charges are in equilibrium

(c) All the charges are in unstable equilibrium

(d) All the charges are in stable equilibrium

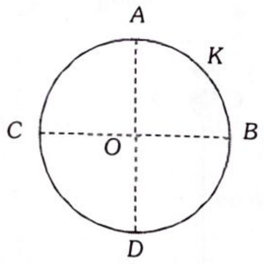
5. Two pith balls carrying equal charges are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become **[2013]**



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

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

6. A thin conducting ring of radius R is given a charge $+Q$. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part $ACDB$ of the ring is **[2008]**



(a) E along KO (b) $3E$ along OK

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

7. A hollow insulated conducting sphere is given a positive charge of $10\,\mu C$. What will be the electric field at the centre of the sphere if its radius is 2 meters? **[1998]**

(a) Zero (b) $5\,\mu Cm^{-2}$

(c) $20\,\mu Cm^{-2}$ (d) $8\,\mu Cm^{-2}$

8. A simple pendulum of period T has a metal bob which is negatively charged. If it is allowed to oscillate above a positively charged metal plate, its period will **[2001]**

(a) Remains equal to T (b) Less than T

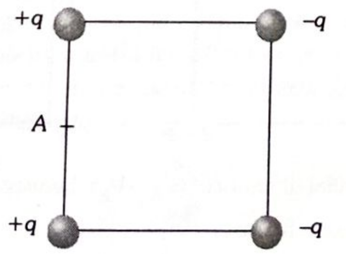
(c) Greater than T (d) Infinite

9. Four point charges $-Q$, $-q$, $2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is **[2012]**

(a) $Q=-q$ (b) $Q=-\frac{1}{q}$

(c) $Q=q$ (d) $Q=\frac{1}{q}$

10. Four electric charges $+q, +q, -q$ and $-q$ are placed at the corners of a square of side $2L$ (see figure). The electric potential at point A, midway between the two charges $+q$ **[2011]**



(a) Zero (b) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}(1+\sqrt{5})$

(c) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

11. Three concentric spherical shells have radii a, b and c $(a < b < c)$ and have surface charge densities $\sigma, -\sigma$ and σ respectively. If V_A, V_B and V_C denote the potentials of the three shells, then, for $c = a + b$, we have **[2009]**

(a) $V_C = V_A \neq V_B$ (b) $V_C = V_B \neq V_A$

(c) $V_C \neq V_B \neq V_A$ (d) $V_C = V_B = V_A$

12. A conducting sphere of radius R is given a charge Q. The electric potential and the electric field at the centre of the sphere respectively are **[2014]**

(a) $\frac{Q}{4\pi\varepsilon_0 R}$ and $\frac{Q}{4\pi\varepsilon_0 R^2}$ (b) Both are zero

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

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

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

The electric field $\vec{E}$ at that point is **[2015]**

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

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

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

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

14. The electric potential at a point in free space due to a charge Q coulomb is $Q \times 10^{11}$ *volts*. The electric field at the point is **[2008]**

(a) $4\pi\epsilon_0 Q \times 10^{20} V/m$ (b) $12\pi\epsilon_0 Q \times 10^{22} V/m$

(c) $4\pi\epsilon_0 Q \times 10^{22} V/m$ (d) $12\pi\epsilon_0 Q \times 10^{20} V/m$

15. 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 **[2014]**

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

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

16. There is an electric field E in X-direction. If the work done on moving a charge $0.2\,C$ through a distance of $2m$ along a line making an angle 60° with the X-axis is 4.0, what is the value of E **[1995]**

(a) $\sqrt{3}\,N/C$ (b) $4\,N/C$

(c) $5\,N/C$ (d) None of these

17. 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 **[1998]**

(a) qEy^2 (b) qE^2y

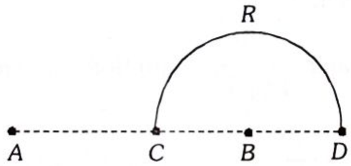
(c) qEy (d) q^2Ey

18. A bullet of mass 2 *gm* is having a charge of $2\mu C$. Through what potential difference must it be accelerated, starting from rest, to acquire a speed of 10 *m/s* **[2004]**

(a) 5 *kV* (b) 50 *kV*

(c) 5 *V* (d) 50 *V*

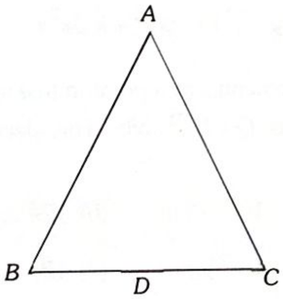
19. Charges $+q$ and $-q$ are placed at points *A* and *B* respectively which are a distance $2L$ apart, *C* is the midpoint between *A* and *B*. The work done in moving a charge $+Q$ along the semicircle *CRD* is **[2007]**



(a) $\frac{qQ}{4\pi\varepsilon_0 L}$ (b) $\frac{qQ}{2\pi\varepsilon_0 L}$

(c) $\frac{qQ}{6\pi\varepsilon_0 L}$ (d) $-\frac{qQ}{6\pi\varepsilon_0 L}$

20. Three charges, each $+q$, are placed at the corners of an isosceles triangle *ABC* of sides *BC* and *AC*, $2a$. *D* and *E* are the mid points of *BC* and *CA*. The work done in taking a charge *Q* from *D* to *E* is **[2011]**



(a) Zero (b) $\frac{3qQ}{4\pi \epsilon_o a}$

(c) $\frac{3qQ}{8\pi \epsilon_o a}$ (d) $\frac{qQ}{4\pi \epsilon_o a}$

21. The mean free path of electrons in a metal is $4\times10^{-8}\ m$. The electric field which can give on an average $2\,eV$ energy to an electron in the metal will be in units of *V/m* **[2009]**

(a) 8×10^{7} (b) 5×10^{-11}

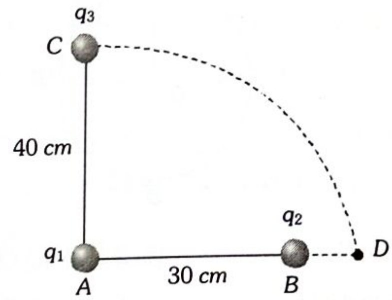
(c) 8×10^{-11} (d) 5×10^{7}

22. If identical charges $(-q)$ are placed at each corner of a cube of side *b*, then electric potential energy of charge $(+q)$ which is placed at centre of the cube will be **[2002]**

(a) $\frac{8\sqrt{2}q^2}{4\pi\varepsilon_0 b}$ (b) $\frac{-8\sqrt{2}q^2}{\pi\varepsilon_0 b}$

(c) $\frac{-4\sqrt{2}q^2}{\pi\varepsilon_0 b}$ (d) $\frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

23. 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 $\frac{q_3}{4\pi\varepsilon_0}k$, where *k* is **[2005]**



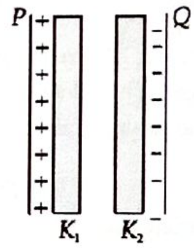
(a) $8q_2$

(b) $8q_1$

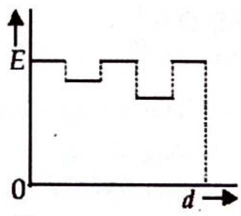
(c) $6q_2$

(d) $6q_1$

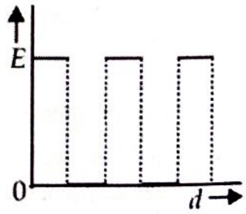
24. Two thin dielectric slabs of dielectric constants K_1 and K_2 ($K_1<K_2$) are inserted between plates of a parallel plate capacitor, as shown in the figure. The variation of electric field *E* between the plates with distance *d* as measured from plate *P* is correctly shown by **[2014]**



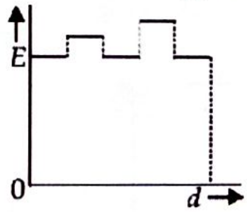
(a)



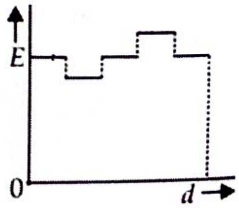
(b)



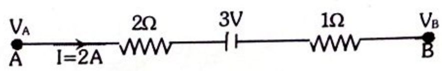
(c)



(d)



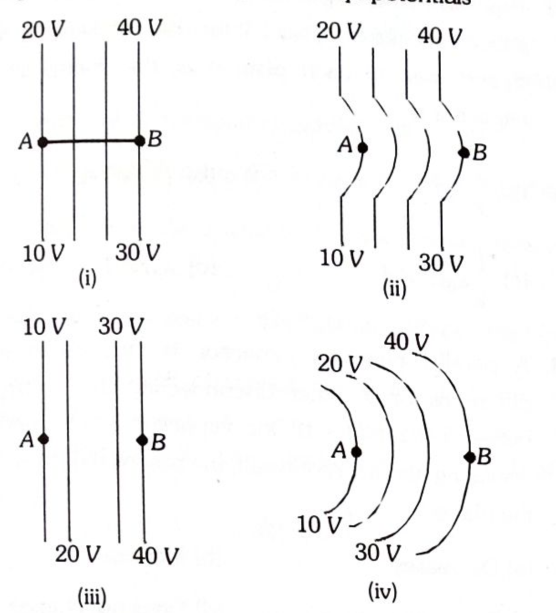
25. The potential difference $(V_A - V_B)$ between the points A and B in the given figure is



(a) +9V (b) –3V

(c) +3V (d) +6V

26. The diagrams below show regions of equipotentials



A positive charge is moved from A to B in each diagram **[2017]**

(a) Maximum work is required to move q in figure (iii)

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

(c) Minimum work is required to move q in figure (i)

(d) Maximum work is required to move q in figure (ii)

27. An electron is moving in a circular path under the influence of a transverse magnetic field of $3.57 \times 10^{-2} T$. If the value of e/m is $1.76 \times 10^{11} C/kg$, the frequency of revolution of the electron is **[2016]**

(a) 62.8 *MHz* (b) 6.28 *MHz*

(c) 1 *GHz* (d) 100 *MHz*

28. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electrical field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in through the same vertical distance h. The time fall of the electron, in comparison to the time fall of the proton is **[2018]**

(a) Smaller (b) 5 times greater

(c) 10 times greater (d) Equal

29. A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then electric field at Q is proportional to **[1998]**

(a) p^{-1} and r^{-2} (b) p and r^{-2}

(c) p^2 and r^{-3} (d) p and r^{-3}

30. The electric intensity due to a dipole of length 10 *cm* and having a charge of 500μC, at a point on the axis at a distance 20 *cm* from one of the charges in air, is **[2001]**

(a) 6.25×10^7 *N/C* (b) 9.28×10^7 *N/C*

(c) 13.1×11^{11} *N/C* (d) 20.5×10^7 *N/C*

31. 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 **[2007]**

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

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

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

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

32. An electric dipole of moment $\vec{p}$ is placed normal to the lines of force of electric intensity $\vec{E}$, then the work done in deflecting it through an angle of 180° is **[2006]**

(a) pE (b) $+2pE$

(c) $-2pE$ (d) Zero

33. An electric dipole of moment 'p' is placed in an electric field of intensity 'E'. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when θ =90°, the torque and the potential energy of the dipole will respectively be **[2012]**

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

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

34. An electric dipole has the magnitude of its charge as q and its dipole moment is p . It is placed in a uniform electric field E . If its dipole moment is along the direction of the field, the force on it and its potential energy are respectively **[2004]**

(a) $2q \cdot E$ and minimum (b) $q \cdot E$ and $p \cdot E$

(c) Zero and minimum (d) $q \cdot E$ and maximum

35. An electric dipole is placed t an angle of 30° with an electric field intensity $2 \times 10^5 N/C$. It experiences a torque equal to $4\,Nm$. The charge on the dipole, if the dipole length is $2\,cm$, is **[2016]**

(a) $7\,\mu C$ (b) $8\,mC$

(c) $2\,mC$ (d) $5\,mC$

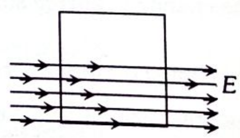
36. A square surface of side L *meteres* is in the plane of the paper. A uniform electric field $\vec{E}$ (*volt/m*), also in the plane of the paper, is limited only to the lower half of the square surface, (see figure). The electric flux is SI units associated with the surface is **[2010]**

(a) Zero

(b) EL^2

(c) $EL^2/(2\varepsilon_0)$

(d) $EL^2/2$

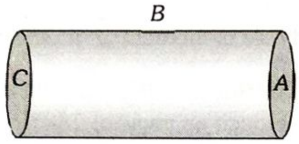


37. An electric charge q is placed at the centre of a cube of side a. The electric flux on one of its faces will be **[2003]**

(a) $\frac{q}{6\varepsilon_0}$ (b) $\frac{q}{\varepsilon_0 a^2}$

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

38. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of *volt-meter* associated with the curved surface B, the flux linked with the plane surface A in units of *volt-meter* will be **[2007]**



(a) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$ (b) $\frac{q}{2\varepsilon_0}$

(c) $\frac{\phi}{3}$ (d) $\frac{q}{\varepsilon_0}-\phi$

39. The electric field in a certain region is acting radially outward and is given by $E = Ar$. A charge contained in a sphere of radius 'a' centred at the origin of the field, will given by **[2015]**

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

(c) $\varepsilon_0 Aa^3$ (d) $4\pi\varepsilon_0 Aa^3$

40. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will **[2011]**

(a) Be doubled (b) Increase four times

(c) Be reduced to half (d) Remain the same

41. The capacity of a parallel plate condenser is $15\,\mu F$, when the distance between its plates is 6 *cm*. If the distance between the plates is reduced to 2 *cm*, then the capacity of this parallel plate condenser will be **[2001]**

(a) $15\,\mu F$ (b) $30\,\mu F$

(c) $45\,\mu F$ (d) $60\,\mu F$

42. A parallel plate air capacitor of capacitance C is connected to a cell of *emf* V and then disconnected from it. A dielectric slab of dielectric constant k, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect? **[2015]**

(a) The energy stored in the capacitor decreases k times

(b) The change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{k}-1\right)$

(c) The charge on the capacitor is not conserved

(d) The potential difference between the plates decreases k times

43. A parallel plate capacitor has a uniform electric field E in the space between the plates. If the distance between the plates is d and area of each plate is A, the energy stored in the capacitor is **[2012]**

(a) $\frac{1}{2}\varepsilon_0 E^2$ (b) $E^2 Ad/\varepsilon_0$

(c) $\frac{1}{2}\varepsilon_0 E^2 Ad$ (d) $\varepsilon_0 EAd$

44. A parallel plate air capacitor is charged to a potential difference of V. After disconnecting the battery, distance between the plates of the capacitor is increased using an insulating handle. As a result, the potential difference between the plates **[2006]**

(a) Decreases (b) Increases

(c) Becomes zero (d) Does not change

45. Two metallic spheres of radii $1\,cm$ and $2\,cm$ are given charges $10^{-2}\,C$ and $5\times10^{-2}\,C$ respectively. If they are connected by a conducting wire, the final charge on the smaller sphere is **[1995]**

(a) $3\times10^{-2}\,C$ (b) $1\times10^{-2}\,C$

(c) $4\times10^{-2}\,C$ (d) $2\times10^{-2}\,C$

46. If the distance between parallel plates of a capacitor is halved and dielectric constant is doubled then the capacitance **[2002]**

(a) Decreases two times (b) Increases two times

(c) Increases four times (d) Remains the same

47. A parallel plate air capacitor has capacity 'C' distance of separation between plates is 'd' and potential difference 'V' is applied between the plates. Force of attraction between the plates of the parallel plate air capacitor is **[2015]**

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

(c) $\frac{C^2V^2}{2d^2}$ (d) $\frac{C^2V^2}{2d^2}$

48. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system **[2017]**

(a) Increases by a factor of 4

(b) Decreases by a factor of 2

(c) Remains the same

(d) Increases by a factor of 2

49. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is **[2018]**

(a) Independent of the distance between the plates

(b) Linearly proportional to the distance between the plates

(c) Proportional to the square root of the distance between the plates

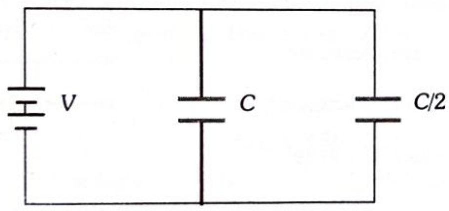
(d) Inversely proportional to the distance between the plates

50. Three capacitors each of capacitance C and of breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination will be **[2009]**

(a) $\frac{C}{3}, \frac{V}{3}$ (b) $3C, \frac{V}{3}$

(c) $\frac{C}{3}, 3V$ (d) $3C, 3V$

51. Two condensers, one of capacity C and the other of capacity C/2, are connected to a V-volt battery, as shown



The work done in charging fully both the condensers is **[2007]**

(a) $2CV^2$ (b) $\frac{1}{4}CV^2$

(c) $\frac{3}{4}CV^2$ (d) $\frac{1}{2}CV^2$

52. Three capacitors each of capacity $4\,\mu F$ are to be connected in such a way that the effective capacitance is $6\,\mu F$. This can be done by **[2003]**

(a) Connecting them in parallel

(b) Connecting two in series and one in parallel

(c) Connecting two in parallel and one in series

(d) Connecting all of them in series

53. A capacitor of capacity C_1 is charged upto V volt and then connected to an uncharged capacitor of capacity C_2. Then final potential difference across each will be **[2002]**

(a) $\frac{C_2V}{C_1+C_2}$ (b) $\left(1+\frac{C_2}{C_1}\right)V$

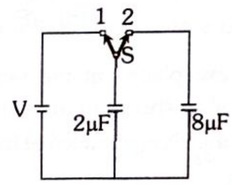
(c) $\frac{C_1V}{C_1+C_2}$ (d) $\left(1-\frac{C_2}{C_1}\right)V$

54. A series combination of n_1 capacitors each of value C_1, is charged by a source of potential difference $4V$. When another parallel combination of n_2 capacitors, each of value C_2, is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has, The value of C_2, in terms of C_1, is then **[2010]**

(a) $\frac{16C_1}{n_1n_2}$ (b) $\frac{2C_1}{n_1n_2}$

(c) $16\frac{n_2}{n_1}C_1$ (d) $2\frac{n_2}{n_1}C_1$

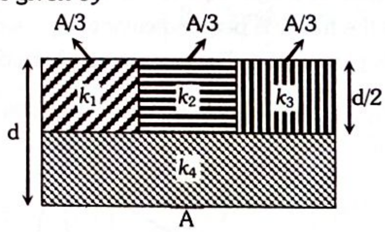
55. A capacitor of $2\mu F$ is charged as shown in the diagram. When the switch S is turned to position 2, the percentage of its stored energy dissipated is **[2016]**



(a) 0% (b) 20%

(c) 75% (d) 80%

56. A parallel-plate capacitor of area A, plate separation d and capacitance C is filled with four dielectric materials having dielectric constants k_1, k_2, k_3 and k_4 as shown in the figure below. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by **[2016]**



(a) $\frac{2}{k}=\frac{3}{k_1+k_2+k_3}+\frac{1}{k_4}$

(b) $\frac{1}{k}=\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{k_3}+\frac{3}{2k_4}$

(c) $k=k_1+k_2+k_3+3k_4$

(d) $k=\frac{2}{3}(k_1+k_2+k_3)+2k_4$

9. AIIMS

1. A body can be negatively charged by **[1998]**

(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

2. Number of electrons in one coulomb of charge will be **[1999]**

(a) 5.46×10^{29} (b) 6.25×10^{18}

(c) $1.6 \times 10^{+19}$ (d) 9×10^{11}

3. Two identical conductors of copper and aluminium are placed in an identical electric field. The magnitude of induced charge in the aluminium will be **[1999]**

(a) Zero (b) Greater than in copper

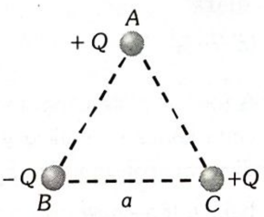
(c) Equal to that in copper (d) Less than in copper

4. Two charged spheres separated at a distance d exert a force F on each other. If they are immersed in a liquid of dielectric constant 2, then what is the force (if all conditions are same) **[1997]**

(a) $F/2$ (b) F

(c) $2F$ (d) $4F$

5. 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 **[2003]**



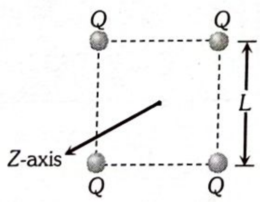
(a) $Q^2/(4\pi\varepsilon_0 a^2)$

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

(c) Zero

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

6. Four point $+ve$ charges of same 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 **[2005]**



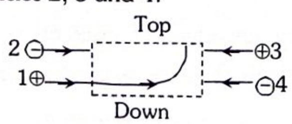
(a) – ve charge oscillates along the Z–axis.

(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.

7. The figure shows the path of a positively charged particle 1 through a rectangular region of uniform electric field as shown in the figure. What is the direction of electric field and the direction of particles 2, 3 and 4? **[2007]**



(a) Top; down, top, down (b) Top; down, down, top

(c) Down; top, top, down (d) Down; top, down, down

8. On rotating a point charge having a charge q around a charge Q in a circle of radius r. The work done will be **[1997]**

(a) $q \times 2\pi r$ (b) $\dfrac{q \times 2\pi Q}{r}$

(c) Zero (d) $\dfrac{Q}{2\varepsilon_0 r}$

9. Equipotential surfaces associated with an electric field which is increasing in magnitude along the x-direction are **[2004]**

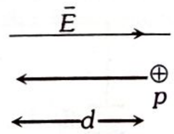
(a) Planes parallel to yz-plane

(b) Planes parallel to xy-plane

(c) Planes parallel to xz-plane

(d) Coaxial cylinders of increasing radii around the x-axis

10. In the figure, a proton moves a distance d in a uniform electric field $\vec{E}$ as shown in the figure. Does the electric field do a positive or negative work on the proton? Does the electric potential energy of the proton increase or decrease **[2007]**



(a) Negative, increase

(b) Positive, decrease

(c) Negative, decrease

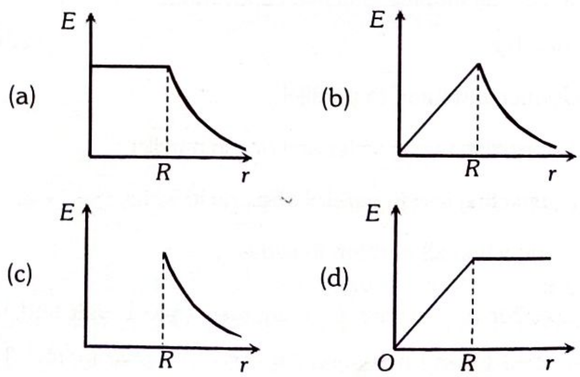
(d) Positive, increase

11. A proton is about 1840 times heavier than an electron. When it is accelerated by a potential difference of 1 kV, its kinetic energy will be **[2003]**

(a) 1840 keV (b) 1/1840 keV

(c) 1 keV (d) 920 keV

12. 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 **[2004]**



13. A sphere of radius R has a uniform distribution of electric charge in its volume. At a distance x from its centre, for $x < R$, the electric field is directly proportional to **[1997]**

(a) $1/x^2$ (b) $1/x$

(c) x (d) x^2

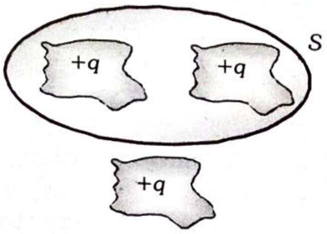
14. Shown below is a distribution of charges. The flux of electric field due to these charges through the surface S is **[2003]**

(a) $3q/\varepsilon_0$

(b) $2q/\varepsilon_0$

(c) q/ε_0

(d) Zero



15. What is the area of the plates of a $3F$ parallel plate capacitor, if the separation between the plates is $5mm$? **[1998]**

(a) $1.694 \times 10^9 m^2$ (b) $4.529 \times 10^9 m^2$

(c) $9.281 \times 10^9 m^2$ (d) $12.981 \times 10^9 m^2$

16. A 40 μF capacitor in a defibrillator is charged to 3000 V. The energy stored in the capacitor is sent through the patient during a pulse of duration $2ms$. The power delivered to the patient is **[2004]**

(a) 45 kW (b) 90 kW

(c) 180 kW (d) 360 kW

17. The voltage of clouds is 4×10^6 *volt* with respect to ground. In a lightening strike lasting 100 *m sec*, a charge of 4 coulombs is delivered to the ground. The power of lightening strike is **[2006]**

(a) 160 MW (b) 80 MW

(c) 20 MW (d) 500 KW

18. A conducting sphere of radius $10cm$ is charged $10\mu C$. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that if the sphere are separated, then surface density of charges, on the spheres will be in the ratio of **[2002]**

(a) 1 : 4 (b) 1 : 3

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

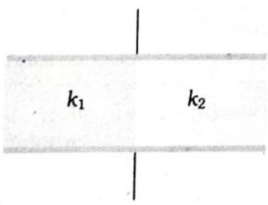
19. A parallel plate condenser is filled with two dielectrics as shown. Area of each plate is A *metre*^{2} and the separation is t *metre*. The dielectric constants are k_1 and k_2 respectively. Its capacitance in farad will be **[2001]**

(a) $\frac{\varepsilon_0 A}{t}(k_1 + k_2)$

(b) $\frac{\varepsilon_0 A}{t} \cdot \frac{k_1 + k_2}{2}$

(c) $\frac{2\varepsilon_0 A}{t}(k_1 + k_2)$

(d) $\frac{\varepsilon_0 A}{t} \cdot \frac{k_1 - k_2}{2}$



20. Five capacitors, each of capacitance value C are connected as shown in the figure. The ratio of capacitance between P and R, and the capacitance between P and Q, is **[2006]**

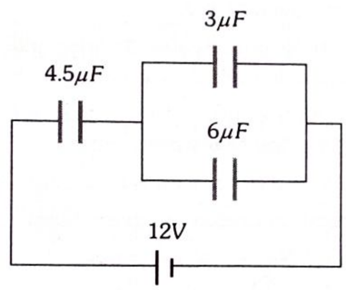
(a) 3 : 1

(b) 5 : 2

(c) 2 : 3

(d) 1 : 1

21. In the circuit shown in the figure, the potential difference across the $4.5\mu F$ capacitor is **[2010]**



(a) $\frac{8}{3}$ *volts* (b) 4 *volts*

(c) 6 *volts* (d) 8 *volts*

22. Three capacitors of capacitance $3\mu F$, $10\mu F$ and $15\mu F$ are connected in series to a voltage source of 100V. The charge on 15 μF is **[2000]**

(a) 50 μC (b) 100 μC

(c) 200 μC (d) 280 μC

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

(a) 40 (b) 32

(c) 8 (d) 2

24. Electric potential of earth is taken to be zero because earth is a good **[1998]**

(a) Insulator (b) Conductor

(c) Semiconductor (d) Dielectric

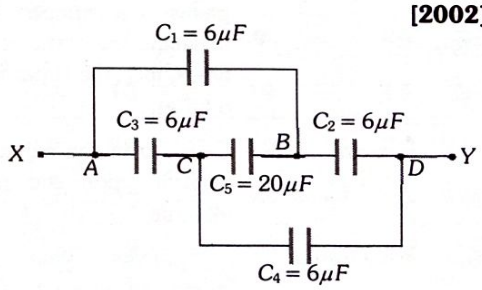
25. What is the effective capacitance between points X and Y **[2002]**

(a) $24\mu F$

(b) $18\mu F$

(c) $12\mu F$

(d) $6\mu F$



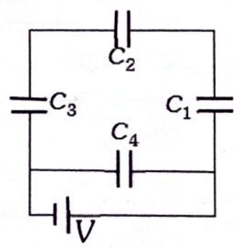
26. A network of four capacitors of capacities equal to $C_1 = C, C_2 = 2C, C_3 = 3C$ and $C_4 = 4C$ are connected to a battery as shown in the figure. The ratio of the charges on C_2 and C_4 is **[2010]**

(a) 22 / 3

(b) 3 / 22

(c) 7 / 4

(d) 4 / 7



10. Assertion & Reason

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.

2. Assertion : If three capacitors of capacitance $C_1 < C_2 < C_3$ are connected in parallel then their equivalent capacitance $C_p > C_3$

Reason : $\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

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.

4. Assertion : Electrons move away from a low potential to high potential region.

Reason : Because electrons have negative charge

5. Assertion : If the distance between parallel plates of a capacitor is halved and dielectric constant is made three times, then the capacitance becomes 6 times.

Reason : Capacity of the capacitor does not depend upon the nature of the material.

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.

7. Assertion : Electric lines of force cross each other.

Reason : Electric field at a point superimposes to give one resultant electric field.

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.

9. 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.

10. 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.

11. Assertion : Displacement current goes through the gap between the plates of a capacitor when the charge of the capacitor does not change.

Reason : The displacement current arises in the region in which the electric field and hence the electric flux does not change with time.

12. 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.

13. 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.

14. Assertion : The tyres of aircraft are slightly conducting.

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

15. 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.

18. Electrostatics – Answers Keys

1. Charge and Coulomb's Law

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

2. Electric Field and Potential

1	a	2	c	3	b	4	c	5	c
6	d	7	d	8	c	9	ab	10	a
11	b	12	c	13	b	14	a	15	c
16	c	17	c	18	d	19	b	20	a
21	c	22	d	23	b	24	a	25	a
26	b	27	a	28	d	29	c	30	c
31	a	32	d	33	c	34	b	35	c
36	b	37	b	38	c	39	b	40	c
41	b	42	c	43	b	44	c	45	c
46	c	47	b	48	d	49	d	50	c
51	b	52	c	53	a	54	a	55	b
56	a	57	b	58	b	59	b	60	a
61	d	62	b	63	d	64	b	65	c
66	b	67	c	68	a	69	c	70	d
71	b	72	b	73	c	74	b	75	c
76	b	77	c						

3. Electric Dipole

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

4. Electric Flux and Gauss's Law

1	c	2	d	3	d	4	d	5	c
6	b	7	a	8	b	9	c	10	d
11	a	12	b	13	d	14	c	15	e
16	a	17	c	18	b	19	a		

5. Capacitance

1	c	2	d	3	d	4	b	5	c
6	a	7	d	8	a	9	d	10	d
11	c	12	c	13	b	14	c	15	b
16	d	17	c	18	a	19	d	20	b
21	b	22	b	23	a	24	a	25	a
26	a	27	a	28	c	29	d	30	d
31	c	32	c	33	d	34	a	35	c
36	b	37	c	38	a	39	d	40	c
41	d	42	b	43	d	44	d	45	c

6. Grouping of Capacitors

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

7. IIT-JEE/AIEEE

1	d	2	b	3	a	4	b	5	d
6	a	7	a	8	c	9	b	10	d

11	a	12	c	13	c	14	d	15	b
16	b	17	d	18	c	19	a	20	c
21	a	22	c	23	b	24	c	25	c
26	c	27	c	28	a	29	b	30	d
31	c	32	b	33	c	34	d	35	d
36	d	37	a	38	b	39	d	40	a
41	a	42	c	43	b	44	b	45	d
46	a	47	c	48	d	49	b	50	c
51	c	52	d	53	c	54	b	55	d
56	a	57	d	58	b	59	d	60	a
61	a	62	d	63	b	64	c	65	c
66	a	67	d	68	c	69	c	70	d
71	c	72	d	73	a	74	d	75	b
76	c	77	c	78	d	79	a	80	c
81	a	82	c	83	d	84	c	85	b
86	b	87	a	88	c	89	c	90	c
91	c	92	c	93	b	94	d	95	d
96	d	97	a	98	d	99	c	100	c
101	a	102	d	103	a				

8. NEET/AIPMT

1	ad	2	c	3	d	4	c	5	c
6	d	7	a	8	b	9	a	10	d
11	a	12	d	13	a	14	c	15	d
16	d	17	c	18	b	19	d	20	a
21	d	22	d	23	a	24	a	25	a
26	b	27	c	28	a	29	d	30	a
31	b	32	d	33	a	34	c	35	c
36	a	37	a	38	a	39	b	40	d
41	c	42	c	43	c	44	b	45	d
46	c	47	a	48	b	49	a	50	c
51	c	52	b	53	c	54	a	55	d
56	a								

9. AIIMS

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

10. Assertion and Reason

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