ELECTROSTATICS

GUPTA CLASSES

For any help contact:
9953168795, 9268789880

ELECTROSTATICS

Charge

Charging a body implies transfer of charge (electrons) from one body to another. Positively charged body means loss of electrons, i.e., deficiency of electrons. Negatively charged body means excess of electrons.

Conservation of charge: In an isolated system, total charge (sum of positive and negative) remains constant.

Quantization of charge: Charge on any body always exists in integral multiples of a fundamental unit of electric charge. This unit is equal to the magnitude of charge on electron (i.*e.* = 1.6 x 10^{-19} coulomb). So $Q = \pm ne$, where n is an integer and e is the charge of the electron.

1. Repulsion is a sure test of electrification. A charged body may attract a neutral body or an oppositely charged body but it always repels a similarly charged body.
2. A body can be charged by means of (a) friction (b) conduction and (c) induction.
3. In charging by induction, if q be the inducing charge, then charge induced on body having dielectric constant K is given by: $q' = -q\left(1-\frac{1}{K}\right)$. For a conductor induced charge is: $q' = -q$ (as K = ∞ for a conductor). Charging a body by means of induction is preferable since the same charged body can be used to charge any number of bodies without loss of charge.
4. A charge at rest produces only electric field around itself; a charge having un-accelerated motion produces electric as well as magnetic field around itself while a charge having accelerated motion emits electromagnetic radiation also in addition to producing electric and magnetic fields.
5. **Surface charge density:** Surface charge density on a charged conductor $\sigma \propto 1/r$ (r is radius of curvature)

Coulomb's law

The force of attraction or repulsion between two point charges is given by:

(a) For air or vacuum $F_{air} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$

(b) For any other medium $F_{medium} = \frac{1}{4\pi\varepsilon}\left(\frac{q_1q_2}{r^2}\right) = \frac{1}{4\pi\varepsilon_0\varepsilon_r}\left(\frac{q_1q_2}{r^2}\right)$, So $\varepsilon_r = \frac{F_{air}}{F_{medium}}$ where, $\varepsilon_r = (\varepsilon/\varepsilon_0)$ = relative permittivity of the medium and it is also known as dielectric constant (K) of the medium. It has got no units and no dimensions. The dielectric constant of a metal is infinity.

2. If a charge Q is to be divided into two parts such that the force between them is to be maximum, then each part is equal to $Q/2$.
3. When two identical conductors having charges q_1 and q_2 are put in contact and then separated, then each has a charge equal to $(q_1 + q_2)/2$. On the other hand, if charges are q_1 and $-q_2$, then each has a charge $(q_1 - q_2)/2$.

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

4. Two charges Q each are at a distance r from each other. If a third charge q equal to $(-Q/4)$ is placed at a distance $(r/2)$ from each charge, then all the charges will be in equilibrium.
5. The force of interaction (attraction or repulsion) between two charges increases with decrease of dielectric constant and is maximum when the medium between them is air.

Electric field and electric field intensity:

The electric field intensity $\vec{E}$ at any point is equal in magnitude to the force experienced per unit (test) charge placed at that point and is directed along the direction of the force experienced,

i.e., $\vec{E} = \frac{\vec{F}}{q_0}$

1. Electric field intensity $\vec{E}$ is a vector quantity. Electric field intensity due to a positive charge is always away from the charge and that due to a negative charge is always towards the charge.
2. Unit of $\vec{E}$ is newton/coulomb or volt/metre and its dimensional formula is $[MLT^{-3}A^{-1}]$.
3. Electric field due to a point charge q at a distance r from it is: $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$
4. Intensity of the electric field inside a charged spherical (hollow or solid) conductor is zero, since charge resides on the outer surface of the conductor.
5. The intensity of the electric field outside the charged spherical (hollow or solid) conductor is:

   $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ where $r > R$ (R = radius of spherical conductor)
6. Electric field due to a non-conducting charged sphere:

   (a) $E_{out} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$, (b) $E_{surface} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2}$, (c) $E_{in} = \frac{1}{4\pi K\varepsilon_0}\frac{Qr}{R^3}$
7. Intensity of the electric field at some point (distant x from centre) on the axis of uniformly charged ring (Radius R) is given by: $E = \frac{1}{4\pi\varepsilon_0}\frac{qx}{(x^2+R^2)^{3/2}}$ i.e. $E \propto x$, for a small distance, but it is zero at the centre of ring.
8. Electric field due to a plane sheet (infinite dimensions) of charge having surface charge density σ is: $E = (\sigma/2\varepsilon_0)$. For a positively charged sheet, the field is directed towards outward normal and does not depend on the distance of point from the sheet.
9. For a charged metal plate, $E_{inside} = 0$ and $E_{out} = (\sigma/\varepsilon_0)$.
10. Intensity of the electric field in between the plates of a charged parallel plate capacitor is $E = (\sigma/\varepsilon_0)$.
11. Electric field at a distance r from a line charge (density λ) is: $E = \frac{\lambda}{2\pi\varepsilon_0 r} = K\left(\frac{2\lambda}{r}\right)$. If the line charge is a cylinder of radius R,

    (a) then the electric field outside: $E = \lambda/2\pi\varepsilon_0 r$

    (b) electric field on the surface; $E = \lambda/2\pi\varepsilon_0 R$

    (c) and electric field inside at a distance r from the axis: $E = \frac{\lambda r}{2\pi\varepsilon_0 R^2}$

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

Electric lines of force

The imaginary line or a curve, tangent to which at any point gives the direction of field at that point, is known as electric line of force.

1. Electric field lines emerge from a positive charge and terminate into a negative charge.
2. Electric lines of force never cross each other.
3. Electric field lines do not exist inside a conductor.
4. Electric field lines are always perpendicular to charged conducting surface.
5. Electric field lines never form closed loops.
6. Electric field lines are always perpendicular to equipotential surface.
7. In a uniform electric field, the electric lines of force are equidistant, parallel straight lines.
8. If the lines of force are closer, the intensity of electric field is more and if the lines of force are far apart, the intensity of electric field is less.
9. If a metallic solid sphere is placed in a uniform electric field, then the lines of force are normal to the surface at every point but they cannot pass through the conductor.

Electric dipole

Two equal and opposite charges separated by a small distance constitute an electric dipole.

Electric dipole moment $\vec{p}$ is a vector quantity whose magnitude is equal to the product of magnitude of one charge and the distance between the two charges. It is directed from negative charge to positive charge.

Electric field at some axial point: at a distance r from midpoint of dipole of length 2*a*, the magnitude of field is: $E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2pr}{[r^2 - a^2]^2}$ The direction of $\vec{E}$ is along axis and parallel to $\vec{p}$. For short dipole $r >> 2a$ $E = \frac{1}{4\pi\varepsilon_0}\left(\frac{2p}{r^3}\right)$

Electric field at some equatorial point: at a distance r from midpoint of dipole of length 2*a*, the magnitude of electric field is: $E = \frac{1}{4\pi\varepsilon_0} \frac{p}{[r^2 + a^2]^{3/2}}$ The direction of $\vec{E}$ is opposite to that of $\vec{p}$.

For short dipole $r >> 2a$ $E = \frac{1}{4\pi\varepsilon_0}\left(\frac{p}{r^3}\right)$

1. If θ be the angle between the direction of uniform electric field *E* and the axis of dipole, then the torque acting on the dipole is: $\tau = pE \sin\theta$ or $\vec{\tau} = \vec{p} \times \vec{E}$ and potential energy $U = -pE\cos\theta$
2. The work done in deflecting the dipole through an angle θ_1 to θ_2 is given by: $W = pE(\cos\theta_1 - \cos\theta_2)$

Electric flux

Electric flux is defined as $d\phi = \vec{E} \cdot \vec{dS}$ or $\phi = \int \vec{E} \cdot \vec{dS}$ and for a closed surface, $\phi = \oint \vec{E} \cdot \vec{dS}$. In a uniform electric field $\vec{E}$, flux through a plane surface of area $\vec{S}$ is: $\phi = \vec{E} \cdot \vec{S} = ES\cos\theta$. The flux is positive, if field lines leave the area, negative if field lines enter the area.

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

Gauss' law: The total or net outward electric flux through a closed surface is equal to the total charge enclosed by the surface divided by ε_0, i.e.,. $\phi = \oint \vec{E}\cdot\vec{dS}$ = (q/ε_0). Even if total net flux through a closed surface is zero, the electric field E at the Gaussian surface may be nonzero. (e.g. A conductor placed in uniform electric field)

Force per unit area on a charged conductor (or electric pressure):

If σ is the surface charge density, then electric pressure $dF/dA = (\sigma^2/2\varepsilon_0)$. The force is always directed outward as $(\pm\sigma)^2$ is positive, i.e., whether body is charged positively or negatively, this force will always try to expand the charged body. A soap bubble or rubber balloon expands on giving a positive or negative charge to it.

Electric potential

The absolute electric potential at any point in the electric field is defined as the work done per unit positive charge required to move the test charge from infinity to that point. Potential difference between two points A and B in an electric field is defined as the work required to move a unit positive charge from the point A to the point B against the intensity of the electric field.

i.e. $V_B - V_A = \frac{W_{AB}}{q_0}$ (where q_0 is the test charge)

(a) If W_{AB} is +ve, $V_B > V_A$ (b) if W_{AB} is – ve, $V_B < V_A$ and (c) if W_{AB} is zero, $V_B = V_A$.

1. The electric potential at a distance r from a point charge q is given by: $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$
2. The electric potential at a point due to a group of point charges q_1, q_2,........, q_n, which are at distances r_1, r_2, ...,r_n, from the point, is given by: $V = V_1 + V_2 + V_3 + \ldots\ldots V_n$
3. The potential at any point due to a dipole is given by: $V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$ (where $p = 2lq$ = electric dipole moment)
4. The potential on the axial line of the dipole: $V = \frac{1}{4\pi\varepsilon_0}\left(\frac{p}{r^2}\right)$ and the potential on the equator of the dipole is zero
5. **Potential due to a charged hollow spherical conductor:** Electric potential is constant from the centre to the surface and is equal to $V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{R}\right)$. Outside the conductor, the potential is inversely proportion to the distance from the centre.
6. If the charge distribution is continuous rather than being a collection of point charges, then $V = \int dV = \frac{1}{4\pi\varepsilon_0}\int\frac{dq}{r}$

Relation between electric field intensity and electric potential difference

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

If A and B are two points in an electric field separated by an infinitesimal distance dx so that the potential difference between them is dV and the electric field intensity is E, then E = – (dV/dx). The negative of the potential gradient is known as intensity of the electric field. The negative sign shows that E points in the direction of decreasing V.

Electric potential energy

1. The electric potential energy of a system of fixed point charges is equal to the work done by an external agent to assemble the system, bringing each charge in from an infinite distance. The potential energy may be positive or negative depending on whether the work is done against the electric force or by the electric force during transport respectively.
2. A charged particle placed in an electric field has potential energy because of its interaction with the electric field.
3. If two charges q_1 and q_2 are separated by a distance r, then the potential energy of system $= \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}$
4. If three charges q_1, q_2 and q_3 are arranged at the three vertices of an equilateral triangle, then the PE of the system is given by: $U = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1 q_2}{r} + \frac{q_2 q_3}{r} + \frac{q_1 q_3}{r}\right]$

Equipotential surface

The locus of all points which are at the same potential is known as equipotential surface.

1. No work is required to move a charge from one point to another on equipotential surface.
2. Near an isolated point charge the equipotential surface is a sphere.
3. The work required to move a unit positive charge around a charge Q along a circle of radius r is equal to zero.
4. The electric lines of force are always normal to the equipotential surface, since E should not have a component along the equipotential surface.
5. The surface of a charged conductor is always an equipotential surface whatever may be its shape.

Motion of charge particle in an electric field

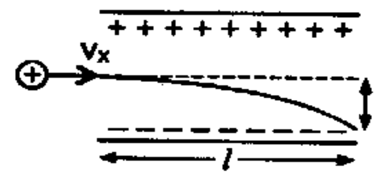
When a positive charge is placed in an electric field, it experiences a force which drives it from points of higher potential to points of lower potential. On the other hand, a negative charge experiences a force driving it from lower to higher potential.

1. The work done in moving a charge between two points in an electric field is independent of the path followed between these two points, since the electric field is a conservative field.
2. If a charged particle is accelerated through a potential difference of V volts, then the kinetic energy acquired by the particle KE = eV.
3. The ratio of the velocities acquired by two charged particles accelerated from rest through the same potential difference are in the ratio: $\frac{v_1}{v_2} = \sqrt{\left(\frac{q_1/m_1}{q_2/m_2}\right)}$

Trajectory of a charged particle in a uniform electric field

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

1. A charged particle thrown horizontally into a uniform electric field acting vertically downwards is similar to a body thrown horizontally from the top of a tower. Therefore, it follows a parabolic path.



2. If t is the time taken by the charged particle to cross the length l of the electric field with constant velocity v_x then $t = (l/v_x)$ and velocity gained by the charged particle along y-direction at the point of exit is: $v_y = at = \frac{eE}{m}\frac{l}{v_x}$
3. Deviation suffered by the charged particle along y-axis, as it just comes out of the electric field, is given by: $y = \frac{1}{2}at^2 = \frac{1}{2}\frac{eE}{m}\cdot\frac{l^2}{v_x^2}$

Electric capacitance

1. The capacitance of a conductor is defined as the ratio of the charge given to the conductor to the potential raised due to it, i.e., $C = Q/V$ (Q is measured in coulomb and V in volt). The SI unit of capacitance is farad.
2. A capacitor or condenser consists of two conductors separated by an insulator or dielectric. The conductors carry equal and opposite charges ±Q. It is an electrical device that stores electric charge.

Electric potential energy stored **in a charged capacitor**

1. The capacitor stores charge as well as electric energy, which is given by: $U = \frac{Q^2}{2C} = \frac{1}{2}QV = \frac{1}{2}CV^2$
2. The energy is stored in the electric field between the plates of a charged capacitor.
3. The energy stored per unit volume in the electric field between the plates is called energy density (u). It is given by: $u = \frac{1}{2}\varepsilon_0 E^2 = \frac{\sigma^2}{2\varepsilon_0}$ where σ represents surface charge density on the plates of capacitor.
4. Force of attraction between oppositely charged plates of capacitor is $F = \frac{Q^2}{2\varepsilon_0 A}$ or $F = \frac{1}{2}\varepsilon_0 E^2 A$

Capacitance formulae for different types of capacitors

1. The electrical capacitance of a conducting sphere is $4\pi\varepsilon_0 R$, where R is the radius of conductor.
2. Capacity of a parallel plate condenser with air in between the plates is given by: $C_0 = \frac{\varepsilon_0 A}{d}$, where A is the effective area of the plates, d is the distance between the plates and ε_0 is the permittivity of free space.
3. Capacitance of a parallel plate capacitor with a dielectric slab of dielectric constant K, completely filled between the plates of the capacitor, is given by: $C_{med.} = \frac{K\varepsilon_0 A}{d} = \frac{\varepsilon_0\varepsilon_r A}{d}$
4. If a dielectric slab of thickness t and dielectric constant K is introduced between the plates, then the capacity of the condenser is given by: $C'_{dielectric} = \frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{K}\right)}$. If the dielectric slab is replaced

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

by a metallic slab of same thickness, then $C'_{metal} = \frac{\varepsilon_0 A}{d-t}$ (because K is infinite for metal). It is interesting to note here that $C'_{\text{metal}} > C'_{\text{dielectric}}$

5. If a number of slabs of thickness $t_1, t_2, ..., t_n$ and dielectric constants $K_1, K_2, ..., K_n$ are completely fill the space between the plates, then the capacity is given by: $C' = \frac{\varepsilon_0 A}{\left[\frac{t_1}{K_1} + \frac{t_2}{K_2} + \frac{t_3}{K_3} + ... + \frac{t_n}{K_n}\right]}$
6. If the upper plate of the parallel plate condenser is connected to the lower plate, then its electrical capacitance becomes infinity.
7. For an air filled spherical capacitor: $C_0 = \frac{4\pi\varepsilon_0 ab}{(b-a)}$.
8. For an air filled cylindrical capacitor: $C_0 = \frac{2\pi\varepsilon_0 L}{\log_e(b/a)}$

Grouping of capacitors

1. In series grouping, $\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ and i.e., $Q_1 = Q_2 = Q_3$. Here, effective capacitance C_S, is always less than the least of the individual capacitances.
2. In parallel grouping, $C_p = C_1 + C_2 + C_3$ and i.e., $V_1 = V_2 = V_3$

Regrouping of condensers

Two condensers of capacity C_1 and C_2 are charged separately to potentials V_1 and V_2. If the condensers are now connected with plates of same polarity together, then

common potential (V) = $\frac{C_1V_1 + C_2V_2}{C_1 + C_2}$ and final charges on two condensers is $q_1' = C_1V$, $q_2' = C_2V$.

Two condensers of capacities C_1 and C_2 are charged separately to potentials V_1 and V_2. If they are reconnected with plates of opposite polarity together, then the common potential is given by:

$V = \frac{C_1V_1 - C_2V_2}{C_1 + C_2}$

Effect of dielectric

1. Effect of inserting dielectric slab on capacitance, potential difference, charge, intensity of the electric field and energy stored with battery still in connection:
(a) $C = KC_0$ (b) $V = V_0$ (c) $Q = KQ_0$ (d) $E = E_0$ (e) $U = KU_0$
2. Battery is disconnected and dielectric slab is inserted:
(b) $C = KC_0$ (b) $Q = Q_0$ (c) $V = V_0/K$ (d) $E = E_0/K$ (e) $U = U_0/K$
3. Capacitor is charged and then battery is disconnected: If the distance between the two plates is increased by insulating handles, then
(a) capacity decreases (b) potential difference increases (c) intensity of electric field remains same
(d) charge on the plates remains same and (e) energy stored in the capacitor increases

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

ASSIGNMENT

1. When a solid body is negatively charged by friction, it means that the body has
   (a) acquired some of electrons
   (b) lost some protons
   (c) acquired some electrons and lost a lesser number of protons
   (d) lost some positive ions.
2. Two positive charges of magnitudes 2 and 3 coulombs are placed 10 cm apart. The electric potential at a distance of 10 cm from the middle point on the right bisector of the line joining the two charges is :
   (a) 5×10^{11} V (b) 4×10^{9} V
   (c) 4×10^{11} V (d) 5×10^{9} V
3. A and B are two points in an electric field. If the work done in carrying 4.0 coulomb of electric charge from A to B is 16.0 joule, the potential difference between A and B is
   (a) zero (b) 2.0 V (c) 4.0 V (d) 16.0 V
4. The work done in moving a positive charge on an equipotential surface is
   (a) finite and positive (b) infinite
   (c) finite and negative (d) zero
5. Two charges are placed at a distance apart. If a glass slab is placed between them, force between them will
   (a) remain the same (b) increase
   (c) decrease (d) be zero
6. Electrons are caused to fall through a p.d. of 1500 volts. If they were initially at rest. their final speed is
   (a) 4.6×10^{7} m/s (b) 2.3×10^{7} m/s
   (c) 0.23×10^{7} m/s (d) 5.1×10^{7} m/s.
7. The potential inside a hollow spherical conductor
   (a) is constant
   (b) varies directly as the distance from the centre
   (c) varies inversely as the distance from the centre
   (d) varies inversely as the square of the distance from the centre.
8. Two plates are 1 cm apart and the potential difference between them is 10 volt. The electric field between the plates is
   (a) 10 N/C (b) 250 N/C
   (c) 500 N/C (d) 1000 N/C
9. A and B are two spherical conductors of the same extent and size. A is solid and B is hollow. Both are charged to the same potential. If the charges on A and B are Q_A and Q_B respectively, then
   (a) Q_A is less than Q_B
   (b) Q_A is greater than Q_B but not double
   (c) $Q_A = Q_B$

Nishant Gupta, D-122, Prashant vihar, Rohini, Delhi-85
Contact: 9953168795, 9268789880

(d) $Q_A = 2Q_B$

10. Two capacitors of capacities C_1 and C_2 are connected in parallel. If a charge Q is given to the assembly, it gets shared. The ratio of the charge on capacitor C_1 to the charge on capacitor C_2 is given by
(a) C_1/C_2 (b) C_2/C_1 (c) C_1^2/C_2^2 (d) C_2^2/C_1^2

11. A capacitor connected to a 10 V battery collects a charge of 40 micro coulomb with air as dielectric and 100 micro coulomb with oil as dielectric. The dielectric constant of the oil is :
(a) 4 (b) 2.5 (c) 0.4 (d) 1.0

12. A given charge situated at a certain distance from a short electric dipole in the end-on position experiences a force F. If 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

13. A charge Q is placed at each of the two opposite corners of a square. A charge q is placed at each of the other two corners. If the resultant force on Q is zero, then
(a) $Q = \sqrt{2}q$ (b) $Q = -\sqrt{2}q$
(c) $Q = 2\sqrt{2}q$ (d) $Q = -2\sqrt{2}q$

14. The electric field in a region of space is given by $\vec{E} = 5\hat{i} + 2\hat{j}$ N/C. The electric flux due to this field through an area $2m^2$ lying in the YZ plane, in S.I. units, is
(a) 10 (b) 20 (c) $10\sqrt{2}$ (d) $2\sqrt{29}$

15. An infinite number of charges, each equal to q coulomb, are placed along the X – axis at x (in metres) = 1, 2, 4, 8, ... and so on. The potential and field in SI units at x = 0 due to this set of charges are respectively $1/4\pi\varepsilon_0$ times
(a) 2q, 4q (b) 2q/5, 4q
(c) 2q/3, 4q/3 (d) 2q, 4q/3

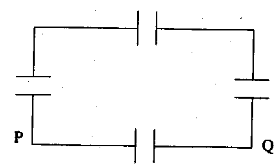
16. Three identical charges are placed at the corners of an equilateral triangle. If the force between any two charges is F, then the net force on each will be
(a) $\sqrt{2}$F (b) 2F (c) $\sqrt{3}$F (d) 3F

17. An electric dipole placed in a uniform electric field will have minimum potential energy when the dipole moment is inclined to the field at an angle
(a) π (b) $\pi/2$ (c) zero (d) $3\pi/2$

18. Two charged conducting spheres of radii R_1 and R_2 separated by a large distance, are connected by a long wire. The ratio of the charges on them is
(a) R_1/R_2 (b) R_2/R_1 (c) R_1^2/R_2^2 (d) R_2^2/R_1^2

19. Two concentric metallic spherical shells are given positive charges. Then
(a) the outer sphere is always at a higher potential
(b) the inner sphere is always at a higher potential
(c) both the spheres are at the same potential
(d) no prediction can be made about their potentials unless the actual values of charges arid radii are known.

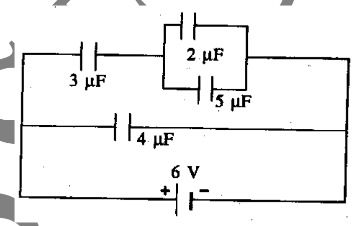
20. In the network shown below, all the capacitors are of 1 microfarad. The equivalent capacitance between P and Q in microfarads is



(a) 4 (b) ¼
(c) ¾ (d) 4/3

21. A capacitor having a capacity of 2.0 microfarad is charged up to 200 V and its plates are joined to a wire. The heat produced in joule will be
(a) 4×10^4 (b) 4×10^{-10}
(c) 4×10^{-2} (d) 2×10^{-2}

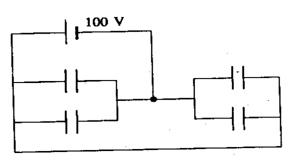
22. In the circuit given, the charge in micro-coulomb, on the capacitor having capacity 5 microfarad is



(a) 4.5 (b) 9
(c) 7 (d) 15

23. Small drops of the same size are charged to V volt each, If 'n' such drops coalesce to form a single large drop, then its potential will be
(a) nV (b) V/n (c) $Vn^{1/3}$ (d) $Vn^{2/3}$

24. Each of the four capacitors in the given circuit is 50 μF. The charge on each capacitor is

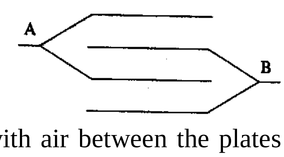


(a) 5×10^3 C
(b) 5×10^{-3} C
(c) 2.5×10^3 C
(d) 2.5×10^{-3} C

25. A capacitor of 20 μF, charged to 500 V, is connected in parallel with another capacitor of 10μF charged to 200 V. The common potential difference across the combination is
(a) 300 V (b) 350 V (c) 400 V (d) 700 V

26. Five identical capacitors connected in series have an equivalent capacitance of 4μF. If all of them are connected in parallel across a 400 V source, the total energy stored in them is
(a) 2J (b) 4 J (c) 8 J (d) 16 J

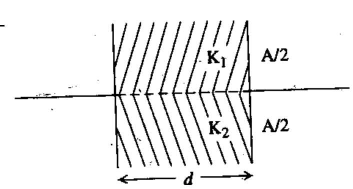
27. Four metallic plates, each having area A, are placed as shown. The distance between the consecutive plates is d. Alternate plates are connected to points A and B. The equivalent capacitance of the system is



(a) $\in_0$A/d (b) $2\in_0$A/d
(c) $3\in_0$A/d (d) $4\in_0$A/d

28. A parallel plate capacitor with air between the plates is charged to a p.d. of 500 V and then insulated. A plastic plate is inserted between the plates filling the whole gap. The p.d. between the plates now becomes 75 V. The dielectric constant of plastic is
(a) 10/3 (b) 5 (c) 20/3 (d) 10

29. Two slabs of the same dimensions, having dielectric constants K_1 and K_2,

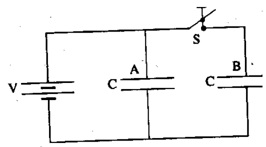


completely fill the space between the plates of a parallel plate capacitor as shown in the figure. If C is the original capacitance of the capacitor, the new capacitance is

(a) $\left(\frac{K_1+K_2}{2}\right)C$ (b) $\left(\frac{2K_1K_2}{K_1+K_2}\right)C$

(c) $\left(K_1+K_2\right)C$ (d) $\left(\frac{K_1K_2}{K_1+K_2}\right)C$

30. The figure 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 the capacitors is filled with a dielectric of constant 3. The ratio of the total energy stored in both capacitors before and after the introduction of the dielectric is



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

31. ,A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitor are moved farther apart by means of insulating handles
   (a) the charge on the capacitor increases
   (b) the voltage across the plates increases
   (c) the capacitance increases
   (d) None of these.

32. An infinite number of capacitors, having capacitances 1μF, 2μF, 4μF, 8μF,…. are connected in series. The equivalent capacitance of the system is
(a) infinite (b) 0.25 μF (c) 0.5 μF (d) 2 μF

33. The radius of a hollow metallic sphere is R. If the potential difference between its surface and a point at a distance of 3R from its centre is V, then the electric field intensity at a distance of 3R from its centre is
(a) V/2R (b) V/3R (c) V/4R (d) V/6R

34. A point charge q is placed at the midpoint of a cube of side L. The electric flux emerging from the cube is
(a) $q/\in_0$ (b) $q/6L^2\in_0$ (c) $6qL^2/\in_0$ (d) zero

35. Electric charges q, q and - 2q are placed at the three corners of an equilateral triangle of side *l*. The magnitude of the electric dipole moment of the system is
(a) ql (b) 2 ql (c) √3ql (d) 4 ql

36. A metallic sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in the figure as
(a) 1 (b) 2 (c) 3 (d) 4

ANSWERS

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