HOLIDAYS HOMEWORK
CLASS-XII
SUBJECT-PHYSICS

Chapter-01: Electric Charges and Fields

Q1) Two bodies A and B are rubbed against each other and it is found that 5×10^{20} electrons transfer from A to B. What is charge acquired by: (i) A (ii) B

Q2) Find the number of electrons that a body must lose in order to acquire a charge of :
(i) 1 C (ii) 19.2 C (iii) 9.6 mC (iv) $0.8\ \mu C$

Q3) A body is losing the electrons at the rate of 2×10^{10} electrons per second.
Find the time taken by the body to acquire a charge of 0.8 C.

Q4) Find the total negative and positive charge in a 230g sample of ethanol.

Q5) Find the total negative charge in one cup(250g) of water.

Q6) A charged rod P attracts rod R where as P repels another charged rod Q.
What type of force is developed between Q and R?

Q7) What happens to the force between two point charges if a plastic sheet is placed between them?

Q8) The electrostatic force between two point charges placed in vacuum is 20N.
What will be the new force between the if
(i) Distance between them is doubled (ii) Distance between them is halved
(iii) they are placed in a medium having dielectric constant of 80 keeping the distance same
(iv) they are placed in a medium of dielectric constant 20 and distance between them is halved

Q9) How does the force between two point charges change if the dielectric constant of the medium in which they are kept increases?

Q10) Force of attraction between two point electric charges placed at a distance d in a medium is F.
What distance apart should these be kept in the same medium, so that force between them becomes F/3?

Q11) Find the force between 2C and 3C charges placed in air 3cm apart from each other.

Q12) Two charges $6mC$ and $8mC$ are placed in air at distance of $10cm$ from each other.
Find the force between them.

Q13) Three positive point charges having charge of magnitude q each are placed at points A,B and C such that AB=BC= r . Find the total force on charge particle place at: (i) A (ii)B.

Q14) Two charge particles 2 C and 5 C are situated at (1m,0m) and (-2m,0m) respectively.
Find the magnitude of force between them.

Q15) Two charge particles 2 C and 5 C are situated at (3m,0) and (0,4m) respectively.
Find the magnitude of force between them.

Q16) A proton and an electron are placed 0.8 cm apart in air.
Find the magnitude and nature of force between them.

Q17) Two fixed charges +9q and +4q are at a distance 4 m apart. At what point between the charges, a third charge +q must be placed to keep it in equilibrium?

Q18) Three similar charges of magnitude q each are placed at corners of an equilateral triangle ABC of side a.
Find the net force acting on charge placed at C.

Q19) Three point charges +q, -q and +q are placed at corners A, B and C respectively of an equilateral triangle of side a. Find net force on charge placed at: (i) A and (ii) B

Q20) Two identical charged spherical bodies having charge $12\ \mu C$ and $-4\ \mu C$ are kept at certain distance apart, then the force between them is F. They are brought in contact with each other and again kept at the same distance. What will be new force between them?

Q21) Two point electric charges of value +q and+ 2q are kept at a distance d apart from each other in air.
A third charge Q is to be kept along the same line in such a way that the entire system is in equilibrium.
Calculate the magnitude of charge Q in terms of q and d and state its nature.

Q22) Four similar charges each having charge '+q' are along x-axis at x=1 cm ,x=2 cm, x=4 cm, x=8 cm .
Find the net force on a charge +q placed at x=0 due to these charges.

Q23) Four similar charges of magnitude q each are placed at corners of a square ABCD of side a.
Find the net force acting on charge placed at C.

Q24) Four similar charges of magnitude q each are placed at corners of a square ABCD of side a.
Find the net force acting on charge Q placed at centre of the square.

Q25) Four charges +q, +q ,-q and -q are placed at corners A,B,C and D respectively of a square ABCD of side a. Find the net force acting on charge Q placed at centre of the square.

Q26) Draw the electric filed lines for a point charge Q when (i) Q>0 (ii) Q<0

Q27) Draw electric field lines for a pair of charges q_1 and q_2 when (i) $q_1q_2>0$ (ii) $q_1q_2<0$

Q28) A system has two charges $q_A = +25\ \mu C$ and $q_B = -25\ \mu C$ located at points A(0,0,-15cm) and B(0,0,+15cm) respectively. Find

(i) Total charge on the system (ii) Electric dipole moment of the system

(iii) Total electric field at point C(0,0,0) (iv) Total electric field at point D(0,0,25cm)

(v) Total electric field at point E(17cm, 0,0)

Q29) Define the term dipole moment of an electric dipole indicating its direction .Write its S.I unit.

Q30) Two charges each 2 x 10^{-7} C but opposite in sign forms a system. These charges are located at points A (0,0, -10) cm and B(0,0, +10) cm respectively.

What is the total charge and electric dipole moment of the system?

Q31) An electric dipole when held at 30^0 with respect to a uniform electric field of 10^4 N/C experienced a Torque of 9 x 10^{-26} Nm. Calculate dipole moment of the dipole?

Q32) An electric dipole with a dipole moment $4 \times 10^{-9}\ Cm$ is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^4 N/C. Calculate the total force and total torque acting on the dipole.

Q33) What is the magnitude of a point charge due to which the electric field 30 cm away has the magnitude of 2N/C.

Q34) If the magnitude of intensity of electric field at a distance x on axial line and at a distance y on equatorial line of a given dipole are equal, then find ratio of $x\ and\ y$.

Q35) A charge q is placed at (1,2,1) and other charge –q is placed at (0,1,0). There exists a uniform electric field $\vec{E} = 2\hat{\imath} + \hat{\jmath}$. What is the total force and total torque acting on the system.

Q36) The distance of the field point on the equatorial plane of a small electric dipole is halved. By what factor will the electric filed due to the dipole change?

Q37) A particle of mass m and charge q initially moving along horizontal with speed u enters the region between the two charged plates. The length of each plate is L and a uniform electric field E is maintained between the plates. Find the vertical deflection of the particle at far edge of the plates.

Q38) At what angle between dipole moment and electric field , electric dipole remains in

(i) Stable equilibrium (ii) Unstable equilibrium .

Q39) At what angle between dipole moment and electric field, the potential energy of electric dipole is

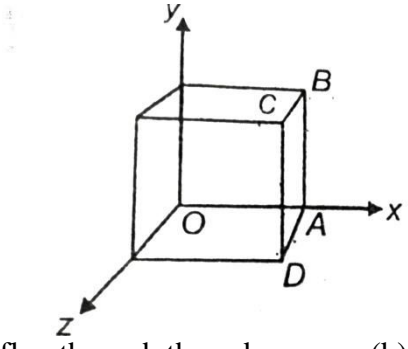
(i) minimum (ii) maximum (iii) zero

Q40) An electric dipole of length 10 cm having charges $+6 \times 10^{-3}C$ and $-6 \times 10^{-3}C$ is placed at 30° with respect to a uniform electric field of magnitude $5 \times 10^4 N/C$. Find the total

(i) Force on dipole (ii) Total torque on dipole

Q41) An electric dipole consists of two opposite charges each of magnitude $4\mu C$ separated by a distance of 2 cm. The dipole is placed in a uniform electric field of $10^4 N/C$. Find the maximum torque experienced by the dipole.

Q42) The electric field components in below figure are $E_x = 800x^2\ N/C$, $E_y = E_z = 0$. Assume, $a = 0.1\ m$



Calculate : (a) Total flux through the cube (b) Total charge enclosed by the cube .

Q43) Electric field in a region is given by , $\vec{E} = 200\hat{\imath}$ N/C for $x > 0$ and $\vec{E} = -200\hat{\imath}$ N/C for $x < 0$.

A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the X-axis so that one face is at $x = +10cm$ and the other is at $x = -10cm$.

(i) What is the net outward flux through each flat face?

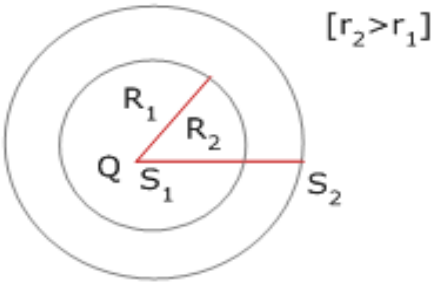
(ii) What is the flux through the sides of the cylinder?

(iii) What is the total flux through the cylinder?

(iv) What is the net charge inside the cylinder?

Q44) The electric field in a certain region of space is $(2\hat{\imath} + 4\hat{\jmath}) \times 10^4$N/C.
Calculate the electric flux due to this field over an area of $(5\hat{\imath} - 3\hat{\jmath}) \times 10^{-2} m^2$.

Q45) A sphere S_1 of radius r_1 encloses a change Q. If there is another concentric sphere S_2 of radius r_2 ($r_2 > r_1$) and there is no additional change between S_1 and S_2. Find the ratio of electric flux through S_1 and S_2.



Q46) If the amount of electric flux entering and leaving a closed surface are ϕ_1 and ϕ_2 respectively.
What is the electric charge inside the surface?

Q47) Two charges -2Q and +Q are located at points (a,0) and (4a,0) respectively. What is the electric flux due to these charges through a sphere of radius '3a' with its centre at the origin?

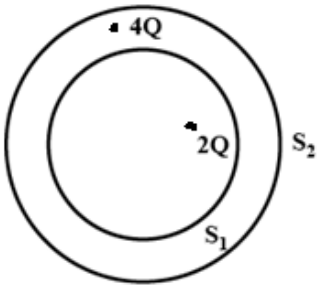
Q48) What is the flux due to electric field $\vec{E} = 2000\hat{\imath}$ N/C through a square of side 10 cm, when placed in
(i) X-Z plane (ii) Y-Z plane (iii) X-Y plane

Q49) What is the flux due to electric field $\vec{E} = 2000\hat{\imath}$ N/C through a square of side 10 cm whose plane makes a 30° angle with X-axis?

Q50) A particle of mass $10^{-3} kg$ and charge $+5\mu C$ enters into a uniform electric filed of $2 \times 10^5 N/C$ moving with a velocity of 20m/s in a direction opposite to that of the field.
Calculate the distance it would travel before coming to rest.

Q51) A charge q is placed at centre of a cube of side a. What is the flux passing through each face of the cube?

Q52) Consider two hollow concentric spheres S_1 and S_2 enclosing charges 2Q and 4Q respectively as shown in the figure.



(i) Find the ratio of electric flux through S_1 and S_2.

(ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 'k' is introduced in the space inside S_1 in place of air?

(iii) What will happen to flux through S_2 if its radius is doubled?

Q53) A spherical surface encloses and electric dipole of length 2 cm having electric dipole moment 6×10^{-8}C-m. Find the net flux through the spherical surface.

Q54) Two charge particles A and B having equal charges are placed at 12 cm and 20 cm respectively from a uniformly charged thin sheet. Which charge will experience greater force?

Q55) Two charge particles $+2\ \mu C$ and $-2\ \mu C$ are separated by $2\ cm$.
Find the electric filed at mid-point of the line joining the two charges.

Q56) An electric dipole have dipole moment $\vec{p} = 10\hat{\imath}$ Cm is placed in uniform electric field $\vec{E} = 0.2\hat{\imath}$ N/C.
Find the force acting on the electric dipole is (in SI unit).

Q57) An electric dipole when held at 30^0 with respect to a uniform electric field of 10^4 N/C experienced a torque of $9 \times 10^{-26}\ Nm$. Calculate dipole moment of the dipole.

Q58) Two charge particles A and B having equal charges are placed at 12 cm and 20 cm respectively from a uniformly charged thin sheet. Which charge will experience greater force? Justify

Q59) Two identical charged spherical bodies having charge 12 μC and $-4\ \mu C$ are kept at certain distance apart, then the force between them is F. They are brought in contact with each other and again kept at the same distance. What will be new force between them?

Q60) A point charge –q having mass m is revolving in a circular path of radius R around a fixed charge q.
Find (i) the total energy of –q
(ii)Time period of revolution of –q

Chapter-02:Electric Potential and Capacitance

Q1) A regular hexagon of side 10cm has a charge 5μC at each of its vertices.
Calculate the potential at the centre of the hexagon.

Q2) A 500 μC charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 μC between two diagonally opposite points on the square.

Q3) What is the electrostatic potential due to an electric dipole at an equatorial point?

Q4) What is the work done in moving a test charge q through a distance of 1 cm along the equatorial axis of an electric dipole?

Q5) Define the term 'potential energy' of charge 'q' at a distance r in an external electric field.

Q6) A point charge Q is placed at point O as shown in the figure. Is the potential difference $V_A - V_B$ positive, negative or zero, if Q is: (i) positive
(ii) negative?

Q7) Figures (a) and (b) show the field lines of a positive and negative point charge respectively.

(a) Give the signs of the potential difference, (i) $V_P - V_Q$ (ii) $V_B - V_A$.
(b) Give the sign of the potential energy difference of a small negative charge between the points Q and P; A and B.
(c) Give the sign of the work done by the field in moving a small positive charge from Q to P.
(d) Give the sign of the work done by the external agency in moving a small negative charge from B to A.
(e) Does the kinetic energy of a small negative charge increase or decrease in going from B to A?

Q8) (a) Calculate the potential at a point P due to a charge of 4×10^{-7}C, located 9 cm away.
(b) Hence obtain the work done in bringing a charge of 2×10^{-9}C from infinity to the point P. Does the answer depend on the path along which the charge is brought?

Q9) A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 V. What is the potential at the centre of the sphere? Also find the charge on sphere.

Q10) A hollow metal sphere of radius 10 cm is charged such that the potential on its surface is 5 V. What is the potential at: (i) the centre of the sphere?
(ii) a point 5cm from the centre?
(iii) a point 20cm from the centre?

Q11) Why is electrostatic potential constant throughout the volume of the conductor and has the same value as its surface?

Q12) Distinguish between a dielectric and a conductor.

Q13) Why must the electrostatic potential inside a hollow charged conductor be the same at every point?

Q14) What is the geometrical shape of equi-potential surfaces due to a single isolated charge?

Q15) Two charges 2μC and –2μC are placed at points A and B 5 cm apart.
(a) Depict an equi-potential surface of the system.
(b) What is the direction of the electric field at every point on this surface?

Q16) Describe schematically the equi-potential surfaces corresponding to
(a) a constant electric field in the z-direction,
(b) a field that uniformly increases in magnitude but remains in a constant (say, z) direction,
(c) a single positive charge at the origin, and
(d) a uniform grid consisting of long equally spaced parallel charged wires in a plane.

Q17) What is the amount of work done in moving a point charge q around a circular arc of radius r at the centre of which another point charge Q is located?

Q18) Two charges 4μC and -4μC are placed at points A and B 3 cm apart. Depict an equi-potential surface of the system.

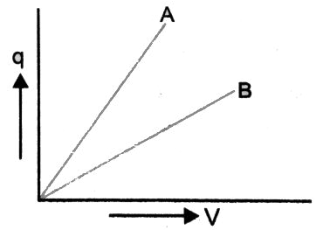
Q19) Two charges 3×10^{-8} C and -2×10^{-8} C are located 15 cm apart. At what point(s) on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero.

Q20) Two charges 5×10^{-8} C and -3×10^{-8} C are located 16 cm apart. At what point(s) on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero.

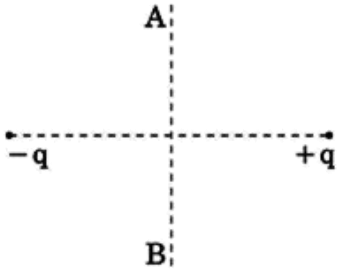
Q21) "For any charge configuration, equi-potential surface through a point is normal to the electric field." Justify.

Q22) Two identical balls having equal positive charge 'q' each are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two?

Q23) The given graph shows variation of charge 'q' versus potential difference 'V' for two capacitors C_1 and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater than that of C_1.
Which line (A or B) corresponds to C_1 and why?



Q24) A charge 'q' is moved from a point A above a dipole of dipole movement 'p' to a point B below the dipole in equatorial plane without acceleration. Find the work done in the process.



Q25) Derive the expression for the electric potential at any point along the axial line of an electric dipole.

Q26) Derive an expression for the potential energy of an electric dipole of dipole movement $\vec{p}$ in the electric field $\vec{E}$.

Q27) Two point charges, $q_1 = 10 \times 10^{-8}$C and $q_2 = -2 \times 10^{-8}$C are separated by a distance of 60 cm in air.
(i) Find at what distance from the charge q_1, would the electric potential be zero.
(ii) Also calculate the electrostatic potential energy of the system.

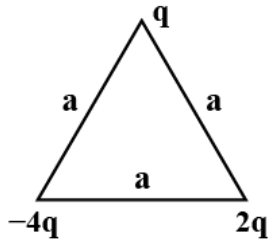
Q28) Two point charges 4Q, Q are separated by 1m in air. At what point on the line joining the charges is the electric field intensity zero? Also calculate the electrostatic potential energy of the system of charges, taking the value of charge, $Q = 2 \times 10^{-7}$C.

Q29) Two point charges 20×10^{-6} C and -4×10^{-6} C are separated by a distance of 50cm in air.
(i) Find the point on the line joining the charges, where the electric potential is zero.
(ii) Also find the electrostatic potential energy of the system.

Q30) (a) Determine the electrostatic potential energy of a system consisting of two charges 7 μC and –2 μC (and with no external field) placed at (–9 cm, 0, 0) and (9 cm, 0, 0) respectively.
(b) How much work is required to separate the two charges infinitely away from each other?

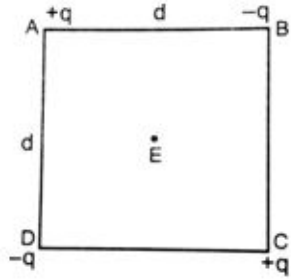
Q31) Two tiny spheres carrying charges 1.5μC and 2.5μC are located 30 cm apart. Find the potential and electric field: (a) at the mid-point of the line joining the two charges, and
(b) at a point 10 cm from this midpoint in a plane normal to the line and passing through the mid-point

Q32) Calculate the work done to dissociate the system of three charges placed on the vertices of a triangle as shown.



Q33) Four identical charges q each are arranged at the corners of a square ABCD of side a
(a) Find the work required to put together this arrangement.
(b) A charge q_0 is brought to the centre of the square, the four charges being held fixed at its corners. How much extra work is needed to do this?

Q34) Four charges are arranged at the corners of a square ABCD of side d, as shown in Figure



(a) Find the work required to put together this arrangement.
(b) A charge q_0 is brought to the centre E of the square, the four charges being held fixed at its corners. How much extra work is needed to do this?

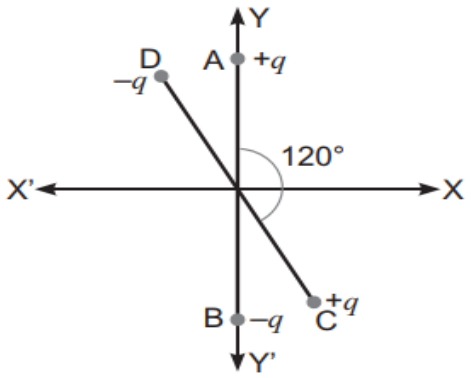
Q35) (a) Can two equi-potential surfaces intersect each other? Give reasons.
(b) Two charges -q and + q are located at points A (0, 0, – a) and B (0, 0, +a) respectively. How much work is done in moving a test charge from point P (7, 0, 0) to Q (-3, 0, 0)?

Q36) Two charges –q and +q are located at points (0, 0, –a) and (0, 0, a), respectively.
(a) What is the electrostatic potential at the points (0, 0, z) and (x, y, 0)?
(b) How much work is done in moving a small test charge from the point (5, 0, 0) to (–7,0,0) along the x-axis? Does the answer change if the path of the test charge between the same points is not along the x-axis?

Q37) Draw 3 equi-potential surfaces corresponding to a field that increases uniformly in magnitude but remains constant along Z-direction. How are these surfaces different from that of a constant electric field along Z-direction?

Q38) Two uniformly large parallel thin plates having charge densities + σ and – σ are kept in the X-Z plane at a distance 'd' apart. Sketch an equi-potential surface due to electric field between the plates. If a particle of mass m and charge q' remains stationary between the plates, what is the magnitude and direction of this field?

Q39) Two small identical electrical dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120° as shown in the figure. What X' is the resultant dipole moment of this combination? If this system is subjected to electric field ($\vec{E}$) directed along + X direction, what will be the magnitude and direction of the torque acting on this?



Q40) The plates of a parallel plate capacitor have an area of $90cm^2$ each and are separated by 2.5mm. The capacitor is charged by connecting it to a 400V supply.

(a) How much electrostatic energy is stored by the capacitor?

(b) View this energy as stored in the electrostatic field between the plates, and obtain the energy per unit volume u. Hence arrive at a relation between u and the magnitude of electric field E between the plates.

Q41) Net capacitance of three identical capacitors in series is 1pF. What will be their net capacitance if connected in parallel?

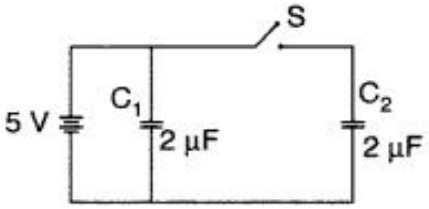
Find the ratio of energy stored in the two configurations if they are both connected to the same source.

Q42) Net capacitance of three identical capacitors in series is 3pF. What will be their net capacitance if connected in parallel?

Find the ratio of energy stored in the two configurations if they are both connected to the same source.

Q43) Draw a plot showing the variation of electric field (E) and electric potential(V) with distance(r) due to a point charge q.

Q44) Figure shows two identical capacitors C_1 and C_2, each of 2μF capacitance, connected to a battery of 5 V. Initially switch 'S' is left open and dielectric slabs of dielectric constant K=5 are inserted to fill completely the space between the plates of the two capacitors.



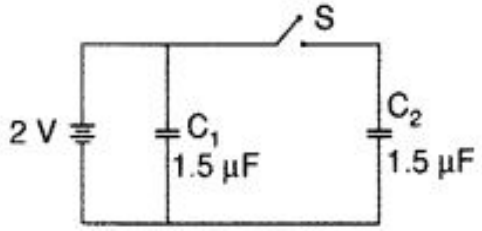
How will the charge and potential difference between the plates of the capacitors be affected after the slabs are inserted?

Q45) An electric dipole is held in a uniform electric field: (a) Show that the net force acting on it is zero.

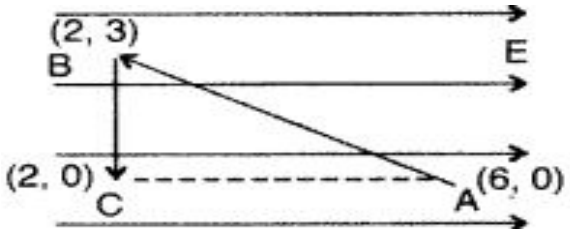
(b) The dipole is aligned parallel to the field.

(c) Find the work done in rotating it through the angle of 180°.

Q46)Figure shows two identical capacitors C_1 and C_2 each of 1.5 μF capacitance, connected to a battery of 2 V. Initially switch 'S' is closed. After sometime 'S' is left open and dielectric slabs of dielectric constant K=2 are inserted to fill completely the space between the plates of the two capacitors. How will the charge and potential difference between the plates of the capacitors be affected after the slabs are inserted?



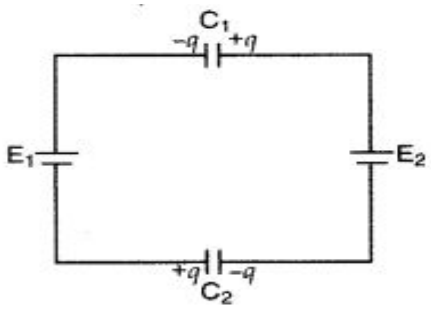
Q47) A test charge 'q' is moved without acceleration from A to C along the path from A to B and then from B to C in electric field E as shown in the figure.



(a) Calculate the potential difference between A and C.

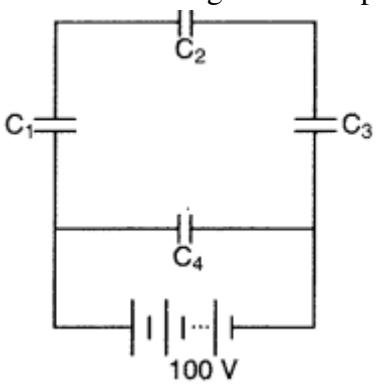
(b) At which point (of the two) is the electric potential more and why?

Q48) Determine the potential difference across the plates of the capacitor 'C_1' of the network shown in the figure.



[Assume $E_2 > E_1$]

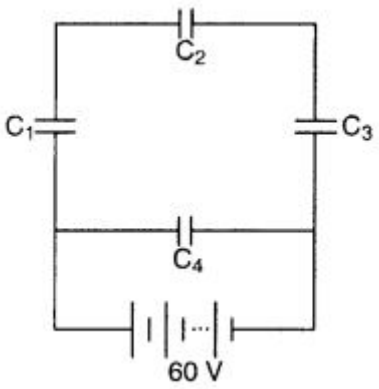
Q49) A network of four capacitors, each of capacitance 15 μF, is connected across a battery of 100 V, as shown in the figure. Find the net capacitance and the charge on the capacitor C_4.



Q50) An electrical technician requires a capacitance of 2μF in a circuit across a potential difference of 1 kV. A large number of 1μF capacitors are available to him each of which can withstand a potential difference of not more than 400V. Suggest a possible arrangement that requires the minimum number of capacitors.

Q51)An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has charge ± 8 nC.

Q52) A network of four capacitors, each of capacitance 30 pF, is connected across a battery of 60 V as shown in the figure. Find the net capacitance and the energy stored in each capacitor.



Q53)An electric dipole of length 2 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $8\sqrt{3}$Nm. Calculate the potential energy of the dipole, if it has a charge of ± 4 nC.

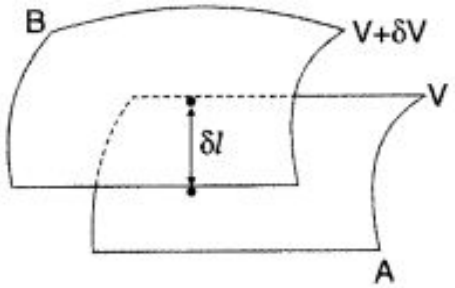
Q54) An electric dipole of length 1 cm, which placed with its axis making an angle of 60° with uniform electric field, experiences a torque of $6\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has a charge of ± 2 nC.

Q55) A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected to another uncharged capacitor having the same capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor.

Q56) Two point charges q_1 and q_2 are located at $\vec{r}_1$ and $\vec{r}_2$ respectively in an external electric field $\vec{E}$. Obtain the expression for the total work done in assembling this configuration.

Q57)Two point charges q and -2q are kept 'd' distance apart. Find the location of the point relative to charge 'q' at which potential due to this system of charges is zero.

Q58) Two closely spaced equi-potential surfaces A and B with potentials V and V+δV, (where δV is the change in V), are kept δl distance apart as shown in the figure.



Deduce the relation between the electric field and the potential gradient between them. Write the two important conclusions concerning the relation between the electric field and electric potentials.

Q59) Why does current in a steady state not flow in a capacitor connected across a battery? However momentary current does flow during charging or discharging of the capacitor. Explain.

Q60)Two parallel plate X and Y capacitors, X and Y, have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric medium of ε_r=4.

(a) Calculate capacitance of each capacitor if equivalent capacitance of the combination is 4μF.

(b) Calculate the potential difference between the plates of X and Y.

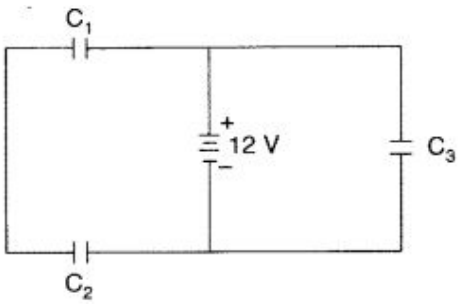
(c) What is the ratio of electrostatic energy stored in X and Y?

Q61)Three identical capacitors C_1, C_2 and C_3 of capacitance 6 μF each are connected to a 12 V battery as shown.

Find: (a) charge on each capacitor

(b) equivalent capacitance of the network

(c) energy stored in the network of capacitors.



Q62) The equivalent capacitance of the combination between A and B in the given figure is 4μF.

(a) Calculate capacitance of the capacitor C.
(b) Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B.
(c) What will be the potential drop across each capacitor?

Q63) A parallel plate capacitor is charged by a battery. After some time the battery is disconnected and a dielectric slab of dielectric constant K is inserted between the plates. How would
(a) the capacitance,
(b) the electric field between the plates and
(c) the energy stored in the capacitor, be affected? Justify your answer.

Q64) (a) A charge +Q is placed on a large spherical conducting shell of radius R. Another small conducting sphere of radius r carrying charge 'q' is introduced inside the large shell and is placed at its centre. Find the potential difference between two points, one lying on the sphere and the other on the shell.
(b) How would the charge between the two flow if they are connected by a conducting wire? Name the device which works on this fact.

Q65) A parallel plate capacitor is charged by a battery. After sometime the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates. How will
(a) the capacitance of the capacitor, (b) electric field between the plates and
(c) the energy stored in the capacitor be affected? Justify your answer in each case.

Q66) (a) Depict the equi-potential surfaces for a system of two identical positive point charges placed a distance 'd' apart.
(b) Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points, $\vec{r}_1$ and $\vec{r}_2$ respectively in the presence of external electric field $\vec{E}$.

Q67) A parallel plate capacitor, each with plate area A. and separation d, is charged to a potential difference V. The battery used to charge it remains connected. A dielectric slab of thickness d and dielectric constant k is now placed between the plates. What change, if any, will take place in:
(a) charge on plates? (b) electric field intensity between the plates?
(c) capacitance of the capacitor? Justify your answer in each case.

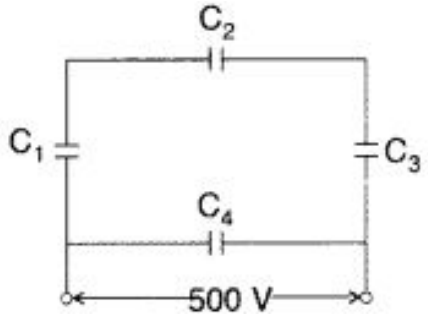
Q68) Deduce the expression for the electrostatic energy stored in a capacitor of capacitance 'C' and having charge 'Q'. How will the
(a) energy stored and
(b) the electric field inside the capacitor be affected when it is completely filled with a dielectric material of dielectric constant 'K'?

Q69) A parallel plate capacitor is charged to a potential difference V by a d.c. source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following will change;
(a) electric field between the plates,
(b) capacitance, and
(c) energy stored in the capacitor.

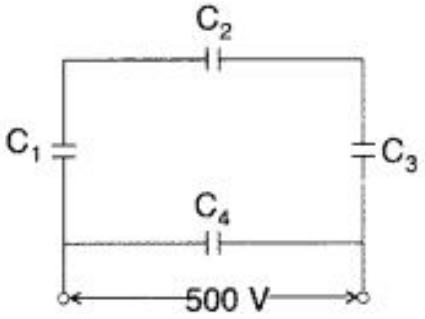
Q70) A network of four capacitors each of 12μF capacitance is connected to a 500 V supply as shown in the figure. Determine:

(a) equivalent capacitance of the network and

(b) charge on each capacitor.



Q71) A network of four capacitors each of 15μF capacitance is connected to a 500 V supply as shown in the figure. Determine: (a) equivalent capacitance of the network and (b) charge on each capacitor.



Q72) A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 360μC. When potential across the capacitor is reduced by 120 V, the charge stored in it becomes 120μC. Calculate:

(a) The potential V and the unknown capacitance C.

(b) What will be the charge stored in the capacitor, if the voltage applied had increased by 120 V?

Q73) A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness $\frac{d}{2}$, where d is the separation between the plates.

Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.

Q74) Calculate the amount of work done to dissociate a system of three charges 1μC, 1μC and -4μC placed on the vertices of an equilateral triangle of side 10 cm.

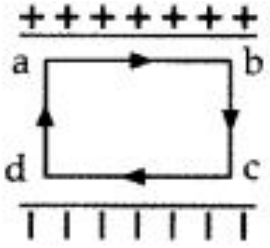
Q75) A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 300μC. When potential across the capacitor is reduced by 100 V, the charge stored in it becomes 100 V. Calculate the potential V and the unknown capacitance. What will be the charge stored in the capacitor if the voltage applied had increased by 100 V?

Q76) Draw the equi-potential surfaces due to an electric dipole. Locate the points where the potential due to the dipole is zero.

Q77) Two thin concentric shells of radii r_1 and r_2 ($r_2 > r_1$) have charges q_1 and q_2.
Write the expression for the potential at the surface of inner and outer shells.

Q78) (a) Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.

(b) The electric field inside a parallel plate capacitor is E. Find the amount of work done in moving a charge q over a closed rectangular loop abcda.

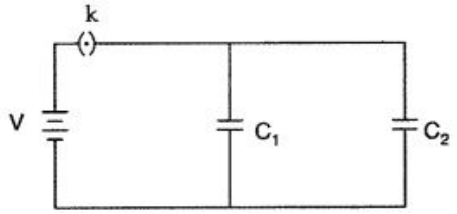


Q79) Derive the expression for the capacitance of a parallel plate capacitor having plate area A and plate separation d.

Q80) A parallel plate capacitor with air between the plates has a capacitance of 12pF. What will be the capacitance if the distance between the plates is reduced by half, and the space between them is filled with a substance of dielectric constant 8?

Q81) A slab of material of dielectric constant K has the same area as the plates of a parallel-plate capacitor but has a thickness $\frac{3}{4}$d, where d is the separation of the plates. How is the capacitance changed when the slab is inserted between the plates?

Q82) Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 3C_2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept dosed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates,

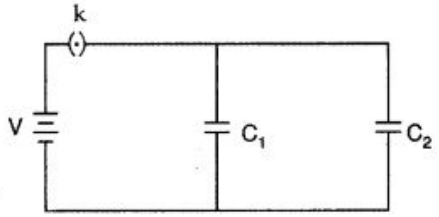


Find the ratio of

(a) the net capacitance and

(b) the energies stored in the combination, before and after the introduction of the dielectric slab.

Q83) Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 2C_2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates.



Find the ratio of

(a) the net capacitance and

(b) the energies stored in the combination, before and after the introduction of the dielectric slab.

Q84) Three capacitors each of capacitance 6pF are connected in series.

(a) What is the total capacitance of the combination?

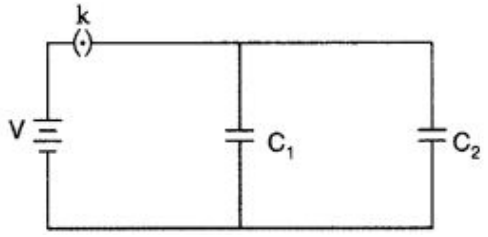
(b) What is the potential difference across each capacitor if the combination is connected to a 100 V supply?

Q85) Three capacitors of capacitances 4pF, 6pF and 8pF are connected in parallel.

(a) What is the total capacitance of the combination?

(b) Determine the charge on each capacitor if the combination is connected to a 100V supply.

Q86) Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = \frac{C_2}{2}$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates.



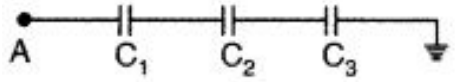
Find the ratio of

(a) the net capacitance and

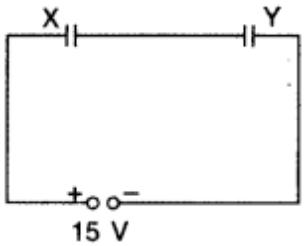
(b) the energies stored in the combination, before and after the introduction of the dielectric slab.

Q87) Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100V. If the energy stored in the two combinations is 0.045J and 0.25J respectively, determine the value of C_1 and C_2. Also calculate the charge on each capacitor in parallel combination.

Q88) Calculate the potential difference and the energy stored in the capacitor C_2 in the circuit shown in the figure. Given potential at A is 90V, C_1=20μF, C_2=30μF and C_3=15μF.



Q89) Two parallel plate capacitors X and Y have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$.



(a) Calculate capacitance of each capacitor if equivalent capacitance of the combination is 4pF.

(b) Calculate the potential difference between the plates of X and Y.

(c) Estimate the ratio of electrostatic energy stored in X and Y.

Q90) Define an equi-potential surface. Draw equi-potential surfaces:

(a) in the case of a single point charge and

(b) in a constant electric field in Z-direction. Why the equi-potential surfaces about a single charge are not equidistant?

(c) Can electric field exist tangential to an equi-potential surface? Give reason.

Q91)A parallel plate capacitor, of capacitance 20pF, is connected to a 100 V supply. After sometime the battery is disconnected, and the space, between the plates of the capacitor is filled with a dielectric, of dielectric constant 5. Calculate the energy stored in the capacitor:

(a) before and

(b) after the dielectric has been put in between its plates.

Q92) (a) Find equivalent capacitance between A and B in the combination given below.
Each capacitor is of 2 μF capacitance.

(b) If a dc source of 7 V is connected across AB, how much charge is drawn from the source and what is the energy stored in the network?

Q93)A 12 pF capacitor is connected to a 50 V battery. How much electrostatic energy is stored in the capacitor? If another capacitor of 6 pF is connected in series with it with the same battery connected across the combination, find the charge stored and potential difference across each capacitor.

Q94) (a) A 900pF capacitor is charged by 100 V battery.
How much electrostatic energy is stored by the capacitor?

(b) The capacitor is disconnected from the battery and connected across another uncharged 900pF capacitor.
What is the electrostatic energy stored by the system?

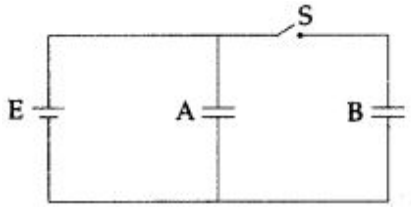
Q95) A 2μF capacitor is charged by a 100V supply. It is then disconnected from the supply, and is connected to another uncharged 1μF capacitor. How much electrostatic energy of the first capacitor is lost in the form of heat and electromagnetic radiation?

Q96) A 900pF capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another uncharged 900pF capacitor. How much electrostatic energy is lost in the process?

Q97) (a) Derive the expression for the electric potential due to an electric dipole at a point on its axial line.
(b) Depict the equi-potential surfaces due to an electric dipole.

Q98) Two identical capacitors of 12pF each are connected in series across a battery of 50 V. How much electrostatic energy is stored in the combination? If these were connected in parallel across the same battery, how much energy will be stored in the combination now? Also find the charge drawn from the battery in each case.

Q99) Two identical parallel plate capacitors A and B are connected to a battery of V volts with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant K. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.



Q100) (a) Write two properties by which electric potential is related to the electric field.
(b) Two point charges q_1 and q_2, separated by a distance of r_{12} are kept in an external electric field(E). Derive an expression for the potential energy of the system of two charges in the field.

Q101) A capacitor of unknown connected across a battery of V volt. A charge of 360pC is stored in it. When the potential across the capacitor is reduced by 120 V, the charge stored in the capacitor becomes 120pC. Calculate V and the unknown capacitance. What would have been the charge on the capacitor if the voltage were increased by 120 V?

Q102) A capacitor of unknown capacitance is connected across a battery of V volt. A charge of 240pC is stored in it. When the potential across the capacitor is reduced by 80 V, the charge stored in the capacitor becomes 80pC. Calculate V and the unknown capacitance.
What would have been the charge in the capacitor if the voltage were increased by 80 V?

Q103) A capacitor of unknown capacitance is connected across a battery of V volt. A charge of 120μC is stored in it. When the potential across the capacitor is reduced by 40 V, the charge stored in the capacitor becomes 40μC. Calculate V and the unknown capacitance. What would have been the charge in the capacitor if the voltage were increased by 40 V?

Q104)A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Without disconnecting the battery, the distance between the plates is tripled and a dielectric medium of k=10 is introduced between the plates is tripled and a dielectric medium of k=10 is introduced between the plates of the capacitor. Explain giving reasons, how will the following be affected:
(a) capacitance of the capacitor (b) charge on the capacitor, and (c) energy density of the capacitor.

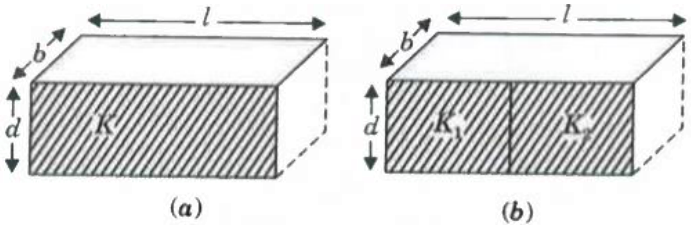
Q105) Derive an expression for the energy stored in a parallel plate capacitor.
On charging a parallel plate capacitor to a potential V, the spacing between the plates is halved, and a dielectric medium of ε_r =10 is introduced between the plates, without disconnecting the d.c. source. Explain, using suitable expressions, how the
(a) capacitance, (b) electric field and (c) energy density of the capacitor change.

Q106) (a) Write two properties of equi-potential surfaces. Depict equi-potential surfaces due to an isolated point charge. Why do the equi-potential surfaces get closer as the distance between the equi-potential surface and the source charge decreases?

(b) An electric dipole of dipole moment $\vec{p}$, is placed in a uniform electric field $\vec{E}$.
Deduce the expression for the torque 'x acting on it.

Q107) (a) Obtain the expression for the potential due to an electric dipole of dipole moment p at a point V on the axial line.

(b) Two identical capacitors of plate dimensions $l \times b$ and plate separation d have dielectric slabs filled in between the space of the plates as shown in the figure.



Obtain the relation between the dielectric constants K, K_1 and K_2.

Q108) (i) If two similar large plates, each of area A having surface charge densities +a and -a are separated by a distance d in air, find the expressions for

(a) field at points between the two plates and on outer side of the plates. Specify the direction of the field in each case.

(b) the potential difference between the plates.

(c) the capacitance of the capacitor so formed.

(ii) Two metallic spheres of radii R and 2R are charged so that both of these have same surface charge density a. If they are connected to each other with a conducting wire, in which direction will the charge flow and why?

Q109) (a) Obtain the expression for the potential due to a point charge.

(b) Use the above expression to show that the potential, due to an electric dipole (length 2a), varies as the 'inverse square' of the distance r of the 'field point' from the centre of the dipole for $r > a$.

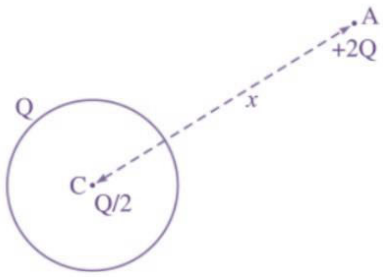
Q110) (a) Define the SI unit of capacitance.

(b) Obtain the expression for the capacitance of a parallel plate capacitor.

(c) Derive the expression for the affective capacitance of a series combination of n capacitors.

Q111) (a) Explain, using suitable diagrams, the difference in the behavior of a conductor and a dielectric in the presence of external electric field. Define the terms polarization of a dielectric and write its relation with susceptibility.

(b) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at its centre C and another charge +2Q is placed outside the shell at a distance x from the centre as shown in the figure.



Find

(i) the force on the charge at the centre of shell and at the point A, (ii) the electric flux through the shell.

Q112) (a) A comb run through one's dry hair attracts small bits of paper. Why? What happens if the hair is wet or if it is a rainy day?

(b) Ordinary rubber is an insulator. But special rubber tyres of aircraft are made slightly conducting. Why is this necessary?

(c) Vehicles carrying inflammable materials usually have metallic ropes touching the ground during motion. Why?

(d) A bird perches on a bare high power line, and nothing happens to the bird. A man standing on the ground touches the same line and gets a fatal shock. Why?

Q113) A spherical conductor of radius 12 cm has a charge of 1.6×10^{-7}C distributed uniformly on its surface. What is the electric field:

(a) inside the sphere
(b) just outside the sphere
(c) at a point 18 cm from the centre of the sphere?

Q114) A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.

(a) A charge q is placed at the centre of the shell. What is the surface charge density on the inner and outer surfaces of the shell?

(b) Is the electric field inside a cavity (with no charge) zero, even if the shell is not spherical, but has any irregular shape? Explain

Q115) Two charged conducting spheres of radii a and b are connected to each other by a wire. What is the ratio of electric fields at the surfaces of the two spheres? Use the result obtained to explain why charge density on the sharp and pointed ends of a conductor is higher than on its flatter portions?

Q116) (a) If Coulomb's law involved $\frac{1}{r^3}$ dependence (instead of $\frac{1}{r^2}$), would Gauss's law be still true?

(b) A small test charge is released at rest at a point in an electrostatic field configuration. Will it travel along the field line passing through that point?

(c) What is the work done by the field of a nucleus in a complete circular orbit of the electron? What if the orbit is elliptical?

(d) We know that electric field is discontinuous across the surface of a charged conductor. Is electric potential also discontinuous there?

Q117) A small sphere of radius r_1 and charge q_1 is enclosed by a spherical shell of radius r_2 and charge q_2. Show that if q_1 is positive, charge will necessarily flow from the sphere to the shell (when the two are connected by a wire) no matter what the charge q_2 on the shell is.

Q118) A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.

(a) A charge q is placed at the centre of the shell.

(i) Find out the surface charge density on the inner and outer surfaces of the shell.

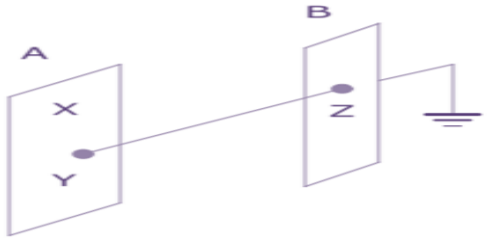
(ii) Find the electric potential on inner surface of shell

(iii) Find the electric potential on outer surface of shell

(b) Is the electric field inside a cavity (with no charge) zero; independent of the fact whether the shell is spherical or not? Explain.

Q119) A $200\mu F$ parallel plate capacitor having plate separation of 5 mm is charged by a 100 V dc source. It remains connected to the source. Using an insulated handle, the distance between the plates is doubled and a dielectric slab of thickness 5 mm and dielectric constant 10 is introduced between the plates. Explain with reason, how the (i) capacitance, (ii) electric field between the plates, (iii) energy density of capacitor will change?

Q120) Two identical plane metallic surfaces A and B are kept parallel to each other in air separated by a distance of 1.0 cm as shown in the figure.



Surface A is given a positive potential of 10V and the outer surface of B is earthed.

(a) What is the magnitude and direction of uniform electric field between point Y and Z?

(b) What is the work done in moving a change of 20mC from point X to Y?