Previous Years

Examination Questions

1 Mark Questions

1. The physical quantity having SI unit NC^{-1} m is .....Delhi 2020

2. A proton released from rest in an electric field will start moving towards a region of ..... potential in the field. **All India 2020**

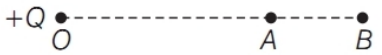
3. The work done in moving a charge particle between two points in a uniform electric field does not depend on the path followed by the particle. Why? **All India 2020**

4. Draw equipotential surfaces for an electric dipole. **Delhi 2019**

5. Draw the equipotential surfaces due to an isolated point charge. **Delhi 2019**

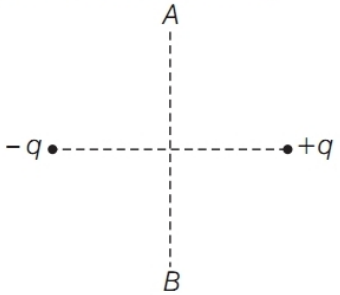
6. Does the charge given to a metallic sphere depend on whether it is hollow or solid? Give reason for your answer. **Delhi 2017**

7. 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?



Delhi 2016, Foreign 2016, Delhi 2011

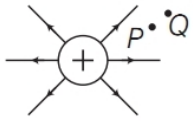
8. A charge q is moved from a point A above a dipole of dipole moment p to a point B below the dipole in equatorial plane without acceleration. Find the work done in this process. **All India 2016**



9. Why are electric field lines perpendicular at a point on an equipotential surface of a conductor? **All India 2015C**

10. Two point charges q and $-2q$ are kept d distance apart. Find the location of point relative to charge q at which potential due to this system of charges is zero. **All India 2014C**

11. The figure shows the field lines of a positive charge. Is the work done by the field in moving a small positive charge from Q to P positive or negative? **Foreign 2014**



12. For any charge configuration the equipotential surface through a point is a normal to the electric field. Justify. **Delhi 2014**

13. What is the geometrical shape of equipotential surfaces due to a single isolated charge? **Delhi 2013, All India 2010 C**

14. What is the amount of work done in moving a point charge around a circular arc of radius r at the centre of which another point charge is located? **All India 2013C**

15. Two charges 2 μC and –2 μC are placed at points A and B at 5 cm apart. Depict an equipotential surface of the system. **Delhi 2013C**

16. Why electrostatic potential is constant throughout the volume of the conductor and has the same value as on its surface? **Delhi 2012**

17. Why the potential inside a hollow spherical charged conductor is constant and has the same value as on its surface? **Foreign 2012**

18. Why there is no work done in moving a charge from one point to another on an equipotential surface? **Foreign 2012**

19. A hollow metal sphere of radius 5 cm is charged such that potential on its surface is 10V. What is the potential at the centre of the sphere? **All India 2011**

20. Can two equipotential surfaces intersect each other? Justify your answer. **Delhi 2011C**

21. Draw equipotential surfaces due to a single point charge. **All India 2011C**

22. Name the physical quantity whose SI unit is JC^{-1}. Is it a scalar or a vector quantity? **All India 2010**

2 Marks Questions

23. Write two important characteristics of equipotential surface. **Delhi 2020**

24. The magnitude of electric field (in NC^{-1}) in a region varies with the distance r (in cm) as

$$E = 10r + 5$$

By how much does the electric potential increase in moving from point at $r = 1$ m to a point at $r = 10$ m? **Delhi 2020**

25. (i) Draw equipotential surfaces corresponding to the electric field that uniformly increases in magnitude along with the z-directions.

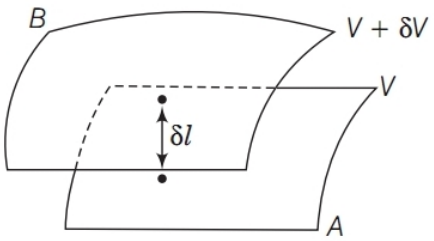
(ii) Two charges $-q$ and $+q$ are located at points $(0, 0, -a)$ and $(0, 0, a)$. What is the electrostatic potential at the points $(0, 0, z)$ and $(x, y, 0)$? **Delhi 2019**

26. (i) Draw the equipotential surfaces due to an electric dipole.

(ii) Derive an expression for the electric field due to a dipole of dipole moment **p** at a point on its perpendicular bisector. **Delhi 2019**

27. Two point charges q_1 and q_2 are located at r_1 and r_2 respectively in an external electric field **E**. Obtain the expression for the total work done in assembling this configuration. **Delhi 2014C**

28. Two closely spaced equipotential surfaces A and B with potentials V and $V+\delta V$, (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 potential. **Delhi 2014C**



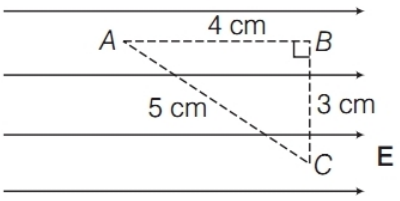
29. Calculate the amount of work done to dissociate a system of three charges, two of 1μC and one of −4μC placed on the vertices of an equilateral triangle of side 10 cm. **All India 2013C**

30. 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.

(i) Calculate the potential difference, between A and C.

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

All India 2012



31. Draw a plot showing the variation of (i) electric field (E) and (ii) electric potential (V) with distance r due to a point charge Q. **Delhi 2012**

32. Two uniformly large parallel thin plates having charge densities $+\sigma$ and $-\sigma$ are kept in the XZ- plane at a distance d apart. Sketch an equipotential 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? **Delhi 2011**

33. Two point charges 3 μC and −3 μC are placed at points A and B at 5 cm apart.

(i) Draw the equipotential surfaces of the system.

(ii) Why do equipotential surfaces get close to each other near the point charge? **All India 2011C**

34. Two charged conducting spheres of radii r_1 and r_2 connected to each other by a wire. Find the ratio of electric fields at the surfaces of the two spheres. **Delhi 2011C**

35. A dipole with its charge $-q$ and $+q$ located at the points $(0, -b, 0)$ and $(0, +b, 0)$ is present in a uniform electric field **E**. The

equipotential surfaces of this field are planes parallel to the YZ-plane.

(i) What is the direction of the electric field **E**?

(ii) How much torque would the dipole experience in this field? **Delhi 2010C**

36. Find out the expression for the potential energy of a system of three charges q_1, q_2 and q_3 located at r_1, r_2 and r_3 with respect to the common origin O. **Delhi 2010C**

3 Marks Questions

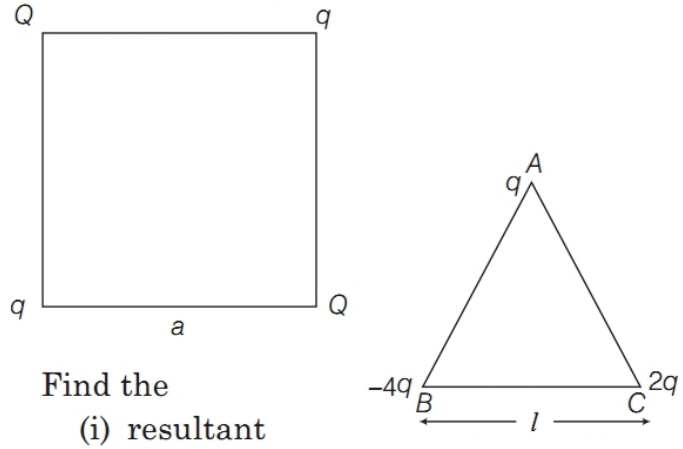
37. (i) Two point charges $+Q_1$ and $-Q_2$ are placed at r distance apart. Obtain the expression for the amount of work done to place a third charge Q_3 at the mid-point of the line joining the two charges.

(ii) At what distance from charge $+Q_1$ on the line joining the two charges (in terms of Q_1, Q_2 and r) will this work done be zero? **Delhi 2020**

38. (i) Draw the equipotential surfaces corresponding to a uniform electric field in the z-direction.

(ii) Derive an expression for the electric potential at any point along the axial line of an electric dipole. **Delhi 2019**

39. Four point charges Q, q, Q and q are placed at the corners of a square of side a as shown in figure.



Find the

(i) resultant electric force on a charge Q and

(ii) potential energy of this system. **CBSE 2018**

40. (i) Three point charges q, $-4q$ and $2q$ are placed at the vertices of an equilateral triangle ABC of side l as shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on the charge q.

(ii) Find out the amount of the work done to separate the charges at infinite distance. **CBSE 2018**

41. (i) Derive the expression for the electric potential due to an electric dipole at a point on its axial line.

(ii) Depict the equipotential surfaces due to an electric dipole. **Delhi 2017**

42. Define an equipotential surface. Draw equipotential surfaces

(i) in case of a single point charge

(ii) in a constant electric field in z-direction. Why the equipotential surfaces about a single charge are not equidistant?

(iii) Can electric field exist tangential to an equipotential surface? Give reason. **All India 2016**

43. (i) Depict the equipotential surfaces for a system of two identical positive point charges placed at a distance d apart.

(ii) 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 with positions $\mathbf{r}_1$ and $\mathbf{r}_2$ respectively in presence of external electric field E. **Delhi 2010**

5 Marks Question

44. Two point charges q and $-q$ are located at points $(0,0,-a)$ and $(0,0,a)$ respectively.

(i) Find the electrostatic potential at $(0,0,z)$ and $(x,y,0)$.

(ii) 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?

(iii) How would your answer change if the path of the test charge between the same points is not along the X-axis but along any other random path?

(iv) If the above point charges are now placed in the same positions in a uniform external electric field **E**, what would be the potential energy of the charge system in its orientation of unstable equilibrium?

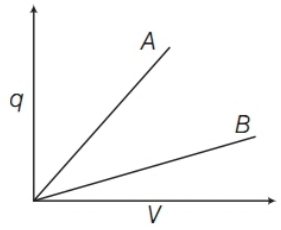
Justify your answer in each case. **2018 C**

Previous Years

Examination Questions

1 Mark Questions

1. Why does current in steady state not flow in a capacitor connected across a battery? However, momentary current does flow during charging or discharging of the capacitor. Explain. **All India 2017**
2. The given graph shows the 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 C_1. Which line (A or B) corresponds to C_1 and why? **All India 2014C**



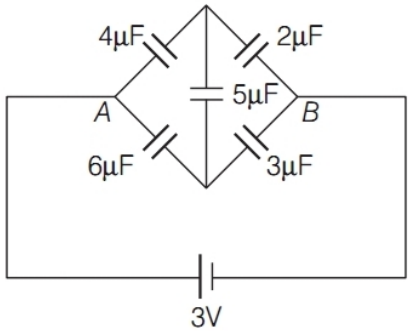
3. Distinguish between a dielectric and a conductor. **Delhi 2012**
4. Define the dielectric constant of a medium. What is its unit? **Delhi 2011 C**

2 Marks Questions

5. Obtain the expression for the energy stored in a capacitor connected across a DC battery. Hence, define energy density of the capacitor. **Delhi 2020**

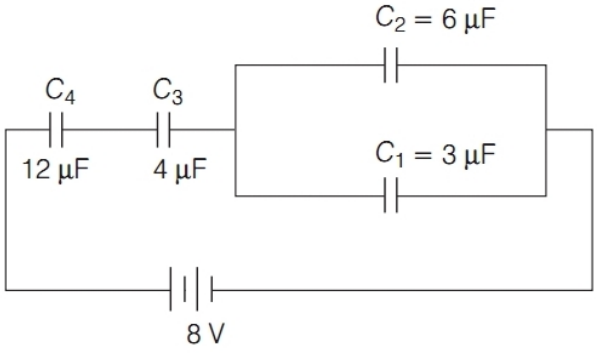
6. Find the total charge stored in the network of capacitors connected between A and B as shown in figure below.

All India 2020



7. A 100 μF parallel plate capacitor having plate separation of 4 mm is charged by 200 V DC. The source is now disconnected. When the distance between the plates is doubled and a dielectric slab of thickness
4 mm and dielectric constant 5 is introduced between the plates, how will (i) its capacitance (ii) the electric field between the plates (iii) energy density of the capacitor get affected? Justify your answer in each case. **CBSE 2019**

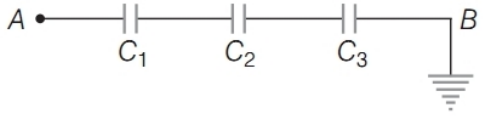
8. In a network, four capacitors C_1, C_2, C_3 and C_4 are connected as shown in the figure.



(i) Find the net capacitance of the circuit.

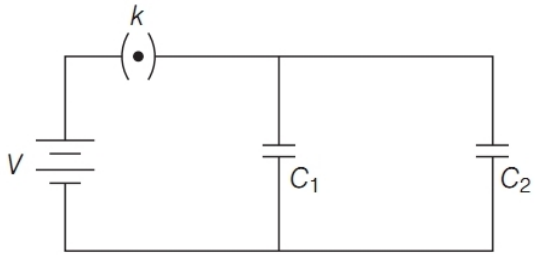
(ii) If the charge on the capacitor C_1 is 6 μC, then (a) calculate the charge on the capacitors C_3 and C_4 (b) net energy stored in the capacitors C_3 and C_4 connected in series. **CBSE 2019**

9. Calculate the potential difference and the energy stored in the capacitor C_2 in the circuit as shown in the figure. Given potential at A is 90 V, $C_1 = 20\,\mu$F, $C_2 = 30\,\mu$F and $C_3 = 15\,\mu$F. **All India 2015**



10. 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. **All India 2014**

11. Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 2C_2$ are connected across a battery of V volt 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

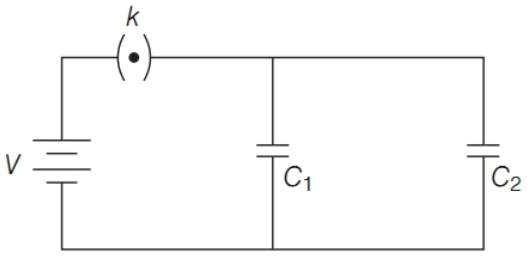
(i) the net capacitance and

(ii) the energies stored in the combination before and after the introduction of the dielectric slab. **Delhi 2014C**

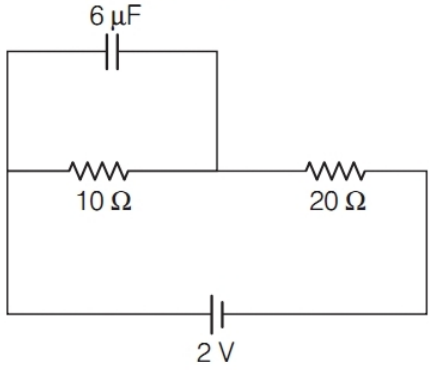
12. Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = C_2/2$ are connected across a battery of V volts as shown in the figure. Initially, the key (k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant K is inserted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

(i) the net capacitance and

(ii) the energies stored in the combination before and after the introduction of the dielectric slab. **Delhi 2014C**

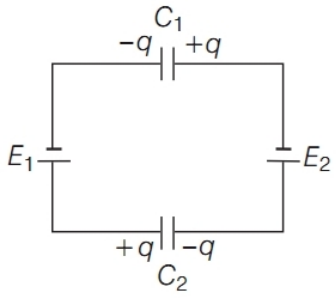


13. Find the charge on the capacitor as shown in the circuit. **Foreign 2014**

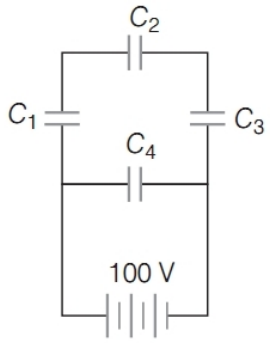


14. A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor, but has the thickness $d/2$. Where, d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor. **Delhi 2013**

15. Determine the potential difference across the plates of the capacitor C_1 of the network shown in the figure below. (assume, $E_2 > E_1$) **All India 2013**

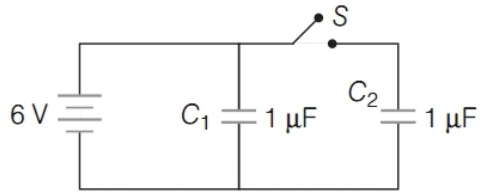


16. A network of four capacitors each of capacitance 15μF is connected across a battery of 100 V as shown in the figure. Find the (i) net capacitance and (ii) the charge on the capacitor C_4. **All India 2012C**



17. How will the
(i) energy stored and
(ii) the electric field inside the capacitor be affected when it is completely filled with a dielectric material of dielectric constant K ? **All India 2012**

18. Two capacitors of 1 μF capacitance are connected to a battery of 6 V. Initially switch S is closed. After sometime S is left open and dielectric slab of dielectric constant $K=3$ are inserted to fill completely the space between the plates of the two capacitors. How will the (i) charge and (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted? **Delhi 2011**

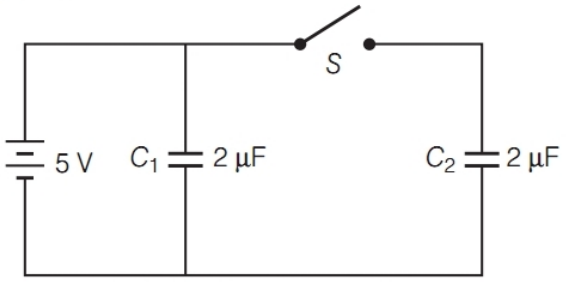


19. Net capacitance of three identical capacitors in series is 1 μF. What will be their net capacitance if connected in parallel?

Find the ratio of energy stored in these two configurations if both are connected to the same source. **All India 2011**

20. 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 closed. After sometime, 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 (i) charge and (ii) potential difference between the plates of the

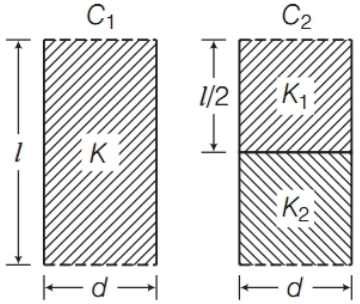
capacitors be affected after the slabs are inserted?



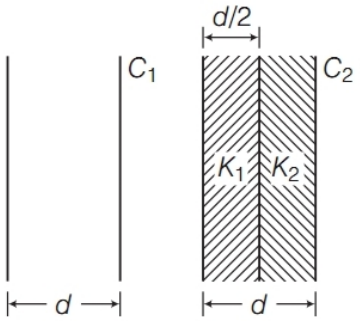
All India 2011; Delhi 2011

21. What is the area of the plates of 2 F parallel plate capacitor having separation between the plates is 0.5 cm? All India 2011

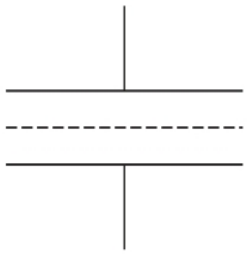
22. Two identical parallel plate (air) capacitors C_1 and C_2 have capacitance C each. The space between their plates is now filled with dielectrics as shown in the figure. If the two capacitors still have equal capacitance, then obtain the relation between dielectric constants K, K_1 and K_2. Foreign 2011



23. You are given an air filled parallel plate capacitor C_1. The space between its plates is now filled with slabs of dielectric constants K_1 and K_2 as shown in figure. Find the capacitance of the capacitor C_2 if area of the plates is A and distance between the plates is d. Foreign 2011



24. Figure shows a sheet of aluminium foil of negligible thickness placed between the plates of a capacitor. How will its capacitance be affected, if



(i) the foil is electrically insulated?

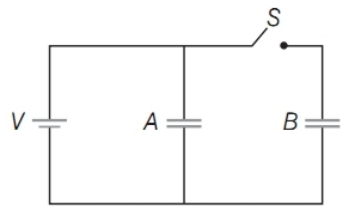
(ii) the foil is connected to the upper plate with a conducting wire? Foreign 2011

25. Distinguish between polar and non-polar dielectric. All India 2010 C

3 Marks Questions

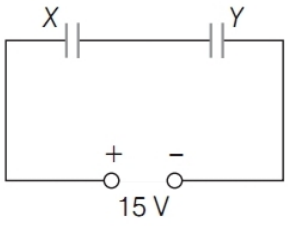
26. A 200 μF parallel plate capacitor having plate separation of 5 mm is charged by a 100 V DC source. It remains connected to the source. Using an insulated handle, the distance between the plates is doubled and a dielectric slab of thickness 5 mm and dielectric constant 10 is introduced between the plates. Explain with reason, how the (i) capacitance (ii) electric field between the plates (iii) energy density of the capacitor will change? CBSE 2019

27. Two identical parallel plate capacitors A and B are connected to a battery of V volts with the switch S is 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. All India 2017



28. 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. Delhi 2017

29. 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 $\varepsilon_r = 4$.

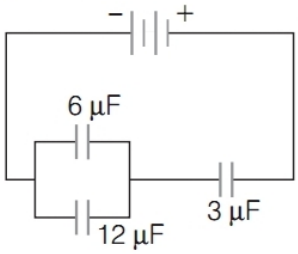


(i) Calculate the capacitance of each capacitor if equivalent capacitance of the combination is 4μF.

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

(iii) Estimate the ratio of electrostatic energy stored in X and Y. **Delhi 2016**

30. In the following arrangement of capacitors the energy stored in the 6μF capacitor is E.



Find the value of the following

(i) energy stored in 12μF capacitor

(ii) energy stored in 3μF capacitor

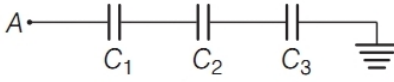
(iii) total energy drawn from the battery

Foreign 2016

31. Find the ratio of the potential differences that must be applied across the parallel and series combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1 : 2 so that the energy stored in these two cases becomes the same. **All India 2016**

32. Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100 V. If the energy stored in the two combinations is 0.045J and 0.25 J respectively, then determine the value of C_1 and C_2. Also, calculate the charge on each capacitor in parallel combination. **All India 2015**

33. 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 90 V, $C_1 = 20\,\mu F$, $C_2 = 30\ \mu F$ and $C_3 = 15\,\mu F$.



Delhi 2015

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

(ii) 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. **Delhi 2014**

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

(ii) Two charged spherical conductors of radii R_1 and R_2 when connected by a conducting plate respectively. Find the ratio of their surface charge densities in terms of their radii.

Delhi 2014

36. In a parallel plate capacitor with air between the plates each plate has an area of $6 \times 10^{-3}\ m^2$ and the separation between the plate is 3 mm.

(i) Calculate the capacitance of the capacitor.

(ii) If this capacitor is connected to 100 V supply, what would be the charge on each plate?

(iii) How would charge on the plates be affected if a 3 mm thick mica sheet of $K = 6$ is inserted between the plates while the same voltage supply remains connected? **Foreign 2014**

37. A capacitor of unknown capacitance is connected across a battery of V volt. The charge stored in it is 360μC . When potential across the capacitor is reduced by 120 V, the charge stored in it becomes 120 μC.

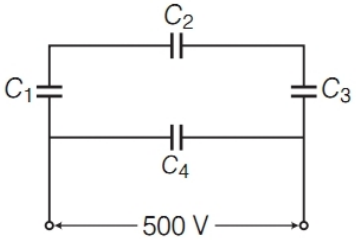
Calculate

(i) the potential V and the unknown capacitance C.

(ii) the charge stored in the capacitor if the voltage applied had increased by 120 V. **Delhi 2013**

38. A capacitor of 200 pF is charged by a 300 V battery. The battery is then disconnected and the charged capacitor is connected to another uncharged capacitor of 100 pF. Calculate the difference between the final energy stored in the combined system and the initial energy stored in the single capacitor. **Foreign 2012**

39. A network of four capacitors each of 12 μF capacitance if connected to a 500 V supply as shown in the figure.



Determine

(i) the equivalent capacitance of the network and

(ii) the charge on each capacitor.

All India 2010

40. 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

(i) the capacitances of the capacitor

(ii) potential difference between the plates

(iii) the energy stored in the capacitors be affected? Justify your answer in each case. **Delhi 2010**

41. 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

(i) charge on plates?

(ii) electric field intensity between the plates?

(iii) capacitance of the capacitor?

Justify your answer in each case. **Delhi 2010**

42. A parallel plate capacitor is charged to a potential difference V by a DC 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? **Delhi 2010**

(i) Electric field between the plates

(ii) Capacitance

(iii) Energy stored in the capacitor.

43. Show that the capacitance of a spherical conductor is $4\pi\varepsilon_0$ times the radius of the spherical conductor. **Delhi 2010**

44. Find the ratio of the potential differences that must be applied across the parallel and the series combination of two identical capacitors so that the energy stored in the two cases becomes the same. **Foreign 2010**

45. (i) How is the electric field due to a charged parallel plate capacitor affected when a dielectric slab is inserted between the plates fully occupying the intervening region?

(ii) A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has thickness $\frac{1}{2}d$, where d is the separation between the plates. Find the expression for the capacitance when the slab is inserted between the plates. **Foreign 2010**

46. (i) Plot a graph comparing the variation of potential V and electric field E due to a point charge Q as a function of distance R from the point charge.

(ii) Find the ratio of the potential differences that must be applied across the parallel and the series combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1 : 2 so that the energy stored in the two cases becomes the same.

Foreign 2010

5 Marks Questions

47. (i) Describe briefly the process of transferring the charge between the two plates of a parallel plate capacitor when connected to a battery. Derive an expression for the energy stored in a capacitor.

(ii) A parallel plate capacitor is charged by a battery to a potential difference V. It is disconnected from battery and then connected to another uncharged capacitor of the same capacitance. Calculate the ratio of the energy stored in the combination to the initial energy on the single capacitor. **Delhi 2019**

48. A capacitor of capacitance C_1 is charged to a potential V_1 while another capacitor of capacitance C_2 is charged to a potential difference V_2. The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other.

(i) Find the total energy stored in the two capacitors before they are connected.

(ii) Find the total energy stored in the parallel combination of the two capacitors.

(iii) Explain the reason for the difference of energy in parallel combination in comparison to the total energy before they are connected. **CBSE 2018**

49. (i) If two similar large plates each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, then find the expression 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.

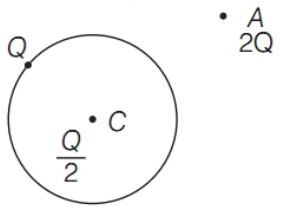
(ii) Two metallic spheres of radii R and $2R$ are charged so that both of these have same surface charge density σ. If they are connected to each other with a conducting wire. In which direction will the charge flow and why? **All India 2016**

50. (i) Explain using suitable diagrams, the difference in the behaviour of a

(a) conductor and

(b) dielectric in the presence of external electric field. Define the terms polarisation of a dielectric and write its relation with susceptibility.

(ii) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $Q/2$ is placed at its centre C and an other charge $+2Q$ is placed outside the shell at a distance x from the centre as shown in the figure.



Find

(a) the force on the charge at the centre of shell and at the point A.

(b) the electric flux through the shell.

All India 2015

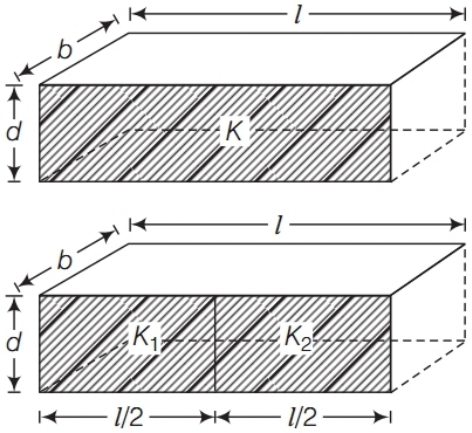
51. (i) Derive the expression for the energy density of the electric field in a parallel plate capacitor.

(ii) A fully charged parallel plate capacitor is connected across an uncharged identical capacitor. Show that the energy stored in the combination is less than the energy stored initially in the single capacitor. **Delhi 2014**

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

(ii) 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 dielectric constants K, K_1 and K_2.

All India 2013

53. (i) A parallel plate capacitor is charged by a battery to a potential difference V. The battery is disconnected and a dielectric slab is inserted to completely fill the space between the plates.

How will

(a) its capacitance

(b) electric field between the plates and

(c) energy stored in the capacitor be affected? Justify your answer giving necessary mathematical expressions for each case.

(ii) (a) Draw the electric field lines due to a conducting sphere.

(b) Draw the electric field lines due to a dipole. **All India 2011**

54. (i) Deduce the expression for the energy stored in a charged capacitor.

(ii) Show that the effective capacitances C of a series combination of three capacitors C_1, C_2 and C_3 is given by

$$C = \frac{C_1 C_2 C_3}{C_1 C_2 + C_2 C_3 + C_3 C_1}.$$

All India 2010C