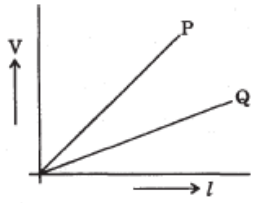
Q1. The variation of potential difference V with length/in case of two potentiometers P and Q is as shown. Which one of these two will you prefer for comparing emfs of two primary cells? **1 Mark**



Q2. An A.C. source with variable frequency is connected to a parallel plate capacitor. How will the displacement current be affected with the decrease in frequency of the source? **1 Mark**

Q3. 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?

Q4. The charging current for a capacitor is 0.25 A. What is the displacement current across its plates?

Q5. A charged particle is placed between the two plates of a charged parallel plate capacitor. It experiences a force F. If one plate is removed, then the force on the particle will be:

A 2F **B** F **C** $\frac{F}{2}$ **D** Zero

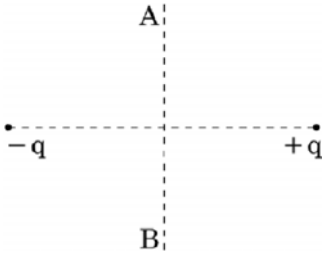
Q6. Define capacitor reactance. Write its S.I. units.

Q7. Ten capacitors, each of capacitance 1 μF, are connected in parallel to a source of 100 V. The total energy stored in the system is equal to:

A 10^{-2} J **B** 10^{-3} J **C** $0{\cdot}5 \times 10^{-3}$ J **D** $0{\cdot}5 \times 10^{-2}$ J

Q8. Why is the electrostatic potential inside a charged conducting shell constant throughout the volume of the conductor?

Q9. 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 the process.



Q10. In potentiometer, a long uniform wire is used to _____ potential gradient along the wire. **1 Mark**

Q11. Two identical capacitors of 12pF each are connected in series across a 50V battery. Calculate the electrostatic energy stored in the combination. If these were connected in parallel across the same battery, find out the value of the energy stored in this combination. **2 Marks**

Q12. 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. **2 Marks**

Q13. A capacitor of capacitance 'C' is being charged by connecting it across a dc source along with an ammeter.Will the ammeter show a momentary deflection during the process of charging? If so, how would you explain this momentary deflection and the resulting continuity of current in the circuit? Write the expression for the current inside the capacitor. **2 Marks**

Q14. A point charge 'q' is placed at O as shown in the figure. **2 Marks**

Is $V_P - V_Q$ positive or negative when (i) q > 0, (ii) q < 0? Justify your answer.

Q15. A parallel plate capacitor of plate area A each and separation d, is being charged by an ac source. Show that the displacement current inside the capacitor is the same as the current charging the capacitor. **2 Marks**

Q16. A parallel plate capacitor is being charged by a time varying current. Explain briefly how Ampere's circuital law is generalized to incorporate the effect due to the displacement current. **2 Marks**

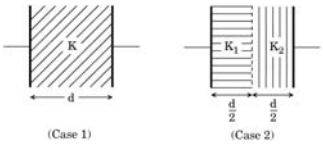
Q17. A capacitor, made of two parallel plates each of plate area A and separation d, is being charged by an external ac source. Show that the displacement current inside the capacitor is the same as the current charging the capacitor. **2 Marks**

Q18. N small conducting liquid droplets, each of radius r, are charged to a potential V each. These droplets coalesce to form a single large drop without any charge leakage. Find the potential of the large drop.

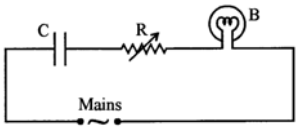
Q19. The electric field and electric potential at any point due to a point charge kept in air is $20NC^{-1}$ and $10NC^{-1}$ respectively. Compute the magnitude of this charge.

Q20. Considering the case of a parallel plate capacitor being charged, show how one is required to generalize Ampere's circuital law to include the term due to displacement current.

Q21. The space between the plates of a parallel plate capacitor is completely filled in two ways. In the first case, it is filled with a slab of dielectric constant K. In the second case, it is filled with two slabs of equal thickness and dielectric constants K_1 and K_2 respectively as shown in the figure. The capacitance of the capacitor is same in the two cases. Obtain the relationship between K, K_1 and K_2.

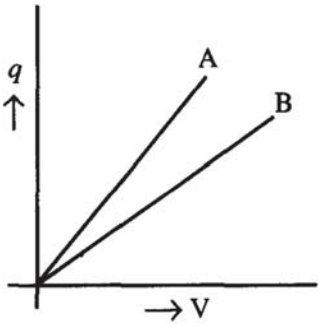


Q22. A capacitor'C', a variable resistor 'R' and a bulb oB' are connected in series to the ac mains in circuit as shown. The bulb glows with some brightness. How will the glow of the bulb change if (i) a dielectric slab is introduced between the plates of the capacitor, keeping resistance R to be the same; (ii) the resistance R is increased keeping the same capacitance?

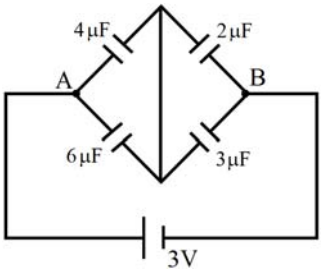


Q23. Two point charges $4\mu C$ and $-2\mu C$ are separated by a distance of 1 m in air. Calculate at what point on the line joining the two charges is the electric potential zero. **2 Marks**

Q24. The given graph shows the variation of charge q versus potential difference V for two capacitors C_1 and C_2. The two capacitors have same plate separation, but the plate area of C_2 is double than that of C_1. Which of the lines in the graph correspond to C_1 and C_2 and why? **2 Marks**



Q25. Find the total charge stored in the network of capacitors connected between A and B as shown in figure: **2 Marks**

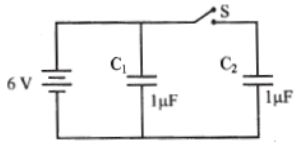


Q26. A capacitor made of two parallel plates, each of area 'A' and separation 'd' is charged by an external dc source. Show that during charging, the displacement current inside the capacitor is the same as the current charging the capacitor.

Q27. When an ideal capacitor is charged by a dc battery, no current flows. However, when an ac source is used, the current flows continuously. How does one explain this, based on the concept of displacement current?

Q28.
1. Can two equipotential surfaces intersect each other? Give reasons.
2. 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)?

Q29. Figure shows two identical capacitors, C_1 and C_2, each of 1 μF capacitance connected to a battery of 6 V. Initially switch 'S' is closed. After sometime 'S' is left open and dielectric slabs 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?

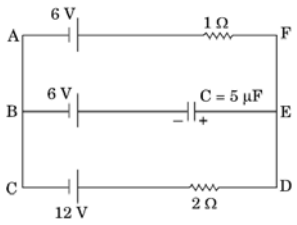


Q30. Obtain the expression for the energy stored in a capacitor connected across a dc battery. Hence define energy density of the capacitor. **2 Marks**

Q31. Two capacitors of capacitance 6 μF an 12 μF are connected in series with a battery. The voltage across the 6 capacitor is 2 V. Compute the total battery voltage. **2 Marks**

Q32. A parallel plate capacitor with air between the plates has a capacitance of 8 pF. The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 5. Calculate the value
of capacitance of the capacitor in the second case. **2 Marks**

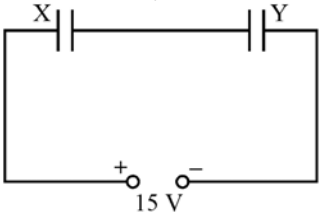
Q33. In the given circuit, with steady current, calculate the potential difference across the capacitor and the charge stored in it. **3 Marks**



Q34. Define displacement current. What role does it play while charging a capacitor by dc source. Is the value of displacement current same as that of the conduction current? Explain. **3 Marks**

Q35. A $100\mu\text{F}$ parallel plate capacitor having plate separation of 4mm is charged by 200V dc. The source is now disconnected. When the distance between the plates is doubled and a dielectric slab of thickness 4mm and dielectric constant 5 is introduced between the plates, how will (i) its capacitance, (ii) the electric field between the plates, and (iii) energy density of the capacitor get affected? Justify your answer in each case. **3 Marks**

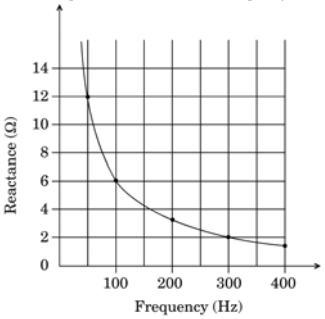
Q36. Two parallel plate capacitors X and Y have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$. **3 Marks**



1. Calculate capacitance of each capacitor if equivalent capacitance of the combination is $4\mu\text{f}$.
2. Calculate the potential difference between the plates of X and Y.
3. Estimate the ratio of electrostatic energy stored in X and Y.

Q37. 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 0.045 J and 0.25 J respectively, determine the value of C_1 and C_2. Also calculate the charge on each capacitor in parallel combination.

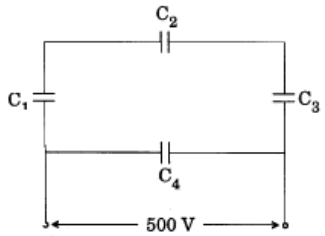
Q38. The figure shows the graphical variation of the reactance of a capacitor with frequency of ac source.



1. Find the capacitance of the capacitor.
2. An ideal inductor has the same reactance at 100Hz frequency as the capacitor has at the same frequency. Find the value of inductance of the inductor.
3. Draw the graph showing the variation of the reactance of this inductor with frequency.

Q39. 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 capacitance of the capacitor, (ii) potential difference between the plates and (iii) the energy stored in the capacitor be affected?
Justify your answer in each case. **3 Marks**

Q40. A network of four capacitors each of 12 µF 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. **3 Marks**



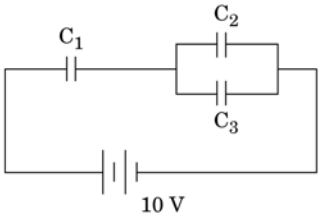
Q41. An alpha particle is accelerated through a potential difference of 100 V. Calculate: **3 Marks**

1. The speed acquired by the alpha particle, and
2. The de-Broglie wavelength associated with it.

(Take mass of alpha particle = 6.4×10^{-27}kg)

Q42. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that due to a single charge. **3 Marks**

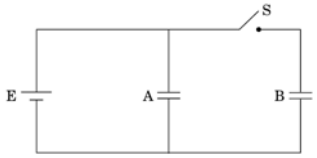
Q43. The figure shows a network of three capacitors $C_1 = 2\mu F;\ C_2 = 6\mu F$ and $C_3 = 3\mu F$ connected across a battery of 10V. If a charge of $6\mu C$ is acquired by the capacitor C_3, calculate the charge acquired by C_1. **3 Marks**



Q44. 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 is then disconnected. A dielectric slab of thickness d and dielectric constant K is now placed between the plates. What change, if any, will take place in.

1. Charge on the plates.
2. Electric field intensity between the plates.
3. Capacitance of the capacitor.

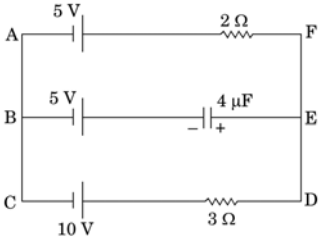
Q45. Two identical parallel plate capacitors A and B are connected to a battery of V volts with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant K. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.



Q46. A 200 μF parallel plate capacitor having plate separation of 5mm is charged by a 100V 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 5mm 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? **3 Marks**

Q47. Three point charges Q_1, Q_2 and Q_3 are located in x y plane at points (-d, 0), (0, 0) and (d, 0) respectively. Q_1 and Q_3 are identical and Q_2 is positive. What will be the nature and value of Q_1 so that the potential energy of the system is zero? **3 Marks**

Q48. In the given circuit, with steady current, calculate the potential drop across the capacitor in terms of V. **3 Marks**



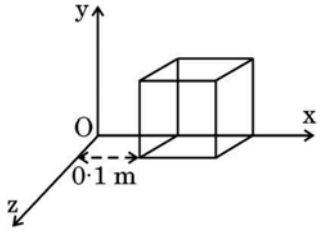
Q49. Explain the underlying principle of working of a parallel plate capacitor. If two similar plates, each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, write expressions for. **3 Marks**

1. the electric field at points between the two plates.
2. the potnetial difference between the plates.
3. the capacitance of the capacitor so formed.

Q50. A cube of side 0·1 m is placed, as shown in the figure, in a region where electric field exists. Here x is in meters and E in NC^{-1}. **3 Marks**

Calculate :

1. The flux passing through the cube, and
2. The charge within the cube.



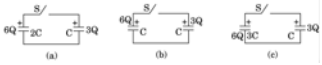
Q51. Define an equipotential surface. Draw equipotential surface:

1. In the case of a single point charge and,
2. In a constant electric field in Z-direction.

Why the equipotential surfaces about a single charge are not equidistant?

3. Can electric field exist tangential to an equipotential surface? Give reason.

Q52. Three circuits, each consisting of a switch 'S' and two capacitors, are initially charged, as shown in the figure. After the switch has been closed, in which circuit will the charge on the left-hand capacitor (i) increase, (ii) decrease and (iii) remain same? Give reasons.



Q53. An air-filled parallel plate capacitor with plate separation 1 mm has a capacitance of 20 pF. It is charged to 4.0 μC. Calculate the amount of work done to pull its plates to a separation of 5 mm. Assume the charge on the plates remains the same.

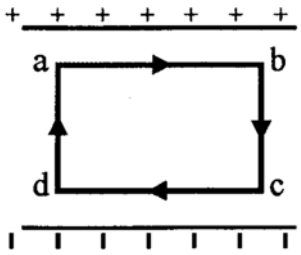
Q54. Write Maxwell's generalisation of Ampere's Circuital Law. Show that in the process of charging a capacitor, the current produced within the plates of the capacitor is $i = \varepsilon_0 \frac{d\Phi E}{dt}$ where Φ_E is the electric flux produced during charging of the capacitor plates.

Q55.

1. Derive the expression for the capacitance of a parallel plate area A and plate separation d.
2. Two charged spherical conductors of radii R_1 and R_2 when conducting wire acquire charges q_1 and q_2 respectively. surface charge densities in terms of their radii.

Q56. **3 Marks**

1. Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.
2. 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 a b c d a.



Q57. A charge Q is distributed over the surfaces of two concentric hollow spheres of radii r and R (R >> r), such that their surface charge densities are equal. Derive the expression for the potential at the common centre. **3 Marks**

Q58. **3 Marks**

A capacitor of $4\mu F$ is charged by a battery of 12V. The battery is disconnected and a dielectric slab of dielectric constant 8 is inserted in between the plates of the capacitor to fill the space completely.
Find the change in the:

1. Charge stored in the capacitor.
2. Potential difference between the plates of the capacitor.
3. Energy stored in the capacitor.

Q59. A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 360 μC. When potential across the capacitor is reduced by 120 V, the charge stored in it becomes 120 μC. **3 Marks**
Calculate:

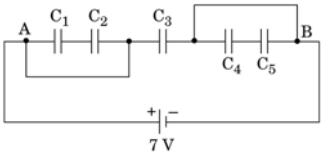
1. The potential V and the unknown capacitance C.
2. What will be the charge stored in the capacitor, if the voltage applied had increased by 120 V?

Q60. In the figure given below, find the: **3 Marks**

1. Equivalent capacitance of the network between points A and B.

Given: $C_1 = C_5 = 8\mu F, C_2 = C_3 = C_4 = 4\mu F$.

2. Maximum charge supplied by the battery.
3. Total energy stored in the network.



Q61.

1. Use Gauss's law to find the electric field due to a uniformly charged infinite plane sheet. What is the direction of field for positive and negative charge densities?
2. Find the ratio of the potential difference that must be applied across the parallel and series combination of two capacitors C_1 and C_2 with their capacitance in the ratio 1: 2 so that the energy stores in the two cases become the same.

Q62. 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 $\varepsilon_r = 10$ is introduced between the plates, without disconnecting the d.c. source. Explain, using suitable expressions, how the (i) capacitance, (ii) electric field and (iii) energy density of the capacitor change.

Q63. Explain the principle of a device that can build up high voltages of the order of a few million volts.
Draw a schematic diagram and explain the working of this device.
Is there any restriction on the upper limit of the high voltages set up in this machine? Explain.

Q64.

1. A conductor of length 'l' is rotated about one of its ends at a constant angular speed 'ω' in a plane perpendicular to a uniform magnetic field B. Plot graphs to show variations of the emf induced across the ends of the conductor with:

1. Angular speed ω.
2. Length of the conductor l.

2. Two concentric circular loops of radius 1cm and 20cm are placed coaxially:

1. Find mutual inductance of the arrangement.
2. If the current passed through the outer loop is changed at a rate of 5A/ ms, find the emf induced in the inner loop. Assume the magnetic field on the inner loop to be uniform.

Q65.

1. Derive an expression for the energy stored in a parallel plate capacitor of capacitance C when charged up to voltage V. How is this energy stored in the capacitor? **5 Marks**
2. A capacitor of capacitance $1\mu F$ is charged by connecting a battery of negligible internal resistance and emf 10V across it. Calculate the amount of charge supplied by the battery in charging the capacitor fully.

Q66.

1. Write two important characteristics of equipotential surfaces. **5 Marks**
2. A thin circular ring of radius r is charged uniformly so that its linear charge density becomes λ. Derive an expression for the electric field at a point P at a distance x from it along the axis of the ring. Hence, prove that at large distances (x >> r), the ring behaves as a point charge.