Capacitors:

Objective Questions:

1. A parallel plate capacitor is charged to a potential of 300 V. Area of the plates is 100 cm^2 and spacing between them is 2 cm. If the plates are moved apart to a distance of 5 cm without disconnecting the power source,

A) The electric field inside the capacitor is (in V/m)

a) 15×10^2 b) 3×10^3 c) 12×10^3 *d) 6×10^3

B) Change in energy of the capacitor is

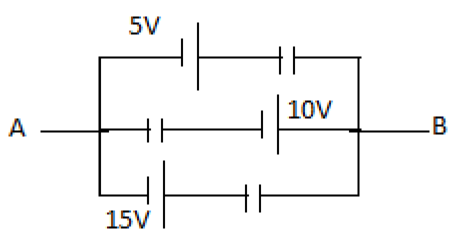
a) $6\times10^{-8} J$ *b) $-1215\times10^{-10} J$ c) $1215\times10^{-10} J$ d) $-243\times10^{-9} J$

C) If the space is increased after disconnecting the power source, the electric field inside the capacitor is (in V/m)

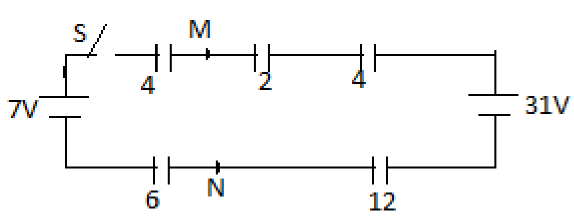
* a) 15×10^3 b) 3×10^3 c) 12×10^3 d) 6×10^3

D) Change in energy of the capacitor in this case is

a) $304\times10^{-9} J$ b) $-1215\times10^{-10} J$ c) $6\times10^{-8} J$ d) $-304\times10^{-9} J$



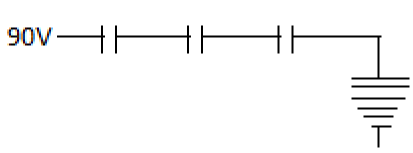
2. Find the potential difference between A and B if the capacitance in the first row is $3\mu F$, in the second row is $2\mu F$ and in the third row is $5\mu F$.



3. Five capacitors with capacitances marked in microfarads are connected as shown in the figure. Initially the switch S is opened and the capacitors are uncharged. When S is closed, steady state is attained, find the p.d between M and N.

4. A parallel plate capacitor of capacity C is connected to a battery and is charged to a potential V. Another capacitor of capacity 2C is connected to another battery and charged to potential 2V. The charging batteries are now removed and the capacitors are connected in parallel in such a way that the positive plate of one is connected to the negative plate of another. The final energy of the system is

a) zero b) $\frac{25CV^2}{6}$ c) $\frac{3CV^2}{2}$ d) $\frac{9CV^2}{2}$



5. The three capacitors from left $C_1, C_2 and C_3$ are 20, 30 and 15 μF.

a) Total charge in the series combination is 600 μC

b) Potential difference between the plates of C_1 is 30 V.

c) The potential difference between the plates of C_2 is 20 V

d) The potential difference between the plates C_3 is 40 V

6. A $3\mu F$ capacitor is charged up to 300 V and $2\mu F$ is charged up to 200 V. The capacitors are then connected so that the plates of the same polarity are connected together. The final potential difference between the plates of the capacitor is

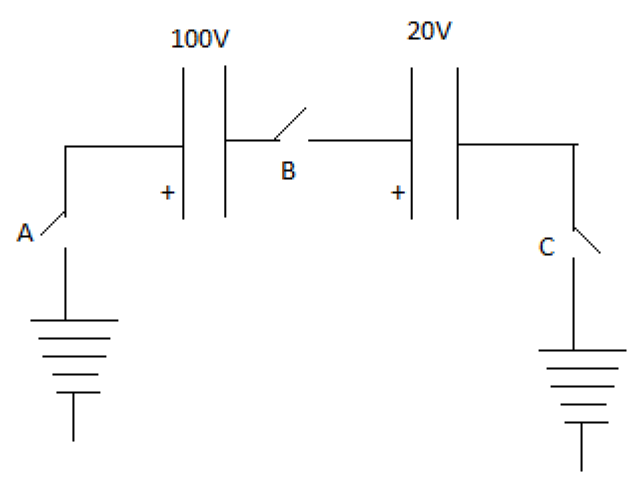
a) 220 V b) 160 V c) 280 V d) 260 V

7. A capacitor of capacitance C is charged to a potential V and disconnected from the battery. The positive plate is then given a charge Q. The new p.d between the plates is

a) $V + \frac{Q}{C}$ b) $V + \frac{Q}{2C}$ c) $\frac{2Q}{C}$ d) 2V

8. In the above problem if the charge Q is given to the negative plate, the new p.d between the plates is

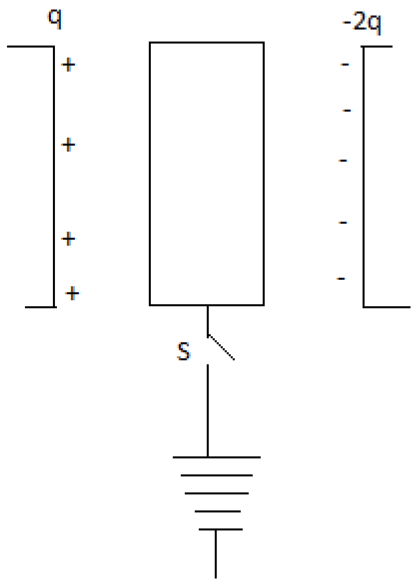
a) $V - \frac{Q}{C}$ b) $V - \frac{Q}{2C}$ c) Zero d) $\frac{V}{2}$



9. In the circuit shown in the figure
the capacitance of the 100 V capacitor is $1\mu F$ and that of 20 V is $2\mu F$. After charging they are connected as shown. When the switches A, B and C are all closed

a) No charge flows through B b) $80\mu C$ charge flows through switch A

c) $40\mu C$ Charge flows through B d) $60\mu C$ charge flows through C



10. The metal plate on the left in the figure carries a charge +q and that on the right has a charge of -2q. What charge will flow through S when it is closed if the central plate is initially neutral?

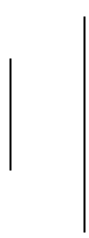
a) Zero b) –q c) q d) 2q

11. A capacitor is connected to a battery. The force of attraction between the plates when the separation between them is halved

a) Remains same b) becomes 8 times c) becomes 4 times d) becomes 2 times

12. Three charged particles are initially at position 1. They are free to move and they come in position 2 after some time. $U_1 and U_2$ are their electrostatic potential energies in position 1 and 2. Then

a) $U_1 > U_2$ b) $U_2 > U_1$ c) $U_1 = U_2$ d) $U_2 \geq U_1$



13. The capacitance of the capacitor of plate areas $A_1 and A_2 (A_1 < A_2)$ at a distance d is

a) $\frac{\varepsilon_0 A_1}{d}$ b) $\frac{\varepsilon_0 A_2}{d}$ c) $\frac{\varepsilon_0 (A_1 + A_2)}{2d}$ d) $\frac{\varepsilon_0 \sqrt{A_1 A_2}}{d}$

14. The capacitance of a parallel plate air capacitor is C_0 and is connected to a battery of emf E. After it is charged it is disconnected. A dielectric slab of constant k which can just fill the air gap of the capacitor is now inserted in it.

a) The potential difference between the plates decreases k times

b) The energy stored in the capacitor decreases k times

c) The change in the energy is $\frac{1}{2} C_0 E^2 (k-1)$ d) the change in the energy is $\frac{1}{2} C_0 E^2 (1 - \frac{1}{k})$

15. The capacitance of a parallel plate capacitor is C_0 when the region between the plates has air. This region is now filled with a dielectric of constant k. The capacitor is now connected to a cell of emf E and the slab is taken out.

a) Charge $EC_0 (k-1)$ flows through the cell b) Energy $C_0 (k-1) E^2$ is absorbed by the cell

c) The energy stored in the capacitor is reduced by $C_0(k-1)E^2$

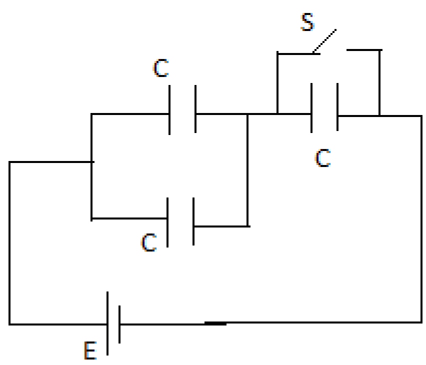
d) The external agent has to do a work $\frac{1}{2}C_0(k-1)E^2$ to take the slab out

16. The two plates X and Y of a parallel plate capacitor of capacitance C are given a charge Q each. X is now joined to the positive terminal and Y to the negative terminal of a battery of emf $\varepsilon = \frac{Q}{C}$

a) Charge Q will now flow from positive terminal to negative terminal of the battery through the capacitor

b) The total charge on the plate X will be 2Q c) the total charge on the plate Y will be zero

d) The battery will supply $C\varepsilon^2$ amount of energy.

17. 

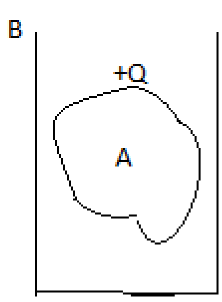
In the circuit shown, if the switch is closed,

a) Some charge will flow out of the positive terminal of the cell

b) Some charge will enter the positive terminal of the cell

c) The amount of charge flowing through the cell will be CE

d) The amount of charge flowing through the cell will be $\frac{4}{3}CE$

18. 

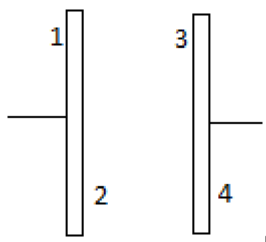
A conductor A is given a charge of amount Q and then placed inside a deep metal can B without touching it.

a) The potential of A does not change when it is placed inside B

b) If B is earthed, Q charge flows from it into the earth.

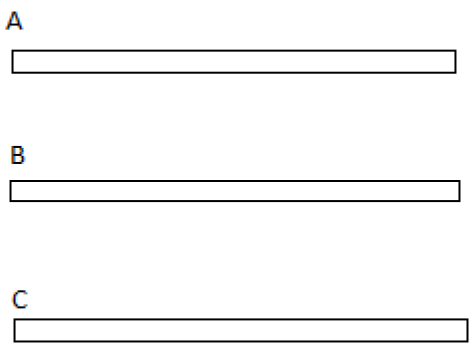
c) If B is earthed, the potential of A is reduced

d) Either (b) or (c) is true or both are true only if the outer surface of B is connected to the earth and not its inner surface.



19. In an isolated parallel plate capacitor of capacitance C, the four surfaces have charges $Q_1, Q_2, Q_3 \, \& \, Q_4$ respectively. The p.d between the plates is

a) $\frac{Q_1+Q_2}{C}$ b) $\left|\frac{Q_2}{C}\right|$ c) $\left|\frac{Q_3}{C}\right|$ d) $\frac{1}{C}[(Q_1+Q_2)-(Q_3-Q_4)]$



20. A, B, C are three large conducting plates placed horizontally. A and C are rigidly fixed and earthed. B is given some charge. Under electrostatic and gravitational forces, B may be

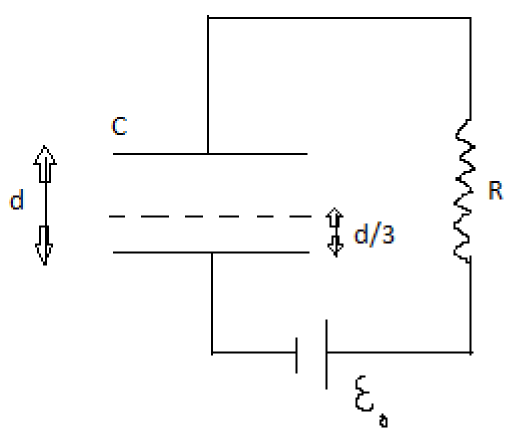
a) In equilibrium mid way between A and C

b) In equilibrium if it is closer to A than to C

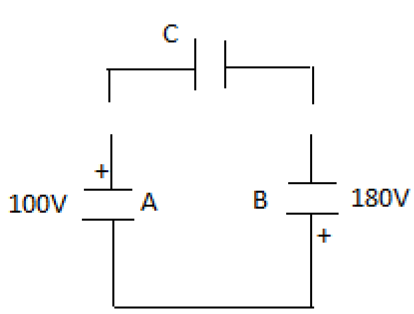
c) In equilibrium if it is closer to C than to A

d) B can never be in stable equilibrium.

Subjective Problems:



1. A parallel plate capacitor C with plates of unit area an separation d is filled with a liquid of dielectric constant K=2. The level of the liquid is d/3 initially. Suppose the liquid level decreases at a constant speed V, find the time constant as a function of time.

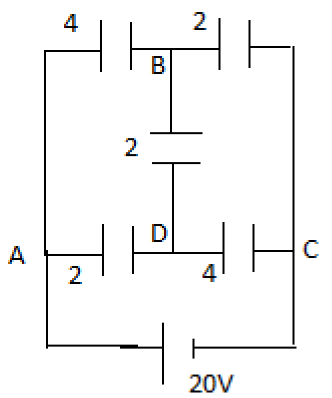


2. Two capacitors A and B of $3\mu F$ and $2\mu F$ respectively are charged to potentials shown with polarities as well. The capacitors are connected as shown with one

wire from each capacitor free. An uncharged $2\mu F$ capacitor C with lead wires falls on the free ends to complete the circuit. Calculate

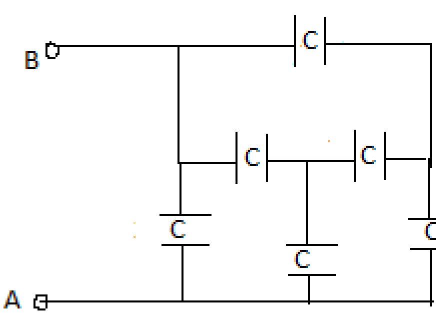
a) The final charge on the three capacitors

b) The amount of electrostatic energy stored in the system before and after the completion of the circuit

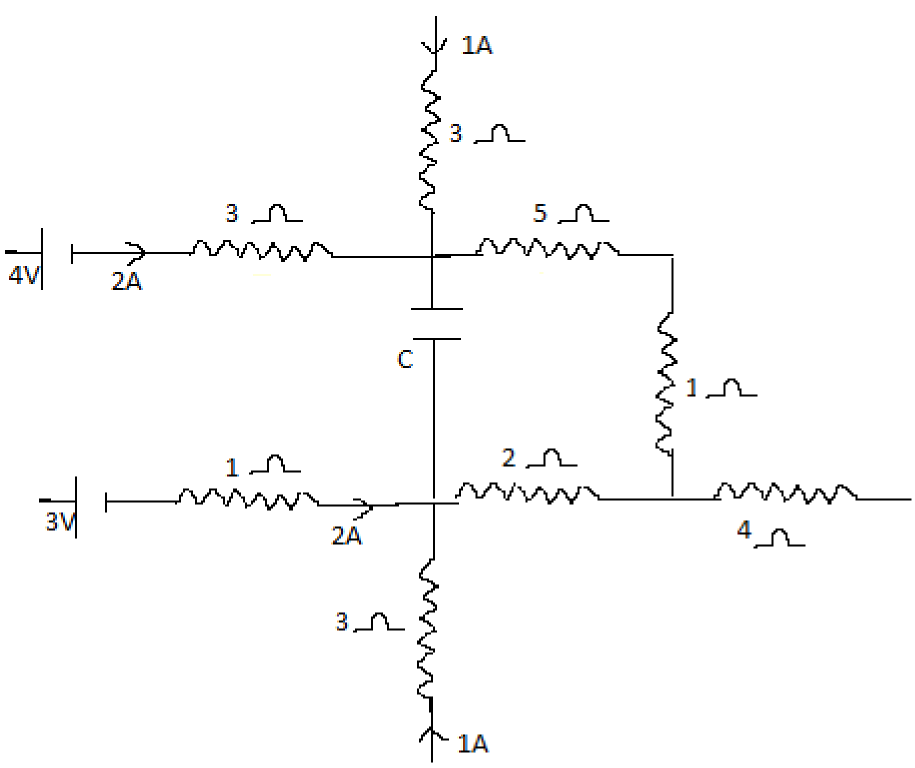


3. The figure shows an arrangement of capacitor and a battery. If the potential of C is zero, then check whether

a) $4(V_A - V_B) + 2(V_D - V_B) = 2V_B$ b) $2(V_A - V_D) + 2(V_B - V_D) = 4V_D$ c) $V_A = V_B + V_D$

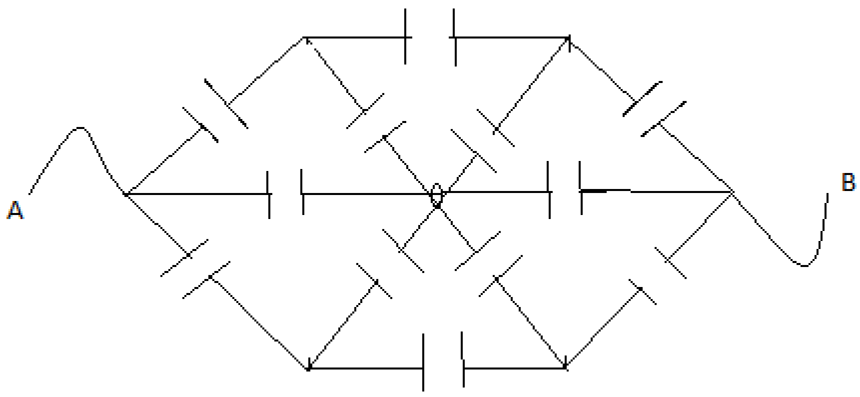


4. Find the equivalent capacitance between A and B.

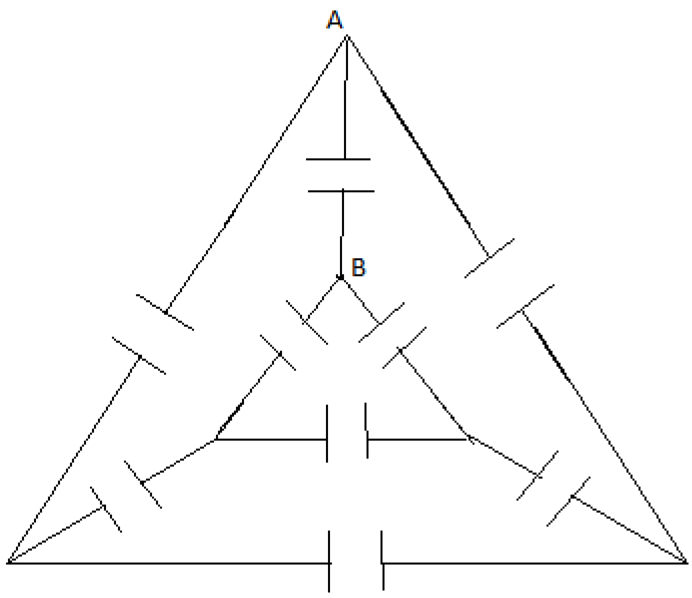


5. A part of a circuit in steady state is as shown. The capacitance of the capacitor C is 4μF. The currents along with their values are also shown. Resistances are as indicated. Calculate the energy stored in the capacitor.

Ans: 0.288mJ

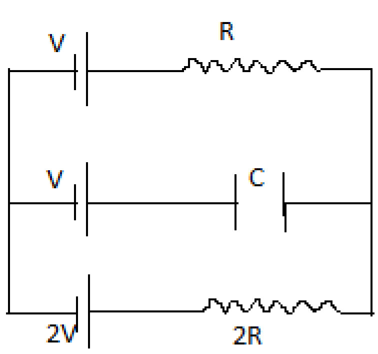
6. 

All the capacitors shown in the figure are of capacitances C. Find the equivalent capacitance between A and B.

7. 

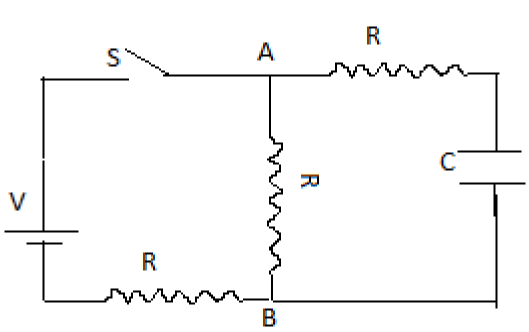
All the capacitors shown are of capacitance C. Find the equivalent capacitance between the points A and B.

Ans: 5C/3

8. 

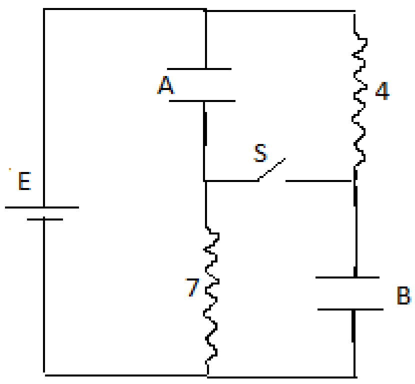
In the given circuit with steady state, the potential drop across the capacitor must be?

Ans: V/3

9. 

In the circuit shown the battery is ideal with p.d V. The capacitor is initially uncharged. The switch is closed at t = 0.

a) Find the charge q at time t   b) Find the current in AB at time t   c) What is its limiting value at t = ∞?



The switch has been closed for a long time and the circuit is in steady state. The capacitor A has a capacitance of 3μF and B has 6μF. The resistances marked are in kilo ohms. Power dissipated in $7k\Omega$ is 2.8 W.

10. The power dissipated in the resistor of $4k\Omega$ is

a) 2.8 W   *b) 1.6 W   c) 4.9 W   d) 0

11. The charge on capacitors A and B are respectively (in μC)

a) 940,940   b) 440,440   *c) 240,840   d) 840,240

12. Long time after the switch is opened, the charge on capacitor A is (in μC)

a) Zero   b) 420   c) 240   *d) 660

13. Column I gives certain situations in which capacitance of a capacitor is changed by different means. Column II gives resulting effect under different conditions. Match the statements in column I with corresponding statements in column II.

Column I	Column II
A: The plates of a parallel plate capacitor are slowly pulled apart. The magnitude of the electric filed intensity inside the capacitor	P: Increases if the capacitor is maintained at constant charge.
B: The plates of a parallel plate capacitor are slowly pulled apart. The potential energy stored in the capacitor	q: Decreases if the capacitor is maintained at constant charge.
C: The capacitance of an air filled parallel plate capacitor on insertion of dielectric	r: Increases if the capacitor is maintained at constant p.d
D: A dielectric slab is inserted inside an air filled parallel plate capacitor. The potential energy stored in the capacitor	s: Decreases if the capacitor is maintained at constant p.d

14. A parallel plate capacitor of plate area A and plate separation d is charged to a potential V and then the battery is disconnected. A slab of dielectric constant k is then inserted between the plates of the capacitor so as to fill the whole space between the plates. Find the work done on the system in the process of inserting the slab.

Ans: $\frac{\varepsilon_0 A V^2}{2d}\left(\frac{1}{k}-1\right)$