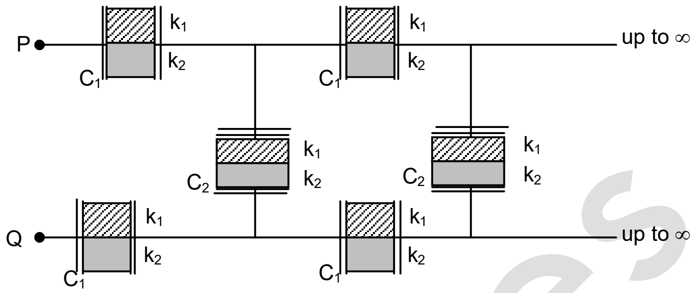
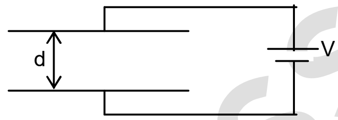
5. Assignment (Subjective Problems)

LEVEL – I

1. Find the equivalent capacitance between the ends P and Q. The plates are of area A, and the distance between them is d. The dielectric constants are k_1 and k_2 where k_1 = 2 and k_2 = 4 of material.

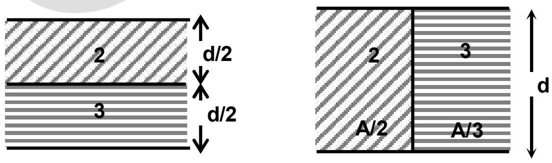


2. The plates of a parallel plate capacitor, having area 'A', are maintained at constant potential difference 'V'. If the initial separation between the plates is 'd', find the work done in increasing the separation of plates to '2d'.



3. A 1 μF and a 2μF capacitor are connected in series across a 1200 V supply.
(a) Find the charge on each capacitor and the voltage across each capacitor.
(b) The charged capacitors are disconnected from the line and from each other, and are now reconnected with terminals of like charge connected together. Find the final charge on each capacitor and the voltage across each capacitor.

4. A capacitor is filled with two dielectrics of the same dimensions but of dielectric constant 2 and 3 respectively. Find the ratio of capacities in the two possible arrangement.



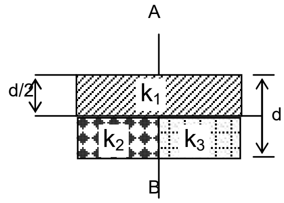
5. A battery of 10 V is connected to a capacitor of capacity 0.1F. The battery is now removed and this capacitor is connected to a second uncharged capacitor. If the charge is equally distributed on these two capacitors, find the total energy stored in the two capacitors. Find the ratio of final energy to the initial energy.

6. The distance between the plates of a parallel plate capacitor is 0.05m. A field of 3×10^4 V/m is established between the plates and an uncharged metal plate of thickness 0.01 m is inserted into the capacitor parallel to its plate. Find potential difference
(a) Before the introduction of the metal plate.
(b) After its introduction.
(c) What would be the potential difference if a plate of dielectric constant K = 2 is introduced in place of metal plate?

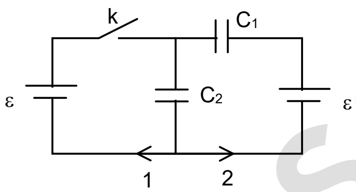
7. Two parallel plate capacitors A and B having capacitance 1 μF and 5μF are charged separately to the same potential of 100 volt.
Now the positive plate of A is connected to the negative plate of B and negative plate of A to the positive plate of B.
Find the final charge on each capacitors and total loss of electrical energy in the given system.

8. Two spherical conductors of radius R and 2R, having potential 4V, and 2V are kept isolated. Find the loss in electrostatic energy if they are connected by a conducting wire.

9. Find the equivalent capacitance between A and B, if the plates have equal area 'A'.

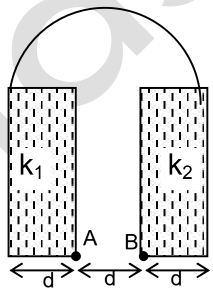


10. In the given circuit diagram, find the charge which will flow through direction 1 and 2 when the key is closed.



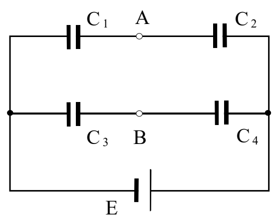
LEVEL – II

1. If the area of parallel plates shown in the figure is 'A' and they are placed at distance 'd' apart form each other, then find the equivalent capacitance between A and B. The two outer plates are connected with a conducting wire.

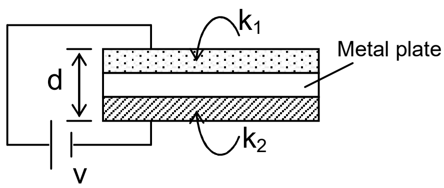


2. A capacitor of capacitance 0.1 μ F is charged until the difference in potential between its plates is 25 V. Then the charge is shared with a second capacitor which has air as dielectric. The potential difference falls to 15 V. If the experiment is repeated with dielectric introduced between the plates of the second capacitor, the potential difference is 8 V. What is the dielectric constant of the material introduced?

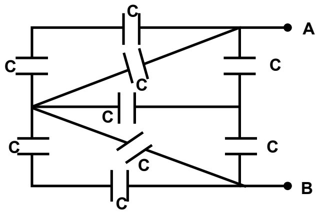
3. Determine the potential difference $\phi_A - \phi_B$ between points A and B of the circuit shown in figure. Under what condition is it equal to zero?



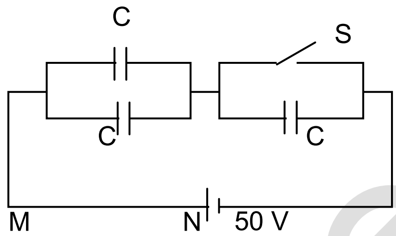
4. Two metal plates form a parallel plate capacitor. The distance between the plates is given as 'd'. A metal plate of thickness (d/2), and two dielectric slabs of thickness (d/4) is introduced between the plates as shown in the figure. If the metal plate is removed find the work done in slowly removing it. (The plates of capacitor is connected to a battery having potential difference 'v')



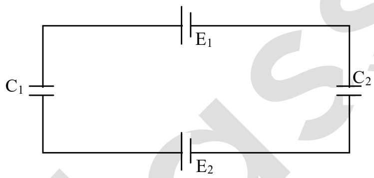
5. Find the equivalent capacitance between A and B in the circuit shown below. If the ends 'A' and 'B' are connected across a 12 V cell, find the electrostatic potential energy of the system. (the capacitance of each capacitor is 100 μF)



6. Each capacitor has a capacitance of 5 μF. Find the charge that will flow through MN when the switch S is closed.



7. In the figure shown, determine the potential differences on the plates of capacitors C_1 = 3μF, C_2 = 7μF, if value of E_1 = 12kV, E_2 = 13kV.



8. Find the equivalent capacitance between A and B, if the plates have equal area A and the separation between the plates is d.

9. A uniform electric field E exists between the plates of a capacitor. The plate length is ℓ and the separation of the plates is d.

(a) An electron and a proton start from the negative plate and positive plate respectively and go to the opposite plates. Which of them wins this race?

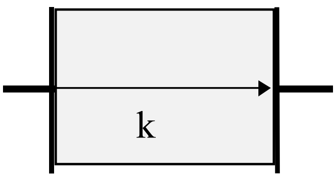
(b) An electron and a proton are projected parallel to the plates from the midpoint of the separation of plates at one end of the plates. Which of the two will have greater deviation when they start with the

(i) same initial velocity

(ii) same initial kinetic energy, and

(iii) same initial momentum?

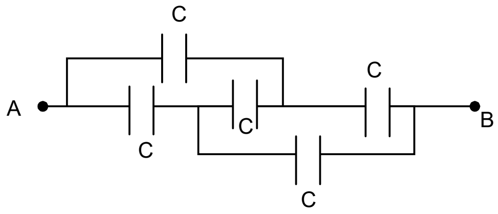
10. Figure shows a parallel plate capacitor having square plates of edge a and plate separation d. The gap between the plate is filled with a dielectric of dielectric constant k which varies from the left plate to the right plate as $k = k_o + \alpha x$, where k_o and α are positive constants and x is the distance from the left end. Calculate the capacitance.



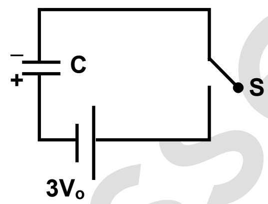
6. Assignment (Objective Problems)

LEVEL - I

1. The equivalent capacitance between A and B is
(A) C
(B) 2C
(C) 1.5 C
(D) none of the above



2. In the circuit shown in the figure, the capacitor C is charged to a potential V_o. The heat generated in the circuit when the switch S is closed, is
(A) $C V_o^2$ (B) $2C V_o^2$
(C) $4C V_o^2$ (D) $8C V_o^2$

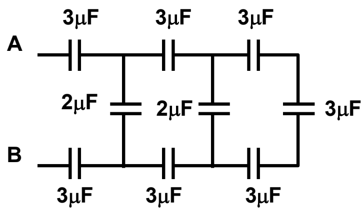


3. The plates of a parallel plate charged capacitor are not parallel, the interface charge density is
(A) is higher at the closer end (B) is non-uniform
(C) is higher at inclined plate. (D) none of the above

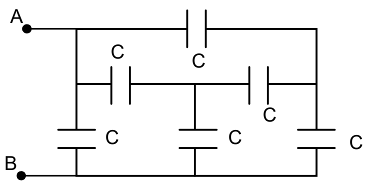
4. There are 'n' identical capacitors, which are connected in parallel to a potential difference V. These capacitors are then reconnected, in series. The potential difference between the extreme ends is :
(A) zero (B) nV
(C) (n – 1) V (D) none of the above

5. The force with which the plates of a pa0rallel plate capacitor having a charge Q and area of each plate A, attract each other is
(A) directly proportional to Q^2 and inversely to A.
(B) inversely proportional to Q^2 and directly to A.
(C) does not depend upon Q^2 and is inversely proportional to A.
(D) none of the above

6. The equivalent capacitance between points A and B for the given figure is
(A) 1μF (B) 2 μF
(C) 3 μF (D) 4 μF



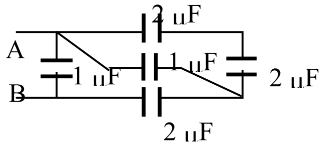
7. The equivalent capacitance between A and B is
(A) 6 C
(B) 4C
(C) 2C
(D) none of the above



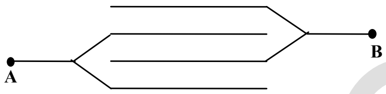
8. A dielectric slab of thickness 4 mm is placed between the plates of a parallel plate capacitor. If the distance between plates is reduced by 3.5 mm, the capacity of the capacitor remains same. Find the dielectric constant of the medium.

(A) 2 (B) 4
(C) 6 (D) 8

9. The effective capacitance between A and B will be
(A) 0.5 μF (B) 1.5 μF
(C) 2 μF (D) 2.5 μF



10. If the capacitance between two successive plates is C, then the capacitance of the equivalent system between A and B is

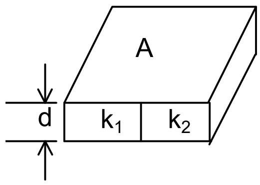


(A) $\frac{C}{3}$ (B) 3C
(C) $\frac{2}{3}C$ (D) $\frac{3}{2}C$

LEVEL – II

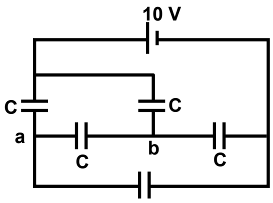
1. Two capacitors are once connected in parallel and then in series. If the equivalent capacitance in two cases are 16F and 3F respectively, then capacitance of each capacitor is
(A) 16 F, 3F (B) 12 F, 4 F
(C) 6F, 8F (D) none of these

2. Two dielectrics of equal size are inserted inside a parallel plate capacitor as shown. With what factor the effective capacitance increases ?



(A) $\frac{k_1k_2}{k_1+k_2}$ (B) $\frac{k_1+k_2}{2}$
(C) $\frac{2k_1k_2}{k_1+k_2}$ (D) none of above

3. What is the energy stored in the capacitor between terminals a and b of the network shown in the figure? (Capacitance of each capacitor C = 5μF).



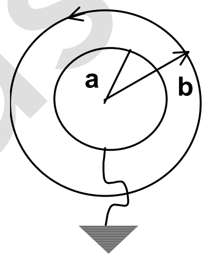
(A) 1 μJ (B) 0.25 μJ
(C) zero. (D) 15.6 μJ

4. One of the plates of a charged parallel plate capacitor is connected to a non conducting spring of stiffness K and the other plate is fixed. The other end of the spring is also fixed. In equilibrium distance between the plates is d, which is twice of the elongation in the spring. If length of the spring is halved by cutting it, the distance between the plates in equilibrium will be (Consider that in both the cases spring is in nature length, if the capacitor is uncharged)
(A) $\frac{3d}{4}$ (B) $\frac{5d}{4}$
(C) 2d (D) $\frac{3}{2}d$

5. Two identical parallel plate capacitors of same dimensions are connected to a DC source in series. When one of the plates of one capacitor is brought closer to other plate
(A) the voltage on the capacitor whose plates came closer is greater than the voltage on the capacitor whose plates are not moved.
(B) the voltage on the capacitor whose plates came closer is smaller than the voltage on the capacitor whose plates are not moved.
(C) the voltage on the two capacitors remain equal.
(D) the applied voltage is divided equally between the two capacitors.

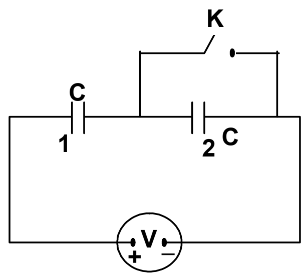
6. You are given 32 capacitors of 4μF capacitance each. How do you connect all of them so that the effective capacitance becomes 8 μF?
(A) 4 capacitors in series and 8 such groups in parallel.
(B) 2 capacitors in series and 16 such groups in parallel.
(C) 8 capacitors in series and 4 such groups in parallel.
(D) All of them in series.

7. Figure shows a spherical capacitor with inner sphere earthed. The capacitance of the system is



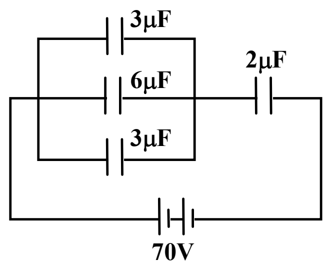
(A) $\frac{4\pi\varepsilon_0 ab}{b-a}$ (B) $\frac{4\pi\varepsilon_0 b^2}{b-a}$
(C) $4\pi\varepsilon_0 (b + a)$ (D) none of these

8. The charge flowing across the circuit on closing the key K is equal to



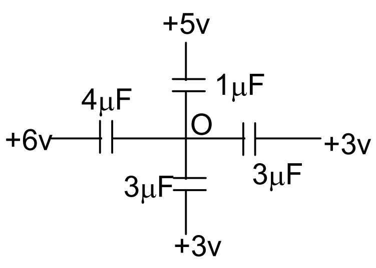
(A) CV (B) $\frac{C}{2}$V
(C) 2CV (D) zero

9. The potential difference across the capacitor of 2μF is



(A) 10 V (B) 60 V
(C) 28 V (D) 56 V

10. What is the potential at point O?



(A) 4.27 V (B) 17 V
(C) zero (D) 34V

7. Hints (Subjective)

LEVEL- I

1. Find the value of C_1 and C_2 and analyse it as the series parallel combination.
2. The capacitance changes so the energy changes.
3. The charges in series combination are equal.
4. In first case, capacitors in series and in second case they are in parallel.
5. Total charge remains conserved.
6. If capacitance changes, the electrostatic energy changes.
7. Find the equivalent capacitance and charge distribution.
8. Find common potential and electrostatic potential energy.
9. Capacitance with dielectrics k_2, k_3 are in parallel and capacitor with dielectric k_1 is in series with the above combination.
10. Compare the charge distribution in both the cases.

LEVEL- II

1. Find individual capacitance and arrange it in the circuit.
2. The total charge has to be conserved.
3. Charge on C_1 and C_2 will be equal and C_3 & C_4 will be equal.
4. Find out total energy in both the cases and difference between them.
5. Apply series parallel concept.
6. Find the equivalent capacitance
7. Apply KVL and charge conservation.
8. Potential on extreme plates will be equal and potential on inner plates will be equal.
9. Force on the charges is due to electric field. Find accelerations. Use kinematics.
10. Take an elemental capacitance of thickness dx. Write capacitance for this then integrate.

LEVEL – I

1. $C_{eq} = 1.07\ \varepsilon_0 A / d$

2. $W = \frac{1}{4}\frac{\varepsilon_0 AV^2}{d}$

3. **(a)** 800 μC, 800V, 800μC, 400V. **(b)** 1600/3V,1600/3μC, $\frac{3200}{3}\mu C$

4. $\frac{24}{25}$

5. 2.5J, $\frac{1}{2}$

6. (a) 1500 Volt (b) 1200 Volt (c) 1350 Volt

7. 0.6 x 10^{-4}C; 3.33 x 10^{-4}C; $\frac{5}{3}\times10^{-2}$ J **8.** $\frac{16\pi\varepsilon_0 Rv^2}{3}$

9. $\frac{2A\varepsilon_0}{d}\left[\frac{(k_2+k_3)(k_1)}{2k_1+k_2+k_3}\right]$

10. Charge flown through path 2= - $\frac{\in c_1c_2}{c_1+c_2}$

Charge flown through path 1= $\varepsilon\, c_2$

LEVEL – II

1. $\frac{A\varepsilon_0}{d}\left[\frac{k_1k_2+k_1+k_2}{(k_1+k_2)}\right]$ **2.** 3.2

3. $\varphi_A-\varphi_B=E\frac{C_2C_3-C_1C_4}{(C_1+C_2)(C_3+C_4)}$, when $C_1/C_2 = C_3/C_4$.

4. $\frac{4A\varepsilon_0 v^2k_1^2k_2^2}{d(k_1+k_2)(k_1+k_2+2k_1k_2)}$

5. 125 μF, 9000 μ J **6.** 333.3 μC

7. 700 V, 300V **8.** $\frac{2\varepsilon_0 A}{d}$

9. (a) Electron (b) (i) Electron (ii) Both equal deviation (iii) Proton

10. $\frac{\varepsilon_0 a^2\alpha}{\ln\left(1+\frac{\alpha d}{K_0}\right)}$

9. Answers to the Objective Assignment

LEVEL - I

1. A **2.** D

3. A **4.** B

5. A **6.** A

7. C **8.** D

9. C **10.** B

LEVEL – II

1. B **2.** B

3. C **4.** B

5. B **6.** A

7. B **8.** B

9. B **10.** A