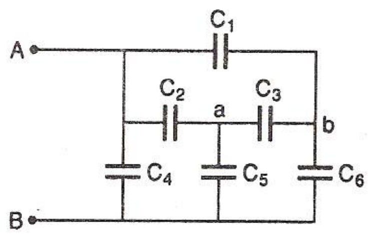
CAPACITANCE

1. Two identical parallel plate capacitors are placed in series and connected to a constant voltage source of V_0 volt. If one of the capacitors is completely immersed in a liquid with dielectric constant K, the potential difference between the plates of the other capacitor will change to:

(a) $\frac{K+1}{K}V_0$ (b) $\frac{K}{K+1}V_0$

(c) $\frac{K+1}{2K}V_0$ (d) $\frac{2K}{K+1}V_0$

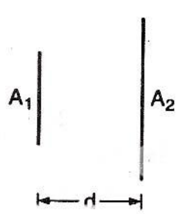
2. Six equal capacitors, each of capacitance C are connected as shown in the figure. Then the equivalent capacitance between A and B is:



(a) 6 C (b) C

(c) 2 C (d) C/2

3. The capacitance of the capacitor of plate areas A_1 and $A_2(A_1 < A_2)$ at a distance d, as shown in the figure, is:



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

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

4. Seven capacitors each of capacitance 2μF are to be connected to obtain a capacitance of 10/11 μF. Which of the following combination is possible?

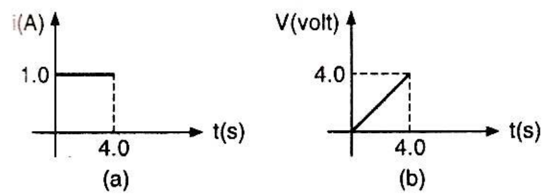
(a) 5 in parallel, 2 in series

(b) 4 in parallel, 3 in series

(c) 3 in parallel, 4 in series

(d) 2 in parallel, 5 in series

5. Current versus time the voltage versus time graph of a circuit element is shown in the figure. The type of the circuit element is:



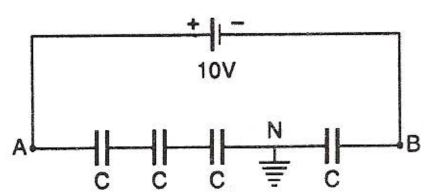
(a) capacitance of 2F

(b) resistance of 2Ω

(c) capacitance of 1F

(d) a voltage source of emf 1V

6. Four identical capacitors are connected in series with a 10 V battery as shown. The point N is earthed. The potentials of points A and B are:



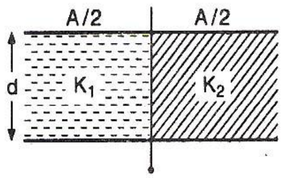
(a) 10 V, 0 V

b) 7.5 V, –2.5 V

(c) 5 V, –5V

d) 7.5 V, 2.5 V

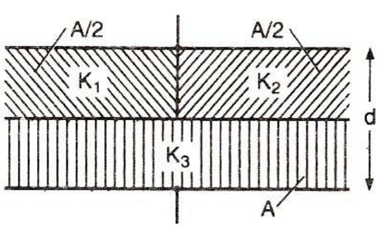
7. A parallel plate condenser is filled with two dielectrics as shown in figure. Area of each plate is A metre^2 and the separation is d metre. The dielectric constants are K_1 and K_2 respectively. Its capacitance (in farad) will be:



(a) $\frac{\varepsilon_0 A}{d}(K_1 + K_2)$ (b) $\frac{\varepsilon_0 A}{d}\left(\frac{K_1+K_2}{2}\right)$

(c) $\frac{\varepsilon_0 A}{d}2(K_1+K_2)$ (d) $\frac{\varepsilon_0 A}{d}\left(\frac{K_1-K_2}{2}\right)$

8. A parallel plate capacitor of area A, plate separation d and capacitance C is filled with three different dielectric materials having dielectric constants K_1, K_2 and K_3 as shown in the figure. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant K is given by: (A = Area of plates)



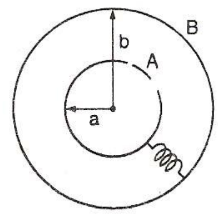
(a) $\frac{1}{K}=\frac{1}{K_1}+\frac{1}{K_2}+\frac{1}{2K_3}$

(b) $\frac{1}{K}=\frac{1}{K_1+K_2}+\frac{1}{2K_3}$

(c) $K = \frac{K_1K_2}{K_1+K_2} + 2K_3$

(d) $K = K_1 + K_2 + 2K_3$

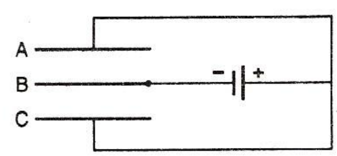
9. Two spherical conductors A and B of radii a and b (b > a) are placed concentrically in air. The two are connected by a copper wire is shown in figure. Then the equivalent capacitance of the system is:



(a) $\frac{4\pi\varepsilon_0 ab}{(b-a)}$ (b) $4\pi\varepsilon_0 (a + b)$

(c) $4\pi\varepsilon_0 b$ (d) $4\pi\varepsilon_0 a$

10. Three plates A, B and C each of area 50 cm^2 have separation 3 mm between A and B and 3 mm between B and C. The energy stored when the plates are fully charged is:



(a) 2 μJ (b) 1.6 μJ

(c) 5 μJ (d) 7 μJ

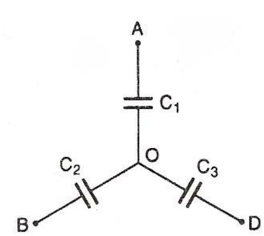
11. Three uncharged capacitors of capacitance C_1, C_2 and C_3 are connected as shown in figure to one another and to points A, B and D at potentials V_A, V_B and V_D. Then the potential at O will be

(a) $\frac{V_A+V_B+V_D}{C_1+C_2+C_3}$

(b) $\frac{V_AC_1+V_BC_2+V_DC_3}{C_1+C_2+C_3}$

(c) $\frac{V_AV_B+V_BV_D+V_DV_A}{C_1+C_2+C_3}$

(d) $\frac{V_AV_BV_D}{C_1C_2+C_2C_3+C_3C_1}$

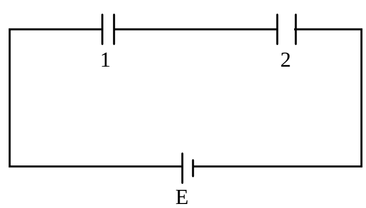


12. Capacity of an isolated sphere is increased n times when it is enclosed by an earthed concentric sphere. The ratio of their radii is:

(a) $\frac{n^2}{n-1}$ (b) $\frac{n}{n-1}$

(c) $\frac{2n}{n+1}$ (d) $\frac{2n+1}{n+1}$

13. Two identical capacitors 1 and 2 are connected in series to a battery as shown in the figure. Capacitor 2 contains a dielectric slab of dielectric slab of dielectric slab of dielectric constant K as shown. Q_1 and Q_2 are the charges stored in the capacitors. Now the dielectric slab is removed and the corresponding charges are Q_1' and Q_2'. Then:



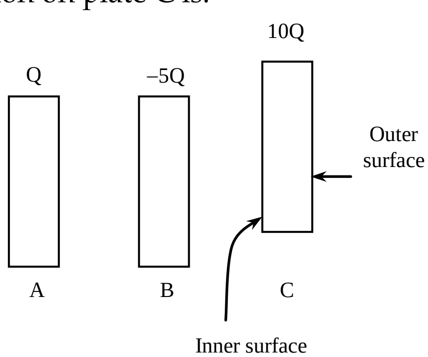
(a) $\frac{Q_1'}{Q_1} = \frac{K+1}{K}$

(b) $\frac{Q_2'}{Q_2} = \frac{K+1}{2}$

(c) $\frac{Q_2'}{Q_2} = \frac{K+1}{2K}$

(d) $\frac{Q_1'}{Q_1} = \frac{K}{2}$

14. Three vary large plates are given charges as shown in the figure. If the cross-sectional area of each plate is the same, the final charge distribution on plate C is:



(a) +5Q on the inner surface, + 5Q on the outer surface

(b) +6Q on the inner surface, +4Q on the outer surface

(c) +7Q on the inner surface, +3Q on the outer surface

(d) +8Q on the inner surface, +2Q on the outer surface

15. Force acting upon a charged particle kept between the plates of a charged condenser is F. If one plate of the condenser is removed, then the force acting on the same particle will become:

(a) 0 (b) F/2

(c) F (d) 2F

16. Two condensers of capacities 2 C and C are joined in parallel and charged upto potential V. The battery is removed and the condensers of capacity C is filled completely with a medium of dielectric constant K. The potential difference across the capacitors will now be:

(a) $\frac{3V}{K+2}$ (b) $\frac{3V}{K}$

(c) $\frac{V}{K+2}$ (d) $\frac{V}{K}$

17. A 20 μF capacitor is connected to 45 V battery through a circuit whose resistance is 2000Ω. What is the final charge on the capacitor?

(a) 9×10^{-4} C (b) 9.154×10^{-4} C

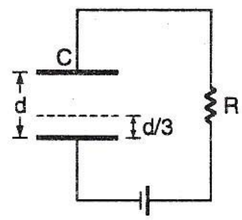
(c) 9.8×10^{-4} C (d) None of the above

18. 64 identical spheres of charges q and capacitance C each are combined to form a large sphere. The charge and capacitance of the large sphere is:

(a) 64q, C (b) 16q, 4C

(c) 64q, 4C (d) 6q, C

19. * A parallel plate capacitor C with plates of the unit area and separation d is filled with a liquid of dielectric constant K = 2. The level of liquid to $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed v, the time constant as a function of time t is:

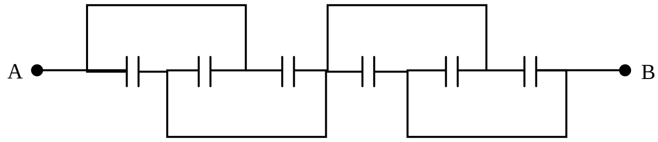


(a) $\frac{6\varepsilon_0 R}{5d+3vt}$
(b) $\frac{(15d+9vt)\varepsilon_0 R}{3d^2-3dvt-9v^2t^2}$
(c) $\frac{6\varepsilon_0 R}{5d-3vt}$
(d) $\frac{(15d-9vt)\varepsilon_0 R}{2d^2-3dVt-9v^2t^2}$

20. * A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has a thickness (3/4) d, where d is the separation of the plates. The ratio of the capacitance C (in the presence of the dielectric) to the capacitance C_0 (in the absence of the dielectric) is:

(a) $\frac{3K}{K+4}$
(b) $\frac{3K}{4}$
(c) $\frac{4K}{K+3}$
(d) $\frac{4}{3}K$

21. * All capacitors used in the diagram are identical and each is of capacitance C. Then the effective capacitance between the points A and B, is:



(a) 1.5 C
(b) 6C
(c) C
(d) 3C

22. When a parallel plate capacitor is connected to a source of constant potential difference, then:

(a) all the charge drawn from the source is stored in the capacitor
(b) all the energy drawn from the source is stored in the capacitor
(c) the potential difference across the capacitor grows very rapidly initially and this rate decreases to zero eventually
(d) only half of the energy drawn from source is dissipated outside the capacitor

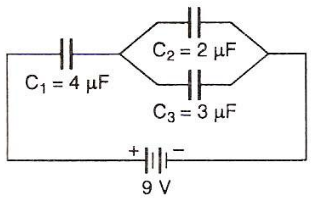
23. Two parallel plate air capacitors are constructed, one by a pair of iron plates and the second by a pair of copper plates, of same area and same spacings. Then:

(a) the copper plate capacitor has a greater capacitance than the iron one
(b) both capacitors have equal non-zero capacitances, in the uncharged state
(c) both capacitors have equal capacitances only if they are charged equally
(d) the capacitances of the two capacitors are equal even if they are unequally charged

24. A parallel plate capacitor is filled with a uniform dielectric. Maximum charge that can be given to it, depends upon:

(a) dielectric constant of the dielectric
(b) dielectric strength of the dielectric
(c) separation between the plates
(d) area of the plates

25. In the figure shown, the charges on C_1, C_2 and C_3 are Q_1, Q_2 and Q_3 respectively. Then:



(a) $Q_1 = 20\mu C$ (b) $Q_2 = 12\mu C$

(c) $Q_2 = 8\mu C$ (d) $Q_3 = 12\mu C$

26. A parallel plate capacitor of $20\mu F$ is connected across a source of constant emf of 30 volt. Without disconnecting the source, a dielectric ($\varepsilon_r = 4$) is introduced to fill the space between the plates. Then:

(a) the energy drawn from the source during the introduction of the dielectric is 0.054 J

(b) the extra energy stored in the capacitor due to introduction of the dielectric is 0.027 J

(c) the energy drawn from the source is equal to that stored in the capacitor

(d) the energy drawn from the source is not equal to that stored in the capacitor

27. A capacitance is charged by using a battery which is then disconnected. A dielectric slab is then slipped between the plates, which results in:

(a) reduction of charge on the plates and increase of potential across the plates

(b) increase in the potential difference across the plates, reduction in stored energy, but no change in the charges on the plates

(c) decrease in the potential difference across the plates, reduction in stored energy, but no change in the charge on the plates

(d) none of the above

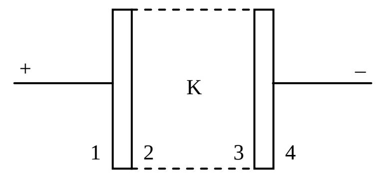
28. An isolated capacitor of capacitance C is charged to a potential V. Then a dielectric slab of dielectric constant K is inserted as shown in the figure. The net charge on four surfaces 1, 2, 3 and 4 would be respectively:

(a) 0, CV, –CV, 0

(b) 0, $\frac{CV}{K}$, $\frac{-CV}{K}$, 0

(c) CV, 0, 0, –CV

(d) CV, $-\frac{CV}{K}$, $\frac{CV}{K}$, –CV



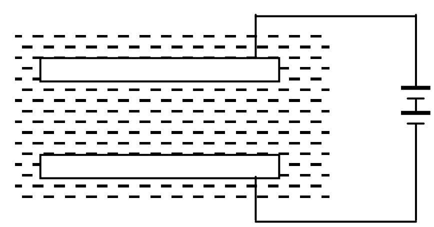
29. A parallel plate capacitor is immersed, in a liquid dielectric having dielectric constant ε as shown in the figure. Find the force acting on a unit surface of the plate from the dielectric:

(a) $\frac{\varepsilon\varepsilon_0 V^2}{2d^2}$

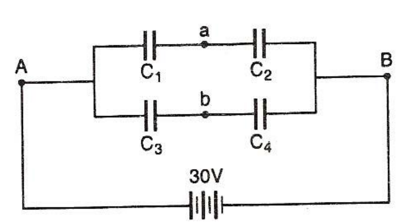
(b) $\frac{\varepsilon_0(\varepsilon-1)V^2}{2d^2\varepsilon}$

(c) $\frac{\varepsilon V^2}{2d^2}$

(d) $\frac{\varepsilon(\varepsilon-1)\varepsilon_0 V^2}{2d^2}$



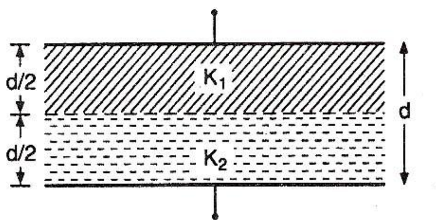
30. Four capacitors with capacitances $C_1 = 1\mu F$, $C_2 = 15\mu F$, $C_3 = 2.5\ \mu F$ and $C_4 = 0.5\ \mu F$ are connected as shown in figure and are connected to a 30 volt source. The potential difference between points a and b is:



(a) 5V (b) 9V

(c) 10 V (d) 13 V

31. A parallel plate condenser with plate area A and separation d is filled with two dielectric materials as shown in the adjoining figure. The dielectric constants are K_1 and K_2 respectively. The capacitance will be:



(a) $\frac{\varepsilon_0 A}{d}(K_1 + K_2)$ (b) $\frac{\varepsilon_0 A}{d}\left(\frac{K_1 + K_2}{K_1 K_2}\right)$

(c) $\frac{2\varepsilon_0 A}{d}\left(\frac{K_1 K_2}{K_1 + K_2}\right)$ (d) $\frac{2\varepsilon_0 A}{d}\left(\frac{K_1 + K_2}{K_1 K_2}\right)$

32. A number of capacitors each of capacitance 1μF and each one of which gets punctured if a potential difference just exceeding 500 volt is applied, are provided. Then an arrangement suitable for giving a capacitor of 2μF across which 3000 volt may be applied requires at least:

(a) 18 component capacitors

(b) 36 component capacitors

(c) 72 component capacitors

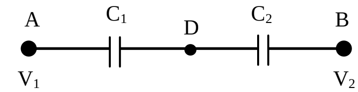
(d) 144 component capacitors

33. A capacitor of capacitance 1μF withstands a maximum voltage of 6kV, while another capacitor of capacitance 2μF, the maximum voltage 4 kV. If they are connected in series, the combination can withstand a maximum of:

(a) 6 kV (b) 4 kV

(c) 10 kV (d) 9 kV

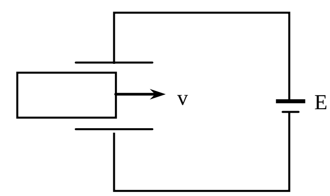
34. Two condensers C_1 and C_2 in the figure. The potential of point A is V_1 and that of B is V_2. The potential of point D will be:



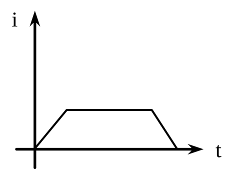
(a) $\frac{1}{2}(V_1 + V_2)$ (b) $\frac{C_1V_2 + C_2V_1}{C_1 + C_2}$

(c) $\frac{C_1V_2 + C_2V_2}{C_1 + C_2}$ (d) $\frac{C_2V_1 - C_1V_2}{C_1 + V_2}$

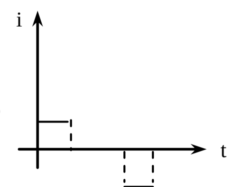
35. A dielectric slab of area A and thickness d is inserted between the plates of capacitor, of area 2A and plate separation d, with a constant speed v as shown in figure. The capacitor is connected to a battery of emf E. The current in the circuit varies with time as:



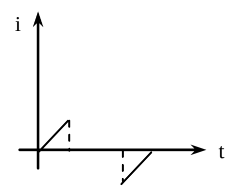
(a)



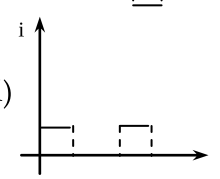
(b)



(c)



(d)



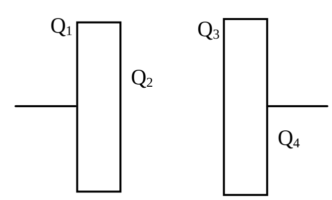
36. In an insulated parallel-plate capacitor of capacitance C, the four surfaces have charges Q_1, Q_2, Q_3 and Q_4 as shown in the figure. The potential difference between the plates is:

(a) $\frac{Q_1 + Q_2 + Q_3 + A_4}{2C}$

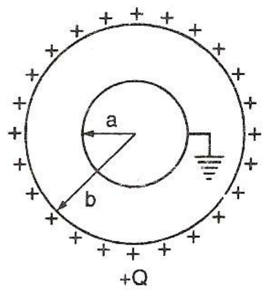
(b) $\frac{Q_2 - Q_3}{2C}$

(c) $\frac{Q_1 + Q_4}{2C}$

(d) $\frac{Q_1 + Q_4}{2C}$



37. Two spherical conductors A and B of radii a and b (b > a) are placed concentrically in air. B is given a charge +Q and A is earthed. The equivalent capacitance of the system is:



(a) $4\pi\varepsilon_0\left(\frac{ab}{b-a}\right)$

(b) $4\pi\varepsilon_0$ (a + b)

(c) $4\pi\varepsilon_0 b$

(d) $4\pi\varepsilon_0\left(\frac{b^2}{b-a}\right)$

38. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge +Q is not given to its positive plate. The potential difference across the capacitor is now:

(a) V (b) $V + \frac{Q}{C}$

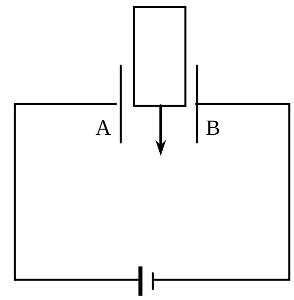
(c) $V + \frac{Q}{2C}$ (d) $V - \frac{Q}{C}$

39. A parallel plate capacitor of capacity 100 μF is charged by a battery of 50 volt. The battery remains connected and if the plates of the capacitor are separated so that the distance between them becomes double the original distance, the additional energy given to the battery by the capacitor (in joule) is:

(a) $\frac{125\times10^{-3}}{2}$ (b) 12.5×10^{-3}

(c) 1.25×10^{-3} (d) 0.125×10^{-3}

40. An insulator plate is passed between the plates of a capacitor. Then current:



(a) always flows from A to B

(b) always flows from B to A

(c) first flows from A to B and then from B to A

(d) first flows from B to A and then from A to B

41. A sheet of aluminium foil of negligible thickness is introduced between the plates of a capacitor. The capacitance of the capacitor:

(a) increases (b) decreases

(c) becomes infinite (d) remains unchanged

42. A fully charged capacitor has a capacitance C. It is discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity s and mass m. If the temperature of the block is raised by ΔT, the potential difference V across the capacitance is:

(a) $\frac{ms\Delta T}{C}$

(b) $\sqrt{\frac{2ms\Delta T}{C}}$

(c) $\sqrt{\frac{2mC\Delta T}{s}}$

(d) $\frac{mC\Delta T}{s}$

43. A parallel plate condenser with a dielectric of dielectric constant K between the plates has a capacity C and is charged to a potential V volt. The dielectric slab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is:

(a) zero

(b) $\frac{1}{2}$ (K – 1) CV²

(c) $\frac{CV^2(K-1)}{K}$

(d) $(K-1)CV^2$

44. Two identical capacitors, have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the combined system is:

(a) $\frac{1}{4}C(V_1^2 - V_2^2)$

(b) $\frac{1}{4}C(V_1^2 + V_2^2)$

(c) $\frac{1}{4}C(V_1 - V_2)^2$

(d) $\frac{1}{4}C(V_1 + V_2)^2$

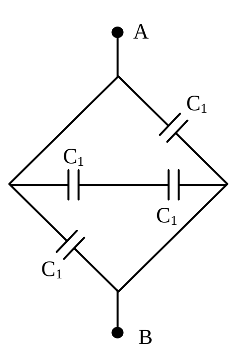
45. Four identical capacitors are connected as shown in diagram. When a battery of 6 V is connected between A and B, the charge stored is found to be 1.5 μC. The value of C_1 is:

(a) 2.5 μF

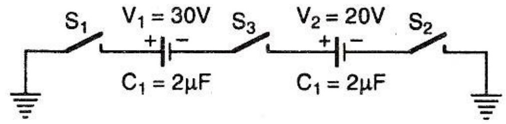
(b) 15 μF

(c) 1.5 μF

(d) 0.1 μF



46. For the circuit shown, which of the following statements is true?



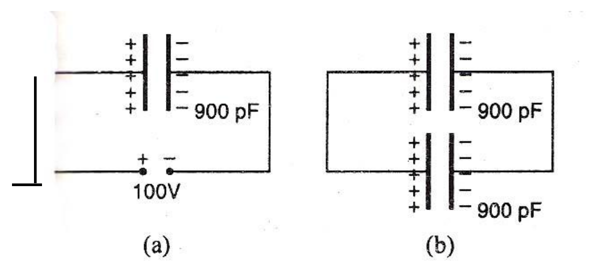
(a) With S_1 closed, $V_1 = 15V$, $V_2 = 20$ V

(b) With S_3 closed, $V_1 = V_2 = 25$ V

(c) With S_1 and S_2 closed, $V_1 = V_2 = 0$

(d) With S_1 and S_2 closed, $V_1 = 30V$, $V_2 = 20$ V

47. * The energy stored in the capacitor as shown in figure 4.5×10^{-6} J. If the battery is replaced by another capacitor of 900 pF as shown in figure, then the total energy of system is:



(a) 4.5×10^{-6} V

(b) 2.25×10^{-6} V

(c) zero

(d) 9×10^{-6} J

48. * Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to halt its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then, the ratio $\frac{t_1}{t_2}$ will be:

(a) 1

(b) $\frac{1}{2}$

(c) $\frac{1}{4}$

(d) 2

49. * A series combination of n_1 capacitors, each of value C_1, is charged by a source of potential difference 4V. When another parallel combination of n_2 capacitors, each of value C_2, is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has. The value of C_2, in terms of C_1, is then:

(a) $\frac{2C_1}{n_1 n_2}$ (b) $16\frac{n_2}{n_1}C_1$

(c) $2\frac{n_2}{n_1}C_1$ (d) $\frac{16C_1}{n_1 n_2}$

50. A parallel plate condenser of plate area A and separation d is charged to a potential V and then the battery is removed. Now a slab of dielectric so as to fill the space between the plates of the capacitor so as to fill the space between the plates. If Q, E and W denote respectively the magnitude of charge on each plate, the electric field between the plates (after introduction of dielectric slab) and work done on the system in the process of introducing the slab, then:

(a) $Q = \frac{\varepsilon_0 AV}{d}$

(b) $Q = \frac{\varepsilon_0 KAV}{d}$

(c) $E = \frac{V}{Kd}$

(d) $W = \frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{K}\right)$

ANSWERS KEY

1	B	**11**	B	**21**	A	**31**	C	**41**	D
2	C	**12**	B	**22**	A,C,D	**32**	C	**42**	B
3	D	**13**	C	**23**	B,D	**33**	D	**43**	A
4	A	**14**	C	**24**	A,B,D	**34**	B	**44**	C
5	C	**15**	B	**25**	A,C,D	**35**	B	**45**	D
6	B	**16**	A	**26**	A,B,C	**36**	C	**46**	D
7	B	**17**	A	**27**	C	**37**	D	**47**	B
8	B	**18**	C	**28**	B	**38**	C	**48**	C
9	C	**19**	A	**29**	D	**39**	A	**49**	B
10	B	**20**	C	**30**	D	**40**	D	**50**	A,C,D