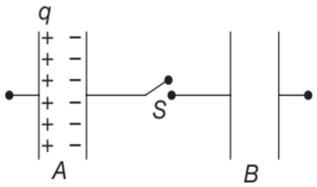
PRACTICE EXERCISES

SINGLE CORRECT CHOICE TYPE QUESTIONS

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. Consider the situation shown in the figure. The capacitor A has a charge q on it whereas B is uncharged. The charge appearing on the capacitor B a long time after the switch is closed is



(A) zero (B) $\frac{q}{2}$

(C) q (D) $2q$

2. Two uncharged metal balls of radius $0.09\ \text{mm}$ each collide such that an electron is transferred between them. The potential difference between the balls is

(A) $16\ \mu\text{V}$ (B) $16\ \text{pV}$ (C) $32\ \mu\text{V}$ (D) $32\ \text{pV}$

3. A parallel plate capacitor of value $1.77\ \mu\text{F}$ is to be designed using a dielectric material of dielectric constant 200, break through strength $3\times10^{6}\ \text{Vm}^{-1}$. In order to make such a capacitor, which can withstand a potential difference of 20 V across the plates, the separation between the plates d and the area of the plates A (each) can be

(A) $d=10^{-6}\ \text{m}, A=10^{-3}\ \text{m}^2$

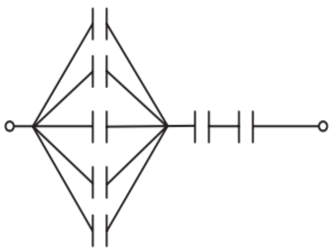
(B) $d=10^{-5}\ \text{m}, A=10^{-2}\ \text{m}^2$

(C) $d=10^{-4}\ \text{m}, A=10^{-4}\ \text{m}^2$

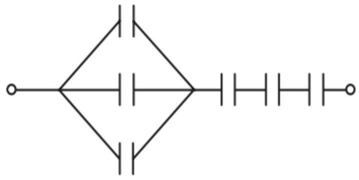
(D) $d=10^{-4}\ \text{m}, A=10^{-5}\ \text{m}^2$

4. Seven capacitors each of capacitance $2\ \mu\text{F}$ are to be connected in a configuration to obtain an effective capacitance of $\left(\frac{10}{11}\right)\mu\text{F}$. Which of combination(s) shown in figure, will achieve the desired results?

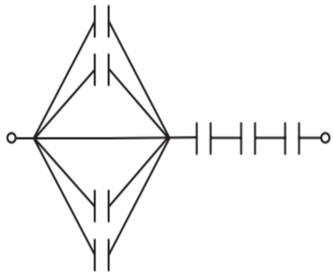
(A)



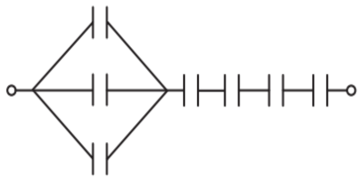
(B)



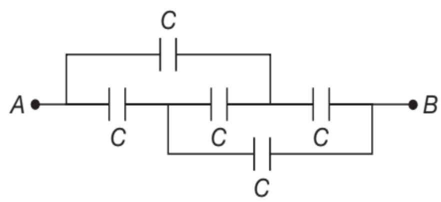
(C)



(D)



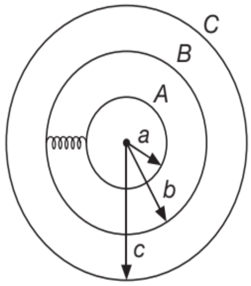
5. In the circuit shown, the equivalent capacitance between the points A and B is



(A) $\frac{C}{5}$ (B) $\frac{C}{3}$

(C) $\frac{C}{2}$ (D) C

6. Three conducting spheres A, B and C of radii a, b and c respectively are as shown in figure. The capacitance of the system, when A and B are connected by a conducting wire is



(A) $4\pi\varepsilon_0\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}\right)$ (B) $4\pi\varepsilon_0\left(\frac{abc}{ab+bc+ca}\right)$

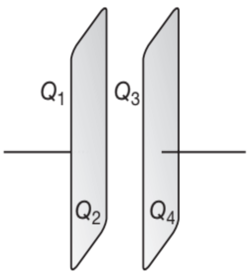
(C) $4\pi\varepsilon_0(a+b+c)$ (D) $4\pi\varepsilon_0\left(\frac{bc}{c-b}\right)$

7. If we treat the earth as a conducting sphere of radius 6400 km, its capacitance would be of the order of

(A) 1 F (B) 1 mF

(C) 1 μF (D) 1000 F

8. An isolated parallel plate capacitor of capacitance C has four surfaces with charges Q_1, Q_2, Q_3 and Q_4 as shown in figure. The potential difference between the plates is



(A) $\frac{Q_1+Q_2+Q_3+Q_4}{2C}$ (B) $\frac{Q_2+Q_3}{2C}$

(C) $\frac{Q_2-Q_3}{2C}$ (D) $\frac{Q_1+Q_4}{2C}$

9. A conducting sphere of radius R, carrying a charge Q is joined to an uncharged conducting sphere of radius $2R$. The charge flowing between them is q. Then

(A) $q=\frac{Q}{4}$ (B) $q=\frac{Q}{3}$

(C) $q=\frac{Q}{2}$ (D) $q=\frac{2Q}{3}$

10. The capacitances of two condensers are C_1 and C_2 and their respective potentials are V_1 and V_2. If they are connected by a thin wire, the loss in energy is

(A) $\frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1+V_2)^2$ (B) $\frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1-V_2)$

(C) $\frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1-V_2)^2$ (D) None of these

11. In a parallel plate capacitor, the region between the plates is filled by a dielectric slab. The capacitor is connected to a battery and the slab is taken out. It is observed that,

(A) some charge is drawn from the battery
(B) some charge is returned to the battery
(C) the potential difference across the capacitor is reduced
(D) the external agent does no work in taking the slab out

12. In a parallel plate capacitor of capacitance C, a metal sheet is inserted between the plates, parallel to them. The thickness of the sheet is half of the separation between the plates. The capacitance now becomes

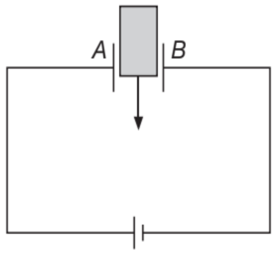
(A) $4C$ (B) $2C$

(C) $\frac{C}{2}$ (D) $\frac{C}{4}$

13. In a parallel plate capacitor, the region between the plates is filled by a dielectric slab. The capacitor is charged from a battery and then disconnected from it. The slab is now taken out. It is observed that,

(A) the potential difference across the capacitor is reduced
(B) the potential difference across the capacitor is increased
(C) the energy stored in the capacitor is reduced
(D) the external agent does no work in taking the slab out

14. A dielectric slab is introduced between the plates of a capacitor in the manner as shown. Then current in outer circuit



(A) always flows from B to A
(B) always flows from A to B
(C) first flows from B to A and then from A to B
(D) first flows from A to B and then from B to A

15. Two capacitors of 3 pF and 6 pF are connected in series and a potential difference of 5 kV is applied across the combination. They are then disconnected and reconnected in parallel. The potential difference across the combination is

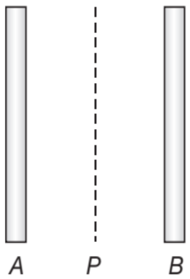
(A) 1.1 MV (B) 2.25 MV
(C) 2250 V (D) 1111 V

16. It is observed that the capacitance of an isolated sphere of radius a is increased n times when it is enclosed by an earthed concentric sphere of radius b. Then $\frac{b}{a}$ equals

(A) $\frac{n^2}{n-1}$ (B) $\frac{n}{n-1}$
(C) $\frac{2n}{n+1}$ (D) $\frac{2n+1}{n+1}$

17. An infinite number of capacitances $2\ \mu F$, $4\ \mu F$, $8\ \mu F$ ...., are connected in series. The equivalent capacitance of the system is
(A) infinite (B) 0.25 μF
(C) 0.5 μF (D) 1 μF

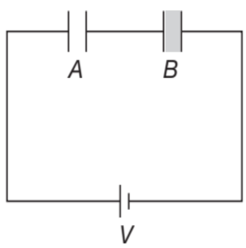
18. An air capacitor consists of two parallel plates A and B having respective charges $2Q$ and $3Q$ as shown in the figure. If C_0 is the capacitance of the capacitor and P be the median plane of the capacitor, then



(A) $V_P - V_A = \frac{Q}{4C_0}$ (B) $V_P - V_A = \frac{Q}{2C_0}$
(C) $V_P - V_A = -\frac{Q}{C_0}$ (D) $V_P - V_B = -\frac{Q}{4C_0}$

19. A capacitor of capacitance 1 μF can withstand a maximum voltage of 6 kV and the other capacitor of capacitance 2 μF can withstand a maximum voltage of 4 kV. The series combination of the capacitor can withstand a maximum voltage of
(A) 4 kV (B) 6 kV
(C) 9 kV (D) 10 kV

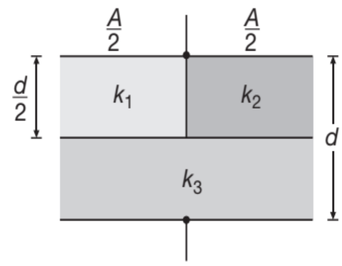
20. Two identical capacitors A and B are connected in series to a battery as shown in figure. Capacitor B contains a dielectric slab of dielectric constant K as shown. Q_1 and Q_2 are the initial charges stored in the capacitors. Now the dielectric slab is removed and the final corresponding charges stored are q_1 and q_2. Then



(A) $\frac{q_2}{Q_2} = \frac{K+1}{2K}$ (B) $\frac{q_1}{Q_1} = \frac{K+1}{K}$
(C) $\frac{q_1}{Q_1} = \frac{K}{2}$ (D) $\frac{q_2}{Q_2} = \frac{K+1}{2}$

21. A parallel plate capacitor having capacitance C_0 is connected to a battery of emf E. It is then disconnected from the battery and a dielectric slab of dielectric constant k completely filling the air gap of the capacitor is inserted in it. If ΔU indicates the change in energy, then
(A) $\Delta U = 0$ (B) $\Delta U = \frac{1}{2}C_0E^2(k-1)$
(C) $\Delta U = \frac{1}{2}C_0E^2\left(1-\frac{1}{k}\right)$ (D) $\Delta U = \frac{1}{2}C_0E^2\left(\frac{1}{k}-1\right)$

22. 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. 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) $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{2k_3}$

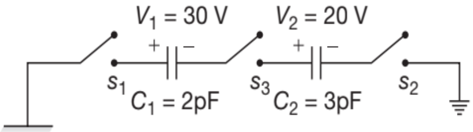
(B) $\frac{1}{k} = \frac{1}{k_1+k_2} + \frac{1}{2k_3}$

(C) $\frac{1}{k} = \frac{k_1k_2}{k_1+k_2} + 2k_3$

(D) $k = \frac{k_1k_3}{k_1+k_3} + \frac{k_2k_3}{k_2+k_3}$

23. Two identical capacitors are joined in parallel and charged to a potential V. Then these are separated and connected in series with the positive plate of one connected to the negative plate of the other. Then
(A) the charges on the plates connected together are destroyed.
(B) the charges on the free plates are enhanced.
(C) the energy stored in the system increases.
(D) the potential difference between the plates becomes $2V$.

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



(A) With S_1 closed, $V_1 = 15\text{ V}$, $V_2 = 20\text{ V}$

(B) With S_3 closed, $V_1 = V_2 = 25\text{ V}$

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

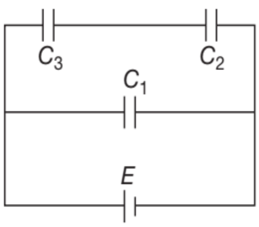
(D) With S_1 and S_3 closed, $V_1 = 30\text{ V}$, $V_2 = 20\text{ V}$

25. For the same kind of field in air and dielectric (of dielectric constant K), let U_a and U_d represent the energy density (energy per unit volume) in air and in a dielectric respectively. Then,

(A) $U_a = U_d$ (B) $U_a = KU_d$

(C) $U_d = KU_a$ (D) $U_a = (K-1)U_d$

26. The charge acquired by C_1 as shown in the figure is Q. The charge acquired by C_2 is $(C_1 = C_2 = C_3)$



(A) Q (B) $\frac{Q}{2}$

(C) $\frac{Q}{4}$ (D) $2Q$

27. The work done in increasing the voltage across the plates of the capacitor from 5 V to 10 V is W. The work done in increasing the voltage from 10 V to 15 V will be

(A) W (B) $\frac{4}{3}W$

(C) $\frac{5}{3}W$ (D) $2W$

28. The plates of a parallel plate capacitor are separated by d cm. A plate of thickness t cm with dielectric constant k_1 is inserted and the remaining space is filled with a plate of dielectric constant k_2. If Q is the charge on the capacitor and area of plates is $A\text{ cm}^2$ each, then potential difference between the plates is

(A) $\frac{Q}{\varepsilon_0 A}\left(\frac{t}{k_1} + \frac{d-t}{k_2}\right)$ (B) $\frac{4\pi Q}{A}\left(\frac{t}{k_1} + \frac{d-t}{k_2}\right)$

(C) $\frac{4\pi Q}{A}\left(\frac{k_1}{t} + \frac{k_2}{d-t}\right)$ (D) $\frac{Q}{\varepsilon_0 A}\left(\frac{k_1}{t} + \frac{d-t}{k_2}\right)$

29. Two capacitors of 1 pF and 2 pF are charged to 200 V and 100 V and then connected by a wire. The potential of the connected system is

(A) 150 V (B) 106 V

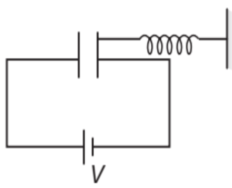
(C) 133 V (D) 187 V

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

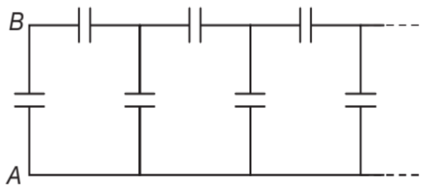
31. One plate of a capacitor is connected to a spring as shown in figure. Area of both the plates is A. In steady state separation between the plates is $\frac{4d}{5}$ (spring was unstretched and the distance between the plates was d when the capacitor was uncharged). The force constant of the spring is approximately



(A) $\frac{\varepsilon_0 AV^2}{2d^3}$ (B) $\frac{4\varepsilon_0 AV}{d^2}$

(C) $\frac{4\varepsilon_0 AV^2}{d^3}$ (D) $\frac{6\varepsilon_0 V^2}{Ad^3}$

32. An infinite ladder of capacitors each 1 μF is made as shown in figure. The capacitance between A and B (in μF) is

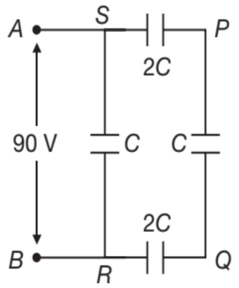


(A) 1 (B) 1.3
(C) 1.6 (D) 0

33. When a dielectric slab of thickness half that of separation is inserted between the plates the capacitance of a capacitor becomes $\frac{4}{3}$ times the original value. The dielectric constant, K of the slab is

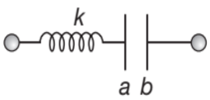
(A) $K = 2$ (B) $K = 4$
(C) $K = 6$ (D) $K = 8$

34. In the circuit shown, a potential difference of 90 V is applied across AB. The potential difference between the points P and Q is



(A) 15 V (B) 30 V
(C) 45 V (D) 60 V

35. Consider an air filled parallel plate capacitor with one plate connected to a spring having a force constant k, and another plate held fixed. The system rests on a frictionless table top.
If the charges placed on plates a and b are $+Q$ and $-Q$, respectively, the spring expand will have an expansion x, given by



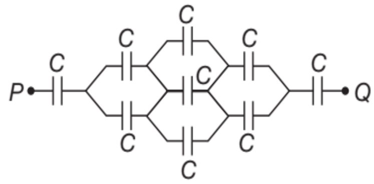
Capacitor connected to a spring

(A) $\frac{Q^2}{kA\varepsilon_0}$ (B) $\frac{2Q^2}{kA\varepsilon_0}$
(C) $\frac{Q^2}{2kA\varepsilon_0}$ (D) None of these

36. Three concentric metallic spherical shells of radii R, $2R$, $3R$ are given charges Q_1, Q_2, Q_3, respectively. It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, $Q_1 : Q_2 : Q_3$ is

(A) $1:2:3$ (B) $1:3:5$
(C) $1:4:9$ (D) $1:8:18$

37. The equivalent capacitance between P and Q if $C = 3\ \mu\text{F}$ is



(A) $3\ \mu\text{F}$ (B) $1\ \mu\text{F}$
(C) $0.9\ \mu\text{F}$ (D) $\infty\ \mu\text{F}$

38. A parallel plate capacitor of capacitance 100 μF is charged to 500 V. The plate separation is then reduced to half its original value. Then
(A) the potential on the capacitor becomes 1000 V
(B) the potential on the capacitor becomes 250 V
(C) the change in stored energy is 3.75×10^{-5} J
(D) the change in stored energy is 6.25×10^{-6} J

39. A parallel plate capacitor has circular plates of 0.08 m radius and 1.0×10^{-3} m separation. If a potential difference of 100 V is applied, the charge on the capacitor will be

(A) 1.8×10^{-10} C (B) 1.8×10^{-8} C
(C) 1.8×10^{-20} C (D) None of the above

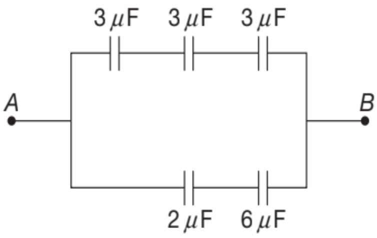
40. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance $2C$ is similarly charged to potential difference $2V$. The charging battery is now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration

(A) ZERO (B) $\frac{3}{2}CV^2$
(C) $\frac{25}{6}CV^2$ (D) $\frac{9}{2}CV^2$

41. The radii of two spheres forming a spherical condenser are 0.5 m and 0.6 m. If a medium of dielectric constant 6 is completely filled in between, the capacity of the condenser will be

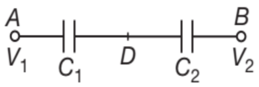
(A) 3.3×10^{-10} F (B) 2×10^{-9} F
(C) 2 F (D) 18 F

42. In the given arrangement of the capacitors, one $3\ \mu\text{F}$ capacitor has got $600\ \mu\text{J}$ of energy. Then the potential difference across $2\ \mu\text{F}$ capacitor is



(A) 15 V (B) 30 V
(C) 45 V (D) 60 V

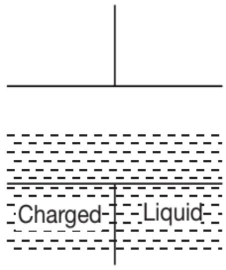
43. Two capacitors C_1 and C_2 in a circuit are joined as shown in figure. The potentials of points A and B are V_1 and V_2 respectively; then the potential of point D will be



(A) $\frac{(V_1+V_2)}{2}$ (B) $\frac{C_2V_1+C_1V_2}{C_1+C_2}$

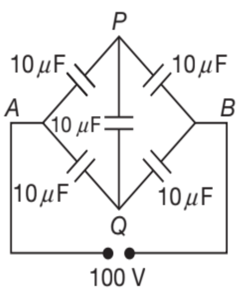
(C) $\frac{C_1V_1+C_2V_2}{C_1+C_2}$ (D) $\frac{C_2V_1-C_1V_2}{C_1+C_2}$

44. A parallel plate capacitor is located horizontally such that one of the plates is submerged in a liquid while the other is above the liquid surface. When plates are charged the level of liquid



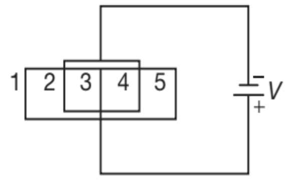
(A) rises
(B) falls
(C) remains unchanged
(D) may rise or fall depending on the amount of charge

45. Five capacitors, each of capacity 10 μF, are connected to a 100 V d.c. supply as shown. The equivalent capacitance between A and B is



(A) 40 μF (B) 30 μF
(C) 20 μF (D) 10 μF

46. Five identical plates, each of area A are joined as shown in figure. The distance between the plates is d. The plates are connected to a potential difference of V volt. The charge on plates 1 and 4 will be



(A) $\frac{\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$ (B) $-\frac{\varepsilon_0 AV}{d}, \frac{2\varepsilon_0 AV}{d}$

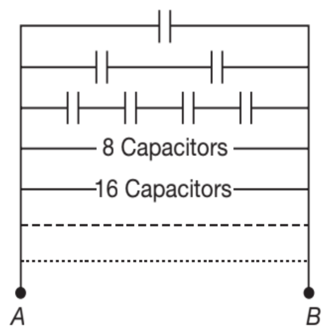
(C) $\frac{\varepsilon_0 AV}{d}, -\frac{2\varepsilon_0 AV}{d}$ (D) $-\frac{\varepsilon_0 AV}{d}, -\frac{2\varepsilon_0 AV}{d}$

47. The capacities of two conductors are C_1 and C_2 and their respective potentials are V_1 and V_2. If they are connected by a thin wire, then the loss of energy will be

(A) $\frac{C_1C_2(V_1+V_2)}{2(C_1+C_2)}$ (B) $\frac{C_1C_2(V_1-V_2)}{2(C_1+C_2)}$

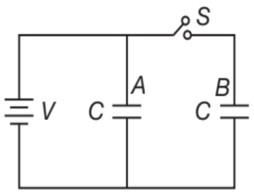
(C) $\frac{C_1C_2(V_1-V_2)^2}{2(C_1+C_2)}$ (D) $\frac{(C_1+C_2)(V_1-V_2)}{C_1C_2}$

48. An infinite number of identical capacitors, each of capacitance 1 μF, are connected as in the figure. The equivalent capacitance between A and B is



(A) $\frac{1}{2}$ μF (B) 1 μF
(C) 2 μF (D) ∞

49. The figure shows two identical parallel plate capacitors connected to a battery with switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of constant 3. The ratio of the total energy stored in both capacitors before and after the introduction of the dielectric is



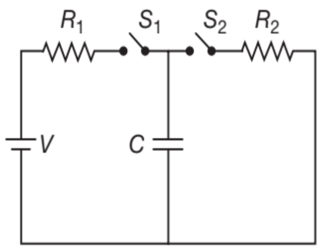
(A) $\frac{5}{3}$ (B) $\frac{3}{5}$

(C) $\frac{5}{2}$ (D) $\frac{2}{5}$

50. Two capacitances, $4\,\mu$F and $6\,\mu$F are connected in series. A potential difference of 500 V is applied between the outer plates of the system. The charge on each capacitor will be

(A) 1200 C (B) 6000 C
(C) 1200 μC (D) 6000 μC

51. A battery of e.m.f. V volt, resistors R_1 and R_2, a condenser C and switches S_1 and S_2 are connected in a circuit shown. The condenser will get fully charged to V volt when

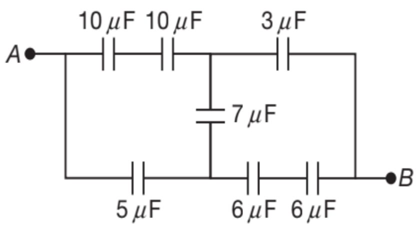


(A) S_1 and S_2 are both closed
(B) S_1 and S_2 are both open
(C) S_1 is open and S_2 is closed
(D) S_1 is closed and S_2 is open

52. A capacitor connected to a 10 V battery collects a charge of 40 μC with air as dielectric and 100 μC with oil as dielectric. The dielectric constant of the oil is

(A) 4 (B) 2.5
(C) 0.4 (D) 1.0

53. In the figure, the equivalent capacitance between A and B is



(A) 3.75 μF (B) 5.25 μF
(C) 6.5 μF (D) 10.5 μF

54. Two parallel plate capacitors of capacitances C and $2C$ are connected in parallel and charged to a potential difference V. The battery is then disconnected and the region between the plates of the capacitor C is completely filled with a material of dielectric constant K. The potential difference across the capacitors now becomes

(A) $\frac{3V}{K+2}$ (B) KV

(C) $\frac{V}{K}$ (D) $\frac{3V}{K}$

55. A parallel plate capacitor with a slab of dielectric constant 3 filling the whole space between the plates is charged to a certain potential and isolated. Then the slab is drawn out and another slab of equal thickness but dielectric constant 2 is introduced between the plates. The ratio of the energy stored in the capacitor later to that stored initially is

(A) $2:3$ (B) $3:2$
(C) $4:9$ (D) $9:4$

56. A capacitor C_1 is charged to a potential difference V. The charging battery is then removed and the capacitor is connected to an uncharged capacitor C_2. The final potential difference across the combination is

(A) $V\frac{C_1}{C_1+C_2}$ (B) $V\frac{C_2}{C_1+C_2}$

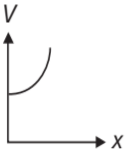
(C) $V\frac{C_1C_2}{C_1+C_2}$ (D) $\frac{V}{C_1+C_2}$

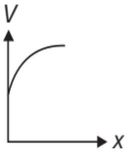
57. In PROBLEM 56, if U is the initial stored energy in capacitor C_1, the final stored energy in the combination is

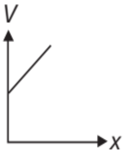
(A) $U\frac{C_1}{C_1+C_2}$ (B) $U\frac{C_2}{C_1+C_2}$

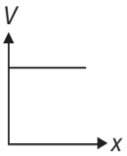
(C) $U\frac{C_1C_2}{C_1+C_2}$ (D) $\frac{U}{C_1+C_2}$

58. Between the plates of a parallel plate dielectric plate is introduced just to fill the space between the plates. The capacitor is charged and later disconnected from the battery. The dielectric plate is slowly drawn out of the capacitor parallel to plates. The plot of the potential difference V across the plates and the length of the dielectric plate drawn out is

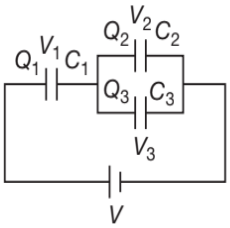
(A) 

(B) 

(C) 

(D) 

59. Three capacitors C_1, C_2 and C_3 are connected to a battery as shown. With symbols having their usual meanings, the correct conditions are



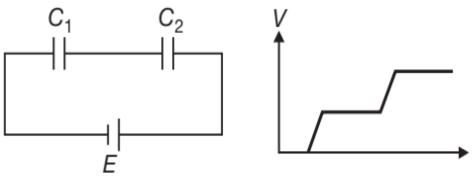
(A) $Q_1 = Q_2 = Q_3$ and $V_1 = V_2 = V$

(B) $V_1 = V_2 = V_3 = V$

(C) $Q_1 = Q_2 + Q_3$ and $V = V_1 + V_2$

(D) $Q_2 = Q_3$ and $V_2 = V_3$

60. Figure (A) shows two capacitors connected in series and connected by a battery. The graph (B) shows the variation of potential as one moves from left to right on the branch containing the capacitors. Then



(A) (B)

(A) $C_1 = C_2$

(B) $C_1 < C_2$

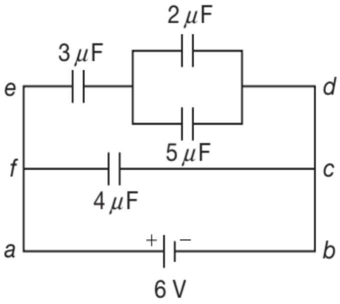
(C) $C_1 > C_2$

(D) C_1 and C_2 cannot be compared

61. A 5 μF capacitor is fully charged across a 12 V battery. It is then disconnected from the battery and connected to an uncharged capacitor. If the voltage across the capacitor becomes 3 V, the capacitance of the uncharged capacitor is

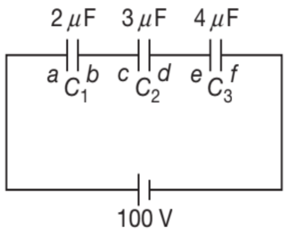
(A) 3 μF (B) 15 μF
(C) 25 μF (D) 60 μF

62. In the circuit given below, the charge in μC, on the capacitor having capacity 5 μF is



(A) 4.5 (B) 9
(C) 7 (D) 15

63. Three capacitors C_1, C_2 and C_3 are connected as shown. If the charges accumulated on the plates a, b, c, d, e and f are q_a, q_b, q_c, q_d, q_e and q_f respectively then



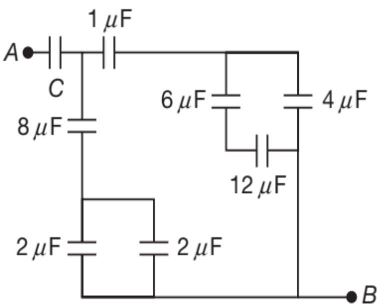
(A) $q_b + q_d + q_f = \left(\frac{100}{9}\right)$ C

(B) $q_b + q_d + q_f = 0$

(C) $q_d + q_c + q_e = 50$ C

(D) $q_b = q_d = q_f$

64. In the given network, the value of C so that the equivalent capacitance between A and B is 1 μF should be



(A) $\frac{32}{23}$ μF (B) $\frac{23}{32}$ μF

(C) $\frac{3}{2}$ μF (D) $\frac{2}{3}$ μF

65. An infinite number of capacitors, having capacitances 1 μF, 2 μF, 4 μF, 8 μF, ... are connected in series. The equivalent capacitance of the system is

(A) infinite (B) 0.25 μF
(C) 0.5 μF (D) 2 μF

66. Separation between the plates of a parallel plate capacitor is d and the area of each plate is A. When a slab of material of dielectric constant K and thickness $t(<d)$ is introduced between the plates, its capacitance becomes

(A) $\dfrac{\varepsilon_0 A}{d+t\left(1-\frac{1}{K}\right)}$ (B) $\dfrac{\varepsilon_0 A}{d+t\left(1+\frac{1}{K}\right)}$

(C) $\dfrac{\varepsilon_0 A}{d-t\left(1-\frac{1}{K}\right)}$ (D) $\dfrac{\varepsilon_0 A}{d-t\left(1+\frac{1}{K}\right)}$

67. Two thin infinite parallel plates have uniform charge densities $+\sigma$ and $-\sigma$. The electric field in the space between them is

(A) $\dfrac{\sigma}{2\varepsilon_0}$ (B) $\dfrac{\sigma}{\varepsilon_0}$

(C) $\dfrac{2\sigma}{\varepsilon_0}$ (D) ZERO

68. A parallel plate capacitor with air between the plates is charged to a potential difference of 500 V and then insulated. A plastic plate is inserted between the plates filling the whole gap. The potential difference between the plates now becomes 75 V. The dielectric constant of plastic is

(A) $\dfrac{10}{3}$ (B) 5

(C) $\dfrac{20}{3}$ (D) 10

69. A parallel plate capacitor is charged to a certain potential difference. A slab of thickness 3 mm is inserted between the plates and it becomes necessary to increase the distance between the plates by 2.4 mm to maintain the same potential difference. The dielectric constant of the slab is

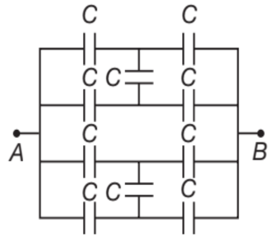
(A) 3 (B) 5
(C) 2.5 (D) 2.4

70. A system of three parallel plates, each of area A, are separated by distances d_1 and d_2. The space between them is filled with dielectrics of permittivities ε_1 and ε_2. The permittivity of free space is ε_0. The equivalent capacitance of the system is

(A) $\dfrac{\varepsilon_1\varepsilon_2 A}{\varepsilon_2 d_1+\varepsilon_1 d_2}$ (B) $\dfrac{\varepsilon_1\varepsilon_2\varepsilon_0 A}{(\varepsilon_1 d_1+\varepsilon_2 d_2)}$

(C) $\dfrac{\varepsilon_0 A}{\varepsilon_1 d_1+\varepsilon_2 d_2}$ (D) $\dfrac{\varepsilon_0 A}{\varepsilon_1 d_2+\varepsilon_2 d_1}$

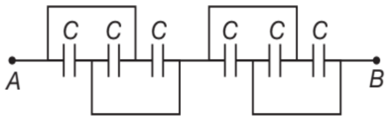
71. The effective capacitance of combination of equal capacitors between points A and B shown in figure is



(A) C (B) 2C

(C) 3C (D) $\dfrac{C}{2}$

72. Six equal capacitors each of capacitance C are connected as shown. The equivalent capacitance between A and B is

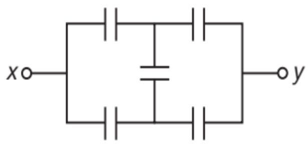


(A) $\dfrac{2}{3}C$ (B) $\dfrac{3}{2}C$

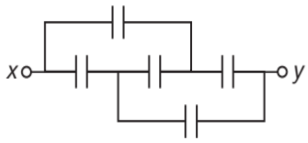
(C) 2C (D) 6C

73. Four ways of making a network of five capacitors of the same value are shown here. Three out of four are identical. The one which is different is

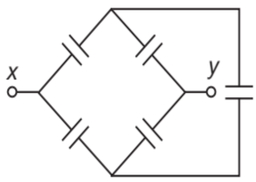
(A)



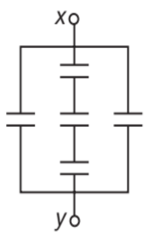
(B)



(C)



(D)

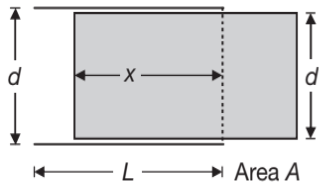


74. An isolated metallic object is charged in vacuum to a potential V, its electrostatic energy being E. It is then disconnected from the source of potential, its charge being left unchanged, and is immersed in a large volume of dielectric with dielectric constant K. Its electrostatic energy is

(A) $\frac{E}{K}$ (B) KE

(C) $\left(\frac{E}{V}\right)K$ (D) $\frac{V^2}{E}K$

75. In a capacitor with $C_0 = \frac{\varepsilon_0 A}{d}$ (in vacuum) and a charge q, a dielectric slab of dielectric constant K is inserted. If the inserted length is x and the edge effects are ignored, then the force on the slab is



(A) attractive and equal to $\frac{1}{2}\frac{q}{C_0 L}(K-1)$

(B) repulsive and equal to $\frac{1}{2}\frac{q}{C_0 L}(K-1)$

(C) attractive and equal to $\frac{1}{2}\frac{q^2}{C_0 L}\times\frac{K-1}{\left(1+\frac{x}{L}(K-1)\right)^2}$

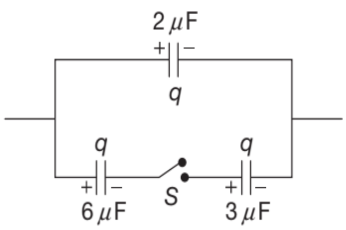
(D) repulsive and equal to $\frac{1}{2}\frac{q^2}{C_0 L}\times\frac{K-1}{\left(1+\frac{x}{L}(K-1)\right)^2}$

76. A capacitor is charged to potential V by a battery of emf V. If an identical capacitor is inserted in the circuit in series with the previous capacitor, the potential difference across the new capacitor is

(A) $2V$ (B) V

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

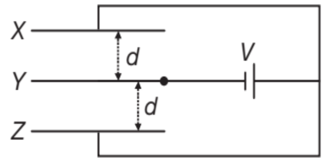
77. The flow of charge through switch S when it is closed is



(A) zero (B) $\frac{q}{4}$

(C) $\frac{2q}{3}$ (D) $\frac{q}{3}$

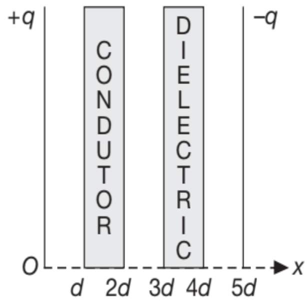
78. Consider the arrangement of three plates X, Y, and Z each of the area A and separation d. The energy stored when the plates are fully charged is

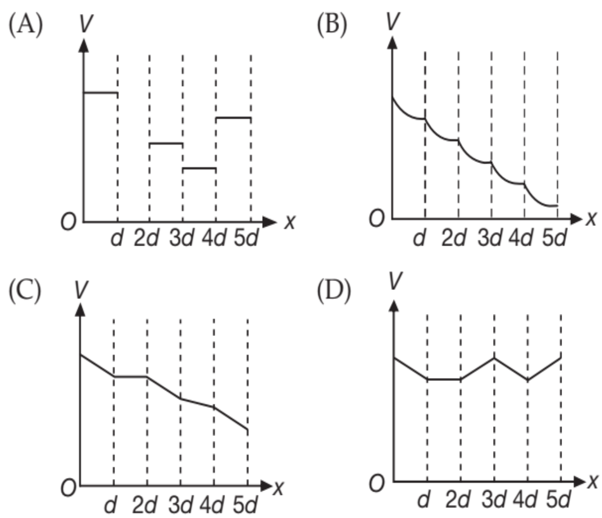


(A) $\frac{\varepsilon_0 AV^2}{2d}$ (B) $\frac{\varepsilon_0 AV^2}{d}$

(C) $\frac{2\varepsilon_0 AV^2}{d}$ (D) $\frac{3\varepsilon_0 AV^2}{2d}$

79. The distance between plates of a parallel plate capacitor is $5d$. The positively charged plate is at $x=0$ and negatively charged plate is at $x=5d$. Two slabs one of conductor and the other of a dielectric of same thickness d are inserted between the plates as shown in figure. Potential (V) versus distance x graph will be





80. Capacitance of a capacitor, having plate separation d, becomes $\frac{4}{3}$ times its original value if a dielectric slab of thickness half the separation is inserted between the plates. The dielectric constant of the slab is

(A) 2 (B) 4

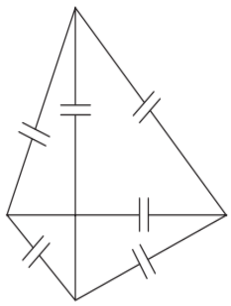
(C) 6 (D) 8

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

(A) remains the same (B) becomes eight times

(C) becomes four times (D) becomes two times

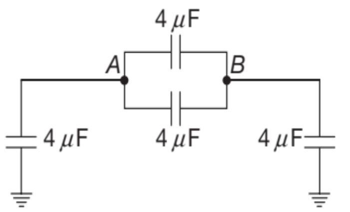
82. If the capacitance of each capacitor is C, then effective capacitance of the shown network across any two junctions is



(A) C (B) $5C$

(C) $\frac{C}{2}$ (D) $2C$

83. Find equivalent capacitance between A and B



(A) $4\ \mu F$ (B) $6\ \mu F$

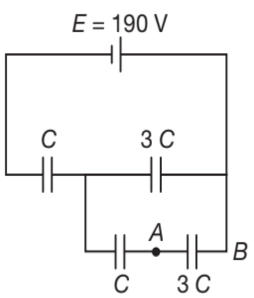
(C) $8\ \mu F$ (D) $10\ \mu F$

84. A capacitor of capacitance $10\ \mu F$ is charged to a potential 50 V with a battery. The battery is now disconnected and an additional charge $200\ \mu C$ is given to the positive plate of the capacitor. The potential difference across the capacitor will be

(A) 50 V (B) 60 V

(C) 80 V (D) 100 V

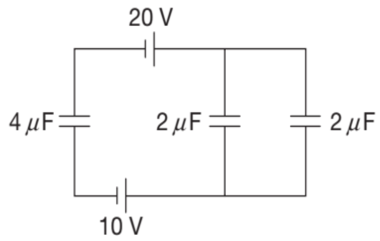
85. In the circuit shown in figure potential difference between A and B is



(A) 10 V (B) 30 V

(C) 60 V (D) 90 V

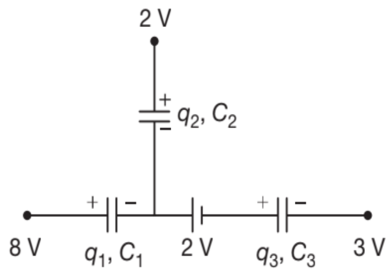
86. In the circuit shown in figure, charge stored in 4 μF capacitor is



(A) 10 μC (B) 20 μC

(C) 40 μC (D) 120 μC

87. A part of the circuit is shown in the figure. All the capacitors have capacitance of $2\ \mu F$, then charge on



(A) capacitor C_1 is zero

(B) capacitor C_2 is zero

(C) capacitor C_3 is zero

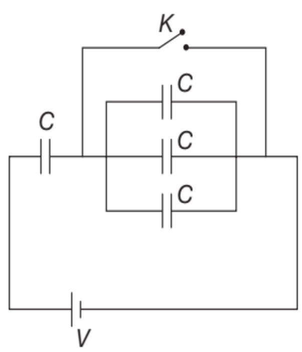
(D) any capacitor cannot be determined

88. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge $+Q$ is now 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) $V + \frac{Q}{C}$

89. The charge flowing through the cell on closing the key K is equal to



(A) $\frac{CV}{4}$ (B) $4CV$

(C) $\frac{3CV}{4}$ (D) $\frac{4CV}{3}$

90. A capacitor is charged until its stored energy is $3\ \text{J}$ and the charging battery is removed. Now another uncharged capacitor is connected across it and it is found that charge distributes equally. The final value of total energy stored in the electric fields is

(A) 1.5 J (B) 3 J

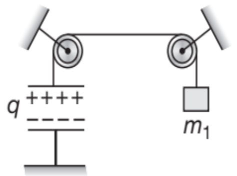
(C) 2.5 J (D) 2 J

91. The effective capacitance of two capacitors of capacitances C_1 and $C_2(C_2 > C_1)$ connected in parallel is $\frac{25}{6}$ times the effective capacitance when they are connected in series. The ratio $\frac{C_2}{C_1}$ is

(A) $\frac{3}{2}$ (B) $\frac{4}{3}$

(C) $\frac{5}{3}$ (D) $\frac{25}{6}$

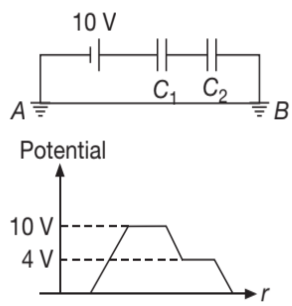
92. In the given system a capacitor of plate area A is charged upto charge q. The mass of each plate is m_2. The lower plate is rigidly fixed. Find the value of m_1 so that the system is in equilibrium



(A) $m_2 + \frac{q^2}{\varepsilon_0 A g}$ (B) m_2

(C) $\frac{q^2}{2A\varepsilon_0 g} + m_2$ (D) None of these

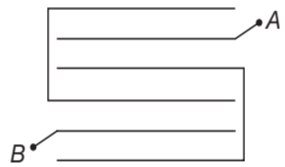
93. Figure shows two capacitors C_1 and C_2 connected with 10 V battery and terminal A and B are earthed. The graph shows the variation of potential as one moves from left to right. Then the ratio of $\frac{C_1}{C_2}$ is



(A) $\frac{5}{2}$ (B) $\frac{2}{3}$

(C) $\frac{2}{5}$ (D) $\frac{4}{3}$

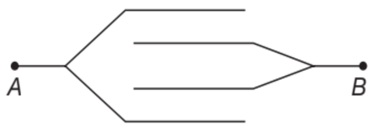
94. If each plate has area A and separation between successive plates is d, then equivalent capacitance between A and B is



(A) $\frac{A\varepsilon_0}{d}$ (B) $\frac{A\varepsilon_0}{2d}$

(C) $\frac{4A\varepsilon_0}{d}$ (D) $\frac{3A\varepsilon_0}{d}$

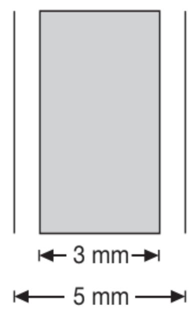
95. Four metallic plates each with a surface area of one side A, are placed at a distance d from each other. The two outer plates are connected to one point A and the two other inner plates to another point B as shown in the figure. Then the capacitance of the system is



(A) $\frac{\varepsilon_0 A}{d}$ (B) $\frac{2\varepsilon_0 A}{d}$

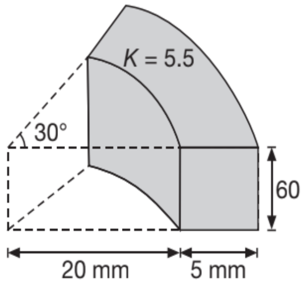
(C) $\frac{3\varepsilon_0 A}{d}$ (D) $\frac{4\varepsilon_0 A}{d}$

96. Separation between the plates of a parallel plate capacitor is 5 mm. This capacitor, having air as the dielectric medium between the plates, is charged to a potential difference 25 V using a battery. The battery is then disconnected and a dielectric slab of thickness 3 mm and dielectric constant $K = 10$ is placed between the plates, as shown. Potential difference between the plates after the dielectric slab has been introduced is



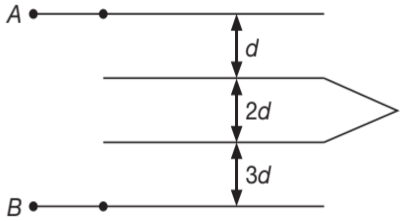
(A) 18.5 V (B) 13.5 V
(C) 11.5 V (D) 6.5 V

97. The capacitance between the inner and outer curved cylindrical conductor surface as shown in figure is (Space between conductor surface is filled with dielectric of $K = 5.5$)



(A) 6.86 pF (B) 1.86 pF
(C) 3.26 pF (D) 12.63 pF

98. If area of each plate is A and the successive separations are d, $2d$ and $3d$, then equivalent capacitances across A and B is

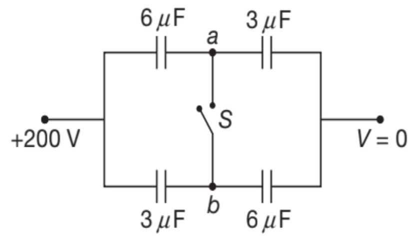


(A) $\frac{\varepsilon_0 A}{6d}$ (B) $\frac{\varepsilon_0 A}{4d}$
(C) $\frac{3\varepsilon_0 A}{4d}$ (D) $\frac{\varepsilon_0 A}{3d}$

99. An air capacitor is charged up to potential V_1. It is connected in parallel to an identical uncharged capacitor filled with a dielectric medium. After redistribution of charge is final potential difference of this combination is V, then the dielectric constant of the substance will be (Assume that both the capacitors with air medium has same capacitance)

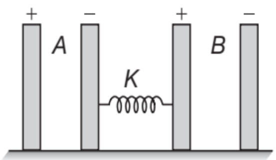
(A) $V^2(V_1 - V)$ (B) $V(V_1 - V)$
(C) $\frac{V}{(V_1 - V)}$ (D) $\frac{(V_1 - V)}{V}$

100. Find the amount of charge that will flow through the switch when it is closed



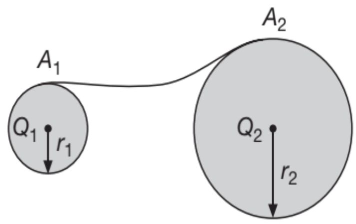
(A) 300 μC (B) 400 μC
(C) 500 μC (D) 100 μC

101. Two charged capacitors A and B have their outer plates fixed and inner plates connected by a spring of force constant k. The charge on each capacitor is q. The extension in the spring at equilibrium is



(A) $\frac{q^2}{2A\varepsilon_0 k}$ (B) $\frac{q^2}{4A\varepsilon_0 k}$
(C) $\frac{q^2}{A\varepsilon_0 k}$ (D) zero

102. Two spherical conductors A_1 and A_2 of radii r_1 and r_2 and carrying charges q_1 and q_2 are connected in air by a copper wire as shown in the figure. Then the equivalent capacitance of the system is



(A) $\frac{4\pi\varepsilon_0 r_1 r_2}{r_2 - r_1}$ (B) $4\pi\varepsilon_0(r_1 + r_2)$
(C) $4\pi\varepsilon_0 r_2$ (D) $4\pi\varepsilon_0 r_1$

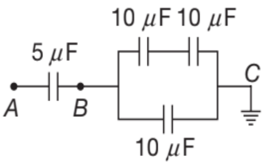
103. A parallel plate capacitor is charged with a battery. Charging is completed, battery is disconnected. Now the separation between plates is decreased then which of following is correct?
(A) Electric field will not be same
(B) Potential differences between plates increases
(C) Capacitance will decrease
(D) Stored energy will decrease

104. Two identical capacitors are connected in parallel across a potential difference V. After they are fully charged, the positive of first capacitor is connected to negative of second and negative of first is connected to positive of other. The loss in energy will be

(A) $\frac{1}{2}CV^2$ (B) CV^2

(C) $\frac{CV^2}{4}$ (D) zero

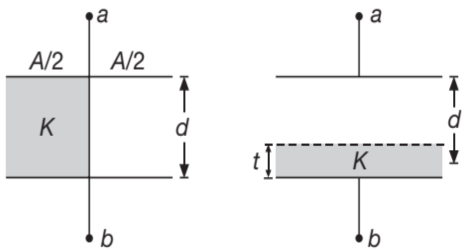
105. In the given circuit, if point C is connected to the earth and a potential of 12000 V is given to point A. The potential at B is



(A) 1500 V (B) 1000 V

(C) 400 V (D) 500 V

106. A capacitor is half filled with dielectric $(K = 2)$ as shown in Arrangement-1. If the same dielectric is to be filled in the same capacitor as shown in Arrangement-2, then the thickness of dielectric so that capacitor still has same capacitance is

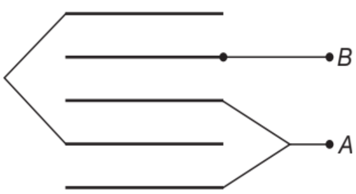


Arrangement – 1 Arrangement – 2

(A) $\frac{2d}{3}$ (B) $\frac{3d}{2}$

(C) $\frac{3d}{4}$ (D) $\frac{4d}{3}$

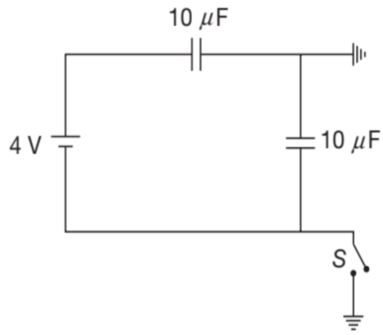
107. Five identical plates of equal area A are placed parallel to and at equal distance d from each other as shown in figure. The effective capacity of the system between the terminals A and B is



(A) $\frac{3}{5}\frac{\varepsilon_0 A}{d}$ (B) $\frac{5}{4}\frac{\varepsilon_0 A}{d}$

(C) $\frac{5}{3}\frac{\varepsilon_0 A}{d}$ (D) $\frac{4}{5}\frac{\varepsilon_0 A}{d}$

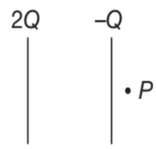
108. In the given figure, the work done by battery after the switch S is closed will be



(A) 100 μJ (B) –100 μJ

(C) 80 μJ (D) –80 μJ

109. In the figure shown the plates of a parallel plate capacitor have unequal charges. Its capacitance is C. P is a point outside the capacitor and close to the plate of charge $-Q$. The distance between the plates is d select incorrect alternative



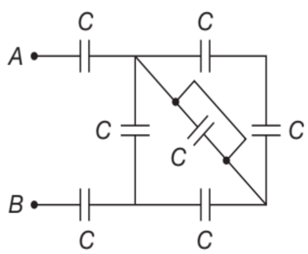
(A) A point charge at point P will experience electric force due to capacitor

(B) The potential difference between the plates will be $\frac{3Q}{2C}$

(C) The energy stored in the electric field in the region between the plates is $\frac{9Q^2}{8C}$

(D) The force on one plate due to the other plate is $\frac{Q^2}{2Cd}$

110. The net capacitance between A and B is



(A) 6C (B) $\frac{2C}{5}$

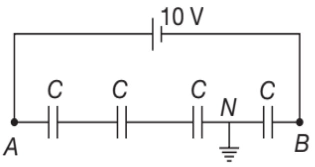
(C) $\frac{2C}{3}$ (D) None of these

111. 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) $\frac{2K}{K+1}V_0$

112. The potential at point A in the circuit is (N point is grounded. Grounding means that potential of that point is zero.)



(A) 10 V (B) 7.5 V

(C) 5 V (D) 2.5 V

113. A parallel plate capacitor has plate area A and separation d and is charged to a potential difference V. The charging battery is then disconnected and the plates are pulled apart until their final separation is $2d$. The work done in this process is

(A) $\frac{\varepsilon_0 AV^2}{2d}$ (B) $\frac{\varepsilon_0 AV^2}{d}$

(C) $\frac{2\varepsilon_0 AV^2}{d}$ (D) $W = 0$

114. A parallel plate capacitor having a plate separation of 2 mm is charged by connecting it to a 300 V supply. The energy density is

(A) 10 Jm^{-3} (B) 1.0 Jm^{-3}

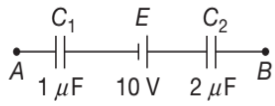
(C) 0.1 Jm^{-3} (D) 0.01 Jm^{-3}

115. An air capacitor of capacity $C = 10\ \mu F$ is connected to a constant voltage battery of 12 V. Now the space between the plates is filled with a liquid of dielectric constant 5. The (additional) charge that flows now from battery to the capacitor is

(A) 120 μC (B) 600 μC

(C) 480 μC (D) 24 μC

116. Potential difference across C_1 and C_2, when $V_A - V_B$ equals 5 V is



(A) 5 V and 10 V (B) 15 V and 15 V

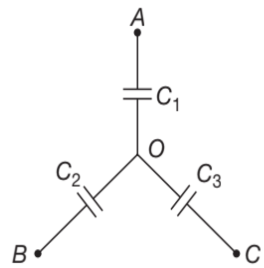
(C) 10 V and 5 V (D) 7.5 V and 7.5 V

117. Two identical capacitors are connected in parallel across a potential difference V. After they are fully charged the battery is removed and the positive of first capacitor is connected to negative of second and negative of first is connected to positive of other. The loss in energy will be

(A) $\frac{1}{2}CV^2$ (B) CV^2

(C) $\frac{CV^2}{4}$ (D) zero

118. Three capacitors of capacitors C_1, C_2, C_3 are connected as shown in the figure. The points A, B and C are at potential V_1, V_2 and V_3 respectively. Then the potential at O will be



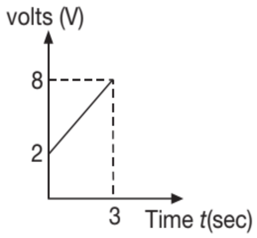
(A) $\frac{V_1+V_2+V_3}{2}$

(B) $\frac{V_1V_2+V_2V_3+V_3V_1}{V_1+V_2+V_3}$

(C) $\frac{V_1C_1+V_2C_2+V_3C_3}{C_1+C_2+C_3}$

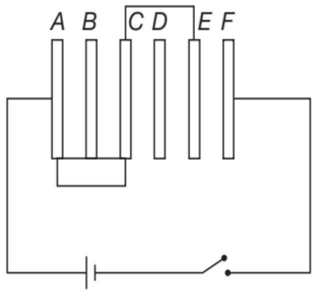
(D) zero

119. A circuit element is placed in a closed box. At time $t = 0$, a constant current generator supplying a current of I amp is connected across the box. Potential difference across the box varies according to graph as shown in the figure. The element in the box is



(A) a resistance of $2\,\Omega$
(B) a battery of emf 6 V
(C) an inductance of 2 H
(D) a capacitance

120. A, B, C, D, E and F are conducting plates each of area A and any two consecutive plates separated by a distance d. The net energy stored in the system after the switch S is closed is



(A) $\frac{3\varepsilon_0 A}{2d}V^2$ (B) $\frac{5\varepsilon_0 A}{12d}V^2$

(C) $\frac{\varepsilon_0 A}{2d}V^2$ (D) $\frac{\varepsilon_0 A}{d}V^2$

121. Two long coaxial cylindrical metal tubes (inner radius a, outer radius b) stand vertically in a tank of dielectric oil (of mass density ρ, dielectric constant K). The inner one is maintained at potential V and the outer one is grounded. The equilibrium height (h) to which the oil rise in the space between the tubes is [Assume this height (h) as a equilibrium height]

(A) $\dfrac{2\varepsilon_0 V^2(K-1)}{\rho g(b^2-a^2)\log_e\left(\frac{b}{a}\right)}$

(B) $\dfrac{\varepsilon_0 V^2(K-1)}{\rho g(b^2-a^2)\log_e\left(\frac{b}{a}\right)}$

(C) $\dfrac{4\varepsilon_0 V^2(K-1)}{g\rho(b^2-a^2)\log_e\left(\frac{b}{a}\right)}$

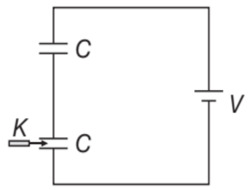
(D) $\dfrac{6\varepsilon_0 V^2(K-1)}{\rho g(b^2-a^2)\log_e\left(\frac{b}{a}\right)}$

122. What fraction of the energy drawn from the charging battery is stored in a capacitor?

(A) 75% (B) 100%

(C) 25% (D) 50%

123. The work done in inserting the dielectric slab inside one of the capacitors as shown in diagram.



(A) $\frac{CV^2}{2}\left(\frac{K-1}{K+1}\right)$ (B) $\frac{CV^2}{4}\left(\frac{K-1}{K+1}\right)$

(C) $\frac{CV^2}{4}\left(\frac{K+1}{K-1}\right)$ (D) $\frac{CV^2}{2}\left(\frac{K+1}{K-1}\right)$

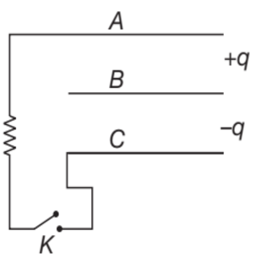
124. The two spherical shells are at large separation one of them has radius 10 cm and has $1.25\,\mu$C charge. The other is of 20 cm radius and has $0.75\,\mu$C charge. If they are connected by a conducting wire of negligible capacity, the charge on the shells are

(A) $1\,\mu$C, $1\,\mu$C (B) $\frac{2}{3}\,\mu$C, $\frac{4}{3}\,\mu$C

(C) $\frac{4}{3}\,\mu$C, $\frac{2}{3}\,\mu$C (D) $0.25\,\mu$C, $0.25\,\mu$C

125. Three identical metal plates of area A are at distance d_1 and d_2 from each other. Metal plate A is uncharged, while plate B and C have respective charges $+q$ and $-q$. If metal plates A and C are connected by switch K through a consumer of unknown resistance, the energy given by the consumer to its surrounding

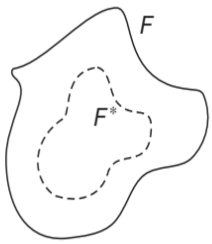
Assume $d_1 = d_2 = d$



(A) $\frac{q^2 d}{4\varepsilon_0 A}$ (B) $\frac{q^2 d}{\varepsilon_0 A}$

(C) $\frac{q^2 d}{2\varepsilon_0 A}$ (D) $\frac{2q^2 d}{\varepsilon_0 A}$

126. A closed body, whose surface F is made of metal foil, has an electrical capacitance C with respect to an uniformly distant point. The foil is now dented in such a way that the new surface F^* is entirely inside or an the original surface as shown in the figure. Then



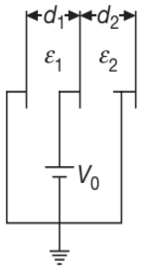
(A) Capacitance of $F^* >$ capacitance of F

(B) Capacitance of $F^* <$ capacitance of F

(C) Capacitance of $F^* =$ capacitance of F

(D) Nothing can be concluded from given

127. A capacitor is composed of three parallel conducting plates. All three plates are of same area A. The first pair of plates are kept a distance d_1 apart and the space between them is filled with a medium of a dielectric ε_1. The corresponding data for the second pair are d_2 and ε_2 respectively. The surface charge density on the middle plate is



(A) $\varepsilon_0 V\left(\frac{\varepsilon_1}{d_1}+\frac{\varepsilon_2}{d_2}\right)$ (B) $-\varepsilon_0 V\left(\frac{\varepsilon_1}{d_1}+\frac{\varepsilon_2}{d_2}\right)$

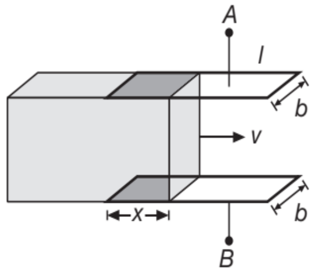
(C) $2\varepsilon_0 V\left(\frac{\varepsilon_1}{d_1}+\frac{\varepsilon_2}{d_2}\right)$ (D) $-2\varepsilon_0 V\left(\frac{\varepsilon_1}{d_1}+\frac{\varepsilon_2}{d_2}\right)$

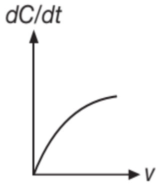
128. A capacitor of capacity C_1 is charged upto potential V volt and then connected in parallel to an uncharged capacitor of capacity C_2. The final potential difference across each capacitor will be

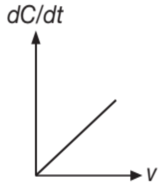
(A) $\frac{C_2 V}{C_1+C_2}$ (B) $\frac{C_1 V}{C_1+C_2}$

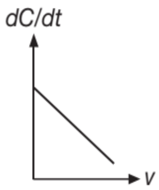
(C) $\left(1+\frac{C_2}{C_1}\right)V$ (D) $\left(1-\frac{C_2}{C_1}\right)V$

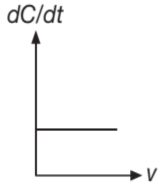
129. Let a dielectric slab be inserted inside the parallel plate capacitor with a speed v. Then the variation of rate of change of capacitance $\frac{dC}{dt}$ with respect to v is



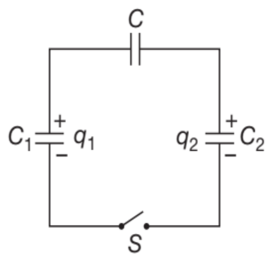
(A) 

(B) 

(C) 

(D) 

130. Two capacitor C_1 and C_2, charged with q_1 and q_2 are connected in series with an uncharged capacitor C, as shown in figure. As the switch S is closed



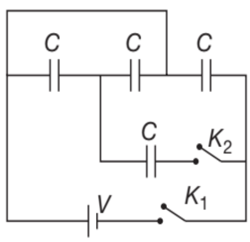
(A) C gets charged in any condition

(B) C gets charged only when $q_1C_2 > q_2C_1$

(C) C gets charged only when $q_1C_2 < q_2C_1$

(D) C gets charged when $q_1C_2 \neq q_2C_1$

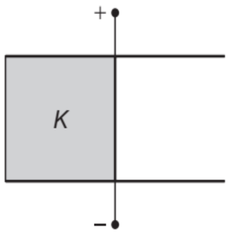
131. Initially K_1 is closed, now if K_2 is also closed, the heat dissipated in the connecting wires is



(A) $\frac{1}{2}CV^2$ (B) $\frac{2}{3}CV^2$

(C) $\frac{1}{3}CV^2$ (D) $\frac{1}{4}CV^2$

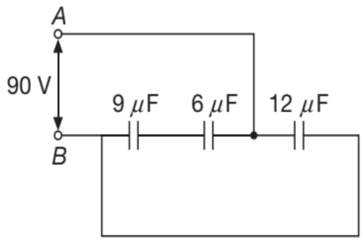
132. Half of the space of a parallel plate capacitor is filled with dielectric as shown. Potential difference V_0 is applied across the plates. The electric field between the plates in the space with dielectric is E_1 and in the space without dielectric is E_2 then



(A) $E_1 = E_2$ (B) $E_1 > E_2$

(C) $E_1 < E_2$ (D) None of these

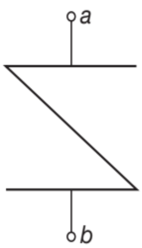
133. The charge on $6\ \mu F$ capacitor is



(A) 540 μC (B) 180 μC

(C) 324 μC (D) 810 μC

134. A thin metallic wire is joined between both the plates of parallel plate capacitor as shown in diagram. The capacitance of the system will be



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

(C) 0 (D) Infinite

135. A capacitor consists of two parallel metal plate of area A separated by a distance d. A dielectric slab of area A, thickness b and dielectric constant k is placed inside the capacitor. If C_K is the capacitance of capacitor with dielectric, how must K and b be selected so that $C_K = 2C$, where C is capacitance without dielectric?

(A) $K = \frac{4b}{2b-d}$ and $\frac{d}{3} < b \le d$

(B) $K = \frac{2b}{2b-d}$ and $\frac{d}{2} < b \le d$

(C) $K = \frac{2b}{2b-d}$ and $\frac{d}{2} \le b \le 2d$

(D) $K = \frac{2b}{2b-d}$ and $\frac{d}{4} \le b \le d$

136. Capacitance 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) $\frac{n}{n-1}$

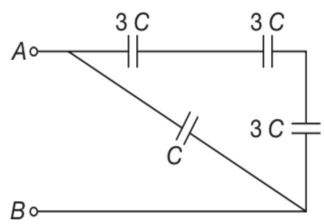
(C) $\frac{2n}{n+1}$ (D) $\frac{2n+1}{n+1}$

137. A capacitor of capacity $C_1 = 1\ \mu F$ can with stand the maximum voltage $V_1 = 16$ KV while another capacitor $C_2 = 2\ \mu F$ can with stand the maximum voltage $V_2 = 4$ KV. The maximum voltage of capacitance connected in series will be

(A) 10 KV (B) 12 KV

(C) 6 KV (D) 4 KV

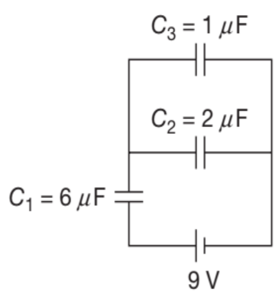
138. The equivalent capacitance between points A and B



(A) C (B) 2C

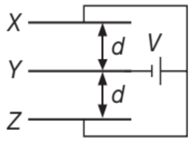
(C) 3C (D) 4C

139. An arrangement of three capacitors is connected to the battery. C_1 and C_2 has fixed capacitances. If C_3 is increased and is made $10\ \mu F$ then



(A) charge on C_1 increases and that on C_2 also increases
(B) charge on C_1 decreases and that on C_2 decreases
(C) charge on C_1 increases but that on C_2 decreases
(D) charge on C_1 decreases but that on C_2 increases

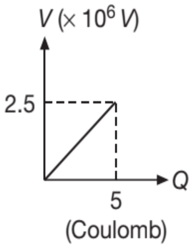
140. Consider an arrangement of three plates X, Y and Z each of area A and separation d. The energy stored, when the plates are fully charged is

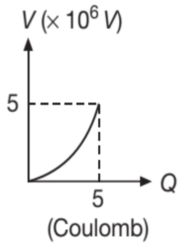


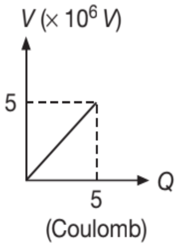
(A) $\frac{\varepsilon_0 AV^2}{2d}$ (B) $\frac{\varepsilon_0 AV^2}{d}$
(C) $\frac{2\varepsilon_0 AV^2}{d}$ (D) $\frac{3\varepsilon_0 AV^2}{d}$

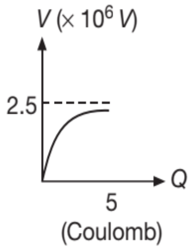
141. From a supply of identical capacitors rated 8 mF, 250 V the minimum number of capacitors required to form a composite 16 mF, 1000 V is
(A) 2 (B) 4
(C) 16 (D) 32

142. A capacitor of $2\ \mu\text{F}$ is charged at a steady rate from zero to 5 coulomb. The graph correctly representing the variation of potential difference across its plates with respect to charge on the condenser is

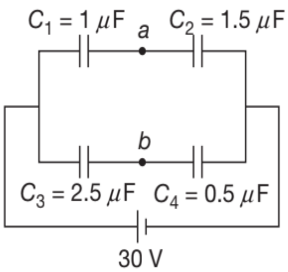
(A)


(B)


(C)


(D)


143. The potential difference between points a and b



(A) 5 V (B) 9 V
(C) −13 V (D) 13 V

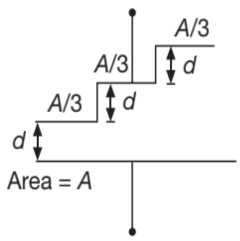
144. Two metallic charged sphere whose radii are 20 cm and 10 cm respectively, each having $150\ \mu\text{C}$ positive charge. The common potential after they are connected by a conducting wire is
(A) 9×10^6 V (B) 4.5×10^6 V
(C) 1.8×10^7 V (D) 13.6×10^6 V

145. A capacitor when filled with a dielectric $K=3$ has charge Q_0, voltage V_0 and Electric field E_0. If the dielectric is replaced with another one having $K=9$, the new value of charge, voltage and field will be respectively
(A) $3Q_0$, $3V_0$, $3E_0$ (B) Q_0, $3V_0$, $3E_0$
(C) Q_0, $\frac{V_0}{3}$, $3E_0$ (D) Q_0, $\frac{V_0}{3}$, $\frac{E_0}{3}$

146. A capacitor with plate separation d is charged to V volts. The battery is disconnected and a dielectric slab of thickness $\frac{d}{2}$ and dielectric constant 2 is inserted between the plates. The potential difference across the terminals becomes
(A) V (B) $2V$
(C) $\frac{4V}{3}$ (D) $\frac{3V}{4}$

147. A parallel plate capacitor C_0 is charged to a potential V_0. The energy stored in the capacitor when the charging battery is kept connected and the plate separation is doubled is U_1. The energy stored in the capacitor when the charging battery is disconnected and the separation between plates is doubled is U_2, then $\frac{U_1}{U_2}$ is
(A) 4 (B) $\frac{1}{4}$
(C) 2 (D) $\frac{1}{2}$

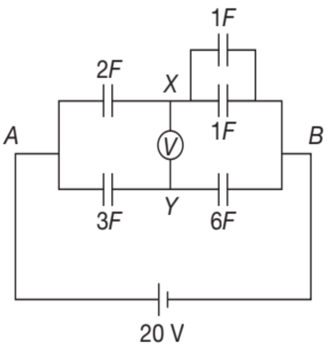
148. A capacitor is made of a flat plate of area A and a second plate having a stair like structure as shown in diagram. The capacitance of the arrangement is



(A) $\frac{\varepsilon_0 A}{d}$ (B) $\frac{18}{11}\frac{\varepsilon_0 A}{d}$

(C) $\frac{11}{18}\frac{\varepsilon_0 A}{d}$ (D) $\frac{\varepsilon_0 A}{3d}$

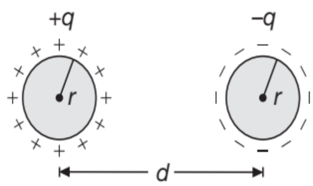
149. Calculate the reading of voltmeter between X and Y then $(V_x - V_y)$ is equal to



(A) 10 V (B) 13.33 V

(C) 3.33 V (D) 10.33 V

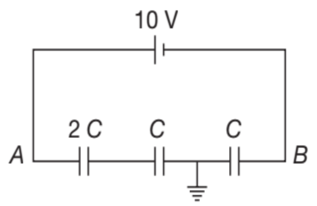
150. Two similar conducting spheres having charge $+q$ and $-q$ are placed at d separation from each other in air. The radius of each ball is r and the separation between their centre is $d(d \gg r)$. The capacitance of the two ball system is



(A) $4\pi\varepsilon_0 r$ (B) $2\pi\varepsilon_0 r$

(C) $4\pi \log_e\left(\frac{\varepsilon_0 r}{d}\right)$ (D) $4\pi \log_e\left(\frac{r}{d}\right)$

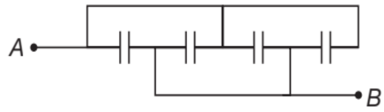
151. Potentials of A and B are respectively



(A) $+6V$, $-4V$ (B) $-6V$, $+4V$

(C) $+10V$, $0V$ (D) $+4V$, $+2V$

152. Four condensers are joined as shown in the adjoining figure. The capacity of each is $8\,\mu$F. The equivalent capacity between the points A and B will be



(A) 32 μF (B) 2 μF

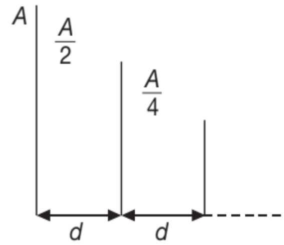
(C) 8 μF (D) 16 μF

153. A capacitor stores $50\,\mu$C charge when connected across a battery. When the gap between the plates is filled with a dielectric, a charge of $100\,\mu$C flows through the battery. The dielectric constant of the material is

(A) 2.5 (B) 2

(C) 4 (D) 3

154. n conducting plates are placed face to face as shown. Distance between any two plates is d. Area of the plates is A, $\frac{A}{2}$, $\frac{A}{4}$ ... $\frac{A}{2^{(n-1)}}$

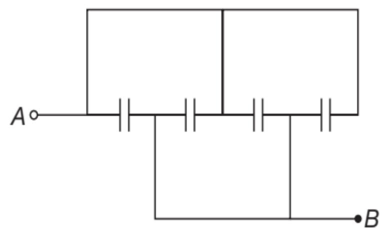


The equivalent capacitance of system is

(A) $\frac{\varepsilon_0 A}{2^n d}$ (B) $\frac{\varepsilon_0 A}{(2^n - 1)d}$

(C) $\frac{\varepsilon_0 A}{(2^n - 2)d}$ (D) $\frac{\varepsilon_0 A}{(2^{n-1} - 1)d}$

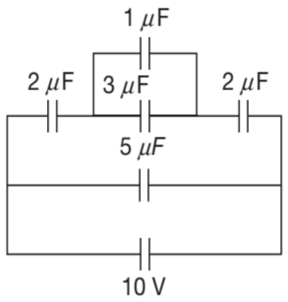
155. Four condensers are joined as shown in fig. The capacity of each is $8\,\mu$F. The equivalent capacity between points A and B will be



(A) 32 μF (B) 2 μF

(C) 8 μF (D) 16 μF

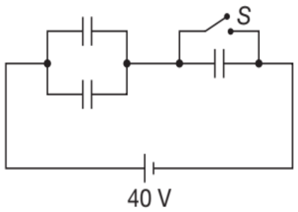
156. The ratio of potential difference between $1\,\mu$F and $5\,\mu$F capacitors is



(A) 1 : 2 (B) 3 : 1

(C) 1 : 5 (D) 10 : 1

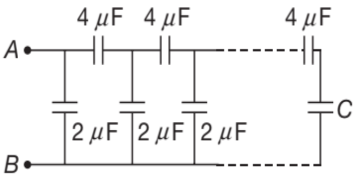
157. Each capacitor in the circuit has capacitance $4\ \mu$F. When the switch S is closed, the charge that flows through AB is



(A) 320 μC (B) 213 μC

(C) 107 μC (D) None of these

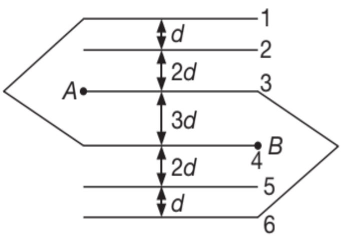
158. A finite ladder is constructed by connecting several sections of $2\ \mu$F, $4\ \mu$F capacitor combinations as shown in the figure. It is terminated by a capacitor of capacitance C. The value of C, such that equivalent capacitance of the ladder between the point A and B becomes independent of the number of sections in between is



(A) 4 μF (B) 2 μF

(C) 18 μF (D) 6 μF

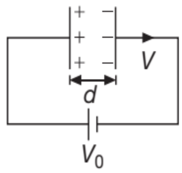
159. Six plates of equal area A and plate separation as shown are arranged equivalent capacitance between A and B is



(A) $\frac{\varepsilon_0 A}{d}$ (B) $\frac{2\varepsilon_0 A}{d}$

(C) $\frac{3\varepsilon_0 A}{d}$ (D) $\frac{\varepsilon_0 A}{4d}$

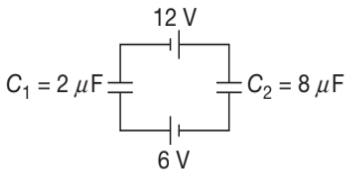
160. A parallel plate capacitor is connected to a battery. The plates are pulled apart with a uniform speed. If x is the separation between the plates, the time rate of change of electrostatic energy of capacitor is proportional to



(A) x^{-2} (B) x

(C) x^{-1} (D) x^2

161. In the circuit shown, the



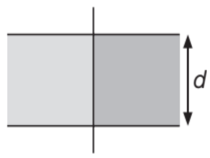
(A) charge on C_2 is greater than C_1

(B) charge on C_1 is greater than C_2

(C) potential difference across C_1 and C_2 are same

(D) potential difference across C_1 is greater than C_2

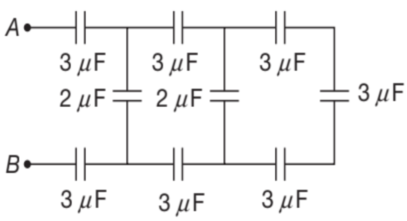
162. A capacitor of capacitance $1\ \mu$F is filled with two dielectrics of dielectric constants 4 and 6. What is the new capacitance?



(A) 10 μF (B) 5 μF

(C) 4 μF (D) None of these

163. The resultant capacitance between (A) and (B) in the following figure is



(A) 1 μF (B) 3 μF

(C) 2 μF (D) 1.5 μF

164. A condenser of capacitance $10\ \mu F$ has been charged to $100\ V$. It is now connected to another uncharged condenser in parallel. The common potential becomes $40\ V$. The capacitance of another condenser is

(A) 15 μF (B) 5 μF

(C) 10 μF (D) 16 μF

165. Two parallel plate capacitors of capacitance C and $3C$ are connected in parallel and charged to a potential difference V with the help of a battery. The battery is disconnected and the space between these two capacitors are filled with dielectric of constant K and $\frac{K}{2}$ respectively. The voltage across the combination will be

(A) $\frac{4V}{3K}$ (B) $\frac{6V}{3K}$

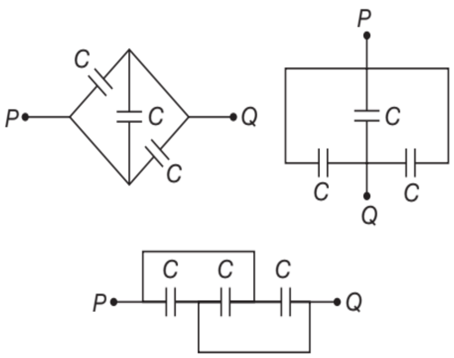
(C) $\frac{8V}{5K}$ (D) $\frac{3V}{5K}$

166. Two insulated metallic spheres of $3\ \mu F$ and $5\ \mu F$ capacitances are charged to $300\ V$ and $50\ V$ respectively. The energy loss, when they are connected by a wire, is

(A) 0.012 J (B) 0.0218 J

(C) 0.0585 J (D) 3.75 J

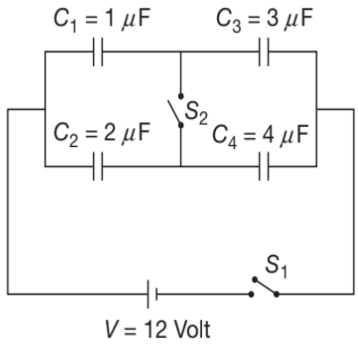
167. The ratio of equivalent capacitances between points P and Q in the following cases is



(A) 1:2:3 (B) 3:2:1

(C) 1:1:1 (D) 1:1:2

168. Initially only S_1 is closed. After a long time S_2 is also closed. The ratio of charge on C_1 when only S_1 is closed to the charge on C_1 when both S_1 and S_2 is closed is



(A) $\frac{1}{2}$ (B) $\frac{14}{15}$

(C) $\frac{15}{14}$ (D) $\frac{2}{1}$

169. Capacitor C_1 of capacitance $1\ \mu F$ and capacitor C_2 of capacitance $2\ \mu F$ are separately charged fully by a common battery. The two capacitors are then separately allowed to discharge through equal resistors at $t = 0$. Then

(A) at $t = 0$, the value of current in the circuit containing $1\ \mu F$ is more than current in the circuit containing $2\ \mu F$

(B) at $t = 0$, the current in $2\ \mu F$ capacitor circuit is more than current in $1\ \mu F$ capacitor circuit

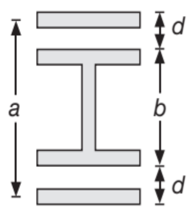
(C) $1\ \mu F$ capacitor losses 50% charge sooner than $2\ \mu F$ capacitor

(D) $2\ \mu F$ capacitor losses 50% charge sooner than $1\ \mu F$ capacitor

170. A number of capacitors each of capacitance $1\ \mu F$ and each one of which get punctured if a potential difference just exceeding 500 volt is applied, are provided. Then an arrangement suitable for giving a capacitor of $2\ \mu F$ 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

171. Two capacitors are joined in series as shown in figure. The area of each plate is A. The equivalent of the combination is

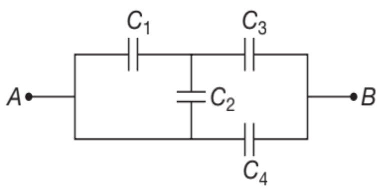


(A) $\dfrac{\varepsilon_0 A}{d_1 - d_2}$ (B) $\dfrac{\varepsilon_0 A}{a - b}$

(C) $\varepsilon_0 A\left(\dfrac{1}{a} - \dfrac{1}{b}\right)$ (D) $\varepsilon_0 A\left(\dfrac{1}{d_1} - \dfrac{1}{d_2}\right)$

172. The charge on capacitor C_2 if a potential difference V is applied between A and B is

(assume $C_1 = C_2 = C_3 = C_4 = C$)



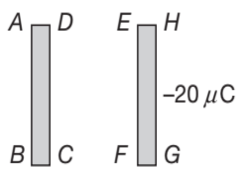
(A) CV (B) $\dfrac{CV}{3}$

(C) $\dfrac{CV}{2}$ (D) $\dfrac{CV}{4}$

173. A parallel plate capacitor is charged to a definite potential and the charging battery is disconnected. Now if the plates of the capacitor are moved apart, then

(A) the stored energy of the capacitor increases
(B) Charge on the capacitor increases
(C) Voltage of the capacitor decreases
(D) The capacitance increases

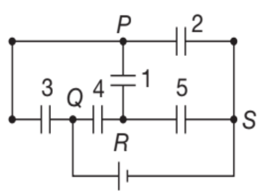
174. A charge $-20\ \mu C$ is given to side GH of the negative plate of the capacitor. The charge on positive plate at CD side is



(A) $+10\ \mu C$ (B) $+20\ \mu C$

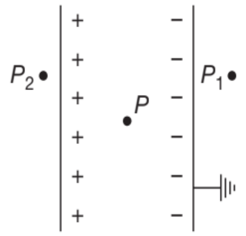
(C) $-10\ \mu C$ (D) None of these

175. The capacitor that will get minimum amount of charge if a battery is connected between Q and S (all capacitors are identical) is



(A) 1 (B) 2
(C) 3 (D) 6

176. There are two metallic plates of a parallel plate capacitor. One plate is given a charge $+q$ while the other is earthed as shown . Points P, P_1 and P_2 are taken as shown in adjoining figure. Then the electric intensity is not zero at



(A) P only (B) P_1 only

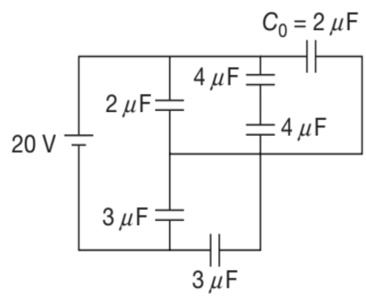
(C) P_2 only (D) P, P_1 and P_2

177. A capacitor of capacitance C_1 is charged to a potential V_0. The electrostatic energy stored in it is U_0. It is connected to another uncharged capacitor of capacitance C_2 in parallel. The energy dissipated in the process is

(A) $\dfrac{C_2}{C_1 + C_2}U_0$ (B) $\dfrac{C_1}{C_1 + C_2}U_0$

(C) $\left(\dfrac{C_1 - C_2}{C_1 + C_2}\right)^2$ (D) $\dfrac{C_1 C_2}{2(C_1 + C_2)}U_0$

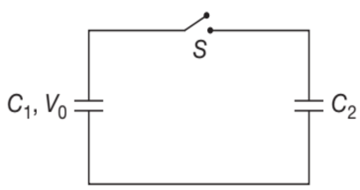
178. Charge on capacitor C_0 is



(A) $10\ \mu C$ (B) $20\ \mu C$

(C) $30\ \mu C$ (D) $0\ \mu C$

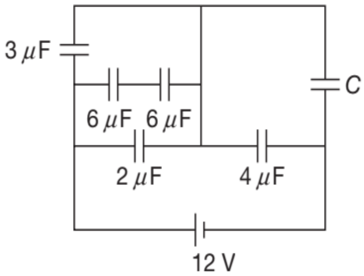
179. A capacitor of capacity C_1 is charged to the potential of V_0. On disconnecting with the battery, it is connected with a capacitor of capacity C_2 as shown in the figure. The ratio of energies before and after the connection of switch S will be



(A) $\frac{(C_1+C_2)}{C_1}$ (B) $\frac{C_1}{(C_1+C_2)}$

(C) C_1C_2 (D) $\frac{C_1}{C_2}$

180. In the given circuit the charge passing through the battery is $48\ \mu C$. The potential difference of capacitor C is



(A) 6 V (B) 8 V

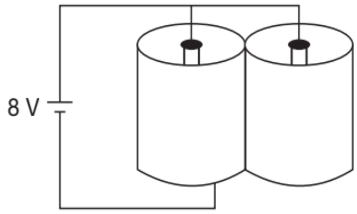
(C) 3 V (D) 4.5 V

181. A parallel plate capacitor is connected to a battery. The plates are pulled apart with a uniform speed. If x is the separation between the plates at any time, then the time rate of change of electrostatic energy of capacitor is proportional to

(A) x^{-2} (B) x

(C) x^{-1} (D) x^2

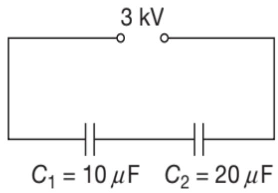
182. The outer cylinders of two cylindrical capacitors of capacitance $2\ \mu F$ each are kept in contact and the inner cylinders are connected through a wire. A battery of emf $8\ V$ is connected. The total charge supplied by battery



(A) $q = 2\ \mu C$ (B) $q = 8\ \mu C$

(C) $q = 16\ \mu C$ (D) $q = 32\ \mu C$

183. Capacitor $C_1(10\ \mu F)$ and $C_2(20\ \mu F)$ are connected in series across a $3\ kV$ supply as shown. The charge on capacitor C_1 is



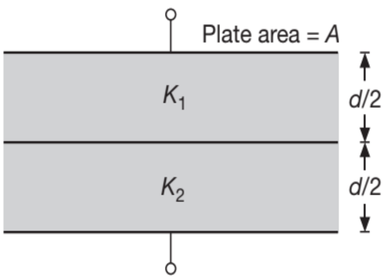
(A) $45000\ \mu C$ (B) $20000\ \mu C$

(C) $15000\ \mu C$ (D) $10000\ \mu C$

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. A parallel plate capacitor is filled with two dielectrics having dielectric constants K_1 and K_2 as shown in the figure. The capacitance of the system is C and that of the two capacitors forming the system is C_1 and C_2. Then we have



(A) $C_1 = \frac{2K_1\varepsilon_0 A}{d}$

(B) $C_2 = \frac{2K_2\varepsilon_0 A}{d}$

(C) C_1 and C_2 are in series

(D) $C = \frac{2\varepsilon_0 A}{d}\left(\frac{K_1K_2}{K_1+K_2}\right)$

2. An air filled parallel plate capacitor having capacitance C_0 is connected to a battery of emf E and then disconnected from it. A dielectric slab having a dielectric constant K, which can just fill the air column in the capacitor, is now inserted in it. Then it is observed that the

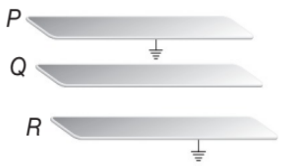
(A) change in energy is $\frac{1}{2}C_0E^2\left(1-\frac{1}{K}\right)$

(B) change in energy is $\frac{1}{2}C_0E^2(K-1)$

(C) energy stored in the capacitor decreases by a factor of K

(D) potential difference between the plates decreases by a factor of K

3. Three large, parallel conducting plates P, Q and R are placed horizontally such that the plates P and R are rigidly fixed and earthed and the plate Q is given some charge. Under the influence of the electrostatic and gravitational forces, the plate Q may stay in equilibrium



(A) midway between P and R
(B) if it is closer to P than to R
(C) if it is closer to R than to P
(D) which is always unstable

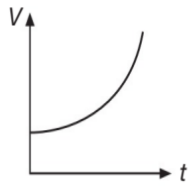
4. Consider a parallel plate capacitor whose negative plate is at $x = 0$ and positive plate is at $x = 4d$. Now a dielectric slab of thickness $2d$ is inserted in the capacitor such that the slab is equidistant from both the plates. The capacitor is given some charge. As x increases from 0 to $4d$, we observe that the
(A) magnitude of the electric field does not change
(B) direction of the electric field does not change
(C) electrostatic potential increases continuously
(D) electrostatic potential first increases, then decreases and then again increases

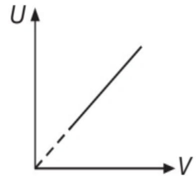
5. A parallel plate capacitor having capacitance C has two plates X and Y each having a charge Q. The plate X is now connected to the positive terminal of a battery and the plate Y to the negative terminal of the same battery of emf $E = \frac{Q}{C}$. Then it is observed that
(A) an energy CE^2 is supplied by the battery
(B) Q amount of charge flows, through the capacitor, from the positive terminal to the negative terminal of the battery
(C) the total charge on the plate X is $2Q$
(D) the total charge on the plate Y is zero

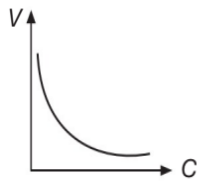
6. Consider a parallel plate capacitor that has been charged from a battery and then disconnected from it. Now the separation between the plates is doubled, then the
(A) external agent has to do some work on the plates
(B) energy stored in the capacitor doubles
(C) potential difference between the plates doubles
(D) field between the plates does not alter

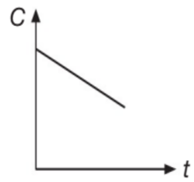
7. A parallel plate capacitor is charged from a cell and then isolated from it. If F be the force of attraction between the plates of the capacitor, E be the electric field in the region between the plates, U be the electrostatic energy stored in the capacitor and ΔV be the potential difference between the plates of the capacitor, then on increasing the separation between the plates we observe that
(A) U increases
(B) F decreases
(C) ΔV decreases
(D) E remains constant

8. A parallel plate capacitor has a dielectric slab that completely fills the empty space of the capacitor. The capacitor is charged by a battery and then battery is disconnected. Now the slab is pull out slowly at $t = 0$. If at time t, capacitance of the capacitor is C, potential difference across is V, and energy stored in it is U, then which of the following graphs are correct?

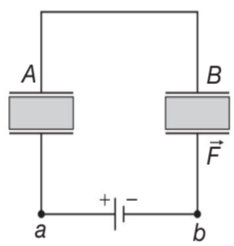
(A)


(B)


(C)


(D)


9. Consider two identical dielectric slabs that are inserted into two identical capacitors A and B connected to the battery as shown in figure. Now the slab of capacitor B is pulled out from it with the battery still remaining connected. Then during the process of removing the dielectric, we observe that the following statement(s) to be correct.



(A) Charge flows from a to b.
(B) Final charge on capacitor B will be less than that on capacitor A.
(C) Work is done by the external force F always appears a significant heat in the circuit.
(D) Internal energy of the battery increases.

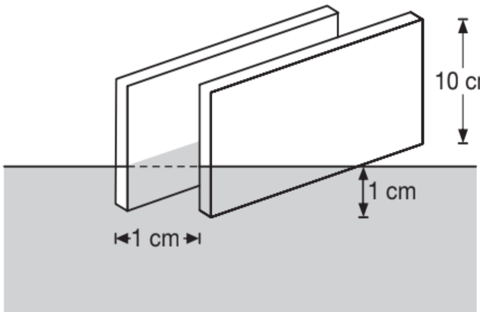
10. A parallel plate capacitor of plate area A and plate separation d is charged to potential difference V and then the battery is disconnected. A slab of dielectric constant K is then inserted between the plates of

the capacitor so as to fill the 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 the slab is inserted), and work done on the system, in questions, in the process of inserting the slab, then

(A) $Q = \frac{\varepsilon_0 AV}{d}$ (B) $Q = \frac{\varepsilon_0 KAV}{d}$

(C) $E = \frac{V}{Kd}$ (D) $W = \frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{K}\right)$

11. A large vessel is filled with water having dielectric constant $K = 81$. Two square plates each of length 10 cm and separated by 1 cm are held parallel to each other with their lower ends just touching the surface of water. The plates are charged by applying a voltage V and then disconnected from the voltage source. The liquid rises by 1 cm between the plates. The capacitor has capacitances C_0 and C without and with water respectively. Then



(A) $C_0 = 8.85\ \mu F$ (B) $C = 0.689$ nF

(C) $V = 1110$ V (D) $C = 80\ \mu F$

12. A conducting sphere of radius R, carrying charge Q, lies inside an uncharged conducting shell of radius $2R$. When joined by a metal wire,

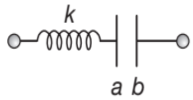
(A) $\frac{Q}{3}$ amount of charge will flow from the sphere to the shell

(B) $\frac{2Q}{3}$ amount of charge will flow from the sphere to the shell

(C) Q amount of charge will flow from the sphere to the shell

(D) $\frac{Q^2}{16\pi\varepsilon_0 R}$ amount of heat will be produced

13. Consider an air filled parallel plate capacitor with one plate connected to a spring having a force constant k and the other plate is held fixed. The system rests on a frictionless table top. The plates have charge density σ and $-\sigma$, area A, charges Q and $-Q$. The electrostatic force due to the electric field created by the plate b is F_e and the spring gets an extension x. Then

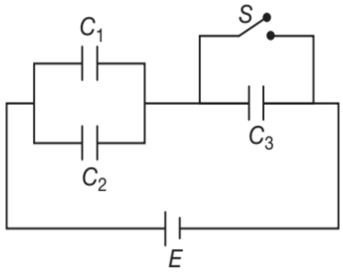


Capacitor connected to a spring

(A) $F_e = \frac{\sigma Q}{2\varepsilon_0}$ (B) $x = \frac{QE}{k}$

(C) $x = \frac{Q^2}{2\varepsilon_0 kA}$ (D) $F_e = \frac{Q^2}{2kA\varepsilon_0}$

14. In an arrangement of capacitors shown $C_1 = C_2 = C_3 = C$. The emf of the battery connected in the circuit is E. When the switch S is closed, then



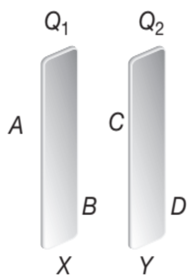
(A) some charge enters the positive terminal of the battery

(B) some charge flows out of the positive terminal of the battery

(C) a charge $\frac{4}{3}CE$ flows through the battery

(D) a charge CE flows through the battery

15. Two large, parallel conducting plates are placed close to each other. The inner surfaces of the two plates have surface charge densities $+\sigma$ and $-\sigma$. The outer surfaces are without charge. The electric field has a magnitude of



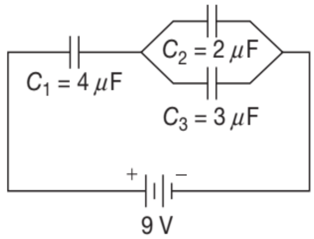
(A) $\frac{\sigma}{\varepsilon_0}$ in the region between the plates.

(B) $\frac{\sigma}{\varepsilon_0}$ in the region outside the plates.

(C) $\dfrac{2\sigma}{\varepsilon_0}$ in the region between the plates.

(D) zero in the region outside the plates.

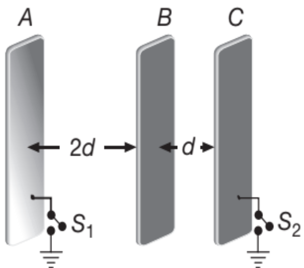
16. In the figure shown, the charges on capacitors C_1, C_2 and C_3 are Q_1, Q_2 and Q_3 respectively. Then



(A) $Q_1 = 20\ \mu C$ (B) $Q_2 = 12\ \mu C$

(C) $Q_2 = 8\ \mu C$ (D) $Q_3 = 12\ \mu C$

17. In the diagram shown, we have three large, identical, parallel conducting plates A, B and C placed such that the switches S_1 and S_2 are open initially and they can be used to earth the plates A and C by just closing them. A charge $+Q$ is given to the plate B. It is observed that a charge of amount



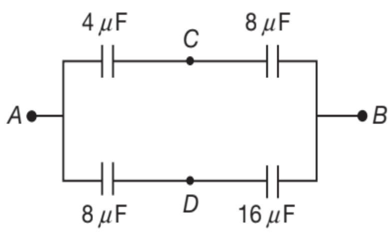
(A) Q will pass through S_1, when S_1 is closed and S_2 is open.

(B) Q will pass through S_2, when S_2 is closed and S_1 is open.

(C) $\dfrac{Q}{3}$ will pass through S_1, $\dfrac{2Q}{3}$ will pass through S_2, when S_1 and S_2 are closed together.

(D) $\dfrac{4Q}{3}$ will pass through S_1, $-\dfrac{Q}{3}$ will pass through S_2, when S_1 and S_2 are closed together.

18. In the circuit shown, some potential difference is applied between A and B. If C is joined to D



(A) no charge will flow between C and D

(B) some charge will flow between C and D

(C) equivalent capacitance between C and D will not change

(D) the equivalent capacitance between C and D will change

19. In a parallel plate capacitor of plate area A, plate separation d and charge q, the force of attraction between the plates is F

(A) $F \propto q^2$ (B) $F \propto d$

(C) $F \propto \dfrac{1}{d}$ (D) $F \propto \dfrac{1}{A}$

20. An air filled parallel plate capacitor has capacitance C_0. Now the air column in the capacitor is completely replaced by a dielectric slab having a dielectric constant K and the capacitor is connected to a battery of emf E and then the slab is taken out. In the process of taking out the dielectric, it is observed that

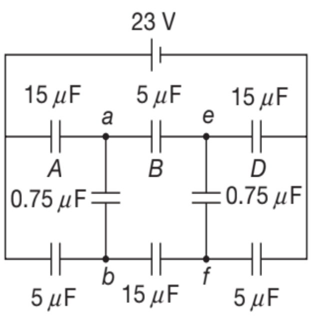
(A) the energy stored in the capacitor reduces by $C_0E^2(K-1)$

(B) a work $\dfrac{1}{2}C_0E^2(K-1)$ has to be done by the external agent to take the slab out

(C) an energy $C_0E^2(K-1)$ is absorbed by the cell

(D) a charge $C_0E(K-1)$ flows through the cell

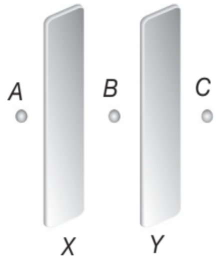
21. In the circuit shown the potential difference between the points ab and ef are V_{ab} and V_{ef} respectively. Then



(A) $V_{ab} = 5$ V (B) $V_{ef} = -5$ V

(C) $V_{ab} = 0$ (D) $V_{ef} = 0$

22. Two large, parallel conducting plates X and Y each having an area A are placed close to each other. The plate X is given a charge Q whereas the plate Y has no charge on it. Three points A, B and C are taken in the different regions of the plates as shown. If $\vec{E}_A$, $\vec{E}_B$ and $\vec{E}_C$ be the respective fields at these points, then



(A) $\left|\vec{E}_B\right| = \dfrac{Q}{\varepsilon_0 A}$ (B) $\left|\vec{E}_B\right| = \dfrac{1}{2}\left(\dfrac{Q}{\varepsilon_0 A}\right)$

(C) $\left|\vec{E}_A\right| = \left|\vec{E}_B\right| = \left|\vec{E}_C\right|$ (D) $\vec{E}_A = -\vec{E}_C$

23. In an attempt to double the separation between the plates of a parallel plate capacitor while it still being connected to a battery, we observe that
(A) the electric field in the region between the plates becomes half
(B) some energy is absorbed by the battery
(C) the external agent has to do some work on the plates
(D) the charge on the capacitor becomes half

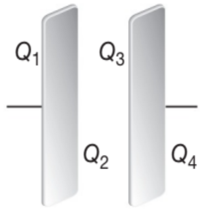
24. Consider a situation where a charge of amount Q is given to an isolated metal plate X of surface area A such that its surface charge density becomes σ_1. Now an isolated identical plate Y is brought close to X such that the surface charge density on X becomes σ_2. When the plate Y is earthed, the new surface charge density becomes σ_3, then which of the following relations seem to be the most appropriate and correct?

(A) $\sigma_1 = \dfrac{Q}{A}$ (B) $\sigma_2 = \sigma_1$

(C) $\sigma_1 = \dfrac{1}{2}\left(\dfrac{Q}{A}\right)$ (D) $\sigma_3 = \dfrac{Q}{A}$

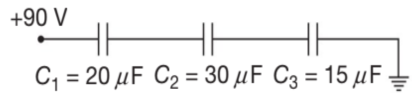
25. Consider a capacitor C that is charged by a battery of emf V to a potential V. The capacitor is then disconnected from the battery and then connected again with it but now with its polarity reversed. Then the
(A) work done by the battery is CV^2
(B) total charge that passes through battery is $2CV$
(C) initial and final energy of the capacitor is same
(D) work done is by the battery is $2CV^2$

26. Consider an isolated parallel plate capacitor having capacitance C. The four surfaces of the capacitor have charges Q_1, Q_2, Q_3 and Q_4, as shown. If ΔV is the potential difference between the plates then



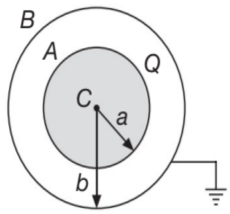
(A) $|Q_2| = C\Delta V$
(B) $Q_1 + Q_2 = C\Delta V$
(C) $(Q_1 + Q_4) + (Q_2 - Q_3) = C\Delta V$
(D) $|Q_3| = C\Delta V$

27. In the arrangement of the capacitors shown, select the correct options



(A) Total charge in this series combination is $600\ \mu$C
(B) The 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 of C_3 is 40 V

28. Consider a conducting sphere A having radius a, charge Q placed concentrically inside a conducting shell B having radius $b(>a)$ and earthed. Let C is the common centre of the sphere A and the shell B. If E and V be the respective electrostatic field and potential at a distance r $(a \le r \le b)$ from C and ΔV be the electrostatic potential difference between the two shells, then



(A) $E = 0$ (B) $E = \dfrac{1}{4\pi\varepsilon_0}\left(\dfrac{Q}{r^2}\right)$

(C) $\Delta V = \dfrac{Q}{4\pi\varepsilon_0}\left(\dfrac{1}{a} - \dfrac{1}{b}\right)$ (D) $V = \dfrac{Q}{4\pi\varepsilon_0}\left(\dfrac{1}{r} - \dfrac{1}{b}\right)$

29. Consider two large parallel conducting plates placed close to each other. It is observed that the inner surfaces of the two plates have surface charge densities $+\sigma$ and $-\sigma$ whereas the outer surfaces possess no charge. If $\vec{E}$ be the electric field between the plates of the capacitor then in the region

(A) between the plates, $|\vec{E}| = \dfrac{\sigma}{\varepsilon_0}$

(B) between the plates, $|\vec{E}| = \dfrac{2\sigma}{\varepsilon_0}$

(C) outside the plates, $|\vec{E}| = 0$

(D) outside the plates, $|\vec{E}| = \dfrac{\sigma}{\varepsilon_0}$

30. Two identical sheets of a metallic foil are separated by d and capacitance of the system is C_0 and charged to a potential difference V_0. Keeping the charge constant, the separation is increased by l. Then the new capacitance and potential difference are C and V respectively. Then

(A) $C = \dfrac{C_0}{\left(1+\dfrac{l}{d}\right)}$ (B) $C = C_0\left(1+\dfrac{l}{d}\right)$

(C) $V = V_0\left(1+\dfrac{l}{d}\right)$ (D) $V = \dfrac{V_0}{\left(1+\dfrac{l}{d}\right)}$

31. Two capacitors, $C_1 = 2\,\mu F$ and $C_2 = 8\,\mu F$ are connected in series across a 300 V source. Then

(A) the charge on each capacitor is 4.8×10^{-4} C

(B) the potential difference across C_1 is 60 V

(C) the potential difference across C_2 is 240 V

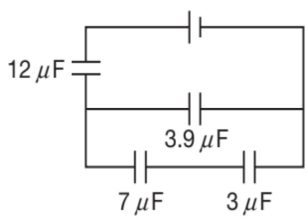
(D) the energy stored in the system is 7.2×10^{-2} J

32. A parallel plate capacitor is connected to a battery. The quantities charge, voltage, electric field and energy associated with this capacitor are given by Q_0, V_0, E_0 and U_0 respectively. A dielectric slab is now introduced to fill the space between the plates with the battery still in connection. The corresponding quantities now given by Q, V, E and U are related to the previous ones as

(A) $Q > Q_0$ (B) $V > V_0$

(C) $E > E_0$ (D) $U > U_0$

33. In the given circuit, the potential difference across the 7 μF capacitor is 6 V. Then



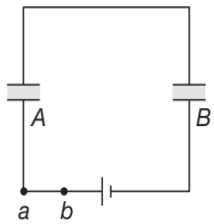
(A) the potential difference across the 12 μF capacitor is 10 V

(B) the potential difference across the 3.9 μF capacitor is 10 V

(C) the charge on the 3 μF capacitor is 42 μC

(D) the emf of the battery is 30 V

34. Identical dielectric slabs are inserted into two identical capacitors A and B. These capacitors and are connected as shown in figure. Now the slab of capacitor B is pulled out with battery remaining connected. Select the correct statement(s).



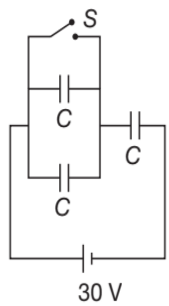
(A) During this process the charge flows from a to b.

(B) Final charge on capacitor B will be less than on capacitor A.

(C) During this process, work is done by external force F which appears as heat in the circuit.

(D) During this process, the battery receives energy.

35. Three capacitors each having capacitance $C = 2\,\mu F$ are connected with a battery of emf 30 V as shown in figure. Select the correct statement(s), when the switch S is closed.



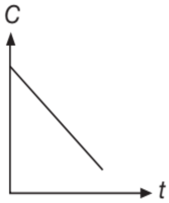
(A) The amount of charge flown through the battery is 20 μC

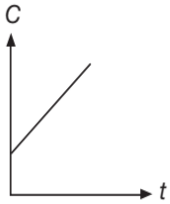
(B) The heat generated in the circuit is 0.6 mJ

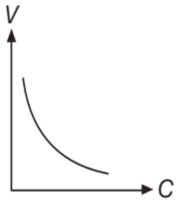
(C) The energy supplied by the battery is 0.6 mJ

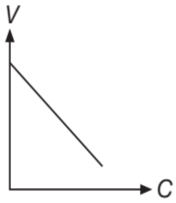
(D) The amount of charge flown through the switch S is 60 μC

36. A parallel plate capacitor has a dielectric slab in it. The slab just fills the space inside the capacitor. The capacitor is charged by a battery and then battery is disconnected. Now the slab is started to pull out slowly at $t = 0$. If at time t, the capacitance of the capacitor is C and potential difference between the plates of a capacitor is V then which of the following graphs is/are correct

(A) 

(B) 

(C) 

(D) 

37. A parallel plate air capacitor is connected to a battery. If plates of the capacitor are pulled further apart, then which of the following statement(s) is/are correct?

(A) Strength of electric field inside the capacitor remain unchanged, if battery is disconnected before pulling the plate.

(B) During the process, work is done by an external force applied to pull the plates whether battery is disconnected or it remain connected.

(C) Potential energy in the capacitor decreases if the battery remains connected during pulling plates apart.

(D) None of the above

38. A $2\,\mu$F capacitor is charged to a potential of 15 V and a $3\,\mu$F is charged to a potential of 10 V and the capacitors are connected such that positive plate of one is connected to the negative plate of the other capacitor and negative plate of one is connected to the positive plate of the other capacitor. Select the correct statement(s) about the final circuit.

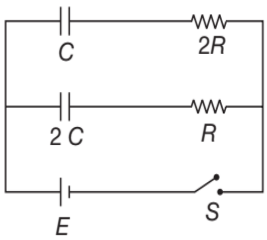
(A) Final charge on each capacitor is zero

(B) Final total electrical energy of the capacitor will be non zero

(C) Total charge flown from A to D is 30 μC

(D) Total charge flown from A to D is –30 μC

39. In the circuit shown in the figure, switch S is closed at time $t = 0$. Select the correct statements



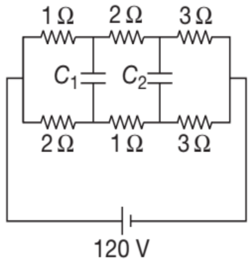
(A) Rate of increase of charge is same in both the capacitors

(B) Ratio of charge stored in capacitors C and $2C$ at any time t would be $1:2$

(C) Time constants of both the capacitors are equal

(D) Steady state charge in capacitors C and $2C$ are in the ratio of $1:2$

40. In the circuit shown in figure, $C_1 = C_2 = 2\,\mu$F. In steady state, the charge stored in



(A) capacitor C_1 is zero

(B) capacitor C_2 is zero

(C) both capacitors is zero

(D) capacitor C_1 is 40 μC

41. The two plates x and y of a parallel plate capacitor of capacitance C are given a charge of amount Q each. x is now joined to the positive terminal and y to the negative terminal of a cell of emf $V = \frac{Q}{C}$, then select the correct statements.

(A) A charge of amount Q will flow from the positive terminal to the negative terminal of the cell 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 energy supplied by the cell is CV^2

42. The plates of a parallel plate capacitor with no dielectric are connected to a voltage source. Now a dielectric of dielectric constant K is inserted to fill the whole space between the plates with voltage source remaining connected to the capacitor. Select the correct statement(s).

(A) The energy stored in the capacitor will become K-times the initial energy.

(B) The electric field inside the capacitor will decrease K-times the initial field.

(C) The force of attraction between the plates will become K^2-times the initial force.

(D) The charge on the capacitor will become K-times the initial charge.

REASONING BASED QUESTIONS

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.
Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.
Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.
Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. **Statement-1:** A spherical conductor charged upto 50 V is placed at the centre of a conducting shell which is charged upto 100 V and connected by a wire. All the charge of the shell flows to the sphere.

   Statement-2: The positive charge always flows from higher to lower potential.

2. **Statement-1:** A single isolated conductor is always equivalent to a capacitor.

   Statement-2: The second plate of an isolated conductor can be assumed at infinity.

3. **Statement-1:** The two adjacent conductors carrying same charge can be at different potentials.

   Statement-2: The potential of a conductor depends on the charge on it, shape and size of its the surrounding charged bodies and the relative separation between them.

4. **Statement-1:** A parallel plate capacitor is charged using a battery and then a dielectric slab is inserted completely filling space between plates without disconnecting battery. Electric field between plates of capacitor will decrease.

   Statement-2: When the battery remains connected, then charge on plates of capacitor increases.

5. **Statement-1:** If two concentric conducting sphere which are connected by a conducting wire. No charge can exist on inner sphere.

   Statement-2: When charge on outer sphere will exist then potential of inner shell and outer shell will be same

6. **Statement-1:** Two concentric spherical shell of different radius are at potential V_A and V_B. If outer shell is earthed then potential difference will not be changed.

   Statement-2: Potential difference between the surfaces of two concentric spherical shells does not depends on the charge on the outer shell.

7. **Statement-1:** If three capacitors of capacitance $C_1 < C_2 < C_3$ are connected in parallel then their equivalent capacitance $C_{\text{parallel}} > C_{\text{series}}$

   Statement-2: $\dfrac{1}{C_{\text{parallel}}} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$

8. **Statement-1:** A charged capacitor is disconnected from a battery. Now if its plates are separated further, the potential energy will fall.

   Statement-2: Energy stored in a capacitor is equal to the work done in charging it.

9. **Statement-1:** There cannot be a potential difference between two adjacent conductors that carry the same amount of positive charge.

   Statement-2: Potential of a conductor can be found by $\left(\dfrac{Q}{C}\right)$ ratio and capacitance C depends on the geometrical parameters like size, area etc.

10. **Statement-1:** When a capacitor is charged by a battery, both the plates receive charges of equal magnitude, irrespective of their sizes.

    Statement-2: The charge distribution on the plates of capacitor is in accordance with charge conservation principle.

11. **Statement-1:** The capacitance of any capacitor is always constant for any charge.

    Statement-2: If the charge on a capacitor increases, its capacitance increases as $C = \dfrac{Q}{V}$.

12. **Statement-1:** A parallel plate capacitor is connected across battery through a key. A dielectric slab of constant K is introduced between the plates. The energy which is stored becomes K times.

    Statement-2: The surface density of charge on the plate remains constant.

13. **Statement-1:** When one plate of a charge parallel plate capacitor is connected to the earth, its capacitance increases.

    Statement-2: Electric potential difference between the plates always decreases.

14. **Statement-1:** If the distance between parallel plates of a capacitor is halved and dielectric constant is made three times, then the capacitance becomes 6 times.

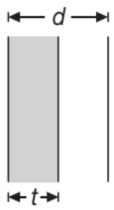
    Statement-2: Capacitance does not depend upon the nature of material of the capacitor plates.

LINKED COMPREHENSION TYPE QUESTIONS

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct. (For the sake of competitiveness there may be a few questions that may have more than one correct options)

Comprehension I

A parallel plate capacitor having capacitance C_0 consists of two metal plates of area A and separation d. A slab of thickness $t(<d)$ is inserted between the plates with its faces parallel to the plates and having the same surface area as that of plates as shown.



Based on the above facts, answer the following questions.

1. The capacitance of the system for the slab to be dielectric having dielectric constant 2 and $d = \frac{t}{3}$ is

(A) $\frac{3}{2}C_0$ (B) $\frac{3}{4}C_0$

(C) $\frac{5}{6}C_0$ (D) $\frac{6}{5}C_0$

2. The ratio $\frac{t}{d}$ for which the capacitance of system will be $\left(\frac{3}{2}\right)$ times that of the conductor with air filling the full space is

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

(C) 1 (D) $\frac{1}{3}$

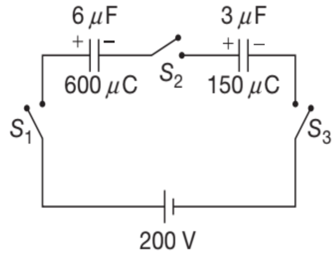
3. The ratio of energy in two cases mentioned in PROBLEM 2, is

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

(C) $\frac{1}{3}$ (D) $\frac{1}{2}$

Comprehension 2

Two capacitors of capacity $6\ \mu F$ and $3\ \mu F$ are charged to 100 V and 50 V separately and are then connected as shown. Now all the three switches S_1, S_2 and S_3 are closed.



Based on the above facts, answer the following questions.

4. It is observed that an isolated system is formed by plate(s)

(A) a and d separately (B) b and c separately

(C) a and d jointly (D) b and c jointly

5. In steady state, the charge on $6\ \mu F$ and $3\ \mu F$ capacitor respectively is

(A) $400\ \mu C$, $400\ \mu C$ (B) $700\ \mu C$, $250\ \mu C$

(C) $800\ \mu C$, $350\ \mu C$ (D) $300\ \mu C$, $450\ \mu C$

6. Suppose Q_1, Q_2 and Q_3 be the magnitudes of charges that flows from switches S_1, S_2 and S_3 after they are closed. Then

(A) $Q_1 = Q_3$ and $Q_2 = 0$

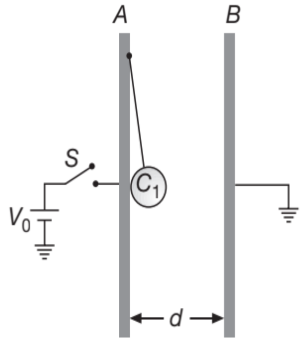
(B) $Q_1 = Q_3 = \frac{Q_2}{2}$

(C) $Q_1 = Q_3 = 3Q_2$

(D) $Q_1 = Q_2 = Q_3$

Comprehension 3

In the given set up the parallel plate capacitor AB has vertical plates with plate separation 50 mm and capacitance C_0. From the plate A a small conducting ball of mass m, capacitance C hangs from a non-conducting silk thread of length 100 mm. The ball initially touches the plate A which is connected to a power supply of voltage V_0 for a short time by closing the switch S and then opening it again. The plate B is grounded. The motion of conducting ball is now observed. It is observed that due to the charge deposited on plates and ball, the ball swings across, touches the plate B, returns, touches A and finally swings out again such that it almost touches plate B. Taking $g = 10\ \text{ms}^{-1}$ and based on the above facts, answer the following questions.



7. The angle made by ball and string with the plate A when the ball is in its final position is

(A) 30° (B) 45°
(C) 60° (D) 0°

8. The ball initially touches plate B, it loses its charge to B, swings back and touches A and then finally again swings out and almost touches plate B. The new common potential V is given by

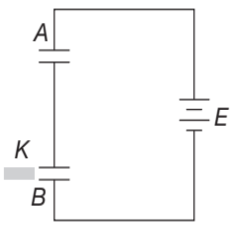
(A) $\dfrac{CV_0}{C+C_0}$ (B) $\dfrac{C_0V_0}{C+C_0}$
(C) V_0 (D) $\left(1+\dfrac{C}{C_0}\right)V_0$

9. The required power supply voltage V_0 is given by

(A) $\left(1+\dfrac{C}{C_0}\right)\sqrt{\dfrac{m}{\sqrt{3}C}}$ (B) $\left(1+\dfrac{C_0}{C}\right)\sqrt{\dfrac{m}{2\sqrt{3}C}}$
(C) $\left(1+\dfrac{C}{C_0}\right)\sqrt{\dfrac{m}{2\sqrt{3}C}}$ (D) $\left(1+\dfrac{C_0}{C}\right)\sqrt{\dfrac{5m}{\sqrt{3}C}}$

Comprehension 4

Two identical capacitors A and B, each of capacitance C are connected in series. The combination is connected to a battery of emf E. A dielectric slab of dielectric constant K is slipped between the plates of capacitor B to cover entire space between the plates.



Based on these facts, answer the following questions.

10. After introduction of dielectric slab in B, the ratio of capacitance of A and B is

(A) $1:1$ (B) $1:K$
(C) $K:1$ (D) $1:\sqrt{K}$

11. After introduction of dielectric slab in B, the ratio of potential differences across A and B will be

(A) $1:1$ (B) $1:K$
(C) $K:1$ (D) $1:\sqrt{K}$

12. The ratio of potential differences across A before and after the introduction of dielectric slab in B will be

(A) $1:1$ (B) $1:K$
(C) $(K+1):2$ (D) $(K+1):2K$

13. The ratio of potential differences across B before and after the introduction of dielectric slab in B will be

(A) $1:1$ (B) $K:1$
(C) $(K+1):2$ (D) $(K+1):2K$

14. The ratio of energy stored in capacitors A and B after the introduction of dielectric slab in B is

(A) $1:1$ (B) $1:K$
(C) $K:1$ (D) $(K+1)^2:K^2$

Comprehension 5

Two spherical conductors A and B have capacitance $2\ \mu$F and $3\ \mu$F. A is given a charge Q and allowed to share with B by means of a conducting wire. Based on these facts, answer the following questions.

15. The ratio of radii of spheres A and B is

(A) $2:3$ (B) $3:2$
(C) $4:9$ (D) $9:4$

16. The charge on A after sharing is

(A) $\dfrac{Q}{5}$ (B) $\dfrac{4Q}{5}$
(C) $\dfrac{2Q}{5}$ (D) $\dfrac{3Q}{5}$

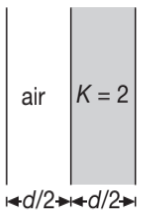
17. The ratio of electrostatic energies of A before and after sharing is

(A) $\dfrac{2}{5}$ (B) $\dfrac{3}{5}$
(C) $\dfrac{4}{25}$ (D) $\dfrac{9}{25}$

18. The ratio of final electrostatic energy of system to initial electrostatic energy of system is
    (A) 1:1 (B) 2:5
    (C) 3:5 (D) 2:3

Comprehension 6

Two metal plates form a parallel plate capacitor. The separation between the plates is d. Now half of the separation between the plates is filled with a dielectric of relative permittivity 2 and of same area.



The new arrangement gets punctured when a potential difference just exceeding 1200 V is applied. Based on these facts, answer the following questions.

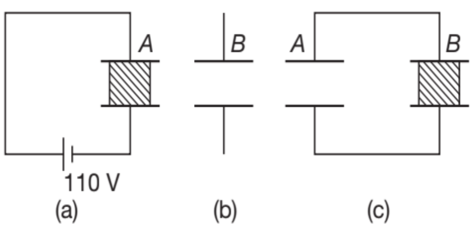
19. The ratio of capacitance before and after insertion of dielectric is
    (A) 1:2 (B) 2:1
    (C) 3:4 (D) 4:3

20. The maximum potential difference that can exist across the dielectric is
    (A) 300 V (B) 400 V
    (C) 600 V (D) 800 V

21. The ratio of electrostatic energy stored by air and dielectric parts of capacitor is
    (A) 1:2 (B) 2:1
    (C) 3:4 (D) 4:3

Comprehension 7

Two parallel plate capacitors A and B have the same separation $d = 8.85 \times 10^{-4}$ m between the plates. The plate areas of A and B are 0.04 m^2 and 0.02 m^2 respectively. A slab of dielectric constant (relative permittivity) $K = 9$ has dimensions such that it can exactly fill the space between the plates of capacitor B.



The dielectric slab is placed inside A as shown in Figure (a). A is then charged to a potential difference of 110 V. The capacitance of A is C_A and the energy stored in it is U_A.

The battery is disconnected and then the dielectric slab is removed from A. The work done by the external agency in removing the slab from A is W.

The same dielectric slab is now placed inside B, filling it completely. The two capacitors A and B are then connected as shown in Figure (c). The energy stored in the system is U. Based on the above facts, answer the following questions.

22. The value of C_A is
    (A) 0.18 nF (B) 2 nF
    (C) 3 nF (D) 1 nF

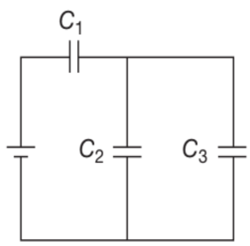
23. The value of U_A approximately is
    (A) 10 μJ (B) 11 μJ
    (C) 12 μJ (D) 13 μJ

24. The value of W is
    (A) 48.4 μJ (B) 38.4 μJ
    (C) 28.4 μJ (D) 18.4 μJ

25. The value of U is
    (A) 10 μJ (B) 11 μJ
    (C) 12 μJ (D) 13 μJ

Comprehension 8

Three capacitors are connected to a battery of voltage V as shown in Figure. Their capacitances are $C_1 = 3C$, $C_2 = C$ and $C_3 = 5C$. Based on the information and the diagram provided, answer the following questions.



26. The equivalent capacitance of this set of capacitors is
    (A) 4C (B) $\frac{23C}{6}$
    (C) 2C (D) None of these

27. The ordering of the capacitors according to the charge they store, from largest to smallest is

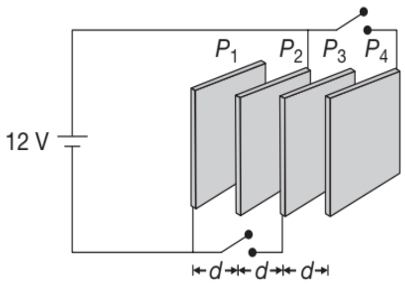
(A) $C_1 > C_2 > C_3$ (B) $C_3 > C_2 > C_1$
(C) $C_3 > C_1 > C_2$ (D) $C_2 > C_1 = C_3$

28. Rank the capacitors according to the potential difference across them, from largest to smallest.
(A) $C_1 > C_2 > C_3$ (B) $C_1 < C_2 = C_3$
(C) $C_1 > C_2 = C_3$ (D) $C_1 < C_2 < C_3$

29. Now if, C_3 is increased then the charge on
(A) C_1 and C_2 increase, C_3 decreases
(B) C_1 and C_3 increase, C_2 decreases
(C) C_1 and C_2 decrease, C_3 increases
(D) C_1 and C_3 decrease, C_2 increases

Comprehension 9

Four parallel metal plates P_1, P_2, P_3 and P_4, each of area 7.5 cm^2 are separated successively by a distance $d = 1.19$ mm as shown in Figure. P_1 is connected to the negative terminal of a battery and P_2 to the positive terminal. The battery maintains a potential difference of 12 V. Based on the information and the diagram provided, answer the following questions.



30. If P_3 is connected to the negative terminal, the capacitance of the three-plate system $P_1P_2P_3$ is
(A) 12.1 pF (B) 11.2 pF
(C) 5.58 pF (D) 16.7 pF

31. The charge on P_2, in pC is
(A) 34 (B) 67
(C) 134 (D) None of these

32. P_4 is now connected to the positive terminal of the battery. The capacitance of the four plate system $P_1P_2P_3P_4$ is
(A) 12.1 pF (B) 11.2 pF
(C) 5.58 pF (D) 16.7 pF

33. The charge on P_4, in pC is
(A) 34 (B) 67
(C) 134 (D) 268

Comprehension 10

Given here are four SITUATIONS. Read them carefully to answer the questions that follow.

Situation 1: A $1\,\mu$F capacitor and a $2\,\mu$F capacitor are connected in series across a 300 V supply line. The charge on each capacitor is found to be Q_1 and Q_2 and potential across each is V_1 and V_2.

Situation 2: The charged capacitors are now disconnected from the line and reconnected with their positive plates together and the negative plates together, with no external voltage being applied. The respective charges and potentials across capacitors are found to be Q_1', Q_2' and V_1', V_2'.

Situation 3: Again the system is reset to the initial conditions and the charged capacitors are disconnected from the line and reconnected with plates of opposite polarity connected together, with no external voltage being applied. The respective charges and potentials across capacitors are found to be Q_1'', Q_2'' and V_1'' and V_2''.

Situation 4: The charged capacitors in situation 2 are disconnected and reconnected with the plates of opposite polarity together. The respective charges and potentials across the capacitors are found to be Q_1''', Q_2''' and V_1''', V_2'''.

Based on the Situations discussed above, answer the following questions.

34. The (Q, V) values in μC and volt respectively for SITUATION 1 are
(A) $Q_1 = Q_2 = 200$; $V_1 = V_2 = 100$
(B) $Q_1 = Q_2 = 100$; $V_1 = 100$; $V_2 = 200$
(C) $Q_1 = 100$; $Q_2 = 200$; $V_1 = V_2 = 100$
(D) $Q_1 = Q_2 = 200$; $V_1 = 200$; $V_2 = 100$

35. The (Q, V) values in μC and volt respectively for SITUATION 2 are
(A) $V_1' = V_2' = 200$; $Q_1 = Q_2 = 200$
(B) $V_1' = V_2' = \frac{200}{3}$; $Q_1' = Q_2' = \frac{400}{3}$
(C) $V_1' = V_2' = \frac{400}{3}$; $Q_1' = \frac{400}{3}$; $Q_2' = \frac{800}{3}$
(D) $V_1' = \frac{200}{3}$; $V_2' = \frac{400}{3}$; $Q_1' = \frac{400}{3}$. $Q_2' = \frac{800}{3}$

36. The (Q, V) values in μC and volt respectively for SITUATION 3 are

(A) $V_1'' = V_2'' = 0$; $Q_1'' = Q_2'' = 0$

(B) $V_1'' \neq V_2'' = 0$; $Q_1'' = Q_2'' \neq 0$

(C) $V_1'' = V_2'' \neq 0$; $Q_1'' \neq Q_2'' = 0$

(D) $(V_1'' = V_2'') \neq 0$; $(Q_1'' = Q_2'') \neq 0$

37. The (Q, V) values in μC and volt respectively for SITUATION 4 are

(A) $V_1'' = V_2'' = \frac{200}{9}$; $Q_1''' = Q_2''' = \frac{800}{9}$

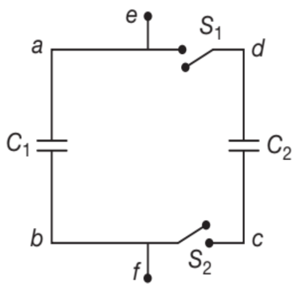
(B) $V_1''' = V_2''' = \frac{400}{9}$; $Q_1''' = \frac{400}{9}$; $Q_2''' = \frac{800}{9}$

(C) $V_1''' = \frac{400}{9}$; $V_2''' = \frac{800}{9}$; $Q_1''' = Q_2''' = \frac{400}{9}$

(D) $V_1''' = \frac{200}{9}$; $V_2''' = \frac{400}{9}$; $Q_1''' = \frac{200}{9}$; $Q_2''' = \frac{400}{9}$

Comprehension 11

Two capacitors $C_1 = 1\ \mu$F and $C_2 = 3\ \mu$F are each charged to a potential $V_0 = 100$ V but with opposite polarity, as shown. Switches S_1 and S_2 are now closed. Based on the above facts, answer the following questions.



38. What is the potential difference between points $'e'$ and $'f'$?

(A) 25 V (B) 50 V
(C) 75 V (D) 100 V

39. What is the final charge on C_1?

(A) 50 μC (B) 75 μC
(C) 150 μC (D) 300 μC

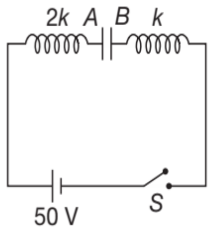
40. What is the charge on C_2?

(A) 50 μC (B) 75 μC
(C) 150 μC (D) 300 μC

41. Energy lost by the system of capacitors, after the switches are closed is

(A) 20 mJ (B) 5 mJ
(C) 15 mJ (D) 10 mJ

Comprehension 12



In the given circuit, two identical parallel conducting plates A and B are connected to a 50 V battery by metal springs of spring constants $2k$ and k respectively. Initially, the switch S is open and the plates are uncharged. In fact, the two plates A and B form a capacitor. When the switch S is closed, the separation between the plates becomes 2 mm and this is one fourth of the initial separation between plates. Also the electrostatic energy stored in the capacitor is found to be 10 mJ. Based on the information provided, answer the following questions.

42. Initially, when the plates were uncharged capacitance of the capacitor was

(A) 0.5 μF (B) 1 μF
(C) 2 μF (D) 4 μF

43. Extension in the spring connected to plate B is

(A) 3 mm (B) 4 mm
(C) 5 mm (D) 6 mm

44. Spring constant of the spring connected to plate A is

(A) 625 Nm^{-1} (B) 1250 Nm^{-1}
(C) 2500 Nm^{-1} (D) 5000 Nm^{-1}

Comprehension 13

Inside a parallel plate capacitor, there is a dielectric slab parallel to the outer plates whose thickness is equal to 70% of the gap width. The dielectric constant of material of the slab is 7. When the slab is absent, the capacitance of the capacitor equals 10 μF. The capacitor was connected to a 10 V battery. Now the capacitor is disconnected from the battery and the slab is removed from the gap. After removal of the slab, the positively charged plate of the capacitor is reconnected with negative terminal of the same battery and negatively charged plate with positive terminal of the battery. Based on the information provided, answer the following questions.

45. Energy stored in capacitor before reconnection is

(A) 500 μJ (B) 1250 μJ
(C) 3215 μJ (D) 4250 μJ

46. Energy stored in the capacitor after reconnection is

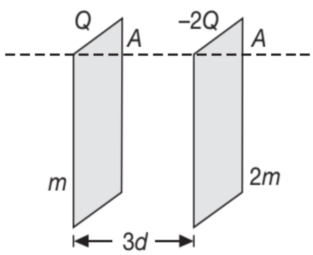
(A) 500 μJ (B) 1250 μJ
(C) 3215 μJ (D) 4250 μJ

47. Heat generated in connecting wires after reconnection with the battery is

(A) 500 μJ (B) 1250 μJ
(C) 3215 μJ (D) 4250 μJ

Comprehension 14

A parallel plate capacitor has two plates of area A each. The mass of the left plate is m and its electric charge is Q. The mass of the right plate is $2m$ and its electric charge is $-2Q$. Initially the plates are fixed and the separation between the plates is $3d$. If C is the capacitance of the capacitor when plates would have been lying at the separation d, then based on the information provided, answer the following questions.



48. Potential difference across plates of capacitor is

(A) $\frac{3Q}{2C}$ (B) $\frac{9Q}{2C}$
(C) $\frac{6Q}{C}$ (D $\frac{3Q}{C}$

49. Energy possessed by the electric field between the plates is

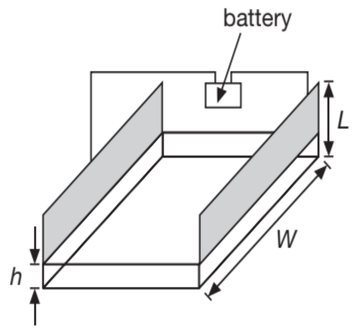
(A) $\frac{27Q^2}{4C}$ (B) $\frac{9Q^2}{8C}$
(C) $\frac{27Q^2}{8C}$ (D) $\frac{81Q^2}{8C}$

50. At a given moment plates are unfixed. What is relative velocity of plates when their distance is reduced to d

(A) $9Q\sqrt{\frac{3}{mC}}$ (B) $\frac{Q}{2}\sqrt{\frac{1}{mC}}$
(C) $\frac{2Q}{3}\sqrt{\frac{1}{3mC}}$ (D) $\frac{9Q}{2}\sqrt{\frac{1}{3mC}}$

Comprehension 15

A fuel gauge uses a capacitor to determine the height of the fuel in the tank. The effective dielectric constant K_{eff} changes from a value of 1 (when the tank is empty) to a value of K, where K is dielectric constant of the fuel (when the tank is full). The appropriate electronic circuitry can determine the effective dielectric constant of the combined air and fuel between the capacitor plates.



Each of the two rectangular plates has a width W and a length L. The height of the fuel between the plates is h. (Ignore fringing effect). Based on the information provided, answer the following questions.

51. The electronic gadget which senses the fuel height is called

(A) level tester (B) strain gauge
(C) transducer (D) capacitor

52. The value of K_{eff} as a function of h is

(A) $\frac{(K-1)h}{L}+1$ (B) $\frac{(K-1)h}{L}$
(C) $\frac{(K-1)h}{L}-1$ (D) $\frac{(K+1)h}{L}-1$

53. When the tank is $\frac{1}{4}$th empty, then the value of K_{eff} is

(A) $\frac{3K}{4}$ (B) $\frac{K-1}{4}$
(C) $(K-1)\frac{3}{4}$ (D) $\frac{K+1}{4}$

Comprehension 16

Consider a series combination of capacitor C_1, C_2 and C_3. Capacitor C_1 and C_3 have air as the dielectric medium between the plates while C_2 has a medium of dielectric constant $K = 3$ filled uniformly between the plates. A potential difference V_0 is applied across the combination. It is observed that potential difference across C_3 is 12 V. The dielectric material $(K = 3)$ between the plates of C_2 is now removed so that its capacity now becomes C_2'. In this situation, the potential difference across C_3 is found to be 9 V. It is also observed that the potential differences across C_1 and C_2' are equal. If the capacitance of C_2 is $6\ \mu\text{F}$, then based on the information provided, answer the following questions.

54. Applied potential difference V_0 is

(A) 10 V (B) 20 V
(C) 30 V (D) 36 V

55. Capacitance C_1 is

(A) 8 μF (B) 6 μF
(C) 3 μF (D) 2 μF

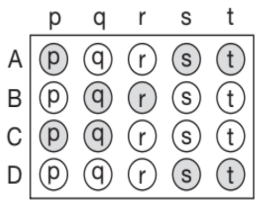
56. Capacitance C_3 is

(A) 8 μF (B) 6 μF
(C) 3 μF (D) 2 μF

MATRIX MATCH/COLUMN MATCH TYPE QUESTIONS

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

If the correct matches are A $\rightarrow$ p, s and t; B $\rightarrow$ q and r; C $\rightarrow$ p and q; and D $\rightarrow$ s and t; then the correct darkening of bubbles will look like the following:

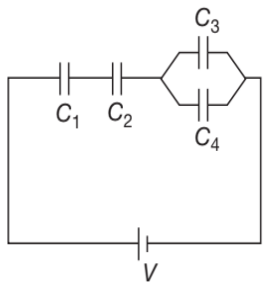


1. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Energy stored in a capacitor carrying charge Q. (potential difference $= V$ between the plates)	(p) CV^2
(B) Energy supplied to a capacitor by a battery of potential difference V.	(q) $\dfrac{Q^2}{2C}$
(C) Energy loss when plates of a charged capacitor are connected together.	(r) $\dfrac{C_1C_2}{2(C_1+C_2)}(V_1-V_2)^2$
(D) Energy loss when charges of two parallel plates capacitors of capacitances C_1 and C_2 at potential differences V_1 and V_2 respectively are shared.	(s) $\dfrac{1}{2}CV^2$

(Continued)

2. In the circuit shown $C_1=C$, $C_2=2C$, $C_3=3C$, $C_4=4C$. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.



COLUMN-I	COLUMN-II
(A) Charge across the capacitor C_3 (multiple of CV)	(p) $\frac{2}{23}$
(B) Potential difference across the capacitor C_4 (multiple of V)	(q) $\frac{6}{23}$
(C) Energy stored across the capacitor C_3 (multiple of CV^2)	(r) $\frac{1}{66}$
(D) Energy stored across the capacitor C_4 (multiple of CV^2)	(s) $\frac{1}{88}$

3. A parallel plate capacitor with air between its plates is charged using a battery and then disconnected from the battery. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.

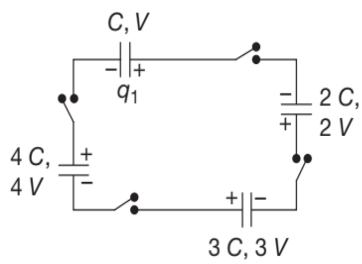
COLUMN-I	COLUMN-II
(A) Potential difference between the plates will decrease if	(p) Separation between the plates is increased to $\frac{K}{2}$ times the initial value and space between the plates after the separation has increased, is completely filled with a dielectric (here K is the dielectric constant)
(B) Electric field strength between the plates will reduce if	(q) Separation between the plates is increased
(C) Electric energy stored in the capacitor will decrease if	(r) A dielectric with $K>1$ is filled between the plates of capacitor
(D) Electric energy density will decrease if	(s) Separation between the plates is reduced

(Continued)

4. Three capacitors of capacitances $2\ \mu F$, $3\ \mu F$ and $6\ \mu F$ are connected in series with a 12 V battery. All the connecting wires are disconnected. The three positive plates are connected together and three negative plates are connected together. The charges on three capacitors after reconnection are Q_1, Q_2 and Q_3 respectively. The charge supplied by battery is Q. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.

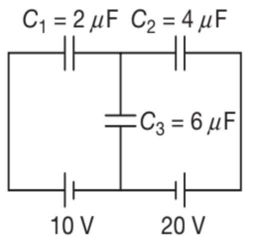
COLUMN-I	COLUMN-II
(A) Q_1	(p) $12\ \mu C$
(B) Q_2	(q) $\frac{216}{11}\ \mu C$
(C) Q_3	(r) $\frac{72}{11}\ \mu C$
(D) Q	(s) $\frac{108}{11}\ \mu C$

5. Capacitors with capacitances C, $2C$, $3C$ and $4C$ are charged to the voltage V, $2V$, $3V$, $4V$ respectively. Circuit is closed. Assume voltages across capacitors in equilibrium are V_1, V_2, V_3 and V_4 respectively. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.



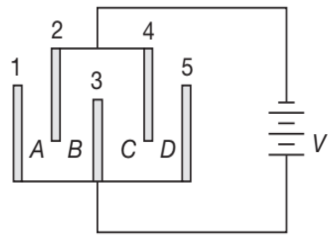
COLUMN-I	COLUMN-II
(A) V_1	(p) $\frac{2V}{5}$
(B) V_2	(q) $\frac{7V}{5}$
(C) V_3	(r) $\frac{19V}{5}$
(D) V_4	(s) $\frac{14V}{5}$

6. In the diagram shown, q_1, q_2 and q_3 are the charges on the capacitors C_1, C_2 and C_3. The potential difference across C_3 is V, where q_1, q_2 and q_3 are in μC and V is in volt. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.



COLUMN-I	COLUMN-II
(A) q_1	(p) 50
(B) q_2	(q) $\frac{10}{3}$
(C) q_3	(r) $\frac{140}{3}$
(D) V	(s) $\frac{25}{3}$

7. Five identical capacitor plates each of area A are arranged such that adjacent plates are at d distance apart. Plates are connected to a source of emf V as shown. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.



COLUMN-I	COLUMN-II
(A) Charge on plate 1 $\left(\text{multiple of } \frac{\varepsilon_0 AV}{d}\right)$	(p) −2
(B) Charge on plate 4 $\left(\text{multiple of } \frac{\varepsilon_0 AV}{d}\right)$	(q) 1
(C) Potential difference between the plates 2 and 3 (multiple of 2 V)	(r) 0
(D) Potential difference between the plates 1 and 5 (multiple of 2 V)	(s) $\frac{1}{2}$

8. In case of two conducting spherical shells having radii a and $b(>a)$. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Shells are concentric and inner is given a charge while outer is earthed	(p) $C = 4\pi\varepsilon_0(a+b)$
(B) Shells are concentric and the outer is given a charge while inner is earthed	(q) $C = \frac{4\pi\varepsilon_0 ab}{b-a}$
(C) Shells carry equal and opposite charges and are separated by a distance d	(r) $C = \frac{4\pi\varepsilon_0 b^2}{b-a}$
(D) Shells are connected by a conducting wire	(s) $C = \frac{4\pi\varepsilon_0}{\frac{1}{a}+\frac{1}{b}-\frac{2}{d}}$

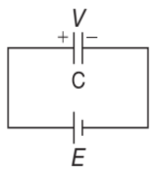
9. A parallel plate capacitor with air between its plates is charged using a battery and remains connected to the battery. Match the quantities in **COLUMN-I** with their respective answer(s) in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Electric field strength between the plates will reduce if	(p) Separation between the plates is increased
(B) Electric energy stored in the capacitor will increase if	(q) Separation between the plates is reduced
(C) Electric energy density will increase if	(r) A dielectric with $K > 1$ is filled between the plates
(D) Charge in the capacitor will decrease if	(s) Separation between the plates is increased to $\frac{K}{2}$ times the initial value and space between the plates, after the separation has increased, is completely filled with a dielectric (here K is the dielectric constant and $K = 3$)

10.

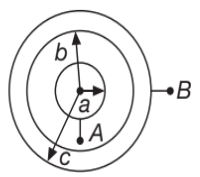
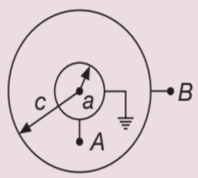
COLUMN-I	COLUMN-II
(A) If distance between plates of an isolated capacitor decreases	(p) Potential difference across plate is decreased
(B) If dielectric is inserted between plates of capacitor whose plates are connected with battery	(q) Capacitance of the capacitor will increase
(C) If area of plates of an isolated capacitor is increased	(r) Energy of capacitor will increase
(D) If distance between plates of capacitor is decreased when the capacitor is connected with battery	(s) Force between the plates will decrease

11. A capacitor of capacitance C is charged to a potential V. Now it is connected to a battery of e.m.f E as shown in the figure. Match the conditions in **COLUMN-I** with the arguments in **COLUMN-II.**

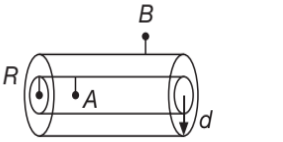
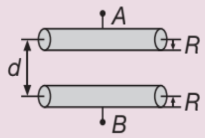


COLUMN-I	COLUMN-II
(A) If $V = E$, then	(p) non-zero charge is supplied by the +ve terminal of battery to +ve plate of capacitor.
(B) If $V > E$	(q) Zero charge is supplied by +ve terminal of battery to +ve plate of capacitor.
(C) If $V < E$, then	(r) non-zero thermal energy will be dissipated in the circuit.
(D) If $V \neq E$, then	(s) outer surfaces of the plates of capacitor have zero charge.

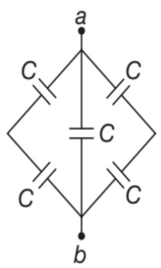
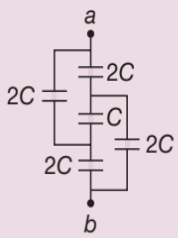
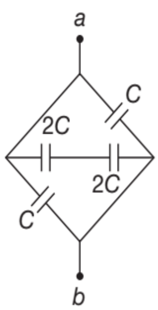
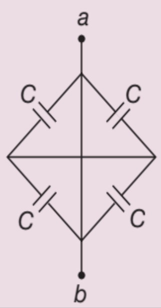
12. Match the columns for the capacitance of systems in **COLUMN-I** to their respective values of capacitance in **COLUMN-II.**

COLUMN-I	COLUMN-II
(A)  (Concentric shells) capacitance C_{AB}	(p) $\frac{4\pi\varepsilon_0 c^2}{c-a}$
(B)  (Concentric shells) Capacitance C_{AB}	(q) $\frac{4\pi\varepsilon_0 ac}{c-a}$

(Continued)

COLUMN-I	COLUMN-II
(C)  (Concentric cylinders) Capacitance C_{AB} per unit length	(r) $\dfrac{2\pi\varepsilon_0}{\log_e\left(\dfrac{d}{R}\right)}$
(D)  (Parallel wires of radius R at separation d) capacitance C_{AB} per unit length)	(s) $\dfrac{\pi\varepsilon_0}{\log_e\left(\dfrac{d}{R}\right)}$

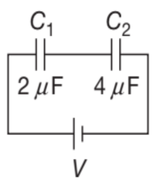
13. Match the Column

COLUMN-I	COLUMN-II
(A) 	(p) C_{eq} between a and b is $2C$
(B) 	(q) C_{eq} between a and b is C
(C) 	(r) C_{eq} between a and b is $3C$
(D) 	(s) C_{eq} between a and b is $4C$

14. Match the entries of **COLUMN-I** with the entries of **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) When a dielectric slab is gradually inserted between the plates of an isolated parallel plate capacitor	(p) The electric potential energy of the system decreases
(B) When a dielectric gradually inserted between the plates of a parallel plate capacitor connected to battery	(q) Work done by external agent is positive
(C) When the plates of a parallel plate capacitor are pulled apart for a capacitor connected to battery	(r) Work done by battery is positive
(D) When the plates of a parallel plate isolated capacitor are pulled apart	(s) Work done by external agent is negative

15. In the given figure, the separation between the plates of C_1 is slowly increased to double of its initial value, then match the following

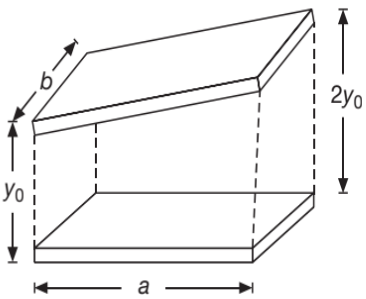


COLUMN-I	COLUMN-II
(A) The potential difference across C_1	(p) increases
(B) The potential difference across C_2	(q) decreases
(C) The energy stored in C_1	(r) increases by a factor of $\dfrac{6}{5}$
(D) The energy stored in C_2	(s) decreases by a factor of $\dfrac{18}{25}$

INTEGER/NUMERICAL ANSWER TYPE QUESTIONS

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

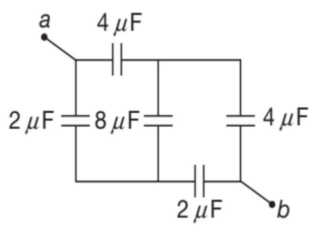
1. A capacitor has rectangular plates of length a and width b. The top plate is inclined at a small angle as shown in figure. The plate separation varies from $d = y_0$ at the left to $d = 2y_0$ at the right where $y_0 \ll a$ and $y_0 \ll b$. The capacitance of the system is found to be $C = \frac{\varepsilon_0 ab}{y_0}\log_e \alpha$. Then find value of α.



2. A 10 μF capacitor has plates with vacuum between them. Each plate carries a charge of magnitude 1000 μC. A particle with charge $-3\ \mu$C and mass 2×10^{-16} kg is fired from the positive plate toward the negative plate with an initial speed of $2\times10^{6}\ \text{ms}^{-1}$. Does it reach the negative plate? If so, find its impact speed in kms^{-1}. If not, what fraction of the way across the capacitor does it travel?

3. Capacitors $C_1 = 6\ \mu$F and $C_2 = 2\ \mu$F are charged as a parallel combination across a 250 V battery. The capacitors are disconnected from the battery and from each other. They are then connected positive plate to negative plate and negative plate to positive plate. Calculate the resulting charge, in μC, on each capacitor.

4. Calculate the equivalent capacitance, in μF, between the points a and b in figure.



5. A detector of radiation called a Geiger tube consists of a closed, hollow, conducting cylinder with a fine wire along its axis. Suppose that the internal diameter of the cylinder is 2.5 cm and that the wire along the axis has a diameter of 0.2 mm. The dielectric strength of the gas between the central wire and the cylinder is $1.2\times10^{6}\ \text{Vm}^{-1}$. Calculate the maximum potential difference, in volt that can be applied between the wire and the cylinder before breakdown occurs in the gas.

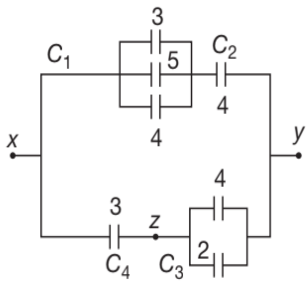
6. A radioactive source in the form of a metal sphere of diameter 10^{-3} m emits β particles at a constant rate of 6.25×10^{10} particles per second. If the source is electrically insulated, how long (in ns) will it take for its potential to rise by 1 V, assuming that 80% of emitted β particles escape from the surface.

7. A parallel plate capacitor is maintained at a certain potential difference. When a 3 mm thick slab is introduced between the plates; in order to maintain the same potential difference, the distance between the plates is increased by 2.4 mm. Find the dielectric constant of the slab.

8. The capacitance of all the capacitors shown in figure are in μF

(a) What is the equivalent capacitance, in μF, between x and y?

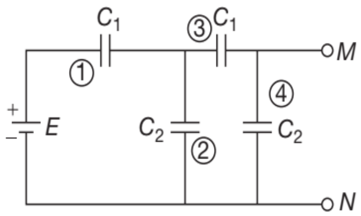
(b) If the charge on 5 μF capacitor is 120 μC, what is the potential difference, in volt, between x and z?



9. A capacitor of capacitance $C_1 = 1\ \mu$F withstands the maximum voltage $V_1 = 0.6$ kV while another capacitor of capacitance $C_2 = 2\ \mu$F withstands the maximum voltage $V_2 = 4$ kV. What maximum kilovolt will the system of these two capacitors withstands if they are connected in series?

10. A parallel capacitor of plate area $0.2\ \text{m}^2$ and spacing 10^{-2} m is charged to 10^{3} V and is then disconnected from the battery. How much work is required if the plates are pulled apart to double the plate spacing? Calculate the final voltage, in kilo volt, of the capacitor if $\varepsilon_0 = \dfrac{1}{36\pi \times 10^7}\ \text{Fm}^{-1}$.

11. Find the potential difference in volt, between points M and N of the system shown, if the e.m.f. is equal to $E = 110$ V and the capacitance ratio $\dfrac{C_2}{C_1} = \eta = 2$.



12. A condenser has capacitance 10 μF and is charged to a potential 150 V.

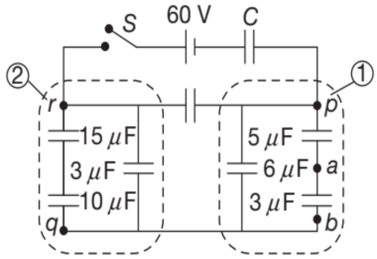
(a) Calculate the charge, in μC.

(b) A second condenser has a capacitance of 20 μF and is charged to a potential of 300 V. If after charging, the two condensers are connected in parallel by wires of negligible capacitance, how much energy, in mJ, is dissipated?

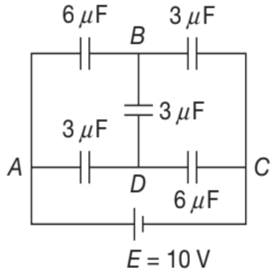
13. A parallel plate capacitor of plate area $A = 10^{-3}$ metre^2 and plate separation $d = 10^{-2}$ m is charged to $V_0 = 100$ V. Then after removing the charging battery, a slab of insulating material of thickness $b = 0.5 \times 10^{-2}$ m and dielectric constant $K = 7$ is inserted between the plates. Calculate the free charge, in pC, on the plates of the capacitor, electric field intensity, in kVm^{-1}, in air, electric field intensity, in Vm^{-1}, in the dielectric, potential difference, in volt, between the plates and capacitance, in pF, with dielectric present.

14. The distance between the parallel plates of a charged condenser is $d = 5$ cm and the intensity of the field $E = 300$ V cm^{-1}. A slab of dielectric constant $K = 5$ and 1 cm wide is inserted parallel to the plates. Determine the potential difference, in volt, between the plates, before and after the slab is inserted. If the slab is replaced by a metal plate so that the final potential difference remains unchanged, what be the thickness, in mm, of the plate?

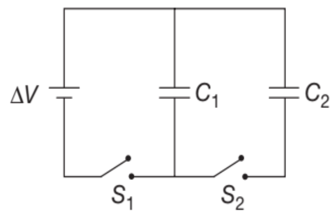
15. The circuit shown in Figure is in steady state. The potential difference between points a and b is 10 V. Find the capacitance, in μF, of the capacitor C.



16. In the circuit shown in Figure. Find the charge, in μC, on each capacitor.



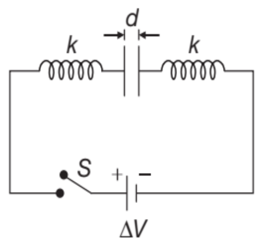
17. Consider the circuit shown in Figure, where $C_1 = 6\ \mu$F, $C_2 = 3\ \mu$F and $\Delta V = 20$ V. Capacitor C_1 is first charged by closing the switch S_1. Switch S_1 is then opened, and the charged capacitor is connected to the uncharged capacitor by closing the switch S_2. Calculate



(a) the initial charge acquired by C_1, in μC.

(b) the final charge on each capacitor, in μC.

18. The circuit in figure consists of two identical parallel metal plates connected by identical metal springs to a 100 V battery. With the switch open, the plates are uncharged, are separated by a distance $d = 8$ mm and have a capacitance $C = 2\ \mu$F. When the switch is closed, the distance between the plates decreases by a factor of half.



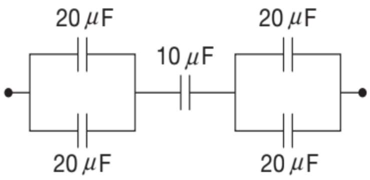
(a) How much charge, in μC, collects on each plate?

(b) What is the spring constant, in Nm^{-1}, for each spring?

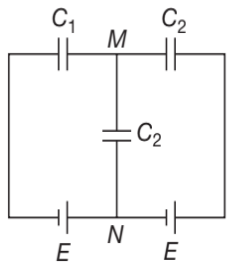
19. A certain storm cloud has a potential of 1×10^8 V relative to a tree. If, during a lightning storm, 50 C of charge is transferred through this potential difference and 1% of the energy is absorbed by the tree, how much sap, in kg (nearest to two digit integer) in the tree can be boiled away?

Assume that the "sap" is "water initially at 30 °C". Water has a specific heat of $4186\ \text{Jkg}^{-1}\ °\text{C}$, a boiling point of 100 °C, and a latent heat of vaporisation of $2.26\times10^6\ \text{Jkg}^{-1}$

20. Each capacitor in the combination shown in figure has a breakdown voltage of 16 V. What is the breakdown voltage, in V, of the combination?



21. Find the potential difference, in volt, between points M and N of the system shown, if the emf is equal to $E = 110$ V and the capacitance ratio $\frac{C_2}{C_1}$ is 2.



22. A 20 pF parallel plate capacitor with air as medium is charged to 200 V and then disconnected from the battery. What is the energy U_i of the capacitor? The plates are then slowly pulled apart (in a direction normal to the plate area) so that the plate separation is doubled. What is the mechanical work done, in nJ, in the process?

23. A 3 μF parallel plate capacitor is connected to a battery of 400 V. The plates are then pulled apart as in above problem, so that the capacitance value becomes 1 μF. This operation is carried out while the capacitor is still connected to the battery of 400 V. Calculate the mechanical work done, in mJ. Account for the loss of energy of the capacitor.

ARCHIVE: JEE MAIN

1. **[Online April 2019]**
Voltage rating of a parallel plate capacitor is 500 V. Its dielectric can withstand a maximum electric field of $10^6\ \text{Vm}^{-1}$. The plate area is $10^{-4}\ \text{m}^2$. What is the dielectric constant if the capacitance is 15 pF? (given $\varepsilon_0 = 8.86\times10^{-12}\ \text{C}^2\text{Nm}^{-2}$)

(A) 3.8 (B) 4.5
(C) 8.5 (D) 6.2

2. **[Online April 2019]**
A parallel plate capacitor has 1 μF capacitance. One of its two plates is given +2 μC charge and the other plate, +4 μC charge. The potential difference developed across the capacitor is

(A) 5 V (B) 1 V
(C) 3 V (D) 2 V

3. **[Online April 2019]**
A capacitor with capacitance 5 μF is charged to 5 μC. If the plates are pulled apart to reduce the capacitance to 2 μF, how much work is done?

(A) 2.55×10^{-6} J (B) 6.25×10^{-6} J
(C) 3.75×10^{-6} J (D) 2.16×10^{-6} J

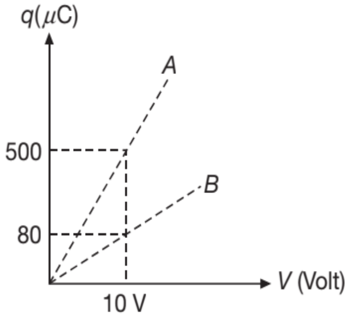
4. **[Online April 2019]**
The parallel combination of two air filled parallel plate capacitors of capacitance C and nC is connected to a battery of voltage, V. When the capacitors are fully charged, the battery is removed and after that a dielectric material of dielectric constant K is placed between the two plates of the first capacitor. The new potential difference of the combined system is L

(A) $\frac{(n+1)V}{(K+n)}$ (B) $\frac{V}{K+n}$

(C) V (D) $\frac{nV}{K+n}$

5. [Online April 2019]

Figure shows charge (q) versus voltage (V) graph for series and parallel combination of two given capacitors. The capacitances are

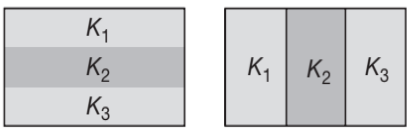


(A) 40 μF and 10 μF (B) 20 μF and 30 μF

(C) 60 μF and 40 μF (D) 50 μF and 30 μF

6. [Online April 2019]

Two identical parallel plate capacitors, of capacitance C each, have plates of area A, separated by a distance d. The space between the plates of the two capacitors, is filled with three dielectrics, of equal thickness and dielectric constants K_1, K_2 and K_3. The first capacitor is filled as shown in figure i, and the second one is filled as shown in figure ii. If these two modified capacitors are charged by the same potential V, the ratio of the energy stored in the two, would be (E_1 refers to capacitor (I) and E_2 to capacitor (II))



(i) (ii)

(A) $\frac{E_1}{E_2}=\frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{K_1K_2K_3}$

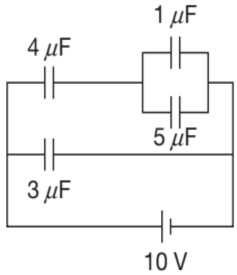
(B) $\frac{E_1}{E_2}=\frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{9K_1K_2K_3}$

(C) $\frac{E_1}{E_2}=\frac{9K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

(D) $\frac{E_1}{E_2}=\frac{K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

7. [Online April 2019]

In the given circuit, the charge on 4 μF capacitor will be

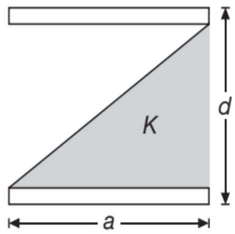


(A) 5.4 μC (B) 9.6 μC

(C) 13.4 μC (D) 24 μC

8. [Online January 2019]

A parallel plate capacitor is made of two square plates of side a, separated by a distance $d(d \ll a)$. The lower triangular portion is filled with a dielectric of dielectric constant K, as shown in the figure. Capacitance of this capacitor is

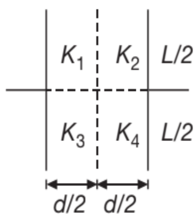


(A) $\frac{K\varepsilon_0 a^2}{d(K-1)}\ln K$ (B) $\frac{K\varepsilon_0 a^2}{d}\ln K$

(C) $\frac{K\varepsilon_0 a^2}{2d(K+1)}$ (D) $\frac{1}{2}\frac{K\varepsilon_0 a^2}{d}$

9. [Online January 2019]

A parallel plate capacitor with square plates is filled with four dielectrics of dielectric constants K_1, K_2, K_3, K_4 arranged as shown in the figure. The effective dielectric constant K will be



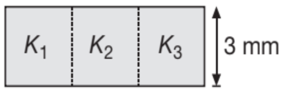
(A) $K=\frac{(K_1+K_2)(K_3+K_4)}{2(K_1+K_2+K_3+K_4)}$

(B) $K=\frac{(K_1+K_2)(K_3+K_4)}{K_1+K_2+K_3+K_4}$

(C) $K=\frac{(K_1+K_3)(K_2+K_4)}{K_1+K_2+K_3+K_4}$

(D) $K=\frac{(K_1+K_4)(K_2+K_3)}{2(K_1+K_2+K_3+K_4)}$

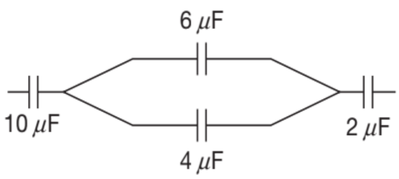
10. [Online January 2019]
A parallel plate capacitor is of area 6 cm^2 and a separation 3 mm. The gap is filled with three dielectric materials of equal thickness (see figure) with dielectric constants $K_1 = 10$, $K_2 = 12$ and $K_3 = 14$. The dielectric constant of a material which when fully inserted in above capacitor, gives same capacitance would be



(A) 36 (B) 14
(C) 12 (D) 4

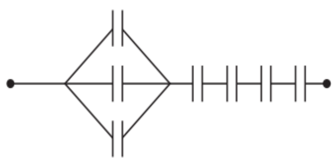
11. [Online January 2019]
A parallel plate capacitor having capacitance 12 pF is charged by a battery to a potential difference of 10 V between its plates. The charging battery is now disconnected and a porcelain slab of dielectric constant 6.5 is slipped between the plates. The work done by the capacitor on the slab is
(A) 560 pJ (B) 692 pJ
(C) 508 pJ (D) 600 pJ

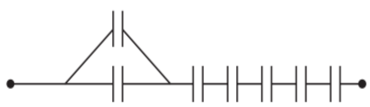
12. [Online January 2019]
In the figure shown below, the charge on the left plate of the $10\ \mu$F capacitor is ... The charge on the right plate of the $6\ \mu$F capacitor is

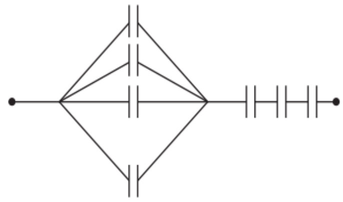


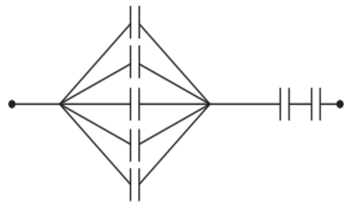
(A) $+18\ \mu$C (B) $-12\ \mu$C
(C) $+12\ \mu$C (D) $-18\ \mu$C

13. [Online January 2019]
Seven capacitors, each of capacitance $2\ \mu$F, are to be connected in a configuration to obtain an effective capacitance of $\left(\frac{6}{13}\right)\mu$F. Which of the combinations, shown in figures below, will achieve the desired value?

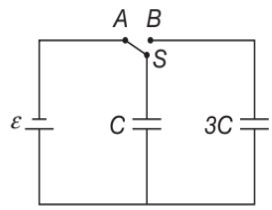
(A)


(B)


(C)


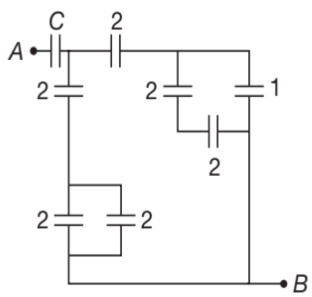
(D)


14. [Online January 2019]
In the figure shown, after the switch S is turned from position A to position B, the energy dissipated in the circuit in terms of capacitance C and total charge Q is



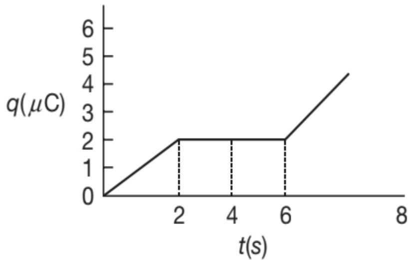
(A) $\frac{3}{8}\frac{Q^2}{C}$ (B) $\frac{1}{8}\frac{Q^2}{C}$
(C) $\frac{5}{8}\frac{Q^2}{C}$ (D) $\frac{3}{4}\frac{Q^2}{C}$

15. [Online January 2019]
In the circuit shown, find C if the effective capacitance of the whole circuit is to be $0.5\ \mu$F. All values in the circuit are in μF.



(A) $\frac{7}{11}\ \mu$F (B) $4\ \mu$F
(C) $\frac{6}{5}\ \mu$F (D) $\frac{7}{10}\ \mu$F

16. [Online January 2019]
The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure



What is the value of current at $t = 4$ s ?

(A) $2\ \mu A$ (B) zero

(C) $3\ \mu A$ (D) $1.5\ \mu A$

17. [2018]

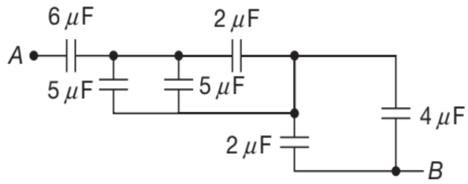
A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20 V. If a dielectric material of dielectric constant $K = \frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be

(A) 1.2 nC (B) 0.3 nC

(C) 2.4 nC (D) 0.9 nC

18. [Online 2018]

The equivalent capacitance between A and B in the circuit given below, is



(A) $5.4\ \mu F$ (B) $4.9\ \mu F$

(C) $3.6\ \mu F$ (D) $2.4\ \mu F$

19. [Online 2018]

A parallel plate capacitor with area $200\ cm^2$ and separation between the plates 1.5 cm, is connected across a battery of emf V. If the force of attraction between the plates is 25×10^{-6} N, the value of V is approximately

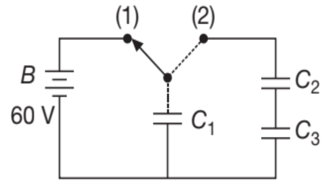
$$\left(\varepsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}\right)$$

(A) 150 V (B) 100 V

(C) 250 V (D) 300 V

20. [Online 2018]

A capacitor $C_1 = 1\ \mu F$ is charged up to a voltage $V = 60$ V by connecting it to battery B through switch (1). Now C_1 is disconnected from battery and connected to a circuit consisting of two uncharged capacitors $C_2 = 3$ F and $C_3 = 6$ F through switch (2), as shown in the figure. The sum of final charges on C_2 and C_3 is



(A) 20 C (B) 40 C

(C) 36 C (D) 54 C

21. [2017]

A capacitance of $2\ \mu F$ is required in an electrical circuit across a potential difference of 1 kV. A large number of $1\ \mu F$ capacitors are available which can withstand a potential difference of not more than 300 V. The minimum number of capacitors required to achieve this is

(A) 2 (B) 16

(C) 24 (D) 32

22. [Online 2017]

The energy stored in the electric field produced by a metal sphere is 4.5 J. If the sphere contains $4\ \mu C$ charge, its radius will be

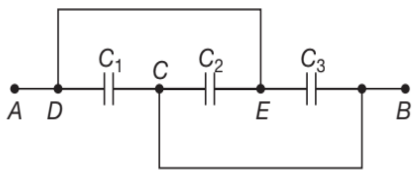
$$\left[\text{Take } \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ Nm^2C^{-2}\right]$$

(A) 32 mm (B) 20 mm

(C) 16 mm (D) 28 mm

23. [Online 2017]

A combination of parallel plate capacitors is maintained at a certain potential difference.



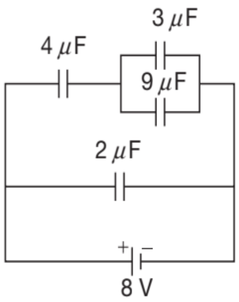
When a 3 mm thick slab is introduced between all the plates, in order to maintain the same potential difference, the distance between the plates is increased by 2.4 mm. Find the dielectric constant of the slab

(A) 6 (B) 5

(C) 4 (D) 3

24. [2016]

A combination of capacitors is set up as shown in the figure. The magnitude of the electric field due to a point charge Q (having a charge equal to the sum of the charges on the $4\ \mu F$ and $9\ \mu F$ capacitors), at a point distant 30 m from it, would equal



(A) 240 NC^{-1} (B) 360 NC^{-1}

(C) 420 NC^{-1} (D) 480 NC^{-1}

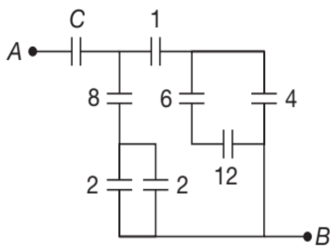
25. [Online 2016]

Three capacitors each of $4\ \mu F$ are to be connected in such a way that the effective capacitance is $6\ \mu F$. This can be done by connecting them

(A) all in series
(B) all in parallel
(C) two in parallel and one in series
(D) two in series and one in parallel

26. [Online 2016]

Figure shows a network of capacitors where the numbers indicates capacitances in micro Farad. The value of capacitance C if the equivalent capacitance between point A and B is to be $1\ \mu F$ is

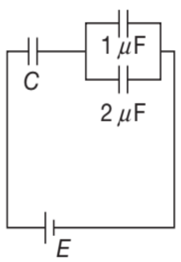


(A) $\frac{32}{23}\ \mu F$ (B) $\frac{31}{23}\ \mu F$

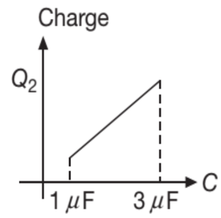
(C) $\frac{33}{23}\ \mu F$ (D) $\frac{34}{23}\ \mu F$

27. [2015]

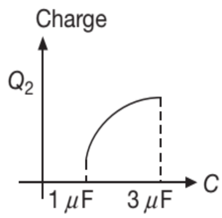
In the given circuit, charge Q_2 on the $2\ \mu F$ capacitor changes as C is varied from $1\ \mu F$ to $3\ \mu F$. Q_2 as a function of C is given properly by (figures are drawn schematically and are not to scale)



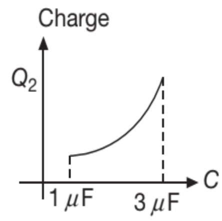
(A)



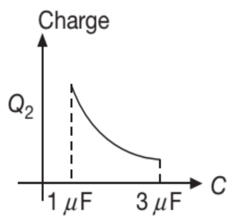
(B)



(C)

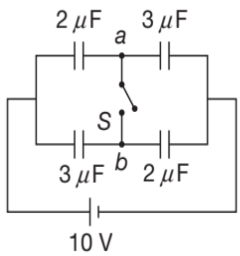


(D)



28. [Online 2015]

In figure is shown a system of four capacitors connected across a 10 V battery. Charge that will flow from switch S when it is closed is



(A) $5\ \mu C$ from b to a
(B) $20\ \mu C$ from a to b
(C) $5\ \mu C$ from a to b
(D) zero

29. [2014]

A parallel plate capacitor is made of two circular plates separated by a distance of 5 mm and with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is $3\times10^4\ V/m$, the charge density of the positive plate will be close to

(A) $6\times10^{-7}\ C/m^2$
(B) $3\times10^{-7}\ C/m^2$
(C) $3\times10^{4}\ C/m^2$
(D) $6\times10^{4}\ C/m^2$

30. [2013]

Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero. Then

(A) $5C_1 = 3C_2$ (B) $3C_1 = 5C_2$

(C) $3C_1 + 5C_2 = 0$ (D) $9C_1 = 4C_2$

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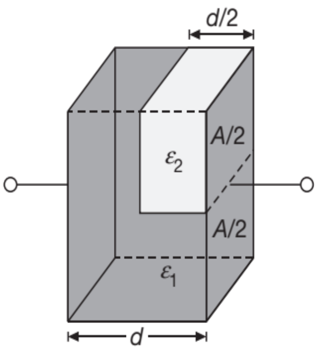
Single Correct Choice Type Problems

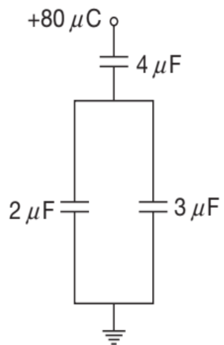
This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. [JEE (Advanced) 2015]
A parallel plate capacitor having plates of area A and plate separation d, has capacitance C_1 in air. When two dielectrics of different relative permittivities ($\varepsilon_1 = 2$ and $\varepsilon_2 = 4$) are introduced between the two plates as shown in the figure, the capacitance becomes C_2. The ratio $\frac{C_2}{C_1}$ is



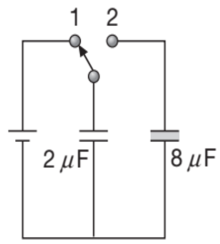
(A) $\frac{6}{5}$ (B) $\frac{5}{3}$
(C) $\frac{7}{5}$ (D) $\frac{7}{3}$

2. [IIT-JEE 2012]
In the given circuit, a charge of $+80\ \mu C$ is given to the upper plate of the $4\ \mu F$ capacitor. Then in the steady state, the charge on the upper plate of the $3\ \mu F$ capacitor is



(A) $+32\ \mu C$ (B) $+40\ \mu C$
(C) $+48\ \mu C$ (D) $+80\ \mu C$

3. [IIT-JEE 2011]
A $2\ \mu F$ capacitor is charged as shown in the figure. The percentage of its stored energy dissipated after the switch S is turned to position 2 is

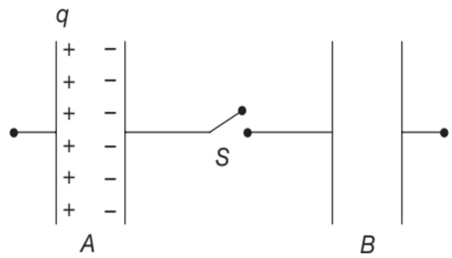


(A) 0% (B) 20%
(C) 75% (D) 80%

4. [IIT-JEE 2002]
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) $\frac{1}{4}C\left(V_1^2 - V_2^2\right)$ (B) $\frac{1}{4}C\left(V_1^2 + V_2^2\right)$
(C) $\frac{1}{4}C\left(V_1 - V_2\right)^2$ (D) $\frac{1}{4}C\left(V_1 + V_2\right)^2$

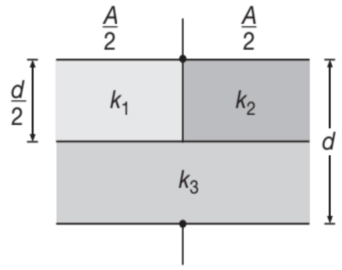
5. [IIT-JEE 2001]
Consider the situation shown in the figure. The capacitor A has a charge q on it whereas B is uncharged. The charge appearing on the capacitor B a long time after the switch is closed is



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

6. [IIT-JEE 2000]
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. 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) $\frac{1}{k}=\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{2k_3}$ (B) $\frac{1}{k}=\frac{1}{k_1+k_2}+\frac{1}{2k_3}$

(C) $\frac{1}{k}=\frac{k_1k_2}{k_1+k_2}+2k_3$ (D) $k=\frac{k_1k_3}{k_1+k_3}+\frac{k_2k_3}{k_2+k_3}$

7. [IIT-JEE 1999]

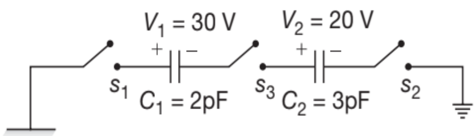
Two identical metal plates are given positive charges Q_1 and $Q_2(<Q_1)$ respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C, the potential difference between them is

(A) $\frac{(Q_1+Q_2)}{2C}$ (B) $\frac{(Q_1+Q_2)}{C}$

(C) $\frac{(Q_1-Q_2)}{C}$ (D) $\frac{(Q_1-Q_2)}{2C}$

8. [IIT-JEE 1999]

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



(A) With S_1 closed, $V_1=15$ V, $V_2=20$ 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_3 closed, $V_1=30$ V, $V_2=20$ V

9. [IIT-JEE 1996]

The magnitude of the electric field E in the annular region of a charged cylindrical capacitor

(A) is same throughout

(B) is higher near the outer cylinder than near the inner cylinder

(C) varies as $\frac{1}{r}$, where r is the distance from the axis

(D) varies as $\frac{1}{r^2}$, where r is the distance from the axis

10. [IIT-JEE 1995]

A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance $2C$ is similarly charged to potential difference $2V$. The charging battery is now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration

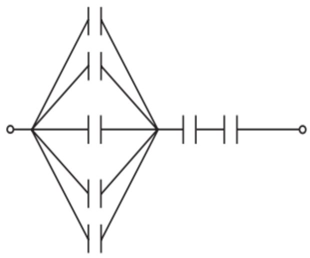
(A) ZERO (B) $\frac{3}{2}CV^2$

(C) $\frac{25}{6}CV^2$ (D) $\frac{9}{2}CV^2$

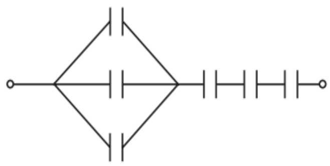
11. [IIT-JEE 1990]

Seven capacitors each of capacitance $2\,\mu$F are to be connected in a configuration to obtain an effective capacitance of $\left(\frac{10}{11}\right)\mu$F. Which of combination(s) shown in figure, will achieve the desired results?

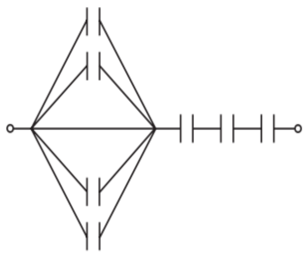
(A)



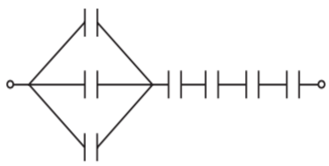
(B)



(C)



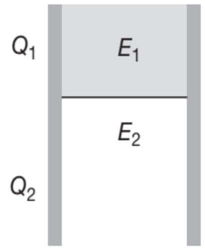
(D)



Multiple Correct Choice Type Problems

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

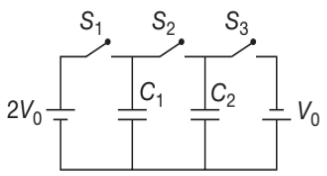
1. **[IIT-JEE 2014]**
A parallel plate capacitor has a dielectric slab of dielectric constant K between its plates that covers $\frac{1}{3}$ of the area of its plates, as shown in the figure. The total capacitance of the capacitor is C while that of the portion with dielectric in between is C_1. When the capacitor is charged, the plate area covered by the dielectric gets charge Q_1 and the rest of the area gets charge Q_2. The electric field in the dielectric is E_1 and that in the other portion is E_2. Choose the correct option/options, ignoring edge effects.



(A) $\frac{E_1}{E_2} = 1$ (B) $\frac{E_1}{E_2} = \frac{1}{K}$

(C) $\frac{Q_1}{Q_2} = \frac{3}{K}$ (D) $\frac{C}{C_1} = \frac{2+K}{K}$

2. **[JEE (Advanced) 2013]**
In the circuit shown in the figure, there are two parallel plate capacitors each of capacitance C. The switch S_1 is pressed first to fully charge the capacitor C_1 and then released. The switch S_2 is then pressed to charge the capacitor C_2. After some time, S_2 is released and then S_3 is pressed. After some time



(A) the charge on the upper plate of C_1 is $2CV_0$
(B) the charge on the upper plate of C_1 is CV_0
(C) the charge on the upper plate of C_2 is 0
(D) the charge on the upper plate of C_2 is $-CV_0$

3. **[IIT-JEE 1998]**
A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at $x = 0$ and positive plate is at $x = 3d$. The slab is equidistant from the plates. The capacitor is given some charge. As x goes from 0 to $3d$

(A) the magnitude of the electric field remains the same
(B) the direction of the electric field remains the same
(C) the electric potential increases continuously
(D) the electric potential increases at first, then decreases and again increases

4. **[IIT-JEE 1991]**
A parallel plate capacitor of plate area A and plate separation d is charged to potential difference 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 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 the slab is inserted), and work done on the system, in questions, in the process of inserting the slab, then

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

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

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

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

5. **[IIT-JEE 1987]**
A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitor are moved farther apart by means of insulating handles
(A) the charge on the capacitor increases
(B) the voltage across the plates increases
(C) the capacitance increases
(D) the electrostatic energy stored in the capacitor increases

6. **[IIT-JEE 1985]**
A parallel plate capacitor is connected to a battery. The quantities charge, voltage, electric field and energy associated with this capacitor are given by Q_0, V_0, E_0 and U_0 respectively. A dielectric slab is now introduced to fill the space between the plates with the battery still in connection. The corresponding quantities now given by Q, V, E and U are related to the previous ones as

(A) $Q > Q_0$ (B) $V > V_0$

(C) $E > E_0$ (D) $U > U_0$

Integer/Numerical Answer Type Questions

In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

1. **[JEE (Advanced) 2019]**
A parallel plate capacitor of capacitance C has spacing d between two plates having area A. The region between the plates is filled with N dielectric layers, parallel to its plates, each with thickness $\delta = \frac{d}{N}$. The dielectric constant of the m^{th} layer is $K_m = K\left(1+\frac{m}{N}\right)$. For a very large $N\left(>10^3\right)$, the capacitance C is $\alpha\left(\frac{K\varepsilon_0 A}{d\ln 2}\right)$. The value of α will be ________.
(ε_0 is the permittivity of free space)

ANSWER KEYS–TEST YOUR CONCEPTS AND PRACTICE EXERCISES

Test Your Concepts-I (Based on General Capacitance)

1. 400 V
2. 2 J
3. (a) 7600 V
   (b) 1.368×10^{-3} J
4. 5 J, $\frac{1}{2}$
5. (a) $\left(\frac{R_1}{R_1+R_2}\right)Q$, $\left(\frac{R_2}{R_1+R_2}\right)Q$
   (b) 0
6. $\left[\left(\frac{V_0}{V}\right)^{\frac{1}{10}}-1\right]C_0$

Test Your Concepts-II (Based on Series and Parallel Combination of Capacitors)

1. (a) $C(\Delta V)^2$
   (b) $\frac{4\Delta V}{3}$
   (c) $4C\frac{(\Delta V)^2}{3}$
2. (a) Net capacitance remains same
   (b) Net capacitance increases.
3. Across the 5 μF capacitor 23.3 V
   Across the 10 μF capacitor 26.7 V
4. (a) $\frac{q^2}{2\varepsilon_0 A}(x_2-x_1)$
   (b) $\frac{1}{2}\varepsilon_0 AV^2\left(\frac{1}{x_2}-\frac{1}{x_1}\right)$
5. 0.24 μF, 0.16 μF
6. 40 mF and 10 mF
7. $\frac{\varepsilon_0 A}{4d}$
8. 78.7 V, 151.3 V.
9. $\frac{\varepsilon_0 A}{a-b}$
10. $\frac{\varepsilon_0 a^2}{d}\left[1-\frac{a\theta}{2d}\right]$
11. (a) Arrangement 1, $\frac{3}{2}\left(\frac{\varepsilon_0 A}{d}\right)$
    (b) Arrangement 2, $\frac{2}{3}\left(\frac{\varepsilon_0 A}{d}\right)$
12. $(n-1)\frac{\varepsilon_0 A}{d}$
13. (a) 4 μF
    (b) $V_1 = 8$ V, $Q_1 = 48\ \mu$C
    $V_2 = 4$ V, $Q_2 = 16\ \mu$C
    $V_3 = 4$ V, $Q_3 = 32\ \mu$C
14. Arrangement 1, $\frac{2\varepsilon_0 A}{d}$
    Arrangement 2, $\frac{3\varepsilon_0 A}{d}$
15. (a) 17 pF
    (b) 1.224×10^{-7} J
16. (a) $\frac{q^2}{2C}$
    (b) $\frac{q^2}{8\pi\varepsilon_0 R}$

Test Your Concepts-III (Based on Dielectrics and Breakdown)

1. $\frac{24}{25}$
2. (b) It becomes κ times the initial charge
3. (a) Electric field decreases by a factor $\left(\frac{K+1}{2}\right)$
   (b) $\frac{CV(K-1)}{2(K+1)}$

4. 3.4%

5. (a) $\frac{\varepsilon_0 A}{d}$

(b) $\frac{\varepsilon_0 A}{d-t}$

(c) $\frac{2\varepsilon_0 A}{d}$

6. (a) $\varepsilon_0 A\left(\frac{K_1}{d_1}+\frac{K_2}{d_2}\right)$ (b) $\varepsilon_0 V\left(\frac{K_1}{d_1}+\frac{K_2}{d_2}\right)$

(c) $\frac{1}{2}\left(\frac{\varepsilon_0 K_1 V^2}{d_1^2}\right)$

7. $\frac{\varepsilon_0 K_1 K_2 A}{d_1 K_2 + d_2 K_1}$

8. 1.54 pF

9. $\frac{3}{5}$

10. (a) $\frac{\varepsilon_0}{d}\left[\ell^2+\ell x(\kappa-1)\right]$

(b) $\frac{1}{2}\left(\frac{\varepsilon_0(\Delta V)^2}{d}\right)\left[\ell^2+\ell x(\kappa-1)\right]$

(c) $\frac{\varepsilon_0(\Delta V)^2}{2d}\ell(\kappa-1)$

(d) 1.55×10^{-3} N

11. $\frac{2}{3}$

Test Your Concepts-IV
(Based on Capacitor Circuits, Kirchhoff's Laws, Charge Flown and Generation of Heat)

1. $\frac{10}{7}C$

2. $V_1=10$ V, $V_2=5$ V

3. 10 μC and $\frac{40}{3}$ μC

4. $\frac{|E_2-E_1|C_1C_2}{C_1+C_2}$

5. $V_1=\frac{E_1(C_2+C_3)-E_2C_2-E_3C_3}{C_1+C_2+C_3}$

$V_2=\frac{E_2(C_1+C_3)-E_1C_1-E_3C_3}{C_1+C_2+C_3}$

$V_3=\frac{E_3(C_1+C_2)-E_1C_1-E_2C_2}{C_1+C_2+C_3}$

6. $\frac{C_1C_4-C_2C_3}{(C_1+C_2)(C_3+C_4)}V$, $\frac{C_1}{C_2}=\frac{C_3}{C_4}$

7. $\frac{V_2C_2-V_1C_1}{C_1+C_2+C_3}$

8. 2C

9. Charge on 2 μF capacitor is $\frac{10}{3}$ μC

Charge on 4 μF capacitor is $\frac{140}{3}$ μC

Charge on 6 μF capacitor is 50 μC

10. $\frac{1}{2}V_2^2C$

11. (i) $\frac{200}{3}$ V, 0 V; (ii) 300 μC

Test Your Concepts-V
(Based on Spherical and Cylindrical Capacitors)

1. 2 pF

2. (a) 2.5×10^4 V

(b) +1 μC

3. $\frac{Q}{q}=N$, $\frac{C}{c}=\frac{R}{r}$, $\frac{V}{v}=N^{\frac{2}{3}}$, $\frac{U}{u}=N^{\frac{5}{3}}$

4. $\frac{4\pi\varepsilon_0 b^2}{b-a}$

5. +24 nC

6. $\frac{\pi L}{\log_e\left(\frac{b}{a}\right)}(K_1+K_2)$

Single Correct Choice Type Questions

1. A	2. B	3. B	4. A	5. D	6. D	7. B	8. C	9. B	10. C
11. B	12. B	13. B	14. C	15. D	16. B	17. D	18. B	19. C	20. A
21. D	22. D	23. D	24. D	25. B	26. B	27. C	28. B	29. C	30. C
31. C	32. C	33. A	34. C	35. C	36. B	37. C	38. B	39. B	40. B
41. B	42. C	43. C	44. A	45. D	46. C	47. C	48. C	49. B	50. C
51. D	52. B	53. A	54. A	55. B	56. A	57. A	58. B	59. C	60. C
61. B	62. B	63. D	64. A	65. C	66. C	67. B	68. C	69. B	70. A
71. B	72. B	73. D	74. A	75. C	76. D	77. A	78. B	79. C	80. A
81. C	82. D	83. D	84. B	85. A	86. B	87. C	88. C	89. C	90. A
91. A	92. C	93. B	94. A	95. B	96. C	97. A	98. B	99. D	100. A
101. A	102. B	103. D	104. B	105. D	106. A	107. C	108. C	109. D	110. B
111. B	112. B	113. A	114. C	115. C	116. C	117. B	118. C	119. D	120. C
121. B	122. D	123. B	124. A	125. A	126. B	127. A	128. B	129. B	130. D
131. C	132. A	133. C	134. D	135. B	136. B	137. B	138. B	139. C	140. B
141. D	142. A	143. C	144. A	145. D	146. D	147. A	148. C	149. C	150. B
151. A	152. A	153. D	154. C	155. A	156. C	157. B	158. A	159. A	160. A
161. D	162. A	163. A	164. A	165. C	166. C	167. C	168. C	169. C	170. C
171. B	172. B	173. A	174. A	175. A	176. A	177. A	178. B	179. A	180. A
181. A	182. D	183. B							

Multiple Correct Choice Type Questions

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

Reasoning Based Questions

1. D	2. A	3. A	4. D	5. A	6. A	7. C	8. D	9. D	10. A
11. C	12. C	13. C	14. B						

Linked Comprehension Type Questions

1. D	2. A	3. B	4. D	5. B	6. D	7. A	8. B	9. C	10. B
11. C	12. D	13. C	14. C	15. A	16. C	17. C	18. B	19. C	20. B
21. B	22. B	23. C	24. A	25. B	26. C	27. A	28. C	29. B	30. B
31. C	32. D	33. B	34. D	35. C	36. A	37. B	38. B	39. A	40. C
41. C	42. C	43. B	44. C	45. B	46. A	47. D	48. B	49. C	50. D
51. C	52. A	53. D	54. D	55. D	56. C				

Matrix Match/Column Match Type Questions

1. A → (q, s)	B → (p)	C → (q, s)	D → (r)
2. A → (q)	B → (p)	C → (s)	D → (r)
3. A → (p, r, s)	B → (p, r)	C → (p, r, s)	D → (p, r)
4. A → (s)	B → (q)	C → (r)	D → (p)
5. A → (r)	B → (p)	C → (q)	D → (s)
6. A → (q)	B → (r)	C → (p)	D → (s)
7. A → (q)	B → (p)	C → (s)	D → (r)
8. A → (q)	B → (r)	C → (s)	D → (p)
9. A → (p, s)	B → (q, r, s)	C → (q, r, s)	D → (p)
10. A → (p, q)	B → (r, q)	C → (p, q, s)	D → (r, q)
11. A → (q, s)	B → (r, s)	C → (p, r, s)	D → (p, r, s)
12. A → (q)	B → (p)	C → (r)	D → (s)
13. A → (p)	B → (p)	C → (r)	D → (q)
14. A → (p, s)	B → (r, s)	C → (p, q)	D → (q)
15. A → (p, r)	B → (q)	C → (s, q)	D → (q)

Integer/Numerical Answer Type Questions

1. $\alpha = 2$	2. Yes, 1000	3. $q_{6\,\mu F} = 750\ \mu C$, $q_{2\,\mu F} = 250\ \mu C$		4. 3
5. 579	6. 6950	7. 5	8. (a) 5, (b) 64	9. 9
10. 2	11. 10	12. (a) 7500, (b) 75	13. 890, 10, 1430, 57, 16	14. 1500, 1260, 8
15. 9	16. Charge on 6 μF capacitor is 24 μC, Charge on 3 μF capacitor is 18 μC			18. (a) 400, (b) 2500
19. 10	20. 24	21. 550	22. 400	23. 160

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1. C	2. B	3. C	4. A	5. A	6. C	7. D	8. A	9. (*)	10. C
11. C	12. A	13. A	14. A	15. A	16. B	17. A	18. D	19. C	20. B
21. D	22. C	23. B	24. C	25. D	26. A	27. B	28. A	29. A	30. B

* No given option is correct

ARCHIVE: JEE ADVANCED

Single Correct Choice Type Problems

1. D	2. C	3. D	4. C	5. A	6. D	7. D	8. D	9. C	10. B
11. A									

Multiple Correct Choice Type Problems

1. A, D	2. B, D	3. B, C	4. A, C, D	5. B, D	6. A, D

Integer/Numerical Answer Type Questions

1. 1