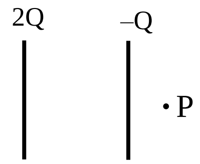
PHYSICS

Q.1 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 potencial difference between the plates will be 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 $\frac{Q^2}{2\pi\epsilon_0 d^2}$ **[D]**

Sol. $E = \frac{2Q}{2A\varepsilon_0} + \frac{Q}{2A\varepsilon_0} \Rightarrow E = \frac{3Q}{2A\varepsilon_0}$

$E = \frac{3}{2}\frac{Q}{Cd} \Rightarrow Ed = \frac{3Q}{2C} = V$

(ii) F = EQ/2

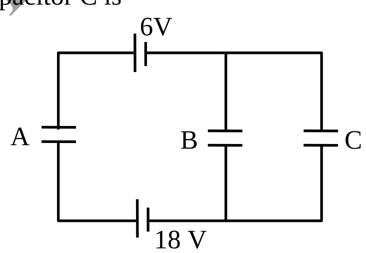
$F = \left(\frac{2Q}{2A\varepsilon_0}\right) \times \frac{(-Q)}{1} = \frac{-Q^2}{A\varepsilon_0}$

$F = \frac{Q^2}{A\varepsilon_0}$

(iii) Energy = $\frac{1}{2}\varepsilon_0 E^2 Ad$

$= \frac{1}{2}\varepsilon_0\left(\frac{3Q}{2cd}\right)^2 Ad = \frac{9}{8}\frac{Q^2}{C}$

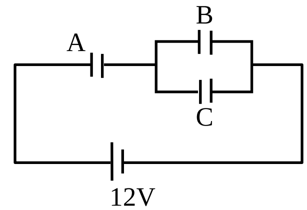
Q.2 Three capacitors A,B and C each of capacitance 1μF are connected as shown. The charge on capacitor C is –



(A) 4 μC (B) 6 μC

(C) 8 μC (D) 2 μC **[A]**

Sol. Equivalent circuit



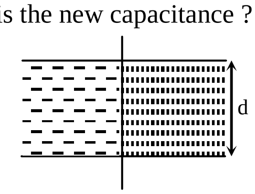
Q.3 A parallel plate capacitor is made by stacking 10 identical metallic plates equally spaced from one another and having the same dielectric between the plates. The alternate plates are then connected. If capacitor formed by two neighbouring plates has a capacitance C, the total capacitance of combination will be -

(A) $\frac{C}{10}$ (B) $\frac{C}{9}$

(C) 9C (D) 10C **[C]**

Sol. C_{eq} = (n – 1) C = 9C

Q. 4 A capacitor of capacitance 1 μF is filled with two dielectrics of dielectric constants 4 and 6. What is the new capacitance ?



(A) 10 μF (B) 5 μF

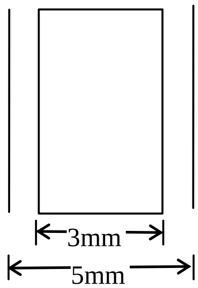
(C) 4 μF (D) None of these **[A]**

Sol. $C_{eq} = \left(\frac{\in r_1 + \in r_2}{2}\right)C$

$= \left(\frac{4+6}{2}\right)$ (1μF) = 5μF

Q. 5 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

Sol. **[C]**

The capacitor is charged by a battery of 25 V. Let the magnitude of surface charge density on each plate be σ. Before inserting the dielectric slab, electric field strength between the plates,

$$E = \frac{\sigma}{\varepsilon_0} = \frac{V}{d}$$

or $\quad E = \frac{\sigma}{\varepsilon_0} = \frac{25}{5\times10^{-3}} = 5000$ N/C

The capacitor is disconnected from the battery but charge on it will not change so that σ has the same value. When a dielectric slab of thickness 3mm is placed between the plates, the thickness of air between the plates will be 5 – 3 = 2 mm. Electric field strength in air will have the same value (5000 N/C) but inside the dielectric, it will be $\frac{5000}{K} = \frac{5000}{10}$

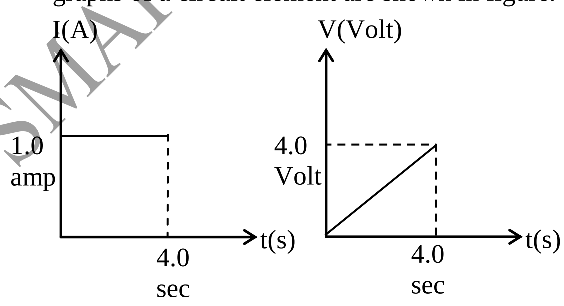
= 500 N/C

so potential difference = $E_{air}\, d_{air} + E_{med}\, d_{med}$

$= 5000 \times (2 \times 10^{-3}) + 500 \times (3 \times 10^{-3})$

= 11.5 V

Q.6 Current versus time and voltage versus time graphs of a circuit element are shown in figure.



The type of the circuit element is :

(A) capacitance of 2 F

(B) resistance of 2Ω

(C) capacitance of 1 F

(D) a voltage source of e.m.f 1 V

Sol. **[C]**

In case of a capacitor

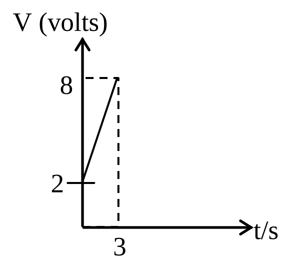
$$q = CV$$

$$\therefore \qquad i = \frac{dq}{dt} = C\left(\frac{dV}{dt}\right)$$

$$\frac{dV}{dt} = \frac{4.0}{4.0}\ \text{V/s} = 1.0\ \text{V/s}$$

Therefore, if C = 1 F then i = 1×1 = 1A (constant)

Q. 7 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 shown in the figure. The element in the box is :



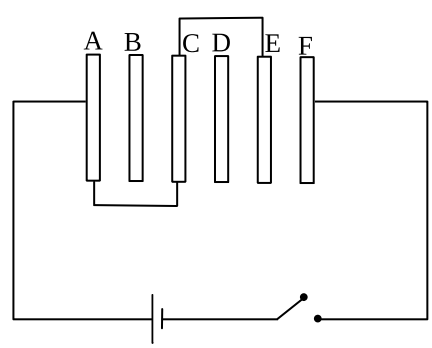
(A) a resistance of 2 ohm

(B) a battery of e.m.f 6 V

(C) an inductance of 2 H

(D) a capacitance of 0.5 F **[D]**

Q.8 A,B,C,D,E,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) $\frac{5\varepsilon_0 A}{12d}V^2$

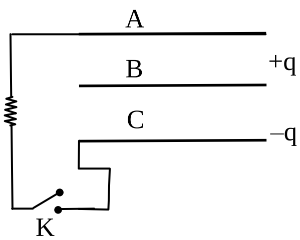
(C) $\frac{\varepsilon_0 A}{2d}V^2$ (D) $\frac{\varepsilon_0 A}{d}V^2$

Sol. **[C]**

$C_{eff} = \dfrac{\varepsilon_0 A}{d}$ since effective capacitance between plates A and E is zero

$\therefore U = \dfrac{1}{2} CV^2 = \dfrac{\varepsilon_0 A}{2d} V^2$

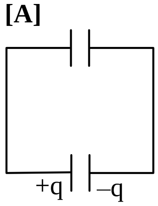
Q.9 Three identical metal plates of area 'A' are at distance d_1 & d_2 from each other. Metal plate A is uncharged, while plate B & C have respective charges +q & – q. If metal plates A &C are connected by switch K through a consumer of unknown resistance, what energy does the consumer give out to its surrounding ? Assume $d_1 = d_2 = d$



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

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

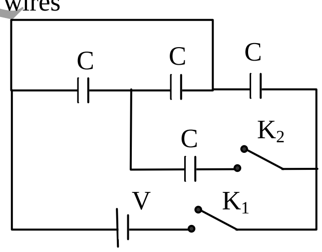
Sol. **[A]**



$$\text{Energy loss} = \frac{1}{2}\frac{C^2}{C+C} \times V^2 = \frac{1}{2}\frac{C}{2} \times \frac{q^2}{C^2}$$

$$= \frac{q^2}{4C} = \frac{q^2 d}{4\varepsilon_0 A}$$

Q.10 Initially K_1 is closed, now if K_2 is also closed, find the heat dissipated in the resistances of connecting wires

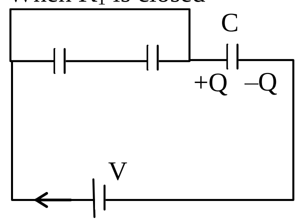


(A) $\dfrac{1}{2} CV^2$ (B) $\dfrac{2}{3} CV^2$

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

Sol. **[C]**

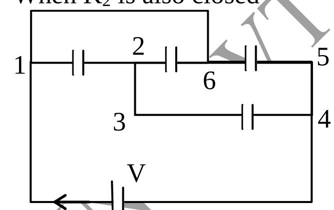
When K_1 is closed



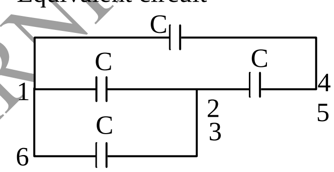
$Q = CV$

energy $U_i = \dfrac{1}{2} CV^2$

When K_2 is also closed



Equivalent circuit



$C_{eq} = C + \dfrac{2C}{3} = \dfrac{5C}{3}$

Energy $U_f = \dfrac{1}{2} \times \dfrac{5C}{3} V^2 = \dfrac{5}{6} CV^2$

Charge supplied by battery after closing K_2

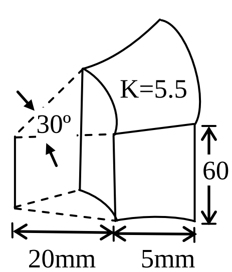
$= \dfrac{5}{3} CV - CV = \dfrac{2}{3} CV$

Energy supplied by battery = $U_f - U_i + \Delta H$

$\dfrac{2}{3} CV^2 = \dfrac{5}{6} CV^2 - \dfrac{1}{2} CV^2 + \Delta H$

$\therefore \Delta H = \dfrac{1}{3} CV^2$

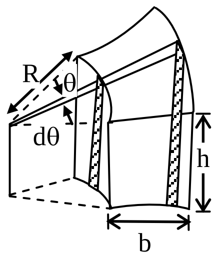
Q. 11 Find the capacitance between the inner & outer curved conductor surface as shown in figure



(A) 6.86 PF (B) 1.86 PF

(C) 3.26 PF (D) 12.63 PF

Sol. **[A]**



$$dc = \frac{\epsilon_0 \, KRd\theta \times h}{b}$$

all small discs are in parallel

$$\therefore C_{eq} = \sum dc = \int_{\theta=0}^{\frac{\pi}{6}} dc$$

$$= \frac{6Kh}{b} R \int_{\theta=0}^{\frac{\pi}{6}} d\theta$$

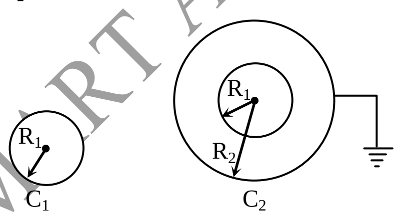
$$= \frac{\pi}{6} \times \frac{\epsilon_0 \, khR}{b}$$

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

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

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

Sol. **[B]**



$C_1 = 4\pi\varepsilon_0 R_1$

and $C_2 = 4\pi\varepsilon_0 \left(\frac{R_1 R_2}{R_2 - R_1}\right)$

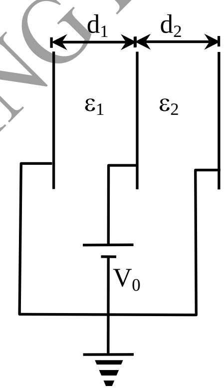
Given that $C_2 = nC_1$

or $\frac{R_2 R_1}{R_2 - R_1} = nR_1$

or $\frac{R_2/R_1}{R_2/R_1 - 1} = n$

or $\frac{R_2}{R_1} = \frac{n}{n-1}$

Q. 13 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 & ε_2 respectively. What is the surface charge density on the middle plate ?

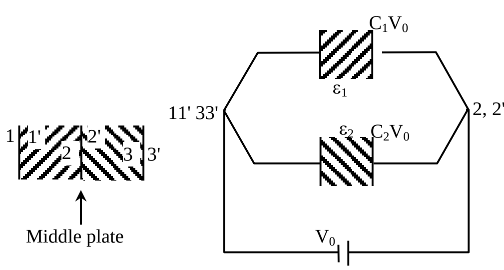


(A) $\varepsilon_0 V\left[\frac{\varepsilon_1}{d_1} + \frac{\varepsilon_2}{d_2}\right]$ (B) $-\varepsilon_0 V\left[\frac{\varepsilon_1}{d_1} + \frac{\varepsilon_2}{d_2}\right]$

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

Sol. **[A]**

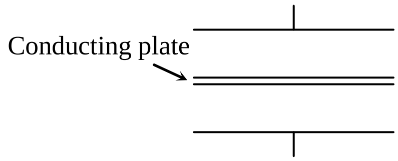
Equivalent circuit



$$\text{Total charge on 2 \& 2' plate} = \left[\frac{\varepsilon_1 \varepsilon_0 A}{d_1} + \frac{\varepsilon_2 \varepsilon_0 A}{d_2}\right] V$$

$$\sigma = \varepsilon_0 V \left[\frac{\varepsilon_1}{d_1} + \frac{\varepsilon_2}{d_2}\right]$$

Q.14 A thin conducting plate is inserted in half way between the plates of a parallel plates capacitor of capacitance C.

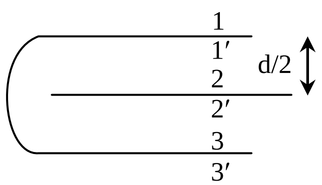


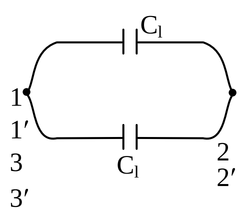
What does the value of capacitance, if both the plate of capacitor is shortened ?

(A) C (B) 2C

(C) 3C (D) 4C

Sol. **[D]**





$$= 2 \times \frac{(\in_0 A)\times 2}{d} = 4 \,.\, \frac{\in_0 A}{d} = 4C$$

Q.15 An air parallel plate capacitor has capacity C. When the area and distance between the plates is doubled, the capacitance is C_1, then $\frac{C_1}{C}$ is –

(A) 1 (B) 2

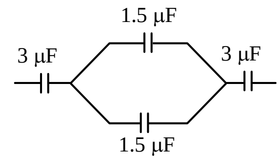
(C) 3 (D) 4 **[A]**

Sol. $C = \frac{\in_0 A}{d}$

$C_1 = \frac{\in_0 (2A)}{2d} = C$

$\frac{C_1}{C} = 1$

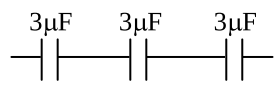
Q.16 Equivalent capacitance in the circuit is –



(A) 1.0 μF (B) 2.0 μF

(C) 1.5 μF (D) 3.0 μF **[A]**

Sol.



$\Rightarrow C_{eq} = 1\mu F$

Q.17 The two spherical shells are at large separation one of them has radius 10 cm and has 1.25 μC charge. The other is of 20 cm radius and has 0.75 μC charge. If they are connected by a conducting wire of negligible capacity, the charge on the shells are-

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

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

[A]

Sol. Total charge = 1.25 μC + 0.75 μC = 2 μC

$q_1' : q_2' = R_1 : R_2 = 1 : 2$

$$\left.\begin{aligned} \therefore\ q_1' &= \frac{1}{3}\times 2 = \frac{2}{3}\mu C \\ q_2' &= \frac{2}{3}\times 2 = \frac{4}{3}\mu C \end{aligned}\right]$$

Q.18 A capacitor of 10 μF is connected to a source of 50 V and then disconnected. When the space between the plates is filled with teflon of dielectric constant 2.5. The new potential difference is –

(A) 20 V (B) 20.8 V

(C) 23.8 V (D) 25 V **[A]**

Sol. Battery disconnected so Q = constant

C' = 2.5 C

$V = \frac{Q}{C} \propto \frac{1}{C}$

$\therefore\ V' = \frac{V}{2.5} = \frac{50}{2.5} = 20$ volt

Q.19 Two metal spheres of capacitances C_1 and C_2 carry some charges. They are put in contact and then separated. The final charges Q_1 and Q_2 on them will satisfy -

(A) $\frac{Q_1}{Q_2} < \frac{C_1}{C_2}$ (B) $\frac{Q_1}{Q_2} = \frac{C_1}{C_2}$

(C) $\frac{Q_1}{Q_2} > \frac{C_1}{C_2}$ (D) $\frac{Q_1}{Q_2} = \frac{C_2}{C_1}$ **[B]**

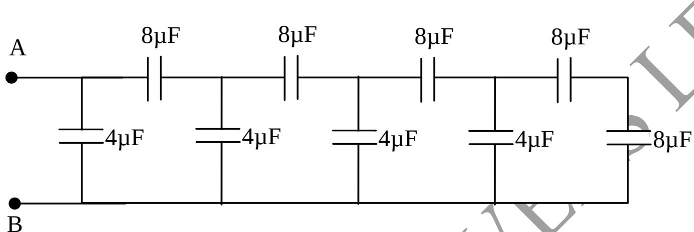
Q.20 How much positive charge should be given to the earth so that to have same potential that of a positively charged sphere of 1 μC and radius 1 cm. Radius of earth = 6400 km -

(A) 600 Coulomb (B) 640 Coulomb

(C) 340 Coulomb (D) 240 Coulomb

[B]

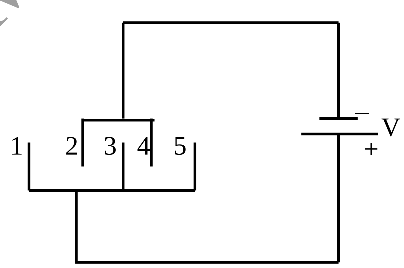
Q.21 Find the equivalent capacitance between A and B.



(A) 2 μF (B) 6 μF

(C) 8 μF (D) 12 μF **[C]**

Q.22 Five identical plates each of area A are joined as shown in the figure the distance between the plates is d. The plates are connected to a potential difference of V volts. The charges 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) $\frac{-\varepsilon_0 AV}{d}, \frac{-2\varepsilon_0 AV}{d}$ **[C]**

Q.23 A condenser of capacitance 10 μF 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 **[A]**

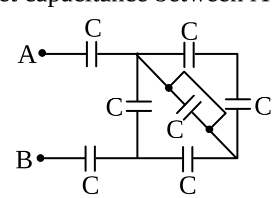
Sol. $C_1 = 10\mu F$ $C_2 = ?$

$V_1 = 100$ V $V_2 = 0$

$V_{common} = 40$ V

$V_{common} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

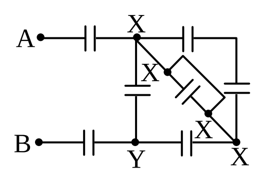
Q.24 The net capacitance between A and B is

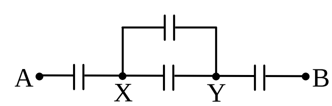


(A) 6 C (B) $\frac{2C}{5}$

(C) $\frac{2C}{3}$ (D) None of these **[B]**

Sol. Use Junction method

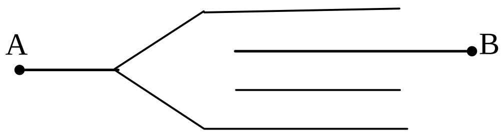




$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{2C} + \frac{1}{C}$$

$$\therefore\ C_{eq} = \frac{2C}{5}$$

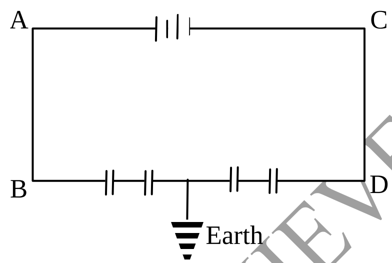
Q.25 If C_0 is the capacitance between two adjacent plates, find the capacitance of the combination between A and B –



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

(B) $\frac{C_0}{4}$ (D) $2C_0$ **[B]**

Q.26 Four equal capacitors , each with a capacitance (C) are connected to a battery of E.M.F 10 volts as shown in the adjoining figure. The mid point of the capacitor system is connected to earth. Then the potentials of B and D are respectively –



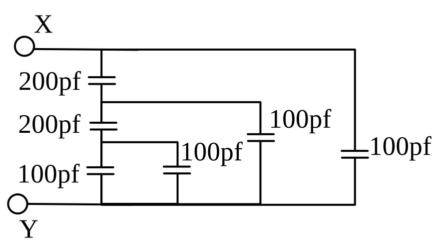
(A) + 10 volts, zero volts

(B) + 5 volts, – 5 volts

(C) – 5 volts, + 5volts

(D) zero volts, 10 volts **[B]**

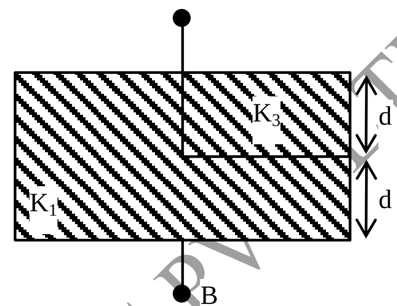
Q.27 The equivalent capacity between the terminals X and Y in the figure shown will be –



(A) 100 pF (B) 200 pF

(C) 300 pF (D) 400 pF **[B]**

Q.28 What is the capacitance of the capacitor of square plates of area A, Shown in figure –

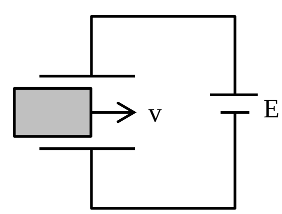


(A) $\frac{\in_0 A}{4d}\,\frac{K_1K_2}{K_1+K_2}$ (B) $\frac{\in_0 A}{d}\,\frac{K_1(K_1+K_2)}{3K_1+K_2}$

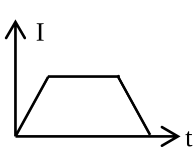
(C) $\frac{\in_0 A}{4d}\,\frac{K_1(K_1+3K_2)}{K_1+K_2}$ (D) $\frac{\in_0 A}{4d(K_1+3K_2)}$

[C]

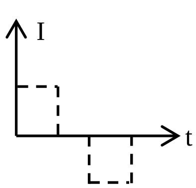
Q.29 A dielectric slab of area A and thickness d is inserted between the plates of a capacitor of area 2A and distance between plates d with a constant speed v as shown in the fig. The capacitor is connected to a battery of emf E. The current in the circuit varies with time as



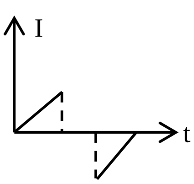
(A)



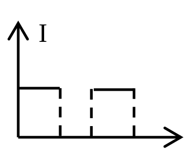
(B)



(C)



(D)



[B]

Q.30 Find the capacitance of a system of three parallel plates each of area A separated by distance d_1 and d_2. The space between them is filled with dielectrics of relative dielectric constants ε_1 and ε_2. The dielectric constant of free space is ε_0 –

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

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

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

(D) $\dfrac{A}{\varepsilon_1\varepsilon_2\varepsilon_0(\varepsilon_1 d_1 + \varepsilon_2 d_2)}$ **[A]**

Q.31 For making a parallel plate capacitor , two plates of copper, a sheet of mica (thickness = 0.1 mm, K = 5.4), a sheet of glass (thickness = 0.2 mm, K = 7) and a slab of paraffin (thickness = 1.0 cm, K = 2) are available. To obtain the largest capacitance, which sheet should you place between the copper plates ?

(A) Mica (B) Glass
(C) Paraffin (D) None of these

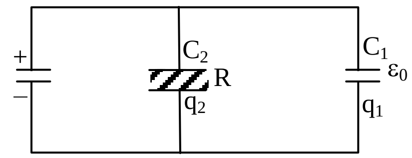
[A]

Q.32 The capacity of a parallel plate condenser is C_0. If a dielectric of relative permittivity ε_r and thickness equal to one fourth the plate separation is placed between the plates, then its capacity becomes C. Then value of $\dfrac{C}{C_0}$ will be-

(A) $\dfrac{5\varepsilon_r}{4\varepsilon_r + 1}$ (B) $\dfrac{4\varepsilon_r}{3\varepsilon_r + 1}$

(C) $\dfrac{3\varepsilon_r}{2\varepsilon_r + 1}$ (D) $\dfrac{2\varepsilon_r}{\varepsilon_r + 1}$ **[B]**

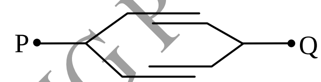
Q.33 In the adjoining diagram the capacitors C_1 and C_2 are connected to battery. Air is filled between the plates of C_1 and a dielectric is filled between the plates C_2, then -



(A) $q_1 < q_2$ (B) $q_1 > q_2$
(C) $q_1 + q_2$ (D) None of these

[A]

Q.34 Figure below shows four plates each of area A and separated from one another by a distance d. What is the capacitance between P and Q –

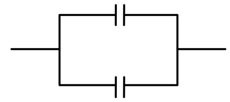


(A) $\dfrac{\varepsilon_0 A}{d}$ (B) $\dfrac{2\varepsilon_0 A}{d}$

(C) $\dfrac{3\varepsilon_0 A}{d}$ (D) $\dfrac{4\varepsilon_0 A}{d}$ **[B]**

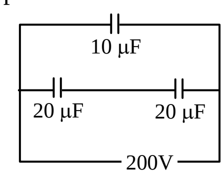
Sol. By using point potential method

equivalent circuit is



$\therefore\ C_{eq} = \dfrac{2\in_0 A}{d}$

Q.35 In the adjoining figure given below, charge on 10 μF capacitor is –

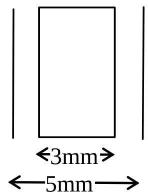


(A) 2×10^{-3} C (B) 16×10^{-4} C
(C) 4×10^{-3} C (D) 8×10^{-4} C **[A]**

Sol. $V_{10\mu F} = 200V$

$\therefore\ Q = CV = (10 \times 10^{-6})(200) = 2 \times 10^{-3}$ C

Q.36 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

Sol. **[C]**

The capacitor is charged by a battery 25 V. Let the magnitude of surface charge density on each plate be σ. Before inserting the dielectric slab, field strength between the plates,

$$E = \frac{\sigma}{\varepsilon_0} = \frac{V}{d}$$

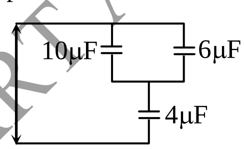
or $$E = \frac{\sigma}{\varepsilon_0} = \frac{25}{5\times10^{-3}} = 5000 \text{ N/C}$$

The capacitor is disconnected form the battery but charge on it will not change so that σ has the same value. When a dielectric slab of thickness 3 mm is placed between the plates, the air thickness between the plates will be 5 – 3 = 2 mm. Electric field strength in air will have the same value (5000 N/C) but inside the dielectric, it will be $\frac{5000}{K} = \frac{5000}{10} = 500$ N/C

So potential difference

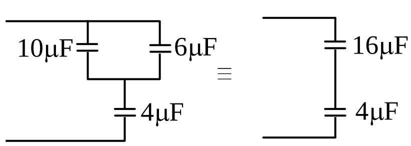
$$= E_{air}\, d_{air} + E_{med}\, d_{med}$$
$$= 5000 \times (2\times10^{-3}) + 500 \times (3\times10^{-3})$$
$$= 11.5\text{V}$$

Q.37 The equivalent capacitance of the combination of the capacitors is –



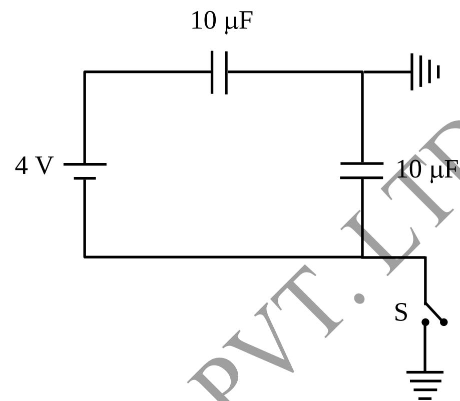
(A) 3.20 μF (B) 7.80 μF
(C) 3.90 μF (D) 2.16 μF **[A]**

Sol.



$$C_{eq} = \frac{16\times4}{16+4} = 3.20\ \mu\text{F}$$

Q.38 In the given fig. the work done by battery after the switch S is closed –



(A) 100 μJ (B) – 100 μJ
(C) 80 μJ (D) – 80 μJ **[C]**

Sol. Before the switch S is closed

$Q_i = C_{eq}\, V$
$= 5 \times 4 = 20\ \mu C$

When the switch S is closed

$Q_f = CV$
$= 10 \times 4 = 40\ \mu C$

$W(\text{cell}) = \Delta QE = (Q_f - Q_i) \times E$
$= 20 \times 4 = 80\ \mu J$

Q.39 A capacitor stores 50 μC charge when connected across a battery. When the gap between the plates is filled with a dielectric, a charge of 100 μC flows through the battery. The dielectric constant of the material is -

(A) 2.5 (B) 2
(C) 4 (D) 3 **[D]**

Sol. $Q_1 = C_1V$

$Q_2 = C_2V$

$$\frac{50}{150} = \frac{\varepsilon_0}{K\varepsilon_0}$$

K = 3

Q.40 Three identical, parallel conducting plates A, B and C are placed as shown. Switches S_1 and S_2 are open, and can connect A and C to earth when closed. +Q charge is given to B. Then:

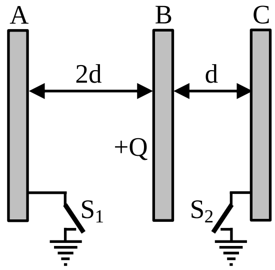


Fig.

(A) If S_1 is closed with S_2 open, a charge of amount Q will pass through S_1

(B) If S_2 is closed with S_1 open, a charge of amount Q will pass through S_2

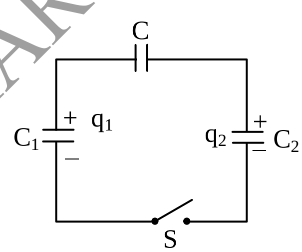
(C) If S_1 and S_2 are closed together, a charge of amount Q/3 will pass through S_1 and a charge of amount 2Q/3 will pass through S_2

(D) All of the above statements are incorrect **[D]**

Sol. When either A or C is earthed (but not both together), a parallel-plate capacitor is formed with B, with ±Q charges on the inner surfaces. [The other plate, which is not earthed, plays no role]. Hence, charge of amount +Q flows to earth.

When both are earthed together, A and C effectively become connected. The plates now form two capacitors in parallel with capacitances in the ratio 1:2 and hence, share charges Q in the same ratio.

Q.41 Two capacitor C_1 & C_2, charged with q_1 & 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 $q_1C_2 > q_2 C_1$

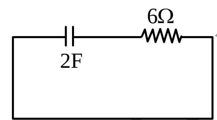
(C) C gets charged only when $q_1C_2 < q_2C_1$

(D) C gets charged when $q_1C_2 \neq q_2 C_1$ **[D]**

Sol. Charge in the circuit flows only when potential difference across C_1 is either greater or less than that across C_2

ie. $\frac{q_1}{C_1} \neq \frac{q_2}{C_2}$ $\therefore$ $q_1 C_2 \neq q_2C_1$

Q.42 In the condenser show in the circuit is charged to 5V and left in the circuit, in 12 s the charge on the condenser will become –



(A) $\frac{10}{e}$ C (B) $\frac{e}{10}$ C

(C) $\frac{10}{e^2}$ (D) $\frac{e^2}{10}$ C **[A]**

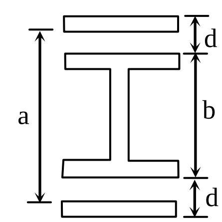
Sol. During discharge

$q_c = CE\left(e^{\frac{-t}{RC}}\right)$

$= 2 \times 5\left(e^{-\frac{12}{12}}\right)$

$= \frac{10}{e}$

Q.43 Two capacitors are joined in series as shown in figure. The area of each plate is A. The equivalent of the combination is –

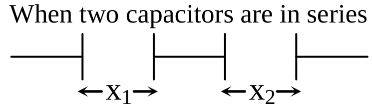


(A) $\frac{\varepsilon_0 A}{d_1 - d_2}$ (B) $\frac{\varepsilon_0 A}{a - b}$

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

[B]

Sol. When two capacitors are in series



$$\Rightarrow \frac{1}{C_{eq}} = \frac{x_1}{\epsilon_0 A} + \frac{x_2}{\epsilon_0 A} = \frac{x_1 + x_2}{\epsilon_0 A}$$

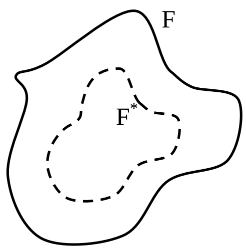
$\therefore C_{eq} = \dfrac{\epsilon_0 A}{x_1 + x_2}$

$= \dfrac{\epsilon_0 A}{\text{Sum of separations between plates}}$

Now in given arrangement
Capacitors are in series
& sum of separations = a – b

$\therefore C_{eq} = \dfrac{\epsilon_0 A}{a - b}$

Q.44 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 **[B]**

Sol. $U_i = \dfrac{Q^2}{2C_i}$

$U_f = \dfrac{Q^2}{2C_f}$

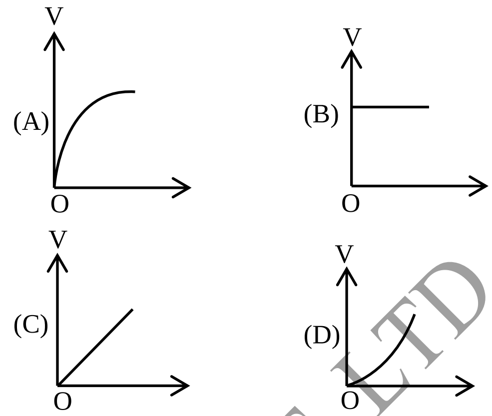
As surface was deformed in such a way that charge on original surface are coming closer or moving perpendicular to electric force acting on them total energy of foil get increase.

$U_f > U_i$

$\dfrac{Q^2}{2C_f} > \dfrac{Q^2}{2C_i}$

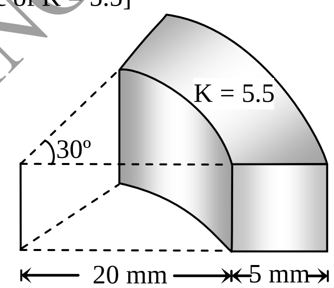
$C_i > C_f$

Q.45 If the current, charging a capacitor, is kept constant then the potential difference V across the capacitor varies with time t as –



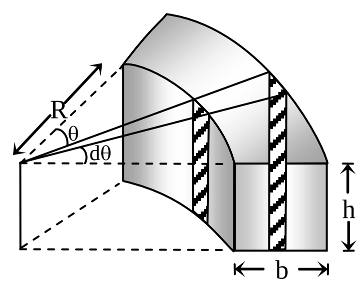
[C]

Q.46 Find the capacitance between the inner and outer curved cylindrical conductor surface as shown in figure :
[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 **[A]**

Sol.



$dC = \dfrac{\varepsilon_0 K R d\theta \times h}{b}$

All small dC are in parallel

$\therefore C_{eq} = \Sigma dC = \displaystyle\int_{\theta=0}^{\frac{\pi}{6}} dC$

$= \dfrac{6KhR}{b} \displaystyle\int_{\theta=0}^{\frac{\pi}{6}} d\theta = \dfrac{\pi}{6} \times \dfrac{\varepsilon_0 KhR}{b}$

Q.47 A parallel plate capacitor is made by stacking n equally spaced plates connected alternately. If the capacitance between any two plates is C. Then the resultant capacitance is -

(A) C (B) nC

(C) (n – 1) C (D) (n +1) C **[C]**

Q.48 A capacitor of capacitance 160 μF is charged to a potential difference of 200V and then connected across a discharge tube which conducts until the potential deference across it has failed to 100 V. The energy dissipated in the tube is -

(A) 6.4 J (B) 4.8 J

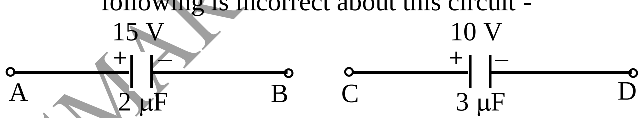
(C) 3.2 J (D) 2.4 J **[D]**

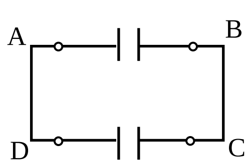
Q.49 A capacitor of capacitance C is charged to a potential difference V_0. The charging battery is disconnected and the capacitor is connected to a capacitor of unknown capacitance C_x. The P.D. across the combination is V. The value of C_x should be-

(A) $\frac{C(V_0 - V)}{V}$ (B) $\frac{C(V - V_0)}{V}$

(C) $\frac{CV}{V_0}$ (D) $\frac{CV_0}{V}$ **[A]**

Q.50 In the figure initial status of capacitance and their connection is shown. Which of the following is incorrect about this circuit -





(A) Final charge on each capacitor will be zero

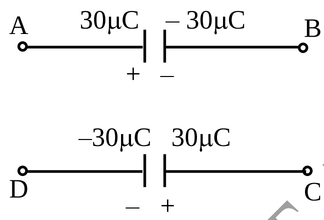
(B) Final total electrical energy of the capacitors will be zero

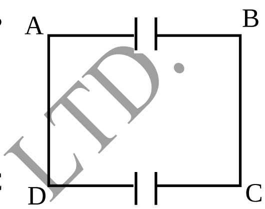
(C) Total charge flown from A to D is 30 μC

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

[D]

Sol. $V = \frac{Q_1 + Q_2}{C_1 + C_2} = 0$





Final potential difference = zero

final charge = zero