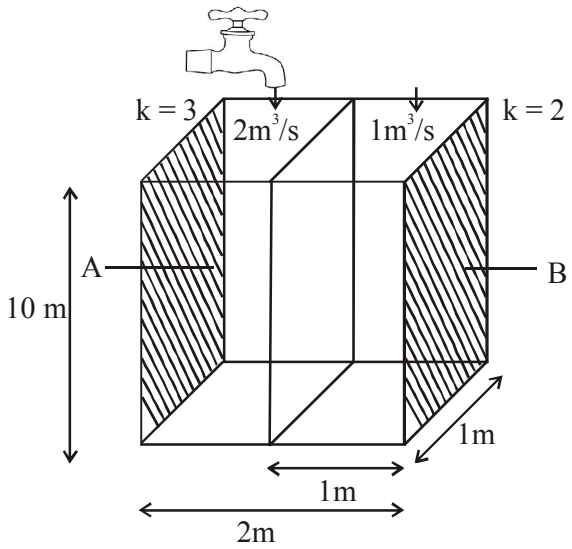
SECTION-I

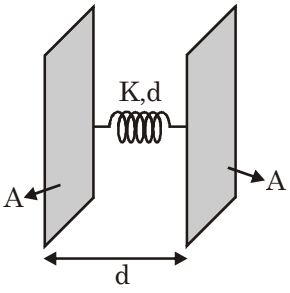
Single Correct Answer Type 5 Q. [3 M (–1)]

1. A thin metallic partition of negligible thickness is inserted between two shaded metallic plates as shown. The remaining ends are then packed with insulating plates to form a container like structure. 2 taps shown are opened at t = 0 and finally closed at t = 5s. Find capacitance of system between A and B after closing taps. (Assume liquid to be non conducting) Volumetric flow rates and dieletric constants of liquid are given.



(A) 8.62×10^{-11}F (B) 8.85×10^{-10}F (C) 4.42×10^{-10}F (D) 4.42×10^{-11}F

2. Consider the figure below, initially distance between plates is 'd' and 'A' is area of plates. In this state spring is at its natural length. Now, charges +Q & –Q are given to plates and system is allowed to reach mechanical equillibrium. Find potential difference between plates in this state of equillibrium.

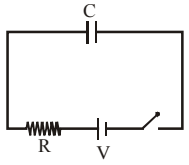


(A) $V = \frac{Qd}{A\varepsilon_0}\left(1 - \frac{Q^2}{2\varepsilon_0 AKd}\right)$ (B) $V = \frac{Qd}{2A\varepsilon_0}\left(1 - \frac{Q^2}{2\varepsilon_0 AKd}\right)$

(C) $V = \frac{Qd}{A\varepsilon_0}\left(1 - \frac{Q^2}{4\varepsilon_0 AKd}\right)$ (D) $V = \frac{Qd}{A\varepsilon_0}\left(1 - \frac{Q^2}{\varepsilon_0 AKd}\right)$

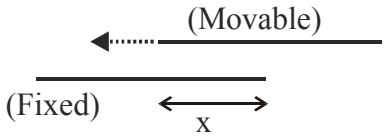
3. In an RC circuit, the time required for the charge on a capacitor to build up to a given fraction of its equilibrium value, is independent of :
(A) the value of the applied emf to the circuit
(B) the value of C
(C) the value of R
(D) none of the above

4. In the circuit shown capacitor is initially uncharged and switch is closed at t = 0. Find the time at which power dissipated in resistor is equal to rate of energy change in capacitor :-



(A) RC (B) RC ℓn 2 (C) RC ℓn 3 (D) 2RC ℓn2

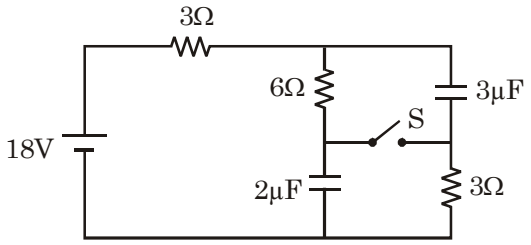
5. A parallel-plate capacitor consists of a fixed plate and a movable plate that is allowed to slide in the direction parallel to the plates. Let *x* be the distance of overlap, as shown in the figure. The separation between the plates is fixed. Assume that the plates are electrically isolated, so that their charges ±Q are constant. Force on the movable plate is proportional to :-



(A) x^{-2} (B) x^{-1} (C) x^{0} (D) x

Multiple Correct Answer Type 5 Q. [4 M (–1)]

6. The given circuit is in steady state with the switch closed. At t = 0 switch is opened, which of the following is/are correct ?



(A) Charge on 2μF before the switch is open is 9μC

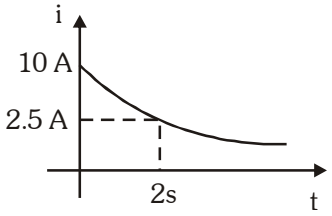
(B) Charge on 3μF before the switch is open is 27μC

(C) voltage across 3μF, a long time after the switch is opened is 18V.

(D) voltage across 2μF, a long time after the switch is opened is 18V

7. The figure, a graph of the current in a discharging circuit of a capacitor through a resistor of resistance of reistance 10Ω.

(A) The initial potential difference across the capactitor is 100 volt.

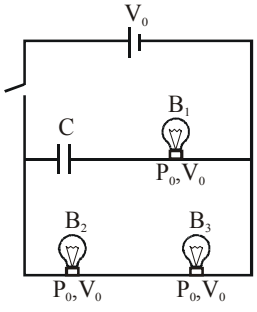


(B) The capacitance of the capacitor is $\frac{1}{10\ell n2}F$.

(C) The total heat produced in the circuit will be $\frac{500}{10\ell n2}$ joules.

(D) The thermal power in the resistor will decrease with a time constant $\frac{1}{2\ell n2}$ second.

8. An uncharged capacitor is connected in circuit as shown in figure. Power ratings of bulbs are given. At t = 0 switch is closed :-



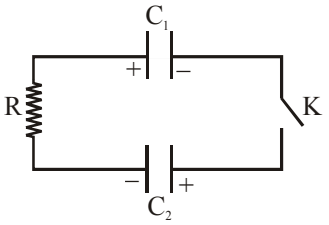
(A) At t = 0, power consumption in circuit is $\frac{3P_0}{2}$

(B) After a long time power consumption in circuit is $\frac{P_0}{2}$

(C) Brightness of B_1 decreases with time

(D) Initially brightness of B_2 is less than B_1 but later B_2 will be brighter

9. Figure shows the polarity and charge on capacitor with K open.



(Given : $C_1 = 2F$, $Q_1 = 4C$, $C_2 = 4F$, $Q_2 = 16C$ and $R = 10\Omega$)

(A) After closing the key, electrostatic electric field between plates of one of capacitor momentarily becomes zero at some instant.

(B) Overall, the circuit would suffer heat loss.

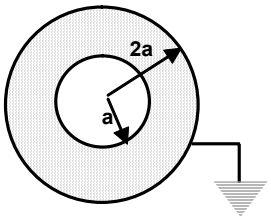
(C) Final charge on 2F capacitor would be 4C (one of the plates) with polarity reversed with respect to initial condition.

(D) Final charge on 4F capacitor would be 8C with polarity reversed with respect to initial condition.

10. The space between two concentric conducting spherical shells of radius a and 2a is filled with a dielectric medium having dielectric constant K and resistivity ρ. The inner sphere is given a charge +Q at t = 0 and outer is earthed then

(A) charge on inner sphere as a function of time is $Qe^{-\frac{t}{\varepsilon_0 K\rho}}$

(B) charge on inner sphere as a function of time is $Qe^{-\frac{2t}{\varepsilon_0 K\rho}}$



(C) resistance is $\frac{\rho}{8\pi a}$

(D) resistance is $\frac{\rho}{4a}$

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Questions no. 11 to 13

It is possible to take a high quality photograph of a very fast moving object by illuminating the object for quite a small fraction of a second. You may have come across photographs of a bullet penetrating a banana or an apple in many text books or magazines. This is called 'Stop action' photography because the fast moving object travels a very short distance during the time of illumination. Harold Edgerton, the inventor of stroboscope, was a pioneer of this kind of photography.

A normal photographic plate works properly if it receives an energy of 4J during the exposure. To release this energy in a very small fraction of time, huge amount of power is required. Such huge power can not be generated directly from a battery because of its high internal resistance. To produce such power a capacitor is used. The time in which a capacitor discharges can be very short. Although, theoretically it would take a long time for a capacitor to discharge completely, it discharges almost completely in about 10 time constants. Consider the following situation. A capacitor of 200μF, storing 4J energy is made to discharge through a flash light in 2ms. This setup is used to take the picture of a bullet moving at a speed of 100 m/s. Assume that the flash light acts as a resistor and there is no other resistance in the circuit.

11. If we use a lens of power 10 diopters, the lens to photographic plate distance is 15 cm and the bullet moves perpendicular to the principal axis, what is the distance covered by bullet as seen on photographic plate in 2ms ?

(A) 1 cm (B) 5 cm (C) 10 cm (D) 20 cm

12. What is the order of energy delivered to the flash light in 2 ms (approx.) ?

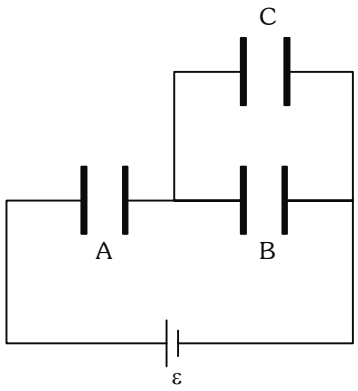
(A) 0.4 J (B) 1.83 J (C) 2.74 J (D) 3.45 J

13. What is the initial current in the circuit ?

(A) 200 A (B) 120 A (C) 700 A (D) 3700 A

Matching List Type (4 × 4) 1 Q. [3 M (–1)]

14. Three capacitor A, B and C are connected with battery of emf ε. All capacitors are identical initially.



List-I

(P) If dielectric slab is inserted between plates of capacitor B slowly with the help of external force, then

(Q) If dielectric slab is inserted between plates of capacitor A slowly with help of external force.

(R) If capacitor C is removed from the circuit, (assuming without any work)

(S) If separation between plates of capacitor A is slowly increased by external force, then

List-II

(1) Chemical energy of battery remains unchanged

(2) Positive work is done on the given system by external force.

(3) Force between plates of capacitor C decreases.

(4) Magnitude of change of charge on B and C is same.

Code :

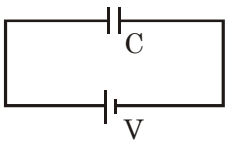
	P	Q	R	S
(A)	3	3	1,3	3,4
(B)	3,4	4	1,3	2,3,4
(C)	3	4	1,4	2,3,4
(D)	3,4	3	1,4	3,4

Matching List Type (4 × 5) 1 Q. [3 M (–1)]

15. Match the condition given in list-I to the corresponding changes in list-II.

List-I

(P) A capacitor C is connected to a battery of potential difference V. Now a dielectric of dielectric constant K is placed keeping the battery connected



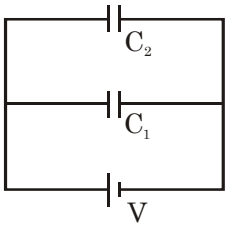
(Q) A capacitor C is charged to a potential difference V and isolated from the battery. Now a dielectric of dielectric constant K is placed between the plates of the capacitor.

List-II

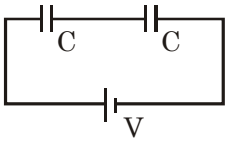
(1) Electric field between the plates of capacitor in which dielectric is placed decreases.

(2) Potential difference between the plates of capacitor in which dielectric is placed remains unchanged.

(R) Two identical capacitors each of capacitance C are connected in parallel to a battery of potential difference V and isolated from the battery. Now a dielectric of dielectric constant K is placed between one of the capacitors keeping the system isolated.



(S) Two identical capacitors are connected in series with a battery of potential difference V. Now a dielectric constant K is placed between the plates of one of the capacitors



(3) Capacitance of the capacitor in which dielectric is placed increases.

(4) Energy of capacitor in which dielectric is placed increases.

(5) Energy stored in the capacitor in which dielectric is placed decreases.

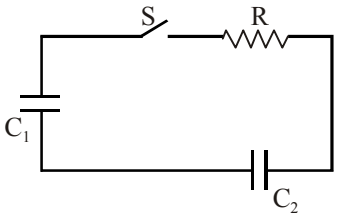
(A) P → 2,3,4; Q → 1,3,4; R → 1,3,5; S → 1,3,4
(B) P → 2,3,4; Q → 1,3,5; R → 1,3,5; S → 1,3,5
(C) P → 2,3; Q → 1,5; R → 3,5; S → 1,2,5
(D) P → 1,2,3,4; Q → 1,2,3,5; R → 2,3,5; S → 1,3,4

SECTION-II

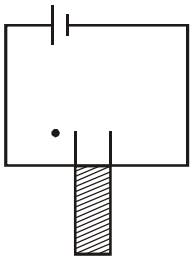
Numerical Answer Type Question **3 Q. [3(0)]**
(upto second decimal place)

1. An uncharged capacitor and a resistor of big resistance are connected in series to a battery of electromotive force 4.5 V. The voltage across the capacitor is 3 V one minute after the closing the circuit. What will the voltage across the capacitor be 2 min. after closing circuit (in V) ?

2. Consider the shown network, the capacitor C_1 (= 6μF) has an initial charge $q_0 = \frac{30e}{e-1}$ μC, $C_2 = 4$ μF and R = 80Ω. Initially C_2 is uncharged. At t = 0, the switch S is closed. Obtain the charge on C_2 (in μC) at t = 192 μs.



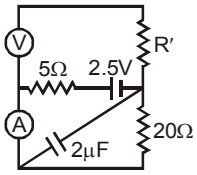
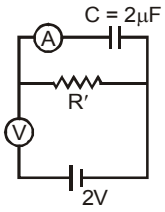
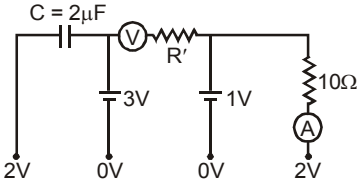
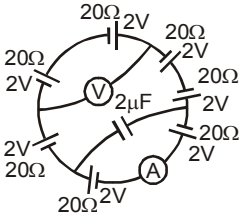
3. A dielectric slab of dielectric constant k, mass m, thickness d and area L × L is hanging vertically in equilibrium under the influence of gravity and electrostatic pull of a capacitor connected to a battery of voltage V. The capacitor has plates of area L × L and distance between plates is d. The capacitor is half filled by the dielectric. Suddenly a mass of m is attached to dielectric without any impulse on the system. The slab falls off in time t. Evaluate t (in sec). Take k = 2, V = 4 volts, L = 80 cm, d = 0.1 mm.



SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Column-I gives some electrical circuits in steady state, column-II gives some statements regrading the circuits match appropriately.

Column-I		**Column-II**
(A)		(P) Reading of voltmeter is 2 V
(B)		(Q) Reading of ammeter is 0.1 A
(C)		(R) Current through R′ is zero
(D)		(S) Charge on capacitor is 2μC
		(T) Current through R' is non-zero

CLASS TEST # 39 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **5 Q. [3 M (–1)]**

1. Ans. (A) **2. Ans. (A)** **3. Ans. (A)** **4. Ans. (B)**
5. Ans. (A)

Multiple Correct Answer Type **5 Q. [4 M (–1)]**

6. Ans. (A,B,C,D) **7. Ans. (A, B, C, D)** **8. Ans. (A,B,C,D)** **9. Ans. (A,B,C)**
10. Ans. (AC)

Linked Comprehension Type **(1 Para × 3Q.) [3 M (-1)]**
(Single Correct Answer Type)

11. Ans. (C) **12. Ans. (D)** **13. Ans. (A)**

Matching List Type (4 × 4) **1 Q. [3 M (–1)]**

14. Ans. (C)

Matching List Type (4 × 5) **1 Q. [3 M (–1)]**

15. Ans. (B)

SECTION-II

Numerical Answer Type Question **3 Q. [3(0)]**
(upto second decimal place)

1. Ans. 4.00 **2. Ans. 12.00** **3. Ans. 0.40**

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Ans. (A) → (P,Q,R) ; (B) → (P,R) ; (C) → (P,Q,R,S) ; (D) → (Q)