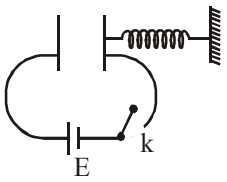
CLASS TEST

PHYSICS CLASS TEST # 41

SECTION-I

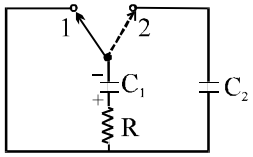
Single Correct Answer Type **6 Q. [3 M (–1)]**

1. A plate A of a parallel plate capacitor is fixed, while the plate B is attached to the wall by a spring and can move, remaining parallel to the plate A (see figure). The capacitor is charged, plate B starts moving & comes to rest in an equilibrium position. The separation between the plates d, decreases by 10%. What will be the decrease in the plate separation if the charging is done in a very short time that the plate B couldn't shift noticeably.



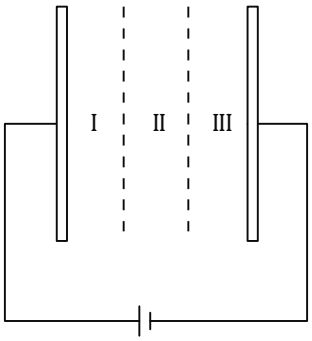
(A) 10 % (B) 8.1 % (C) 9 % (D) 6.3 %

2. A charged capacitor C_1 is discharged through a resistor R. When the discharge current attains the value I_0, the key is shifted from 1 to 2. Then the amount of heat Q liberated in the resistor starting from this moment, is



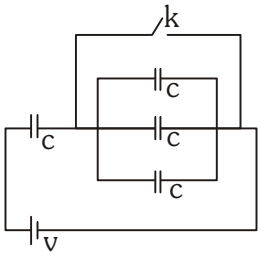
(A) $\frac{I_0^2R^2C_1C_2}{2(c_1+c_2)}$ (B) $\frac{I_0^2R^2C_1C_2}{4(c_1+c_2)}$ (C) $\frac{I_0^2R^2}{2}\left(\frac{(C_1+C_2)}{C_1C_2}\right)$ (D) None

3. The figure shows a capacitor having three layers of equal thickness and same area as that of plate. Layer I is vaccum, layer II is conductor and layer III is dielectric of dielectric constant K. The ratio of energy stored in region III to total energy stored in capacitor is :-



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

4. The charge flown through the cell on closing the key k is equal to



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

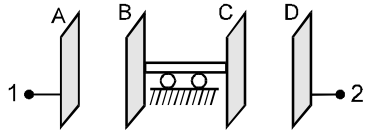
5. A,B,C,D are large conducting plates kept parallel to each other. A and D are fixed. Plates B and C, connected to each other by a rigid conducting rod can slide over frictionless rails as shown. Initially the distance between plates A and B is same as that between plates C and D. If now the rod (alongwith plates B and C) is slightly moved towards right, the capacitance between the terminals 1 and 2.

(A) remains unchanged

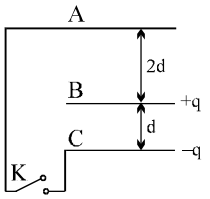
(B) increases

(C) decreases

(D) nothing can be said



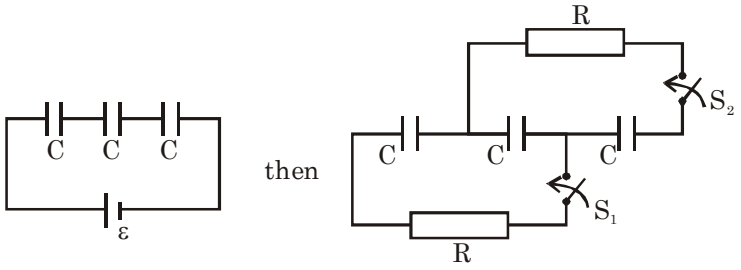
6. Three identical large metal plates of area A are at distances d and 2d from each other as shown. Metal plate A is uncharged, while metal plates B and C have respective charges +q and –q. Metal plates A and C are connected by switch K through a wire. How much energy is lost when switch is closed?



(A) $\frac{2q^2d}{3\varepsilon_0 A}$ (B) $\frac{q^2d}{6\varepsilon_0 A}$ (C) $\frac{q^2d}{3\varepsilon_0 A}$ (D) none of these

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

7. Three identical charge-less capacitors of capacitance C each are connected in series. The capacitors are charged by connecting a battery of electromotive force ε to the terminal as shown in figure. Next, the battery is disconnected, and two resistors of resistance R are connected simultaneously as shown in figure below. If switches S_1 & S_2 are closed simultaneously at time t = 0, then choose the **CORRECT** option(s):



(A) Current in any resistor R just after t = 0 is $\frac{2\varepsilon}{3R}$.

(B) Final magnitude of charge on all the capacitors will be same.

(C) Total heat loss through any one resistor is $\frac{4}{54}C\varepsilon^2$.

(D) Initial total energy stored in the system is $\frac{3}{2}C\varepsilon^2$.

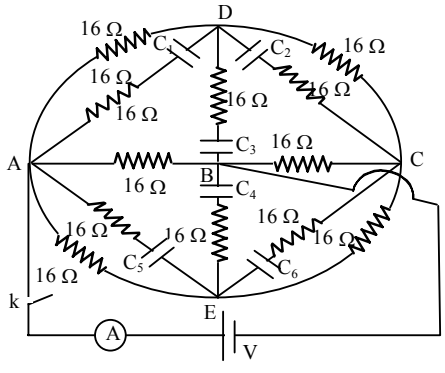
8. The resistance each of 16 Ω and capacitance of each 100 μF are arranged as shown in the figure. A battery of emf 12V is joined across A and B. Then

(A) reading of the ammeter just after key closed is 2A.

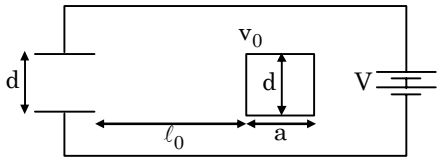
(B) reading of the ammeter long time after key closed is $\frac{9}{8}$ A

(C) reading of the ammeter just after key closed is 1A.

(D) reading of the ammeter long time after key closed is $\frac{3}{8}$ A



9. A parallel plates capacitor is made of square conducting plates of side a and the separation between plates is d. The capacitor is connected with battery of emf V volt as shown in the figure. There is a dielectric slab of dimension a × a × d with dielectric constant k. At t = 0, dielectric slab is given velocity v_0 towards capacitor as shown in the figure. (Neglect the effect of gravity and electrostatic force acting on the dielectric when dielectric is out side of capacitor. Also ignore any type frictional force acting on the dielectric during its motion) let the x be the length dielectric inside the capacitor at t = t sec. [$\lambda_0 >> a$]



(A) Motion of dielectric slab is periodic but not simple harmonic motion

(B) Motion of dielectric slab is simple harmonic motion

(C) At any time, the slope of graph of total energy verses x is twice the slope of graph of potential energy verses x.

(D) The value of maximum energy stored in the system is $\frac{1}{2}mv_0^2 + \frac{\varepsilon_0 a^2 V^2}{2d}(2k-1)$

10. To measure the capacitance of a conductor, it is first charged to a potential V_0 = 1350 V. It is then connected by a conducting wire to a distant metal sphere of radius r = 3cm. As a result the conductor potential drops to V_1 = 900 V.

Choose the correct option (s)

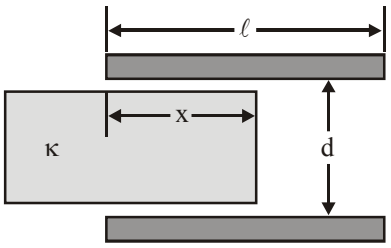
(A) Initial charge on the conductor is 9nC

(B) Capacitance of the conductor is $\frac{1}{150}$ nF

(C) Charge on the metal sphere after connection is 6nC

(D) Electrostatic potential energy decreases after redistribution of charges.

11. Two square plates of sides ℓ are placed parallel to each other with separation d as suggested in figure. You may assume d is much less than ℓ. The plates carry uniformly distributed static charges $+Q_0$ and $-Q_0$. A block of metal has width ℓ, length ℓ, and thickness slightly less than d. It is inserted at distance x into the space between the plates. The charges on the plates remain uniformly distributed as the block slides in. In a static situation, a metal prevents an electric field from penetrating inside it. The metal can be thought of as a perfect dielectric, with $\kappa \to \infty$.



(A) The stored energy as a function of x is given by $\frac{Q_0^2 d(\ell - x)}{(2\ell^3 \in_0)}$

(B) The magnitude of the force that acts on the metallic block is given by $\frac{Q_0^2 d}{(\ell^3 \in_0)}$ to the right .

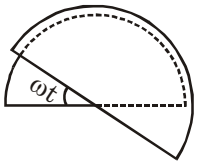
(C) The area of the advancing front face of the block is essentially equal to ℓd, the stress (force per unit area) on it is $\frac{Q_0^2}{(2\ell^4 \in_0)}$.

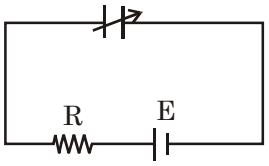
(D) The energy density in the electric field between the charged plates in terms of Q_0, ℓ, d, and $\in_0$ is $\frac{Q_0^2}{(2\ell^4 \in_0)}$

Linked Comprehension Type (1 Para × 2Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Question no. 12 and 13

A variable condensator or also known as varco is a capacitor that its capacitance can be varied. One type is varied by turning one of its plates clockwise. Suppose that a varco consists of a pair of half circle plate with diameter D separated by a distance d. the varco plate is rotating with angular velocity ω. The other plate is fixed. The plates may have some initial charge.





This varco is connected in a circuit as shown. We will consider t = 0 to $t = \frac{\pi}{\omega}$.

12. If the current is constant.

(A) The angular velocity is increasing with time

(B) The angular velocity is decreasing with time

(C) The angular velocity is constant with time

(D) It is not possible.

13. If R = 0 what torque needs to be applied to rotate the plate with constant small angular velocity?

(A) $\frac{\varepsilon_0 E^2 D^2}{16d}$ clockwise

(B) $\frac{\varepsilon_0 E^2 D^2}{16d}$ anticlockwise

(C) $\frac{\varepsilon_0 E^2 D^2}{8d}$ clockwise

(D) $\frac{\varepsilon_0 E^2 D^2}{8d}$ anticlockwise

Linked Comprehension Type (1 Para × 2 Q.) [4 M (–1)]
(Multiple Correct Answer Type)

Paragraph for Question no. 14 and 15

A parallel plate capacitor placed in a cylindrical tank is filled with a liquid of dielectric constant k. The area of cross section of tank is A and height of liquid is equal to the length of the square plate of plate area ℓ^2. The separation of plates is d. A very small hole of area 'a' is opened at the bottom of the tank at t = 0. If the capacitor in the process remains connected with a battery of emf E. Assume that the level of liquid in the capacitor remains same as outside and Bernoulli's equation is valid for the situation.

14. Choose the **CORRECT** statement(s) :

(A) The current in circuit as a function of time is $i = \frac{\in_0 \ell E}{d}(k-1)\frac{a}{A}\left(\sqrt{2g\ell} - \frac{a}{A}gt\right)$

(B) The current in circuit as a function of time is $i = \frac{\in_0 \ell E}{2d}(k-1)\frac{a}{A}\sqrt{2g\ell}$.

(C) The capacitance of capacitor decreases with time.

(D) The potential difference between the plates of capacitor remains constant.

15. Choose the **CORRECT** statement(s) :

(A) The rate at which the level of liquid decreases is $\frac{dh}{dt} = \frac{a}{2A}\sqrt{2g\ell}$

(B) The rate at which the level of liquid decreases is $\frac{dh}{dt} = \frac{a}{A}\left(\sqrt{2g\ell} - \frac{a}{A}gt\right)$

(C) The power supplied by the battery increases with time.

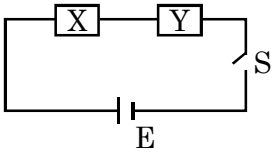
(D) When the container gets empty, the power delivered by the battery becomes zero.

Matching list based comprehension Type (4 × 4 × 4) 1 Table × 3 Q. [3(–1)]

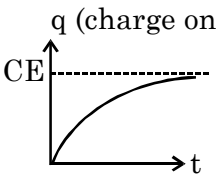
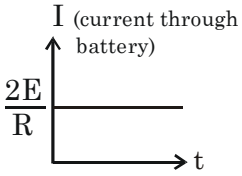
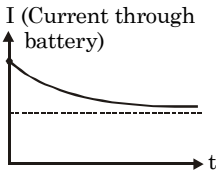
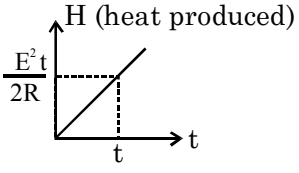
Single option correct (Three Columns and Four Rows)

Answer Q.16, Q.17 and Q.18 by appropriately matching the information given the three columns of the following table.

Following is a circuit containing an ideal battery of emf E in which the elements X & Y are unknown & may be a capacitor C, a resistor R, a battery of emf E, or may be their combination as mentioned in each case. The connecting wires are perfectly conducting.



The switch S is initially open & it is closed at t = 0.

	Column-1		Column-2		Column-3
(I)	Element X is R Element Y is C	(i)	Entire energy (non–zero) supplied by batteries is dissipated as heat	(P)	
(II)	Both elements X & Y are R each	(ii)	Total charge drawn from the battery(s) after long time is $\frac{CE}{2}$	(Q)	
(III)	Element X is R, element Y is a parallel combination of R and C	(iii)	Total heat produced in circuit is less than the energy supplied by the battery(s)	(R)	
(IV)	Element X is R element Y is battery E joined with same polarity	(iv)	I = 0 just after S is closed as well as after long time	(S)	

16. Of the given 4 situations, which one has maximum value of current just after closing the switch ?

(A) I, iii, P (B) IV, i, Q (C) II, iii, P (D) III, i, S

17. In which case the charge drawn from the battery(s) during t = 0 to t = RC is the least ?

(A) II - i - S (B) I, iii, P (C) III, ii, Q (D) IV, i, Q

18. In which case the current through battery(s) has different non zero values just after closing the switch & after a long time ?

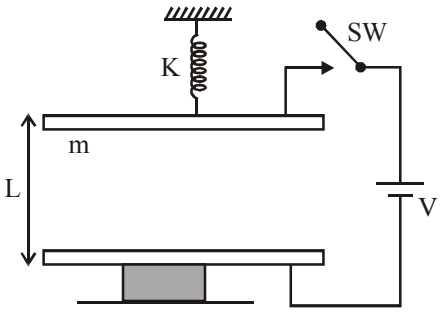
(A) II - i - S (B) I, iv, Q (C) IV, i, Q (D) III - iii- R

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 1 Q. [4 M (0)]

1. A parallel plate capacitor having its lower end fixed and upper end is attached with spring having spring constant K. Upper plate is in equilibrium before switch is closed. After switch is closed, the condition on the potential of battery so that the system can acquire new equilibrium position is $V \le \sqrt{\left(\frac{p}{q}\right)^r \frac{L^3K}{\varepsilon_0 A}}$.

Then p + q + r is ? [p & q are smallest possible integers and V is potential difference across the battery]



CLASS TEST # 41 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

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

5. Ans. (A) **6. Ans. (B)**

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

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

11. Ans. (A, C, D)

Linked Comprehension Type **(1 Para × 2Q.) [3 M (-1)]**

(Single Correct Answer Type)

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

Linked Comprehension Type **(1 Para × 2 Q.) [4 M (–1)]**

(Multiple Correct Answer Type)

14. Ans. (A,C,D) **15. Ans. (B,D)**

Matching list based comprehension Type (4 × 4 × 4) **1 Table × 3 Q. [3(–1)]**

Single option correct (Three Columns and Four Rows)

16. Ans. (B) **17. Ans. (A)** **18. Ans. (D)**

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **1 Q. [4 M (0)]**

1. Ans. 8