CLASS TEST

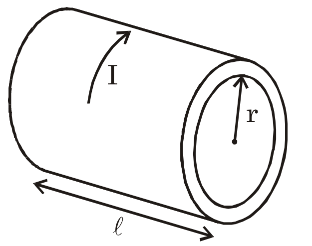
SECTION-I

Single Correct Answer Type **4 Q. [3 M (–1)]**

1. A capacitor and a coil in series are connected to a 6 volt ac source. By varying the frequency of the source, maximum current of 600 mA observed. If the same coil is now connected to a cell of emf 6 volt and internal resistance of 2Ω, the steady-state current through it will be :-

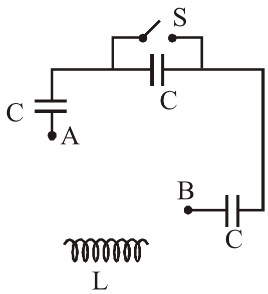
(A) 0.5 A (B) 0.6 A (C) 1.0 A (D) 2.0 A

2. A hollow cylinder has length ℓ, radius r, and thickness d, where $\ell >> r >> d$, and is made of a material with resistivity ρ. A time-varying current I flows through the cylinder in the tangential direction. Assume the current is always uniformly distributed along the length of the cylinder. The cylinder is fixed so that it cannot move; assume that there are no externally generated magnetic fields during the time considered for the problems below. Assume current at t = 0 to be I_0. What is current I(t) for t > 0



(A) $I = I_0 e^{-\frac{\rho}{2\mu_0 rd}t}$ (B) $I = I_0 e^{-\frac{2\rho}{\mu_0 rd}t}$ (C) $I = I_0 e^{-\frac{2\mu_0 rd}{\rho}t}$ (D) $I = I_0 e^{-\frac{\mu_0 rd}{2\rho}t}$

3. Three capacitor of capacitance C each are connected in series as shown in the figure. Initially switch S is open. Now capacitors are charged by a battery of emf V by connecting between terminal A and B. After long time battery is disconnected and inductor of inductance L is connected between A and B at time t = 0 so that an oscillatory circuit is formed. Now at an instant t_0 switch S is closed, then find the amplitude of charge oscillations of the remaining capacitors.



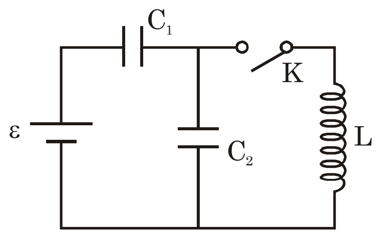
(A) $CV\sqrt{\frac{1}{6}\left(1-\frac{\cos^2\left(\sqrt{\frac{3}{LC}}\right)t_0}{3}\right)}$

(B) $\frac{CV}{3}\sqrt{\frac{1}{5}\left(1-\frac{\cos^2\left(\sqrt{\frac{3}{LC}}\right)t_0}{3}\right)}$

(C) $CV\sqrt{\frac{1}{4}\left(1-\frac{\cos^2\left(\sqrt{\frac{3}{LC}}\right)t_0}{3}\right)}$

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

4. Consider the electrical circuit given below; initially chargeless capacitors C_1 and C_2 were connected to a battery and at certain moment, the key K will be closed. After that moment, current and voltage will start oscillating. For these oscillations :



(A) When charge on C_2 is maximum, current through C_1 is same as current in L.

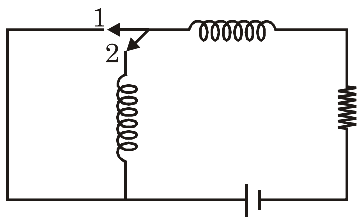
(B) When charge on C_1 is maximum, power delivered by battery is positive.

(C) Charge on C_2 is maximum when current through L is maximum.

(D) None of these

Multiple Correct Answer Type 7 Q. [4 M (–1)]

5. In the circuit shown, switch can be placed in position 1 or 2.



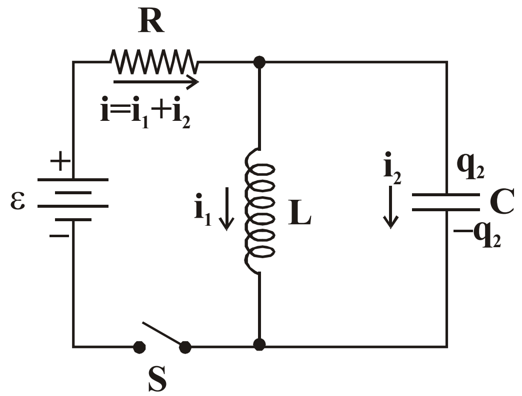
(A) If switch is in position 1 for a very -2 long time and then shifted to 2 at t = 0 then current will grow with time for t > 0

(B) If switch is in position 1 for a very -2 long time and then shifted to 2 at t = 0 then current will decay with time for t > 0

(C) If switch is in position 2 for a very -2 long time and then shifted to 1 at t = 0 then current will decay with time for t > 0

(D) If switch is in position 2 for a very -2 long time and then shifted to 1 at t = 0 then current will not change for t > 0

6. Consider the circuit shown in figure. At time t = 0, switch S is closed. The current through the inductor is i_1, the current through the capacitor branch is i_2, and the charge on the capacitor is q_2. Then choose the **CORRECT** statements :-



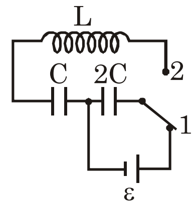
(A) At any instant according to Kirchoff rule, $R(i_1 + i_2) + L\left(\frac{di_1}{dt}\right) = \varepsilon$

(B) At any instant according to Kirchoff rule, $R(i_1 + i_2) - \frac{q_2}{C} = \varepsilon$

(C) Initial values of i_1 & i_2 will be zero and $\frac{\varepsilon}{R}$ respectively

(D) Initial values of i_1 & i_2 will be $\frac{\varepsilon}{R}$ and zero respectively

7. In the circuit shown in the figure, the switch is initially at position 1 for a long time. Now, at $t = 0$, the switch is turned to position 2. Initially charge on capacitor 'C' is zero. Choose the ***CORRECT*** statements:-



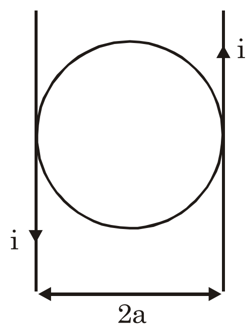
(A) After the switch is thrown to position 2, the circuit performs LC oscillation with angular frequency $\sqrt{\dfrac{3}{2LC}}$

(B) Just after the switch is turned, the current through the circuit is $E\sqrt{\dfrac{2C}{3L}}$

(C) The maximum charge in capacitor 'C' is equal to $\dfrac{4CE}{3}$

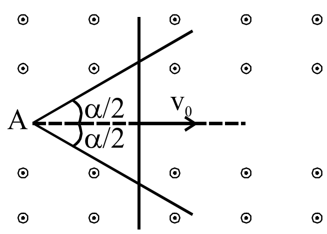
(D) The maximum charge in capacitor 'C' is equal to $\dfrac{CE}{3}$

8. Two conductors of infinite length carry a current i each, which varies with time according to relation $i = i_0 e^{\left(\frac{2}{\mu_0}\right)t}$. They are parallel and separated by a distance 2a. A circular conducting ring of radius a and having a resistance 1 Ω/length, in the plane of wires lies between the two straight conductors and insulated from them as shown :-



(A) Mutual inductance of system is 2 μ_0a.
(B) Mutual inductance of system is μ_0a.
(C) Net magnetic field at the centre of circle is always zero.
(D) Net magnetic field at the centre of circle increases with time.

9. A long straight wire of negligible resistance is bent into V shape, its two arms making an angle α with each other and placed horizotally in a vertical, homogeneous field B. A rod of total mass m, and resistance r per unit length, is placed on V shaped conductor, at a distance x_0 from its vertex A, and perpendicular to the bisector of angle α (see fegure)



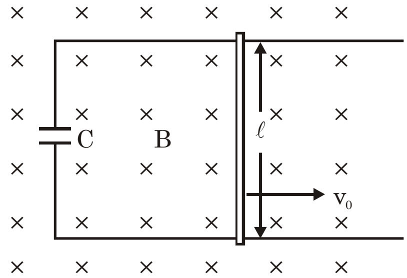
The rod is started off with an initial velocity v_0 in the direction of bisector and away from vertex A. The rod is long enough not to fall off the wire during the subsquent motion, and the electrical contact between the two is good although friction between them is negligible. Choose ***CORRECT*** statement(s)

(A) At any position x, let velocity of wire is v then $\dfrac{B^2}{r}x_0^2\tan\dfrac{\alpha}{2} + mV_0 = \dfrac{B^2}{r}x^2\tan\dfrac{\alpha}{2} + mv$

(B) maximum value of x cordinate of wire is $x_{max} = \sqrt{x_0^2 + \dfrac{mv_0 r}{B^2\tan\dfrac{\alpha}{2}}}$

(C) As x increases, v decreases
(D) Whatever is the direction of vertical magnetic field, the rod will ultimately stop.

10. Two fixed parallel conducting rails of negligible resistance are connected at one end by a capacitor C. Distance between the rails is ℓ. Arrangement is kept on a horizontal plane with vertical uniform magnetic field as shown in the figure. Initially capacitor is uncharged & a rod of resistance R & mass m is laid perpendicularly on to the rails & given a velocity v_0. Choose the **CORRECT** option(s), provided that the rail is long enough & homogeneous field extends far enough (Friction & effect of self induction is negligible)



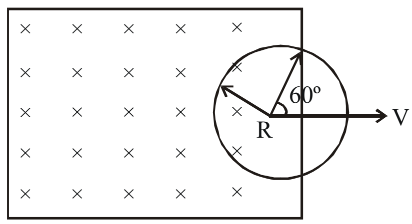
(A) Final velocity of the wire is $\frac{B^2\ell^2C}{m+B^2\ell^2C}v_0$.

(B) Final charge on the capacitor is $\left[\frac{mB\ell C}{m+B^2\ell^2C}\right]v_0$.

(C) Final current in the circuit is $\frac{Bv_0\ell}{2R}$.

(D) Ratio of final kinetic energy & initial kinetic energy is $\left(\frac{m}{m+B^2\ell^2C}\right)^2$.

11. A circular conducting loop of radius R and resistance per unit length λ is pulled out from the region of uniform magnetic field with constant velocity v. The situation shown in the figure corresponds to time t = 0. Mark out the **CORRECT** statement(s) :



(A) Just after t = 0 i.e., the motion starts, the induced current in the loop is $\frac{\sqrt{3}Bv}{2\pi\lambda}$

(B) Current will be induced in the loop for $\frac{3R}{2v}$sec

(C) At any time t, the current induced in the loop is given by $\frac{Bv\sqrt{3R^2-4v^2t^2+4Rvt}}{\lambda\times 2\pi R}$ and is in clockwise direction.

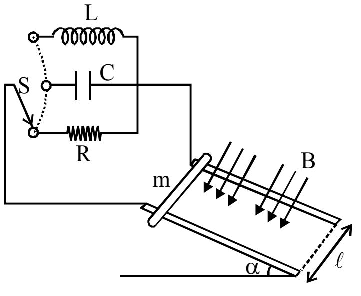
(D) Induced current is in clockwise direction for t = 0 to $\frac{R}{2v}$ and thereafter it becomes in anticlockwise direction.

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

Paragraph for Question Nos. 12 & 13

A homogeneous field of magnetic induction $\vec{B}$ is perpendicular to a track of width ℓ which is inclined at an angle α to the horizontal. A frictionless conducting rod of mass m straddles the two rails of the track as shown infigure. Now the rod is being released from rest, if the circuit formed by the rod and the track is closed by :-

(ii) a capacitor of capacitance C, or (ii) a coil of inductance L or (iii) a resistor ?



12. Mark the **INCORRECT** statement :-

(A) If switch is connected to resistor then rod eventually attains terminal velocity.

(B) If switch connected to capacitor velocity continuously increases.

(C) If switch connected to inductor then rod executes simple harmonic motion with initial position as equilibrium position.

(D) If resistor is connected then long time after power dissipated in resistor equals power delivered by gravity

13. Mark the correct statement :-

(A) with inductor angular frequency of oscillation is given by $\omega^2 = \dfrac{B^2\ell^2}{2mL}$

(B) with capacitor acceleration of rod is $a = \dfrac{mg\sin\alpha}{m + B^2\ell^2 C\cos^2\alpha}$

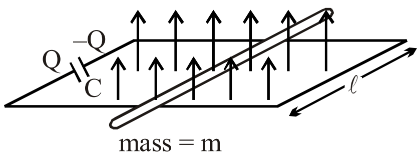
(C) with inductor equilibrium position is given by $x_0 = \dfrac{mgL\sin\alpha}{B^2\ell^2}$

(D) displacement of rod as function of time is given by $x(t) = A\cos\omega t$ (where origin is at initial position)

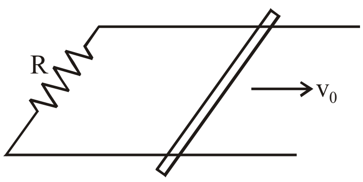
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 7 Q. [4 M (0)]

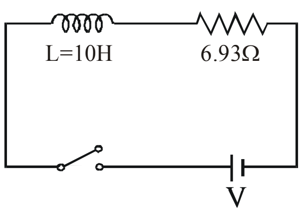
1. An arrangement of smooth pair of long conducting rails which are resistanceless are joined to a charged capacitor. The rails are connected by a rod of mass m and length l and resistance R. Vertical magnetic field is uniform. The rod is initially at rest. It starts moving due to the influence of magnetic field. What should be the mass of the rod (in mg) so that its kinetic energy in steady state is maximum ?
[Take : l = 1m, B = 2T, C = 1μF, R = 1Ω]



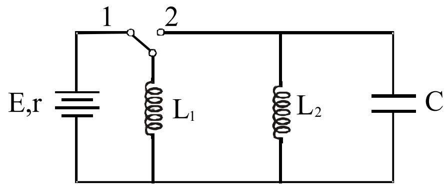
2. A rod of mass m = 2kg slides without friction along two parallel rails at distance d = 1.3 m from each other (see figure). The rails are joined by a resistor to a resistance R = 0.32Ω and placed in a vertical magnetic field of induction B = 0.4 T. The rod is pushed with velocity v_0 = 3.38 m/s. Find the distance (in m) covered by the rod until it stops.



3. A resistor and an inductor in series are connected to a battery through a switch. After the switch has been closed, at what time (in sec) will the Joule heat dissipated in the resistor change at the fastest rate?

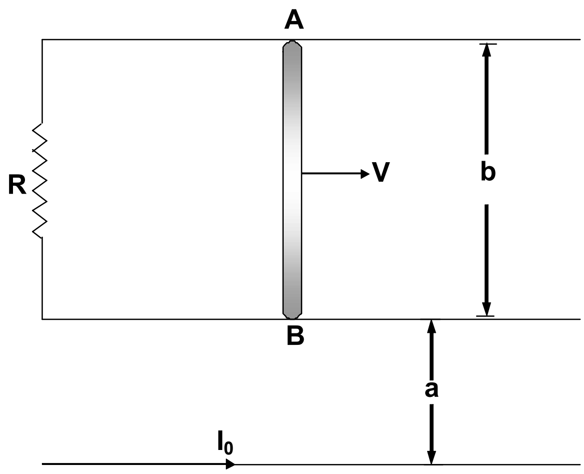


4. A circuit shown consists of two inductors of inductances L_1 and L_2, a capacitor of capacitance C, a battery of electromotive force E and internal resistance r and a switch. Initially the switch was in position 1 for a long time. Find the maximum current (in A) in the inductor L_2 after the switch is thrown to position 2 ?
(Given : E = 5V, L_1 = 4mH, L_2 = 1mH, $r = 2\Omega$)

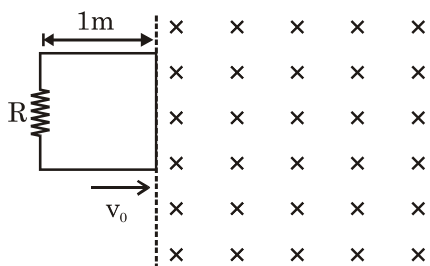


5. A long straight conductor carries a current I_0. At distances a and (a + b) from it, there are two identical wires, each having resistance λ per unit length, which are inter–connected by a resistance R as shown in Figure. A conducting rod AB of length b can slide along the wires without friction. At t = 0, the rod is in extreme left position and starts to move to the right without friction and with constant velocity v. The force function (in terms of time t) required to maintain velocity of rod constant to V m/s is

$\frac{\mu_0^2 I_0^2 V}{K\pi^2(R + 2Vt\lambda)}\left[\log_e\left(\frac{a+b}{a}\right)\right]^2$. The value of K is



6. A rigid square loop having resistance R and mass 100 gm has side length 1m. It is projected with velocity v_0 = 5 m/s in a region having uniform magnetic field of strength 10 T as shown in figure. Find the value of $\frac{R}{100}$ (in ohms) so that the loop comes to rest when it is completely inside the magnetic field region. (ignore gravity)



7. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field B = Kxt^2, where K = constant, x is the distance (in metre) from the centre of the disc and t is the time (in second) is switched on perpendicular to the plane of the disc. The torque (in N-m) acting on the disc after 15 sec. (Take 2KQ = 1 S.I. unit and R = 1 metre).

CLASS TEST # 63			ANSWER KEY
	SECTION-I		
Single Correct Answer Type			**4 Q. [3 M (–1)]**
1. Ans. (A)	**2. Ans. (B)**	**3. Ans. (A)**	**4. Ans. (A)**
Multiple Correct Answer Type			**7 Q. [4 M (–1)]**
5. Ans. (A, D)	**6. Ans. (A, C)**	**7. Ans. (A, C)**	**8. Ans. (A, D)**
9. Ans. (A,B,C,D)	**10. Ans. (B,D)**	**11. Ans. (A, B, C)**	
Linked Comprehension Type (Single Correct Answer Type)		**(1 Para × 2 Q.) [3 M (-1)]**	
12. Ans. (C)	**13. Ans. (C)**		
	SECTION-III		
Numerical Grid Type (Ranging from 0 to 9)			**7 Q. [4 M (0)]**
1. Ans. 4	**2. Ans. 8**	**3. Ans. 1**	**4. Ans. 4**
5. Ans. 4	**6. Ans. 2**	**7. Ans. 2**	