PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

INDUCTANCE

Illustration

1. A small square loop of wire of side l is placed inside a large square loop of wire of side $L(> > l)$. The loops aer coplanar and their centres coincide. What is the mutual inductance of the system?

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2. What is the mutual inducatance of a system of coaxical cables carrying current in opposite directions a sshows in Fig. 4.3. Their radii are a and b, respectively.

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3. The equivalent inductance of two inductors is 2.4 H when connected in parallel and 10 H when connected in series. What is the value of inductances of the individual inductors?

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4. What will happen to the inductance of a solenoid

a. when the number of turns and the length are double keeping the area of cross section same?

b. when the air inside the solenoid is replaced by iron of relative permeability μ_r?

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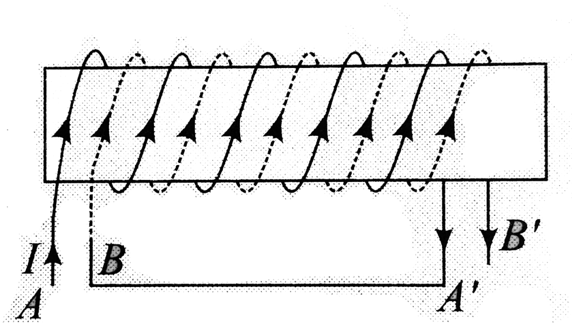
5. In Fig. coil 1 and coil 2 are wound on a long cylindrical insulator. The ends A' and B are joined together and current I is passed. Self-inductance of the two coils are L_1 and L_2, and their mutual inductance is M.

a. Show that this combination can be replaced by a single coil of equivalent inductange given by

$L_{eq} = L_1 + L_2 + 2M.$

b. How could the coils be reconnected by yieldings an equivalent inductance of

$L_{eq} = L_1 + L_2 - 2M.$



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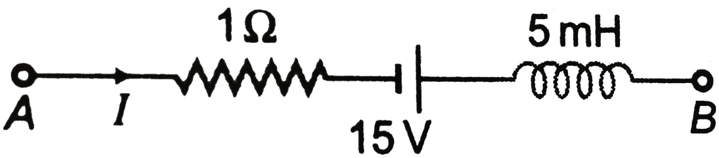
6. The network shown in the figure is a part of complete circuit. What is the potential difference $V_B - V_A$ when the current I is $5A$ and is decreasing at a rate of $10^3 A/s$?



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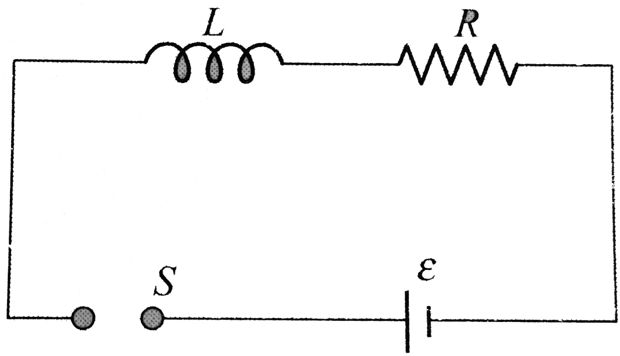
7. In an LR circuit as shows in Fig.when the swtich is closed, how much time will it take for the current to grow to a value n times the maximum value of current (where $n < 1$)?



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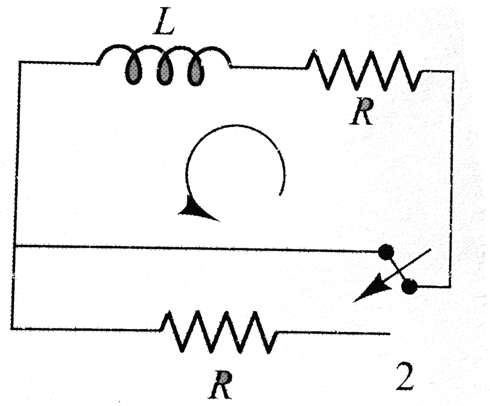
8. In the circuit shows in Fig. the initail current through the inductor at $t = 0$ is I_0. After a time $t = L/R$, the switch is quickly shifted to position 2.

a. Plot a graph showing the variation of current with time.

b. Calculate the value of current in the inductor at $t = \frac{3}{2}\frac{L}{R}$.



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9. During the decay of current in an LR circuit, if the current falls to η times the intial value in time T, then determine the value of time constane.

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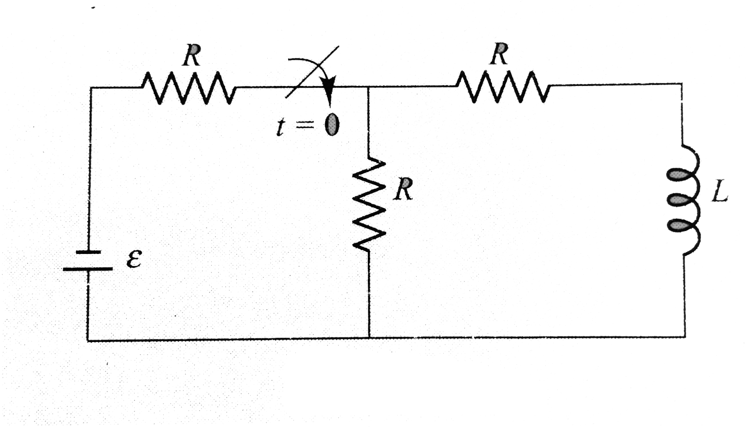
10. In the following circuit (Fig.)the switch is closed at $t = 0$. Intially, there is no current in inductor. Find out the equation of current in the inductor coil as s function of time.



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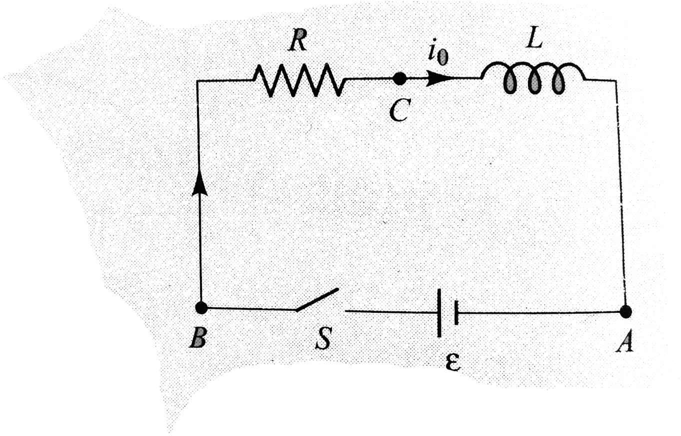
11. Figure shows a circuit consisting of an ideal cell, an inductor L, and a resistor R, connected in series. Let switch S be closed at $t=0$. Suppose at $t=0$, the current in the inductor is i_o, then find out the equation of current as a function of time.



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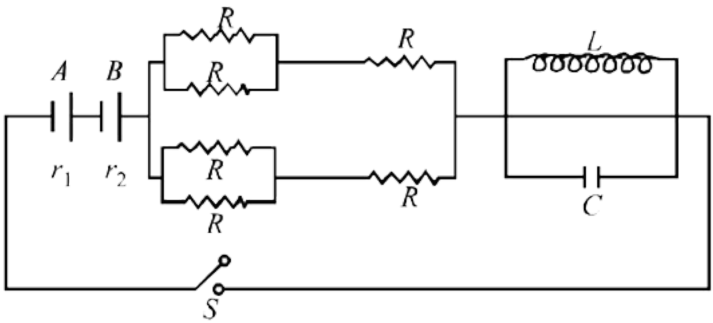
12. In the figure both cells A and B are of equal emf. Find R for which potential difference across battery A will be zero, long time after the switch is closed. Internal resistance of batteries A and B (r_1) and (r_2) respectively $(r_1 > r_2)$.



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13. Consider the RL circuit in Fig. When the switch is closed in position 1 and opens in position 2, electrical work must be performed on the inductor and on the resistor. The energy stored in the inductor is for the resistor energy appears as heat.

a. What is the ratio of P_L / P_R of the rate at which energy is stored in the inductor to the rate at which energy is dissipated in the resistor?

b. Express the ratio P_L / P_R as a function of time.

c. If the time constant of circuit is t, what is the time at which $P_L = P_R$?

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14. Derive an expression for the total magnetic energy stored in two coils with inductances L_1 and L_2 and mutual inductance M, when the currents in the coils are I_1 and I_2, respectively.

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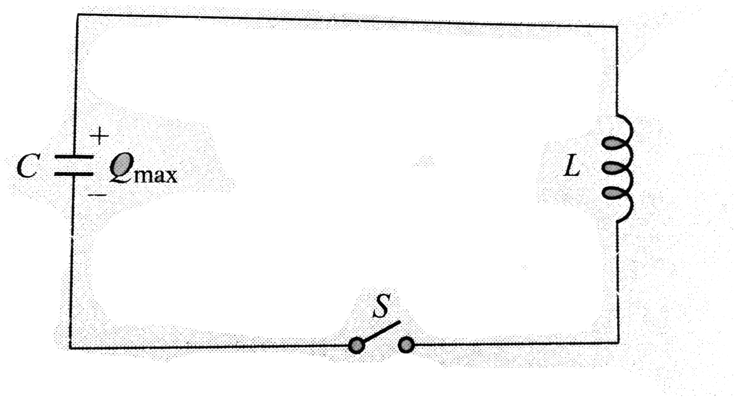
15. In an LC circuit as shows in Fig. the switch is closed at $t = 0. Q_{\max} = 100 \mu C, L = 40 mH$, $C = 100 \mu F$.

a. Determine the equation for instantaneous change on the capacitor.

b. Determine the equation for instantaneous current in the circuit.



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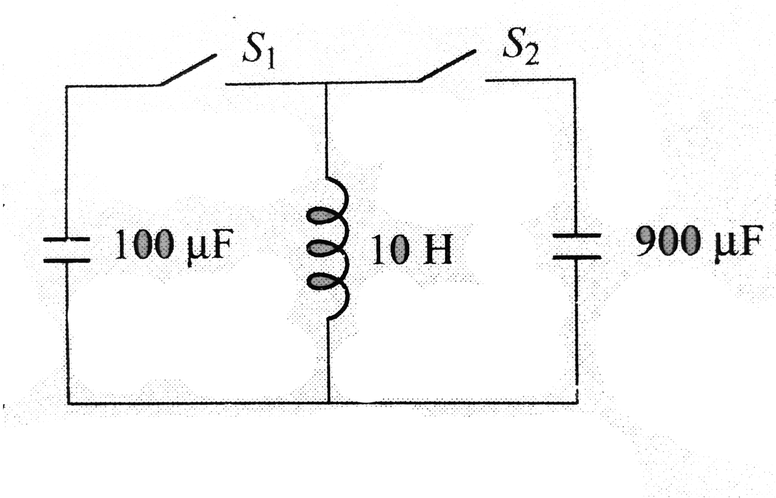
16. Initially the $900\mu F$ capacitor is charged to $100V$ and the $100\mu F$capacitor is uncharged in

Fig. Then switch S_2 is closed for time t_1, after which it is opened and at the same instant switch S_1 is closed for time t_2 and then opened. It is now found that $100 \mu F$ capacitor is charged to $300 \mu F$ capacitor is charged to $300 V$. Find the minimum possible value of the time interval t_1 and t_2.



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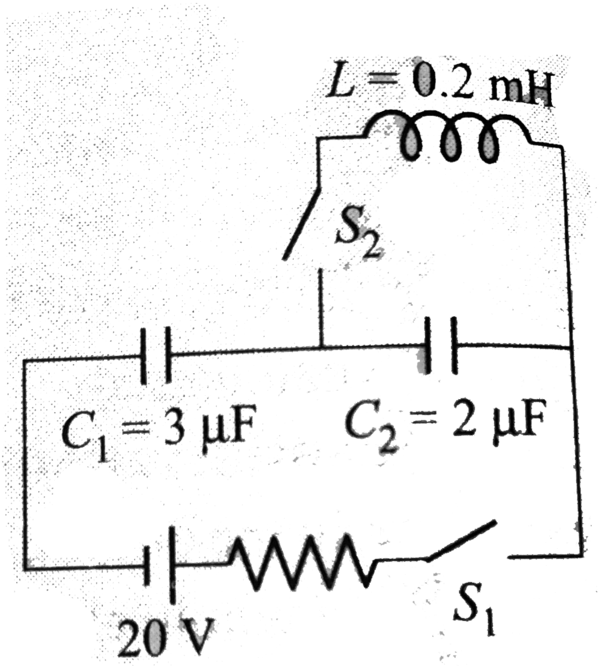
17. The circuit shows in Fig. is in the steady state with switch S_1 closed. At $t = 0, S_1$ is opened and switch S_2 is closed.

a. Derive expression for the charge on capacitor C_2 as a function of time.

b. Determine the first instant t, when the energy in the inductor becomes one-third of that in the capacitor.



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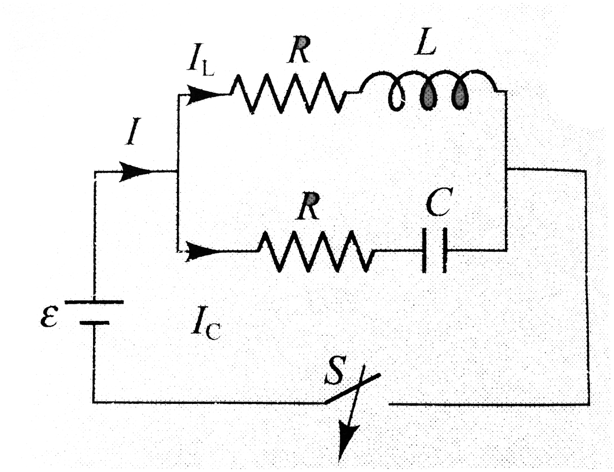
18. In the circuit shows in Fig. the battery has negligible internal resistance. Show that the current in the circuit through the battery rises instanlty to its steady state value E/R when the switch is closed, provided that resistance R is $\sqrt{L/C}$.



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19. An inductor of inductance $2.0 mH$ is connected across a charged capacitor of capacitance $5.0 \mu F$ and the resulting $L-C$ circuit is set oscillating at its natural frequency. Let Q denotes the instantaeus charge on the capacitor and I the current in the circuit. It is found that the maximum value of Q is $200 \mu C$.

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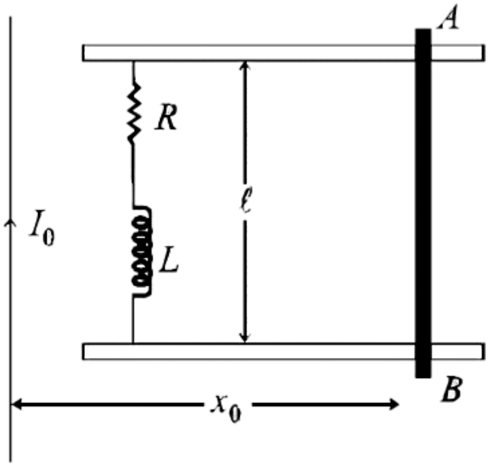
Solved Examples

1. A metal bar AB can slide on two parallel thick metallic rails separated by a distance l. A resistance R and an inductance L are connected to the rails as shown in the figure. A long straight wire carrying a constant current I_0 is placed in the plane of the rails and perpendicular to them as shown. The bar AB is held at rest at a distance x_0 from the long wire. At t=0, it is made to slide on the rails away from wire. Answer the following questions.

(a) Find a relation among i, $\frac{di}{dt}$ and $\frac{d\phi}{dt}$, where i is the current in the circuit and ϕ is the flux of the megnetic field due to the long wire through the circuit.

(b) It is observed that at time t=T, the metal bar AB si at a distance of $2x_0$ from the long wire and the resistance R carries a current (i_1). Obtain an expression for the net charge that has flown through riesistance R form t=0 to t=T.

(c) THe bar is suddenly stopped at time T. THe current through resistance R is found to be $\frac{i_1}{4}$ at time 2T. Find the value of $\frac{L}{R}$ in terms of hte other given quantities.



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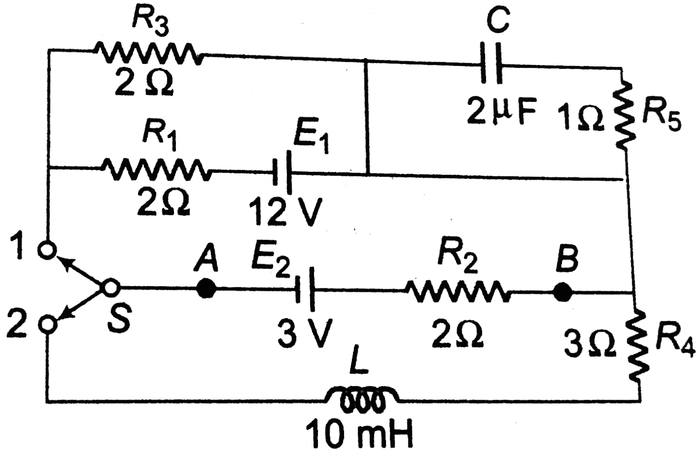
2. A circuit containing a two position switch S is shown in figure



a. The switch S is in position 1. Find the potential differecne $V_A - V_B$ and the rte of production of joule heat in R_1

b. If now the switch S is put in position 2 at $t = 0$. Find ltbRrgt i steady current in R_4 and ii hte time when current in R_4 is half the steady value. Also calculate the energy stored in the inductor L at that time.

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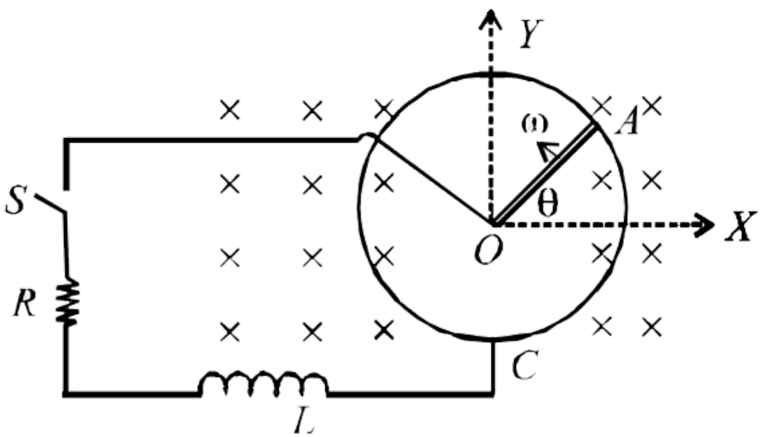
3. A metal rod OA of mann 'm' and length 'r' is kept rotating with a constantangular speed ω in a vertical plane about a horizontal axis at the end O. The free end A is arraged to slide without friction along fixed conduction circular ring in the same plane as that of rotation. A uniform and constant magnetic induction $\overrightarrow{B}$ is applied perpendicular and into the plane of rotation as shown in the figure below. An inductor L and an external resistance R are connected through a swithch S between the point O and a point C on the ring to form an electrical circuit. Neglect the resistance of the ring and the rod. Initially, the switch is open.



(a) What is the induced emf across the teminal of the switch?

(b) The switch S is closed at time t=0.

(i) Obtain an expression for the current as a function of time.

(ii) In the steady state, obtin the time dependence of the torque required to maintain the constant angular speed, given that the rod OA was along th positive X-axis at t=0.

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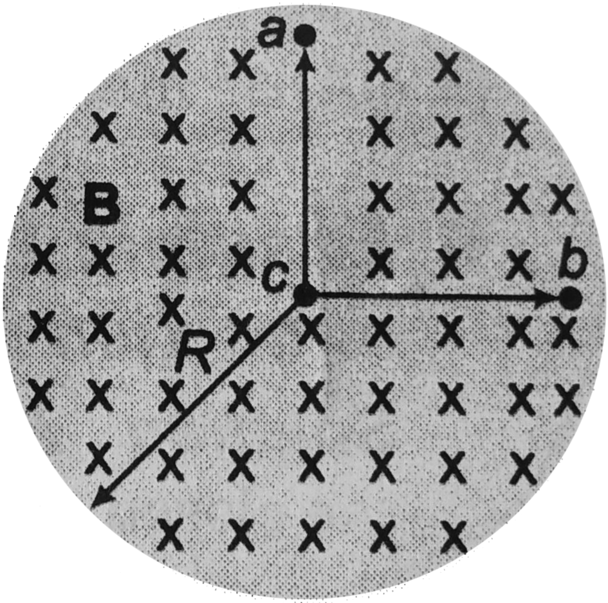
Exercise 4.1

1. The magnetic field B at all points within a circular region of the radius R is uniform space and directed into the plane of the page in figure. If the magnetic field is increasing at a rate dB/dt what are the magnitude and direction of the force on as stationary positive point charge q located at points a, b, c? (Point a is a distance r above the centre of the region, point b is a distance r to the right to the centre and point c is at the centre of the region).



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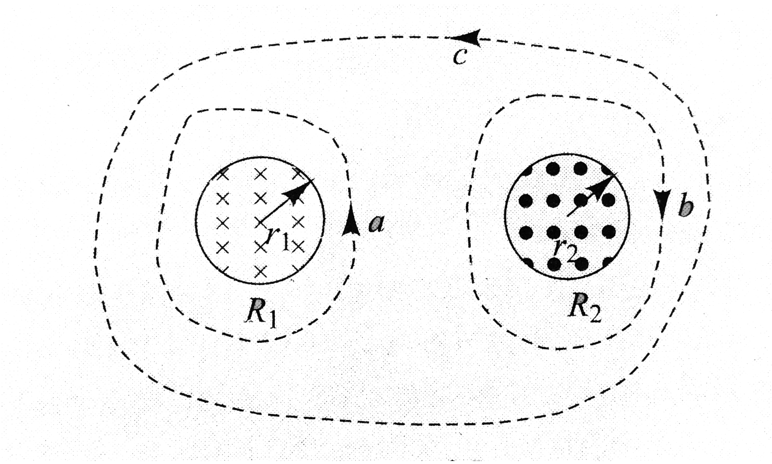
2. Figure shows two circular regions R_1 and R_2 with redii $r_1 = 21.2 cm$ and $r_2 = 32.3 cm$, respectively. In R_1 there is a uniform magetic field $B_1 = 48.6mT$ into the page and in R_2 there is a uniform magnetic field $B_2 = 77.2mT$ out of the page (ignore any fringing of these fields).Both fields are decreasing at the rate $8.50mTs^{-1}$. Calculate the intergal $\oint \vec{E} . \vec{dl}$ for each of the three identical paths.



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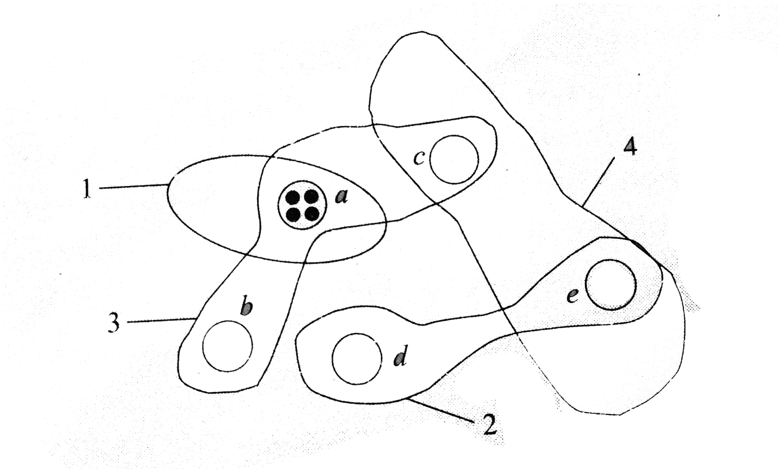
3. Figure shows five lettered regions in which a uniform magnetic field extends directly either out of the page (as in region a) or into he page. The field is increasing in magnitude at the same steady rate in all five regions, the regions are identical in area. Also shows are four numbered paths along which $\oint \vec{E} \,.\, \vec{dl}$ has the magnitudes given below in terms of a quantity mag. Determine whether the magnetic fields in regions b through e are directed into ot out of the page.



?

Path	1	2	3	4
$\oint \vec{E} . \vec{dl}$	mag	$2(mag)$	$3(mag)$	0

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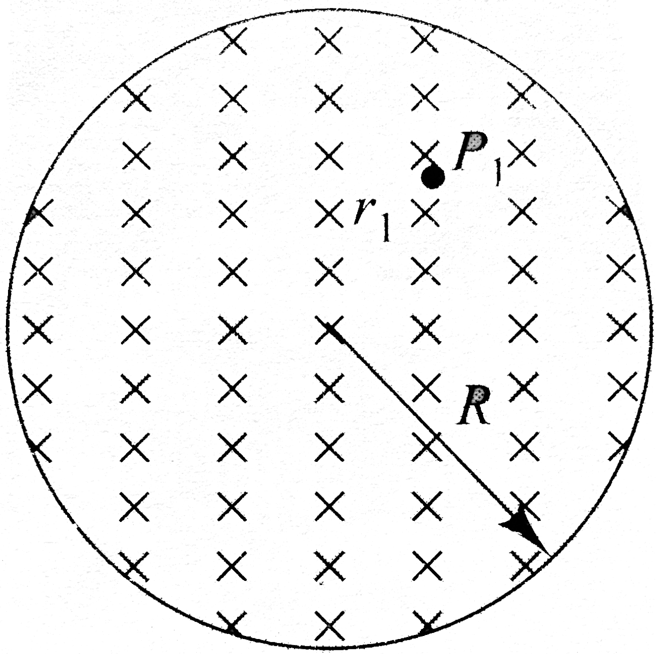
4. A magentic field directed into the page changes with time according to $B = (0.0300t^2 + 1.4.40)T$, where t is in seconds. The field has a circular cross section of radius $R = 2.50 cm$. What are the magitude and direction of the electric field at point P_1 when $t = 3.00 s$ and $r_1 = 0.0200 m$?



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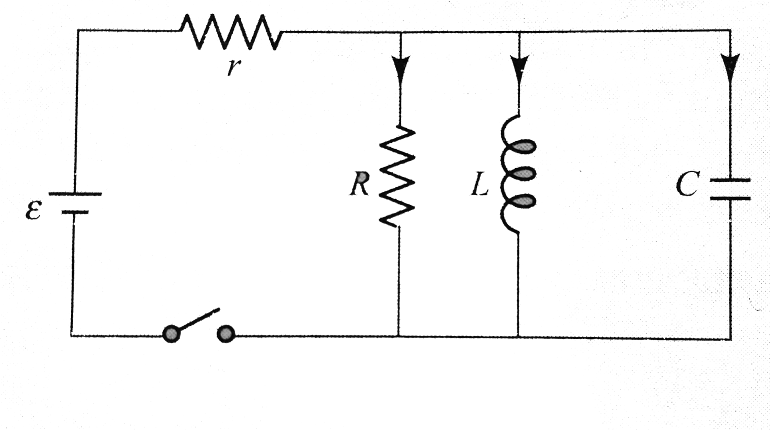
5. Figure shows an LCR circuit. When the switch is closed, the currents through resistor R, inductor L, and capacitor C are I_1, I_2, and I_3, respectively. Determine the values of I_1, I_2, and I_3.



a. at $t = 0$ b. at $t = \infty$

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6. It has been proposed to use large inductors as energy storage devices.

a. How much electrical energy is converted to light and thermal energy by a $200 - \Omega$ light bulb in one day?

b. If the amount of energy calculated in part (a) is stored in an inductor in which the current is $80.0A$, what is the inductance?

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7. A $1-k\Omega$ resistor is connected in series with a $10-mH$ inductor, a $30V$ battery and an open switch. At time $t=0$, the switch is suddenly closed.

a. What is the maximum current in this circuit and when does it occur?

b. What are the voltage drops across the inductor and across the resistor $20\mu s$ after the switch is closed?

c. On a single set of axes, sketch the voltage across the resistor and the voltage across the inductor as functions of time. Also, sketch a graph of the current in the circuit as s function of time.

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8. A capacitor with capacitance $6 \times 10^{-5} F$ is charged by connecting it to a $12 - V$ battery. The capacitor is disconnected from the battery and connected across an inductor with $L = 1.50 H$.

a. What are the angular frequency ω of the electrical oscillations and the period of these oscillations (the time for one oscillation)?

b. What is the intial charge on the capacitor?

c. How much energy is intially stored in the capacitor?

d. What is the charge on the capacitor 0.0230 s after the connecting to the inductor is made? Interpret the sign of the your answer.

e. At the times given in part (d), what is the current in the inductor? Interpret the sign of your answer.

f. At the time given in part (d), how much electrical energy is stored in the capactior and how much is stored in the inductor?

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9. In the circuit shows in Fig. , $E = 10V$, $R_1 = 5\Omega$, $R_2 = 10\Omega$, and $L = 5H$. For the two separate conditions, (i) switch S is just closed and (ii) switch S is closed for a long time, calculate

a. current i_1 through R_1,

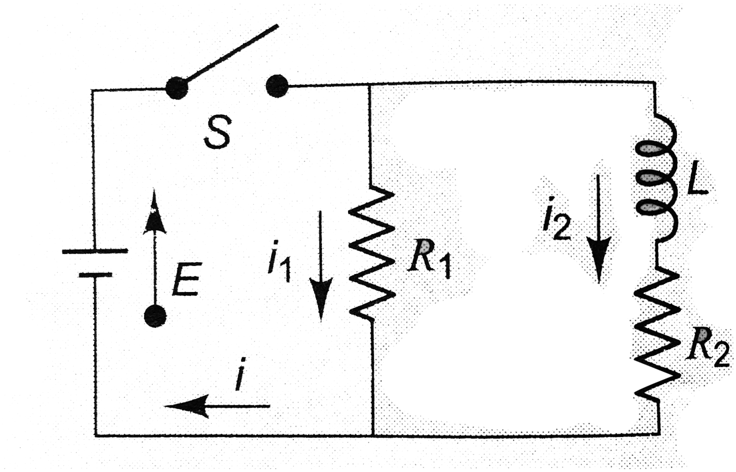
b. current i_2 through R_2,

c. current i through the switchs,

d. the potential difference across R_2,

e. the potential difference across L,

f. di_2 / dt.



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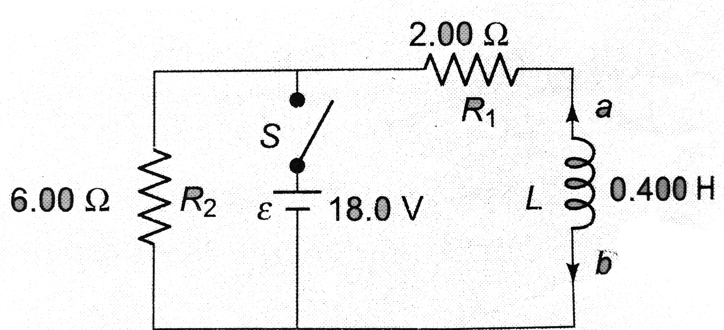
10. In Fig. the switch is closed and steady-state conditions are established. The switch is thrown open at $t = 0$.

a. Find the initial voltage E_0 across L just after $t = 0$. Which end of the coil is at the heigher potential : a or b?

b. Make freehand graphs of the current in R_1 and R_2 as a funtion of time, treating the steady-state directions as positive. Show values before and after $t = 0$.

c. How long after $t = 0$ does the current in R_2 have the value $2mA$?



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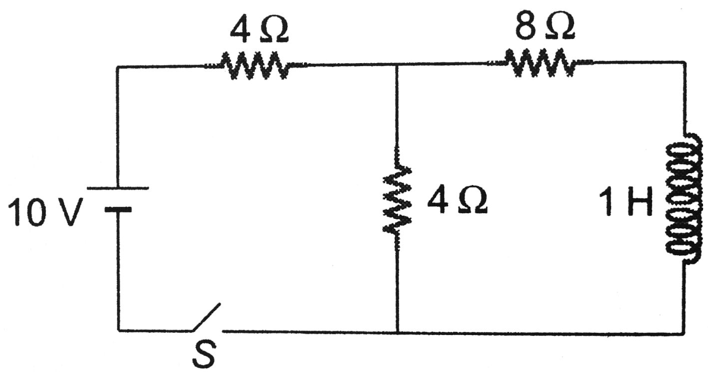
11. The switch in figure is closed at time $t = 0$. Find the current in the inductor and the current through the switch as functions of time thereafter.



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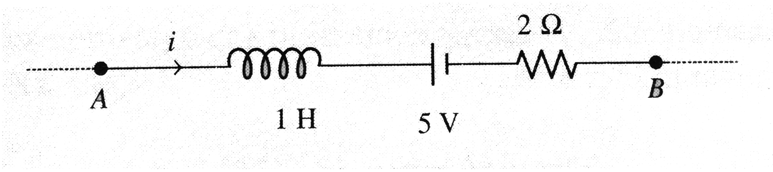
12. AB is a part of circuit. Find the potential difference $V_A - V_B$ if

a. current $I = 2A$ and is constant,

b. current $i = 2A$ and is increasing at the rate of $1As^{-1}$,

c. current $i = 2A$ and is decreasing at the rate $1As^{-1}$,



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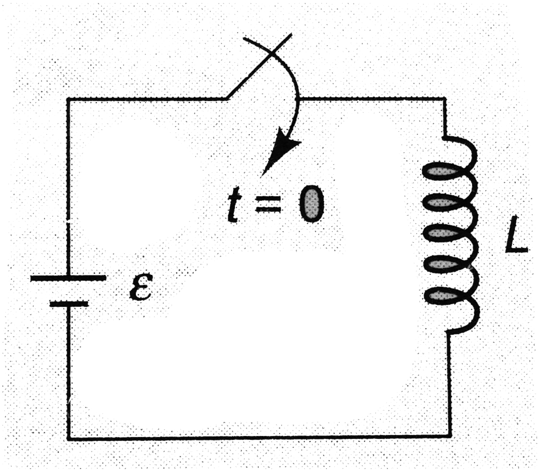
13. A circuit contains an ideal cell and an inductor with a switch. Initially, the switch is open. It is closed at $t = 0$. Find the current as a function of time.



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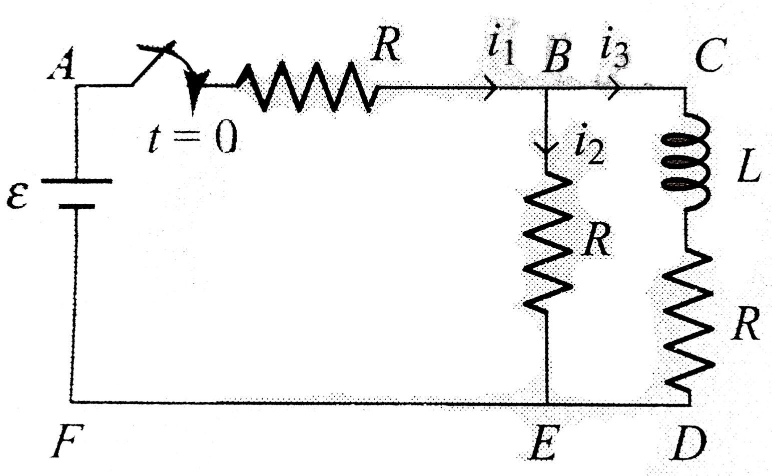
14. In the following circuit (Fig.) the switch is closed at $t = 0$. Find the current i_1, i_2, i_3 and di_3/dt at $t = 0$ and at $t = \infty$. Intitially, all current are zero.



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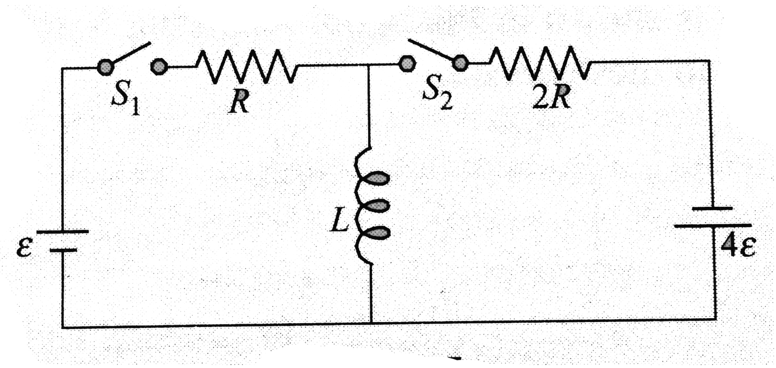
15. In a circuit S_1 remains closed for a long time and S_2 remain open. Now S_2 is closed and S_1 is opened. Find out the di/dt in the right loop just after the moment.



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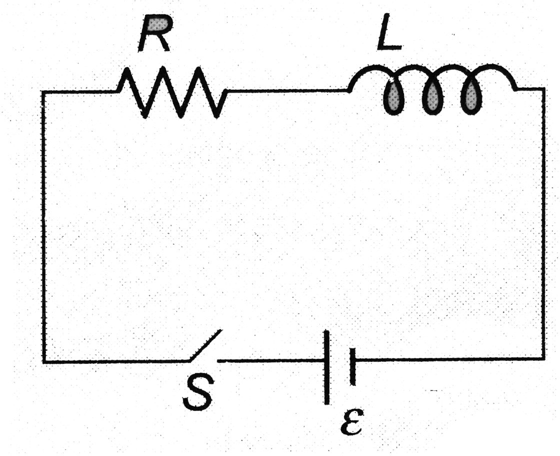
16. At $t = 0$, switch S is closed (shown in Fig.). After a long time, suddenly the inductance of the inductor is made η times lesser (L/η) than its initial value. Find out current just after the operation.



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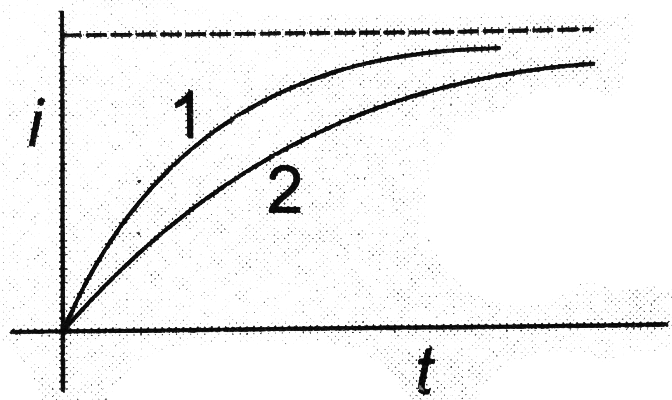
17. Which of the two curves shows has lesser time constant.



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18. Two insulated wires are wound on the same hollow cylinder, s as to from two solenoids shering a common air-filled core. Let l be the length of the core, A the cross -sectional area of the core, N_1 the number of times the first wire is wound around the core, and N_2 the number of times the second wire is wound around the core. Find the mutual inductance of the two solenoids, neglecting the end effects.

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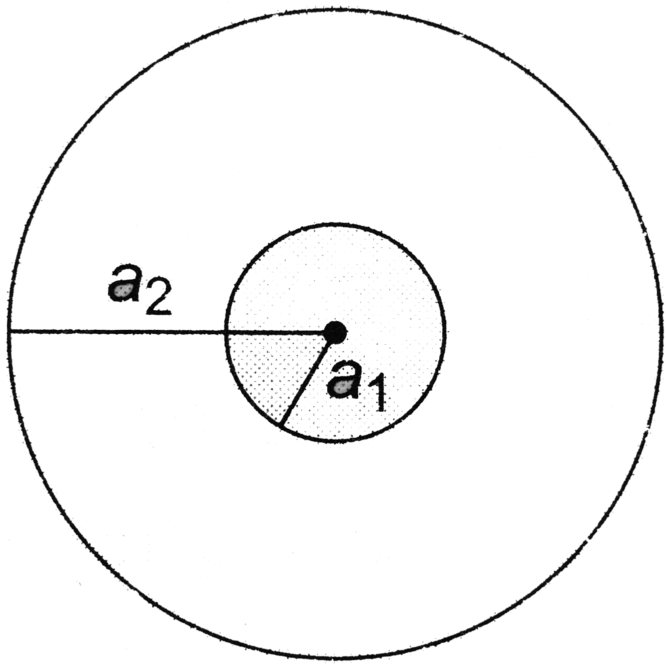
19. Find the mutual inductance of two concentric coils of radii a_1 and

$a_2(a_1 < < a_2)$ if the planes of the coils are same.



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20. Solve problem 19 if the planes of the coils are perpendicular.

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21. Find the mutual inductance of two concentric coils of radii a_1 and $a_2 (a_1 < < a_2)$ if the planes of the coils are perpendicular.

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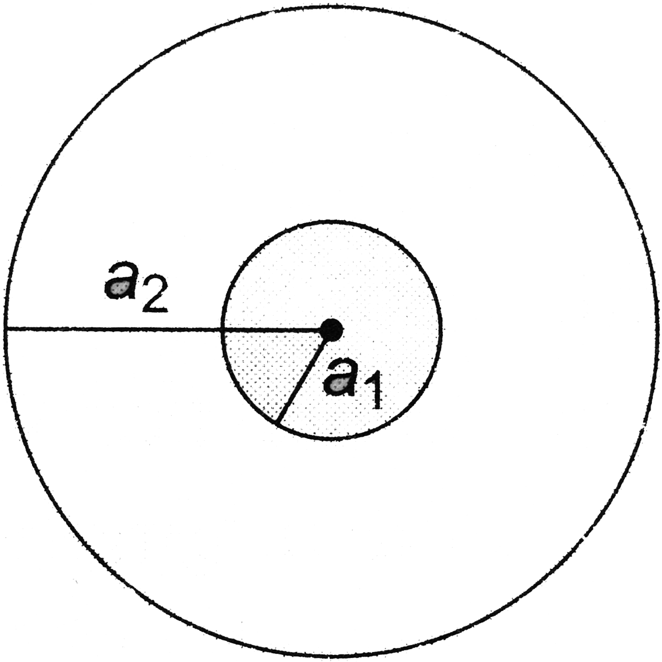
22. Figure. shows two concentric coplanar coils with radii a and $b(a < < b)$. A current $I = 2t$ flows in the smaller loop. Neglecting self-inductance of the larger loop,

a. find the mutual inductance of the two coils,

b. find the emf induced in the larger coil,

c. if the resistance of the larger loop is R, find the current in it as a function of time.



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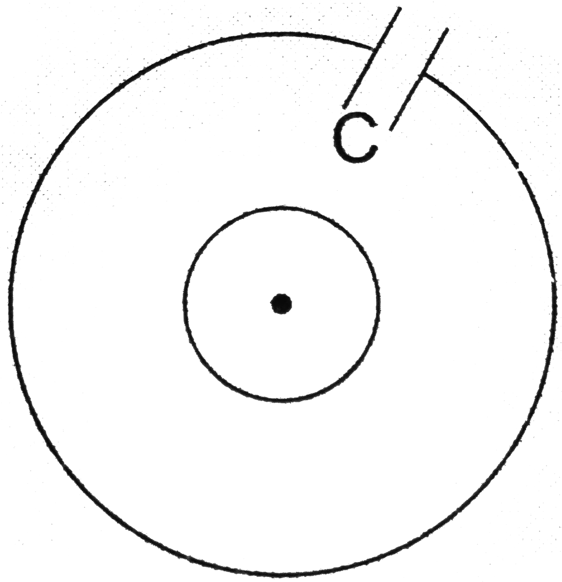
23. Figure. shows two concentric coplanar coils with radii a and $b(a < < b)$. A current $I = 2t$ flows in the smaller loop. Neglecting self-inductance of the larger loop, if a capacitor of capacitance C is also connected in the larger loop as shows in Fig . , find the charge on the capacitor as a function of time.



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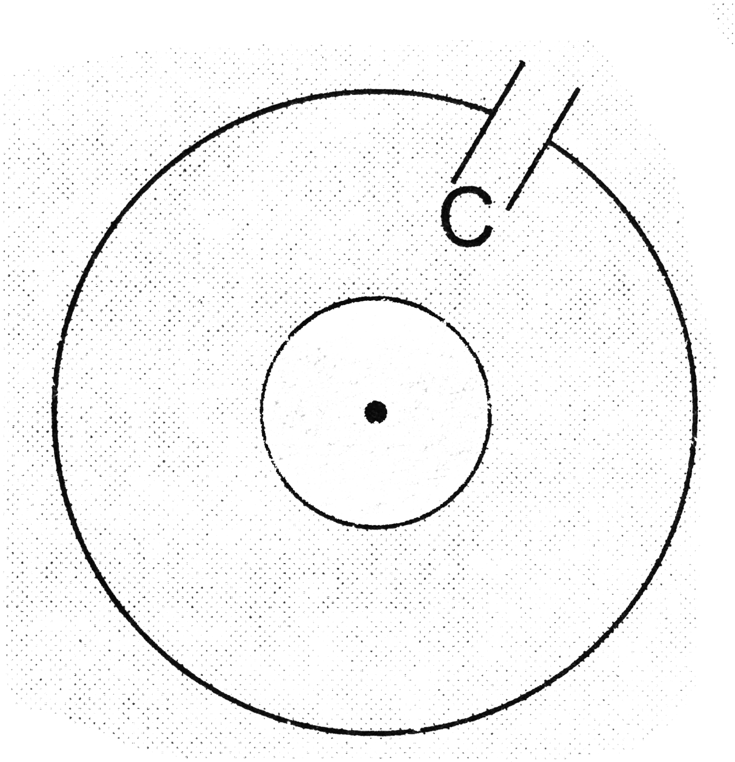
24. If the current in the inner loop changes according to $I = 2t^2$ (Fig .), then find the

current in the capacitor as a function of time.



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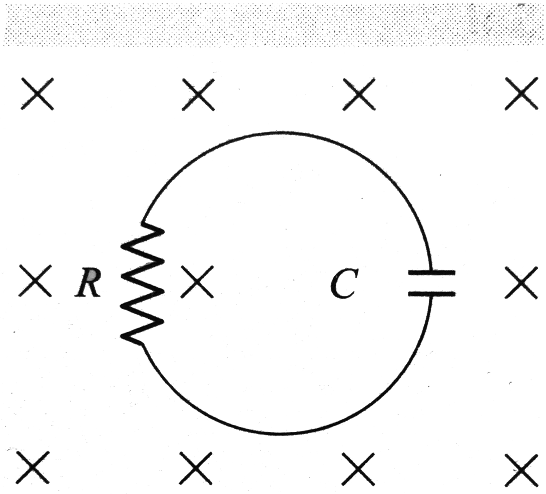
Exercises (subjective)

1. In Fig. a uniform magnetic field decrease at a constant rate $dB/dt = K$, where K is a positive constant. Circular loop of wire of radius a containing a resistnce R and a capacitnce C is placed with its plane normal to the field.

a. Find the charge Q on the capacitor when it is fully charged.

b. Which plate is at higher potential when it is fully charged?



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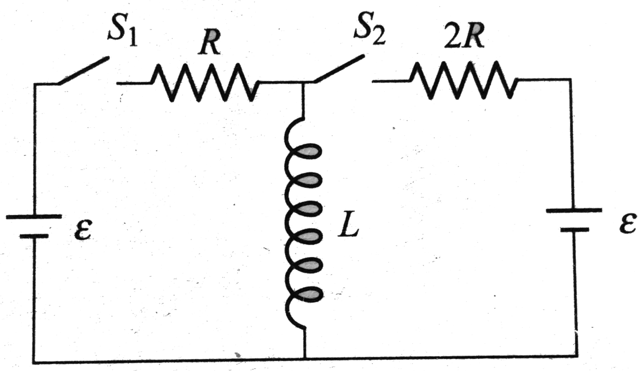
2. In the circuits shows in S_1 and S_2 are switches. S_2 remains closed for a long time and S_1 is opened. Now S_1 is also closed. Just after S_1 is closed, find the potential difference

(V) across R and di/dt (with sign) in L.



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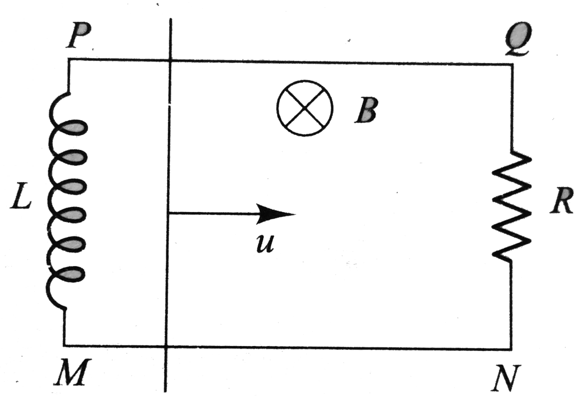
3. In Fig a rod of length l and mass m moves with an intial velocity u on a fixed frame containing inductor L and resistance R. PQ and MN are smooth conducting wires. There is auniform magnetic field of strength B. Initially, there is no current in the inductor. find the total cherge flows through the inductor by the time, velocity of rod becomes ν_f and the rod has travelled a distance x.



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4. A $1.00 mH$ inductor and a $1.00 \mu F$ capacitor are connected in series. The current in the circuit is described by $i = 20t$, where t, is in second and i is in ampere. The capacitor initially has no charge. Determine

(a) the voltage across the inductor as a function of time,

(b) the voltage across the capacitor as a function of time,

(c) the time when the energy stored in the capacitor first exceeds that in the inductor.

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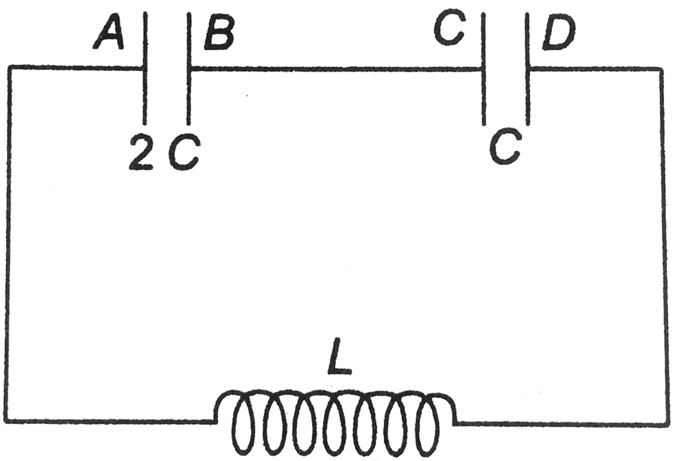
5. Two capacitors of capacitances $2C$ and C are connected in series with an inductor of inductance L. Initially, capacitors have charge such that $V_B - V_A = 4V_0$ and $V_C - V_D = V_0$. Initial current in the circuit is zero. Find



(a) maximum current that will flow in the circuit,

(b) potential difference across each capacitor at that instant,

(c) equation of current flowing towards left in the inductor.

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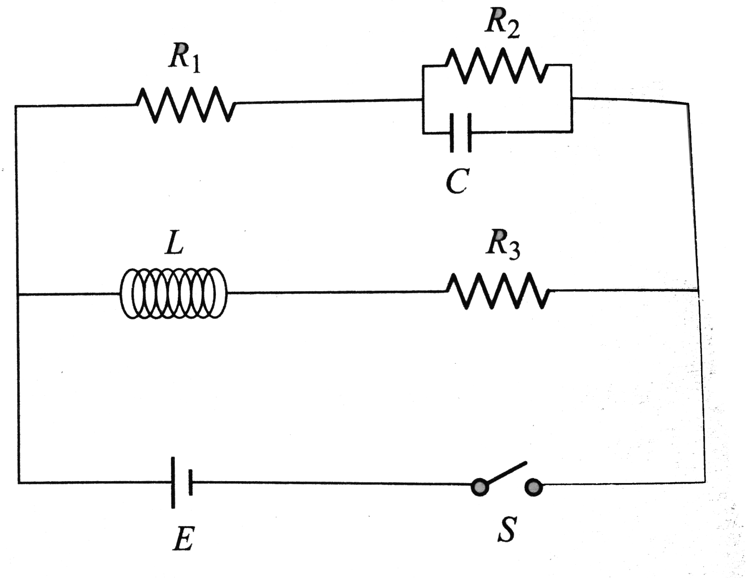
6. Switch S is cloesd in the circuit at time $t = 0$. Find the current through the capacitor and the inductor at any time t



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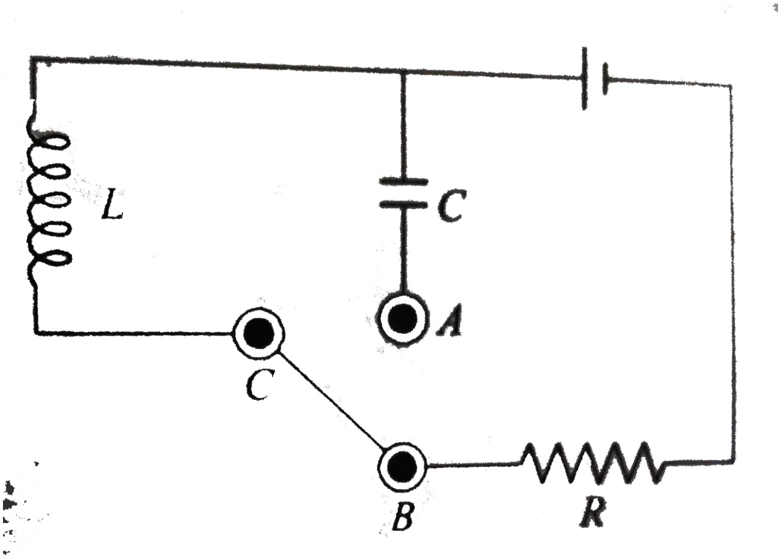
7. In the circuit shows in Fig the capacitor is initially uncharged and the two - way switch is connected in the position BC. Find the current through the resistence R as a function of time t. After time $t = 4$ ms, the switch is connected in the position AC. Find the frequency of oscillation of the capacitor of the circuit in the position, and the maximum charge on the capacitor C. At what time will the energy stored in the capacitor be one-half of the total energy stored in the circuit? It is given

$L = 2 \times 10^{-4} H, C = 5mF, R = \frac{In2}{10}\Omega$ and emf of the battery $= 1V$.



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Exercises (single Correct)

1. A mutual inductor consists of two coils X and Y as shown in Fig. in which one-quarter of the magnetic flux produced by X links with Y, giving a mutual inductance M. What will be the mutual inductance when Y is used as the primary?

A. $M/4$

B. $M/2$

C. M

D. $2M$

Answer: C

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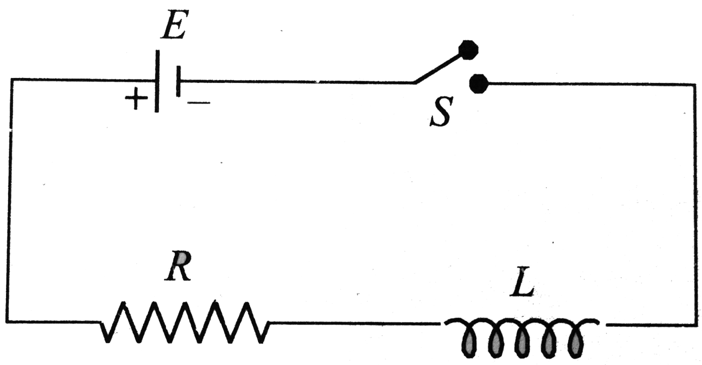
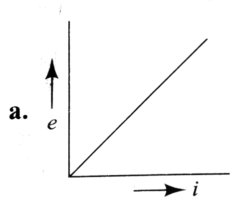
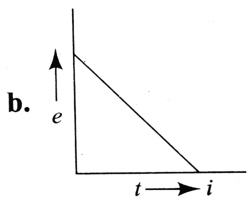
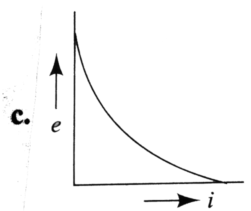
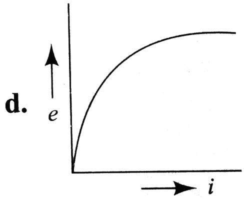
2. Switch S of the circuit shows in Fig. is closed at $t = 0$. If e denotes the induced emf in L and i the current flowing through the circuit at time t, then which of the following graphs correctly represents the variation of e with i?



A. 

B. 

C. 

D. 

Answer: B

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3. A small coil of radius r is placed at the centre of a large coil of radius R, where $R > > r$. The two coils are coplanar. The mutual inductance between the coils is proportional to

A. r / R

B. r^2 / R

C. r^2 / R^2

D. r / R^2

Answer: B

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4. A circuit contains two inductors of self-inductance L_1 and L_2 in series (Fig) If M is the mutual inductence, then the effective inductance of the circuit shows will be

A. $L_1 + L_2$

B. $L_1 + L_2 - 2M$

C. $L_1 + L_2 + M$

D. $L_1 + L_2 + 2M$

Answer: D

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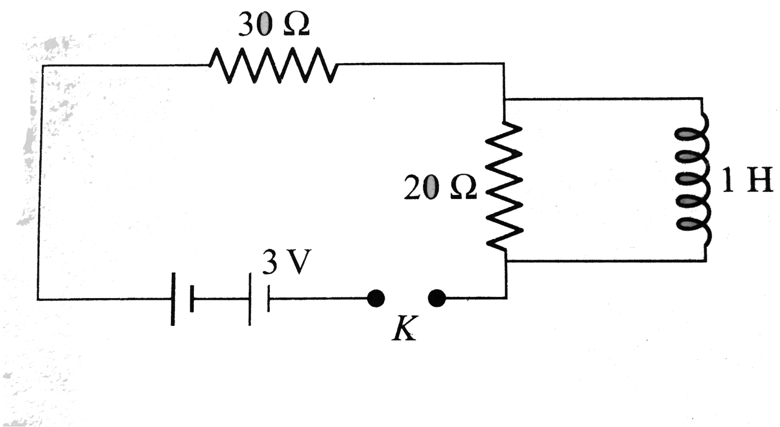
5. In the circuit Fig the final current through 30Ω resistance when circuit is completed is



A. $3A$

B. $0.1A$

C. $5A$

D. $0.5A$

Answer: B

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6. The coefficient of mutual inductance of two circuits A and B is $3mH$ and their respective resistanaces are 10 and 4Ω. How much current should change in $0.02s$ in circuit A, so that the induced current in B should be $0.0060A$?

A. $0.24A$

B. $1.6A$

C. $0.18A$

D. $0.16A$

Answer: D

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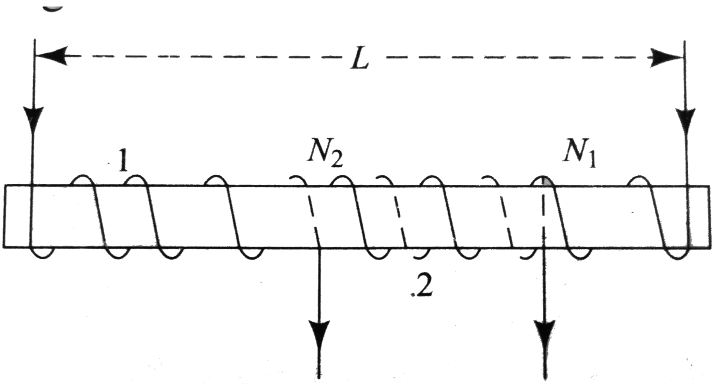
7. A long solenoid of length L, cross section A having N_1 turns has about its center a small coil of N_2 turns as shows in Fig The mutual inductance of two circuits is



A. $\dfrac{\mu_0 A(N_1 / N_2)}{L}$

B. $\dfrac{\mu_0 A(N_1 N_2)}{L}$

C. $\mu_0 A N_1 N_2 L$

D. $\dfrac{\mu_0 A N_1^2 N_2}{L}$

Answer: B

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8. An emf of 15 V is applied in a circuit coil containing 5 H inductance and 10Ω resistance. The ratio of the currents at time $t=\infty$ and t = 1 s is

A. $\dfrac{e^{1/2}}{e^{1/2}-1}$

B. $\dfrac{e^2}{e^2-1}$

C. $1-e^{-1}$

D. e^{-1}

Answer: B

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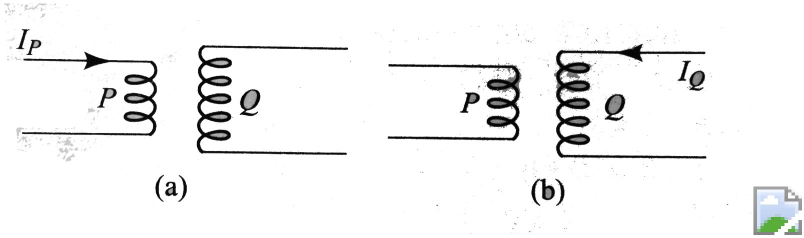
9. In Fig (a) and (b), two air-cored solenoids P and Q have been shows. They are placed near each other. In Fig (a), when I_P, the current in P, changes at the rate of $5As^{-1}$, an emf of $2mV$ is induced in Q. The current in P is then switched off, and the current changing at $2As^{-1}$ is fed through Q as shows in the figure. What emf will be induced in P?



A. $8 \times 10^{-4} V$

B. $2 \times 10^{-3} V$

C. $5 \times 10^{-3} V$

D. $8 \times 10^{-2} V$

Answer: A

Watch Video Solution

10. A coil of inductance $0.20H$ is connected in series with a switch and a cell of emf $1.6V$. The total resistance of the circuit is 4.0Ω. What is the initial rate of growth of the current when the switch is closed?

A. $0.050As^{-1}$

B. $0.40As^{-1}$

C. $0.13As^{-1}$

D. $8.0As^{-1}$

Answer: D

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11. The length of a wire required to manufacture a solenoid of length l and self-induction L is (cross-sectional area is negligible)`

A. $\sqrt{\frac{2\pi Ll}{\mu_0}}$

B. $\sqrt{\frac{\mu_0 Ll}{4\pi}}$

C. $\sqrt{\frac{4\pi Ll}{\mu_0}}$

D. $\sqrt{\frac{\mu_0 Ll}{2\pi}}$

Answer: C

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12. The inductance L of a solenoid of length l, whose windings are made of material of density D and resistivity ρ, is (the winding resistance is$R$)

A. $\frac{\mu_0}{4\pi l}\frac{Rm}{\rho D}$

B. $\frac{\mu_0}{4\pi R}\frac{lm}{\rho D}$

C. $\frac{\mu_0}{4\pi l}\frac{R^2 m}{\rho D}$

D. $\frac{\mu_0}{2\pi R}\frac{lm}{\rho D}$

Answer: A

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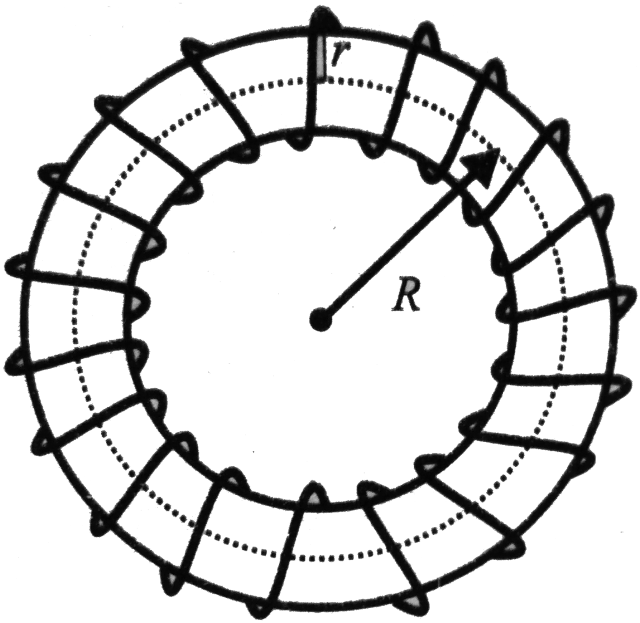
13. A toroid is wound over a circular core. Radius of each turn is r and radius of toroid is $R(\; > \; > r)$. The coefficient of self-inductance of the toroid is given by



A. $L = \dfrac{\mu_0 N r^2}{2R}$

B. $L = \dfrac{\mu_0 N r}{2R}$

C. $L = \dfrac{\mu_0 N r^2}{R}$

D. $L = \dfrac{\mu_0 N^2 r^2}{2R}$

Answer: D

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14. A straight solenoid of length $1m$ has 5000 turns in the primary and 200 turns in the secondary. If the area of cross section is $4cm^2$, the mutual inductance will be

A. $503H$

B. $503mH$

C. $503\mu H$

D. $5.03H$

Answer: C

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15. The approximate formula expressing the formula of mutual inductance of two coaxial loops of the same redius a when their centers are separated by a distance l with $l > \quad > a$ is

A. $\frac{1}{2}\frac{\mu_0\pi a^4}{l^3}$

B. $\frac{1}{2}\frac{\mu_0 a^4}{l^2}$

C. $\frac{\mu_0}{4\pi}\frac{\pi a^4}{l^2}$

D. $\frac{\mu_0}{\pi}\frac{a^4}{l^3}$

Answer: A

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16. The length of a thin wire required to manufacture a solenoid of length $l = 100 cm$ and inductance $L = 1 mH$, if the solenoid's cross-sectional diameter is considerably less than its length is

A. $1km$

B. $0.10km$

C. $0.010km$

D. $10km$

Answer: B

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17. Current in a coil of self-inductance $2.0H$ is increasing as $I = 2\sin t^2$. The amount of energy spent during the period when the current changes from 0 to $2A$ is

A. $1J$

B. $2J$

C. $3J$

D. $4J$

Answer: D

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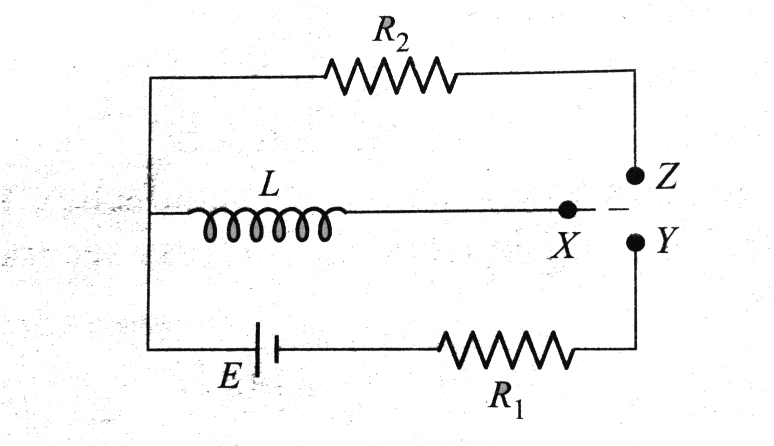
18. In the current shows Fig x is joined to Y for a long time and then X is joined to Z. The total heat produced in R_2 is



A. $\frac{LE^2}{2R_1^2}$

B. $\frac{LE^2}{2R_2^2}$

C. $\dfrac{LE^2}{2R_1R_2}$

D. $\dfrac{LE^2R_2}{2R_1^3}$

Answer: A

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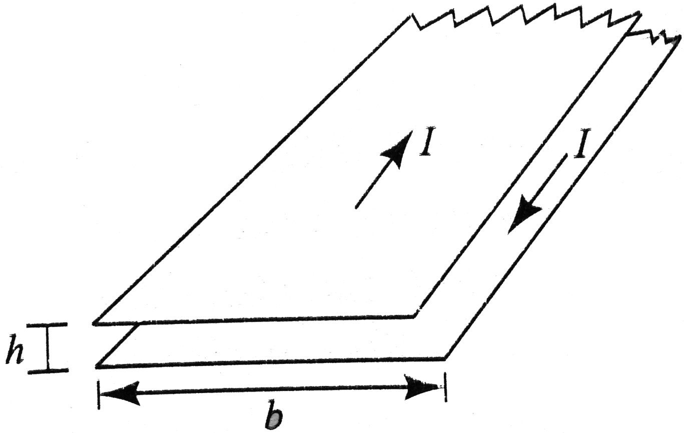
19. Calculate the inductance of a unit length of a double tape line as shows in Fig if the tapes are separated by a distance h which is considerably less than their width b.



A. $\dfrac{\mu_0 h}{b}$

B. $\dfrac{\mu_0 h}{2b}$

C. $\dfrac{2\mu_0 h}{b}$

D. $\dfrac{\sqrt{2}\mu_0 h}{b}$

Answer: A

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20. Find the inductance of a unit length of two long parallel wires, each of radius a, whose centers are a distance d apart and carry equal currents in opposits directions. Neglect the flux within the wire.

A. $\frac{\mu_0}{2\pi} In\left(\frac{d-a}{a}\right)$

B. $\frac{\mu_0}{\pi} In\left(\frac{d-a}{a}\right)$

C. $\frac{3\mu_0}{\pi} In\left(\frac{d-a}{a}\right)$

D. $\frac{\mu_0}{3\pi} In\left(\frac{d-a}{a}\right)$

Answer: B

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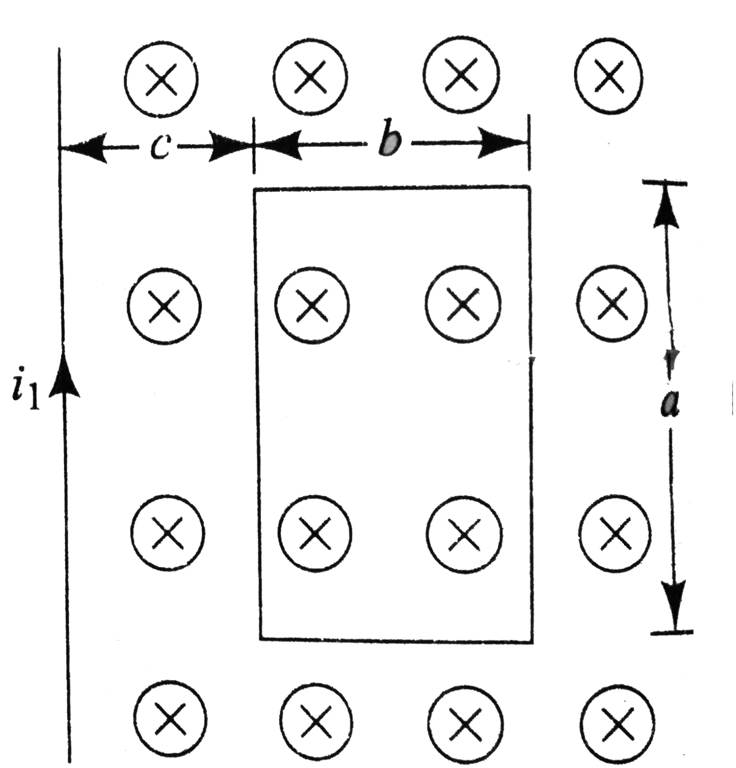
21. Figure shows a rectangular coil near a long wire. The mutual inductance of the combination is



A. $\frac{\mu_0 a}{2\pi} In\left(1-\frac{b}{c}\right)$

B. $\frac{\mu_0 a}{2\pi} In\left(1+\frac{b}{c}\right)$

C. $\frac{\mu_0 a}{\pi} In\left(1+\frac{b}{c}\right)$

D. $\frac{\mu_0 a}{\sqrt{2}\pi} In\left(1+\frac{b}{c}\right)$

Answer: B

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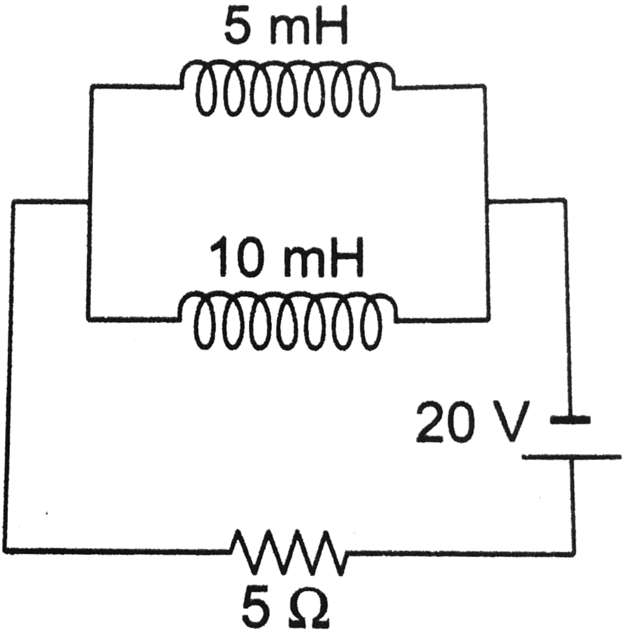
22. In the given circuit, find the current through the $5mH$ inductor in steady state.



A. $\frac{2}{3}A$

B. $\frac{8}{3}A$

C. $\frac{1}{3}A$

D. $\frac{2}{3}A$

Answer: B

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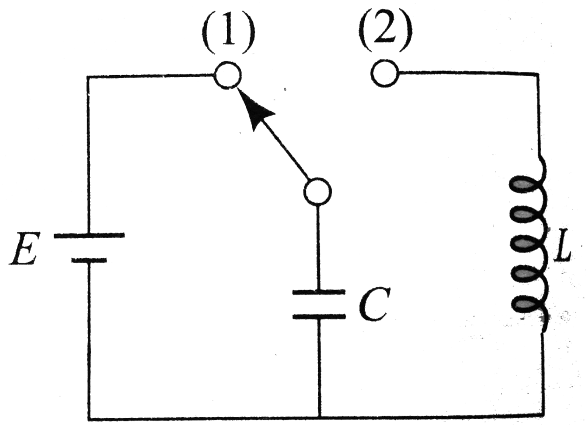
23. In the following electrical network at $t = < 0$ Fig key is placed on (1) till the capacitor got fully charged. Key is placed on (2) at $t = 0$. Time when the energy in both the same for the time is



A. $\frac{\pi}{4}\sqrt{LC}$

B. $\frac{3\pi}{4}\sqrt{LC}$

C. $\frac{\pi}{3}\sqrt{LC}$

D. $\frac{2\pi}{3}\sqrt{LC}$

Answer: A

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24. The total heat produced in resistor r in an RL circuit when the current in the inductor decreases from I_o to 0 is

A. LI_0^2

B. $\frac{1}{2}LI_0^2$

C. $\frac{3}{2}LI_0^2$

D. $\frac{1}{3}LI_0^2$

Answer: B

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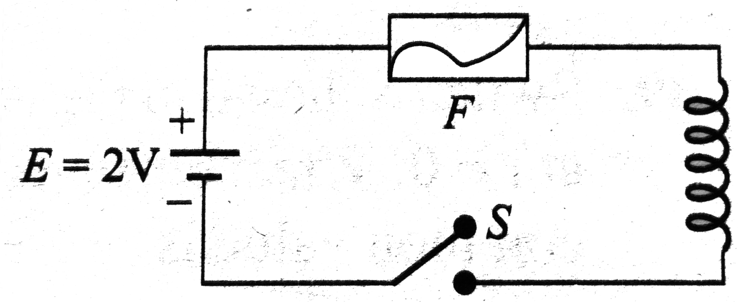
25. In the circuit shows Fig the cell is ideal. The coil has an inductance of $4H$ and zero resistance. F is a fuse of zero resistance and will blow when the current through it reaches $5H$. The switch is closed at $t=0$. The fuse will blow



A. almost at once

B. after $2s$

C. after $5s$

D. after $10s$

Answer: D

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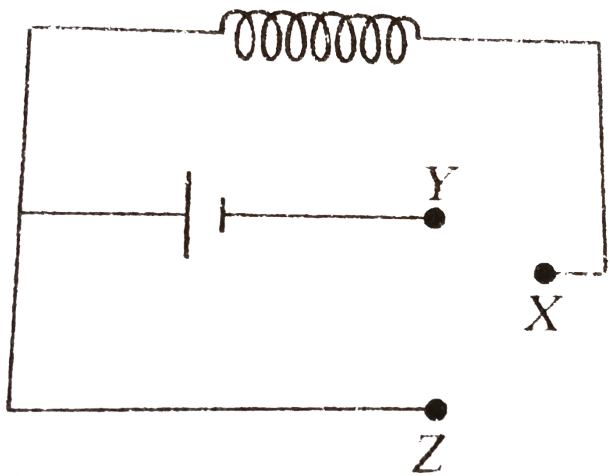
26. In the circuit shown, the coil has inductance and resistance. When X is joined to Y, the time constant is τ during growth of current. When the steady state is reached, then heat is produced in the coil at a rate P. If X is now joined to Z, then choose the correct statement.



A. the total heat produed in the coil is $p\tau$

B. The total heat produced in the coil is $\frac{1}{2}P\tau$

C. The total heat produced in the coil is $2P\tau$

D. The data given are not sufficient to reach a conlusion

Answer: B

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27. A long solenoid having 200 turns per centimeter carries a current of $1.5A$. At the center of the solenoid is placed a coil of 100

turns of cross-sectional area $3.14 \times 10^{-4} m^2$ having its axis parallel to the field produced by the solenoid. When the direction of current in teh solenoid is reversed within $0.05 s$, the induced emf in the coil is

A. $0.48 V$

B. $0.048 V$

C. $0.0048 V$

D. $48 V$

Answer: B

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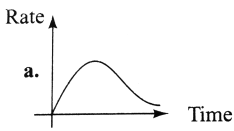
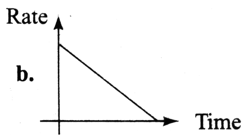
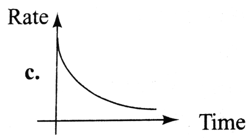
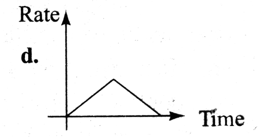
28. In an L-R circuit connected to a battery at which energy ius stored in the inducator is plotted against time during the growth of current in the ciruit Which of the following best represents the resulting curve?

A. 

B. 

C. 

D. 

Answer: A

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29. Two coils are at fixed locations. When coil 1 has no current and the current in coil 2 increases at the rate of 15.0A/s the emf in coil 1 in 25.0mV, when coil has no current and coil 1 has acurrent of 3.6A, the flux linkage in coil 2 is

A. $16mWb$

B. $10mWb$

C. $4.00mWb$

D. $6.00mWb$

Answer: D

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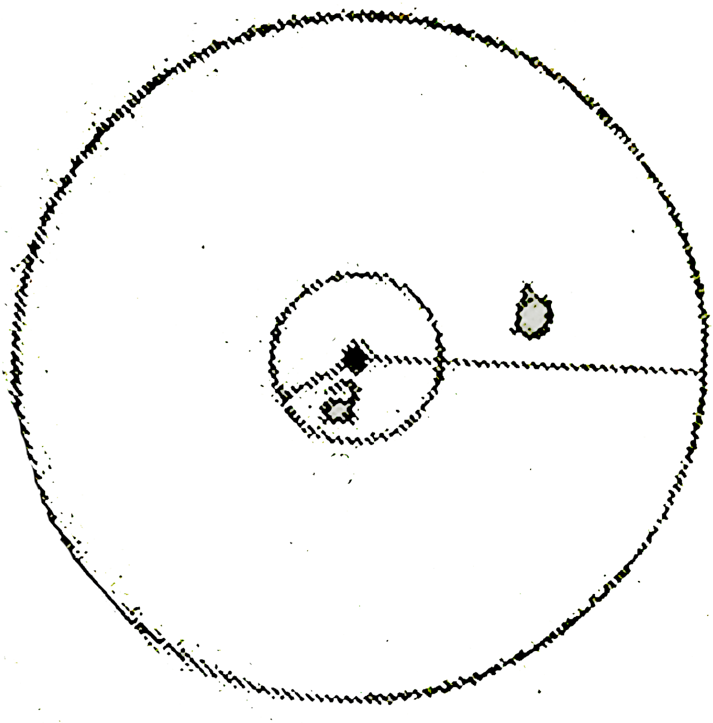
30. Two concentric and coplanar circular coils have radii a and b($> \, > a$) as shown in the figure. Resistance of the inner coil is R. Current in the outer coil is increased from 0 to I, then

the total charge circulating the inNer coil is



A. $\dfrac{\mu_0 i a^2 \pi}{2Rb}$

B. $\dfrac{\mu_0 i a b}{2R}$

C. $\dfrac{\mu_0 i a b}{2a}\dfrac{\pi b^2}{R}$

D. $\frac{\mu_0 ib}{2\pi R}$

Answer: A

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31. A current i_0 is flowin through on L-R circyuit of time constant t_0. The source of current is seitched off at time t=0. Let r be the value of (-di/dt) at tiemt t=0. Assuming this rate to be constant, the current will reduce to zero in a time interval of

A. t_0

B. et_0

C. $\frac{t_0}{e}$

D. $\left(1 - \frac{1}{e}\right)t_0$

Answer: A

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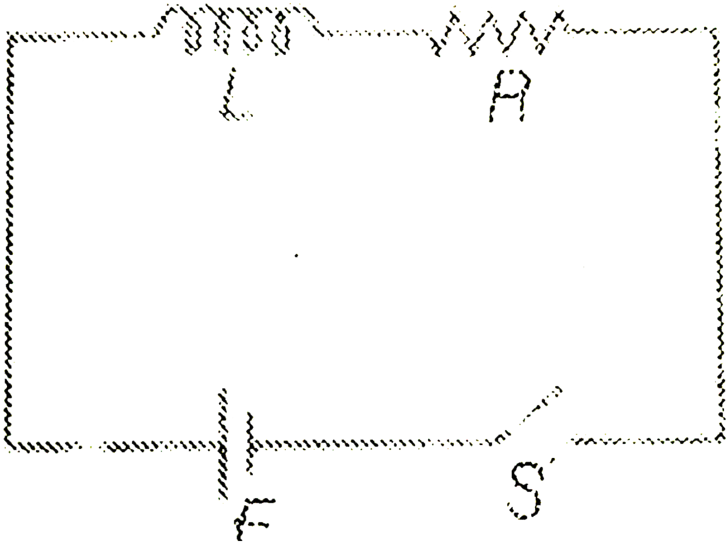
32. In the circuit shown in figure switch S is closed at time t=0. The charge which passes through the battery in one time constant is



A. $\dfrac{eR^2E}{L}$

B. $E\left(\dfrac{L}{R}\right)$

C. $\dfrac{EL}{eR^2}$

D. $\dfrac{eL}{ER}$

Answer: C

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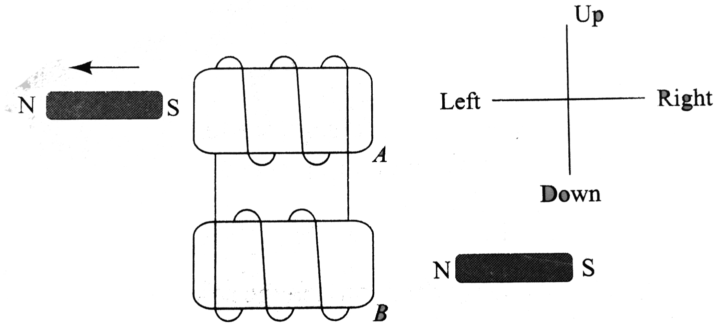
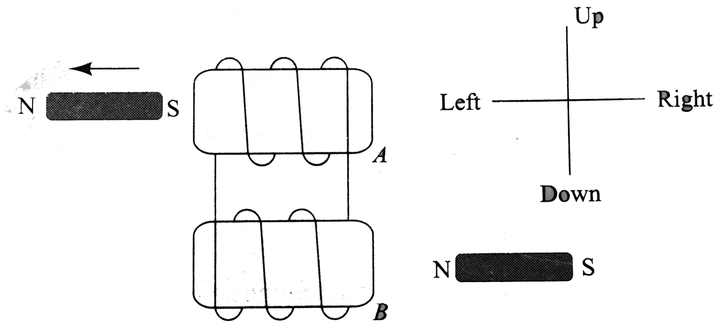
33. A bar magnet was pulled away from a hollow coil A as shows in Fig As the south pole came out of the coil, the bar magnet next to hollow coil B experiened a magnetic force





A. to the right

B. to the left

C. upward

D. equal to zero

Answer: A

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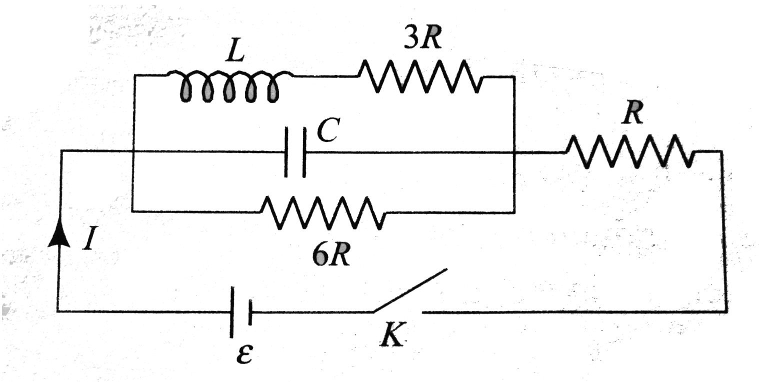
34. In the given circuit (Fig), key K is witched on the at $t = 0$. The ratio of current i through the cell at $t = 0$ to that at $t = \infty$ will be



A. $3:1$

B. $1:3$

C. $1:2$

D. $2:1$

Answer: A

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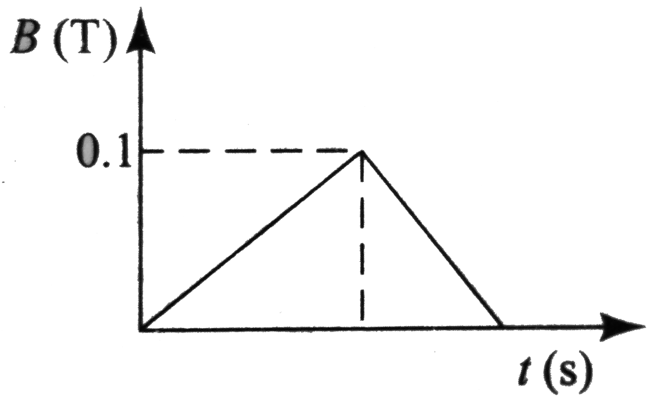
35. A closed loop of cross-sectional area $10^{-2}m^2$ which has inductance $L = 10mH$ and negligible resistance is placed ti time-varying magnetic field. Figure shows the variation of B with time for the intervel $4s$.

The field is perpendicular to the plane of the loop (given at $t = 0, B = 0, I = 0$). The value of the maximum current induced in the loop is



A. $0.1mA$

B. $10mA$

C. $100mA$

D. Date insufficient

Answer: C

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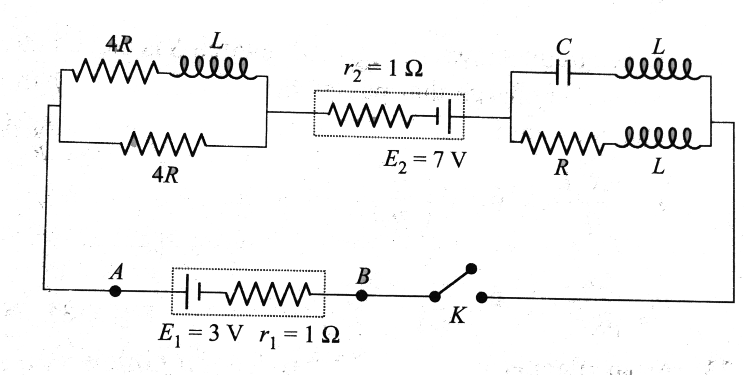
36. In Fig. key K is closed at $t = 0$. After a long time, the potential difference between A and B is zero, the value of R will be $[r_1 = r_2 = 1\Omega, E_1 = 3V$ and $E_2 = 7V$, $C = 2\mu F, L = 4mH$, where r_1 and r_2 are the internal resistances of cells E_1 and E_2, respectively].



A. $\frac{4}{3}\Omega$

B. $\frac{4}{9}\Omega$

C. $\frac{2}{3}\Omega$

D. 4Ω

Answer: B

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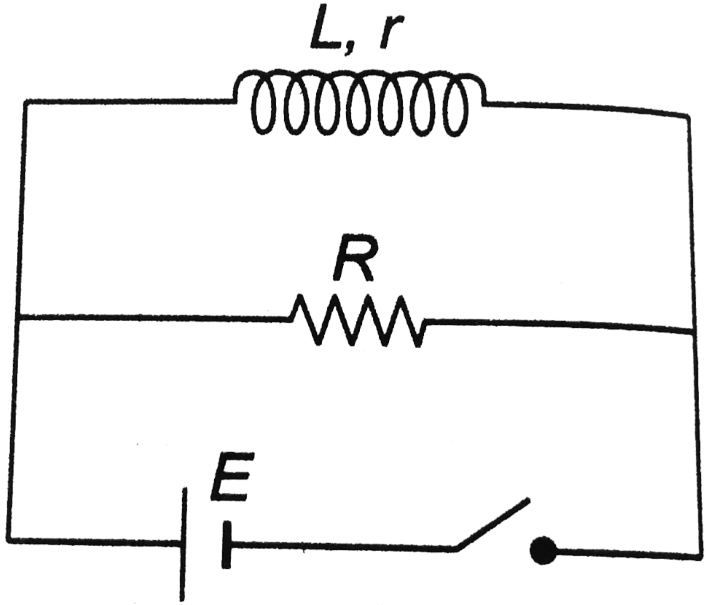
37. A solenoid of inductance L with resistance r is connected in parallel to a resistance R. A battery of emf E and of negligible internal resistance is connected across the parallel combination as shown in the figure. At time $t = 0$, switch S is opened, calculate

(a) current through the solenoid after the switch is opened.

(b) amount of heat generated in the solenoid.



A. Current in the inductor just after removing the battery is $\frac{E(r+R)}{rR}$

B. Total enery dissipated in the solenoid and the reistor long time after removing the battery is $\frac{1}{2}L\frac{E^2(R+r)^2}{r^2R^2}$

C. The amount of heat generated in the solenoid due to removing the battery is $\frac{E^2L}{2r(r+R)}$

D. The amount of heat generated in the solenoid due to removing the battery is $\frac{E^2L}{2R(r+R)}$

Answer: C

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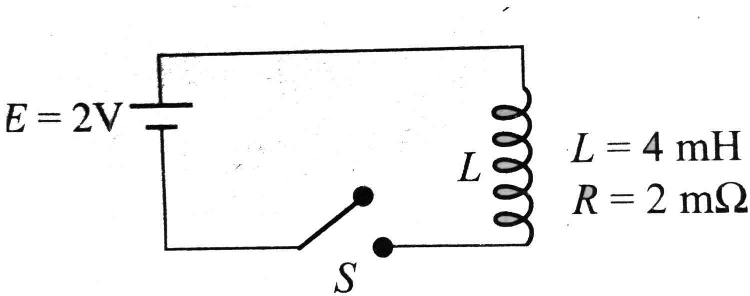
38. The cell in the circuit shows in Fig is ideal. The coil has an inductance of $4mH$ and a resistance of $2m\Omega$. The switch is closed at $t = 0$. The amount of energy stored in the inductor at $t = 2s$ is (take $e = 3$)



A. $\frac{4}{3} J$

B. $\frac{8}{9} \times 10^3 J$

C. $\frac{8}{9} \times 10^3 J$

D. $2 \times 10^3 J$

Answer: B

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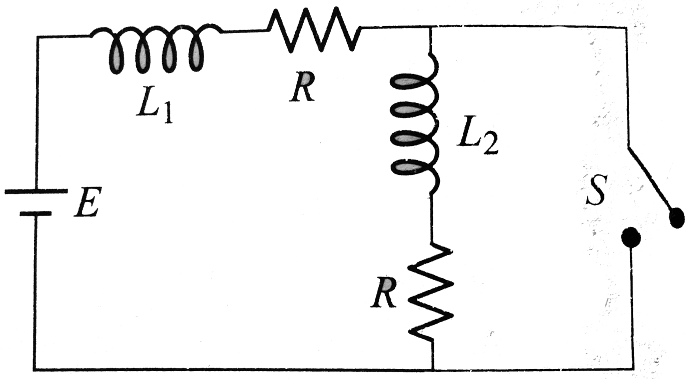
39. Switch S shown in Fig. is closed for $t < 0$ and is opened at $t = 0$. When currents through L_1 and L_2 are equal, their common value is



A. $\dfrac{E}{R}$

B. $\dfrac{E(L_2 + L_2)}{RL_1}$

C. $\dfrac{EL_1}{R(L_1 + L_2)}$

D. $\dfrac{E}{R}\dfrac{(L_1 + L_2)}{L_2}$

Answer: C

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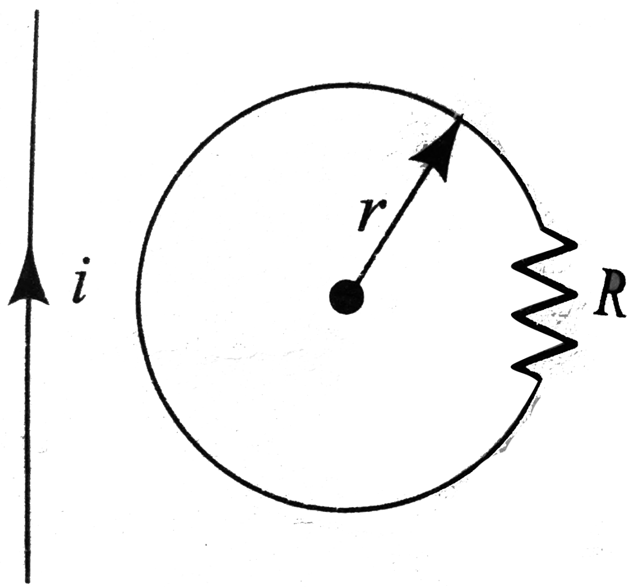
40. In Fig, the mutual inductance of a coil and a very long straight wire is M, coil has resistance R and self-inductance L. The current in the wire varies according to the law $I = at$, where a is a constant and t is the time, the time dependence of current in the coil is



A. $\frac{M}{aR}$

B. $maRe^{-Rt/L}$

C. $\frac{M}{R}e^{-tR/L}$

D. $\frac{Ma}{R}\left(1-e^{-tR/L}\right)$

Answer: D

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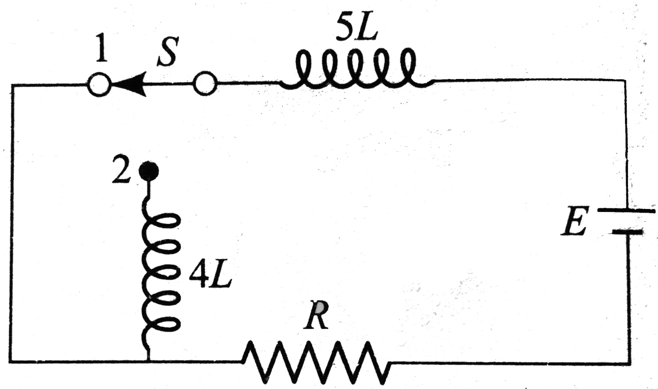
41. In the circuit shows in Fig switch S is shifed to position 2 from position 1 at $t=0$, having been on position 1 for a long time. The current in the circuit just after shifting of switch will be (battery and both the inductors are ideal)



A. $\frac{4}{5}\frac{E}{R}$

B. $\frac{5}{4}\frac{E}{R}$

C. $\frac{5}{9}\frac{E}{R}$

D. $\frac{E}{R}$

Answer: C

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42. The capacitance in an oscilatory LC circuit is increased by 1%. The charge in inductance required to restore its frequency of oscillation is to

A. decrease it by 0.5%

B. increase it by 1%

C. decrease it by 1%

D. decrease it by 2%

Answer: C

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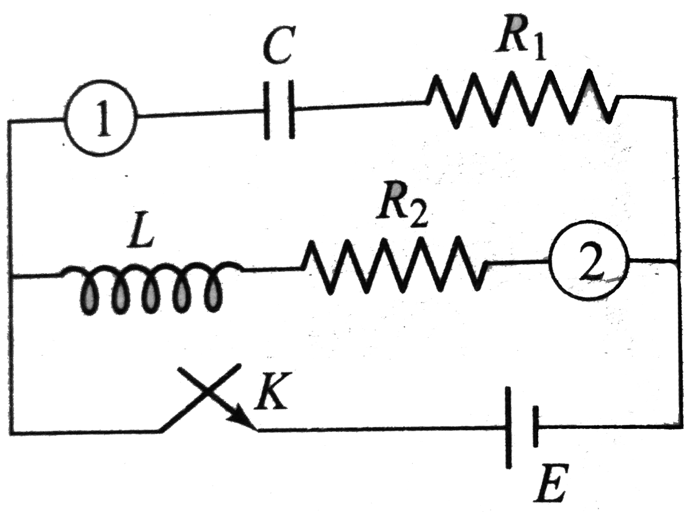
43. In the circuit of Fig. (1) and (2) are ammeters. Just after circuit K is pressed to complete the circuit, the reading is



A. maximum in both 1 and 2

B. zero in both 1 and 2

C. zero in 1, minimum in 2

D. maximum in 1, zero in 2

Answer: D

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44. A wire of fixed length is wound on a solenoid of length 'l' and radius 'r' . Its self inductiane is found to be Now if same wire is wound on a solenoid of length ad radius $\frac{r}{2}$ then the self inductance will be

A. $2L$

B. L

C. $4L$

D. $8L$

Answer: A

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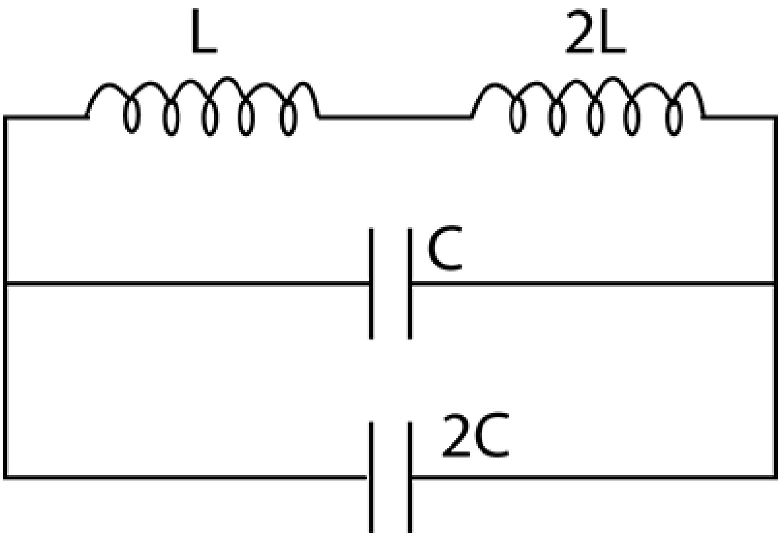
45. The frequency of oscillation of current in the circuit is



A. $\dfrac{1}{3\sqrt{LC}}$

B. $\dfrac{1}{6\pi\sqrt{LC}}$

C. $\dfrac{1}{\sqrt{LC}}$

D. $\dfrac{1}{2\pi\sqrt{LC}}$

Answer: B

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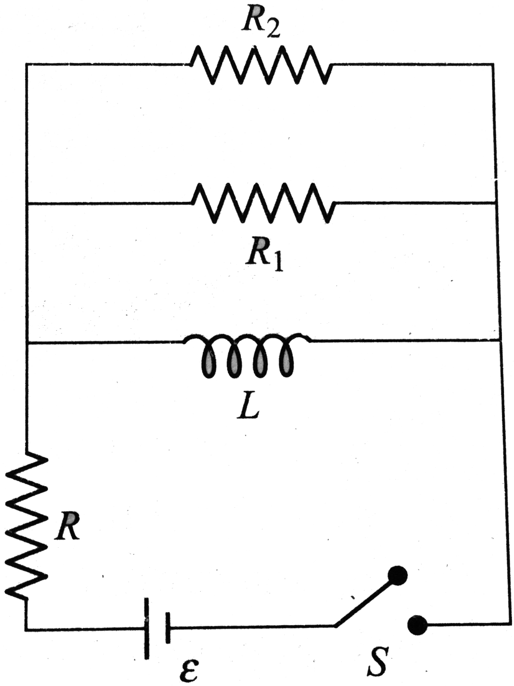
46. In Fig. switch S is closed for a long time. At $t = 0$, if it is opened, then



A. total heat produced in resistor R after opening the switch is $\frac{1}{2}\frac{L\varepsilon}{R^2}$

B. total heat produced in resistor R_1 after opening the switch is

$$\frac{1}{2}\frac{L\varepsilon^2}{R^2}\left(\frac{R_1}{R_1+R_2}\right)$$

C. heat produced in resistor R_1 after opening the switch is $\frac{1}{2}\frac{R_2L\varepsilon^2}{(R_1+R_2)R^2}$

D. no heat will be produced in R_1

Answer: C

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47. A closed circuit of a resistor R, inductor of inductance L and a source of emf E are connected is series. If the inductance of the coil is abruptly decreaed to $L/4$ (by removing its magnetic core), the new current immediately after this moment is (before decreasing the inductance the circuit is in steady state)

A. zero

B. $\frac{E}{R}$

C. $4\frac{E}{R}$

D. $\frac{E}{4R}$

Answer: C

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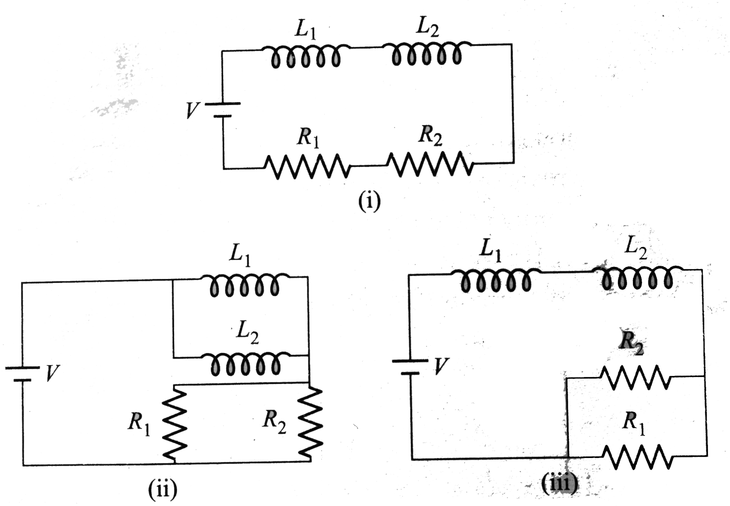
48. Given $L_1 = 1mH,\ R_1 = 1\Omega,\ L_2 = 2mH,$

$R_2 = 2\Omega$



Neglecting mutual inductance, the time

constants (in ms) for circuits (i), (ii), and (iii) are

A. $1, 1, \frac{9}{2}$

B. $\frac{9}{4}, 1, 1$

C. $1, 1, 1$

D. $1, \frac{9}{4}, 1$

Answer: A

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49. A horizontal ring of radius $r = \frac{1}{2}m$ is kept in a vertical constant magentic field $1T$. The ring is collapsed from maximum area to zero area in $1s$. Then the emf induced in the ring is

A. $1V$

B. $(\pi / 4)V$

C. $(\pi / 2)V$

D. πV

Answer: B

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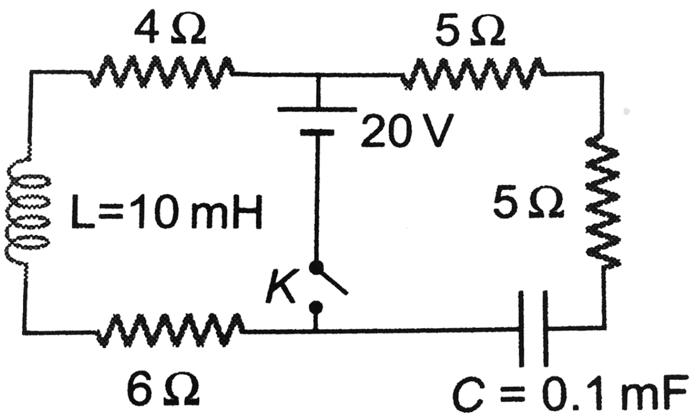
50. In the circuit shown the key (K) is closed at $t = 0$, the current through the key at the instant $t = 10^{-3} \ln, 2$ is



A. $2A$

B. $3.5A$

C. $2.5A$

D. 0

Answer: C

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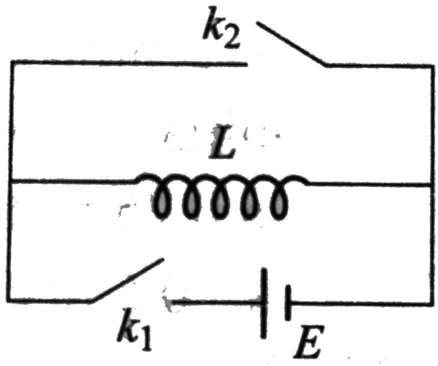
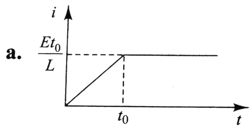
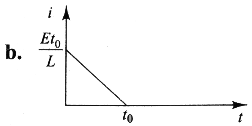
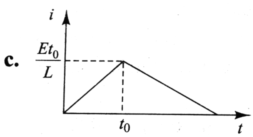
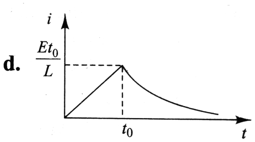
51. In the circuit shows in Fig. switch k_2 is open and switch k_1 is closed at $t = 0$. At time $t = t_0$, switch k_1 is opened and switch k_2 is simultaneosuly closed. The variation of inductor current with time is



A. 

B. 

C. 

D. 

Answer: A

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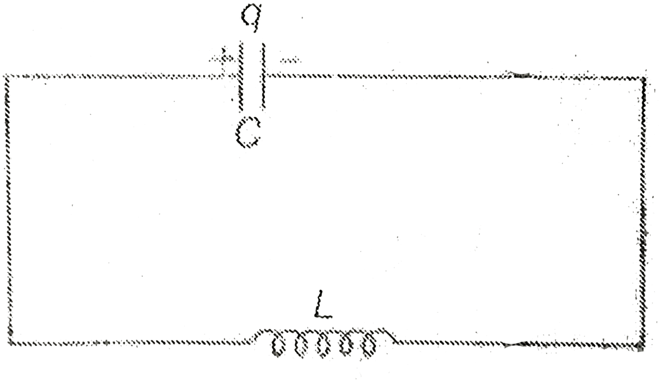
52. In an L-C circuit shown in figure

C=1F, L=4H

At time t=0, charge in the capacitor is 4C and it is decreasing at a rate of $\sqrt{5}C/s$



Maximum charge in the capacitor can be

A. Maximum charge in the capacitor can be

$6C$

B. Maximum charge in the capacitor can be

$8C$

C. Charge in the capacitor will be maximum

after time $3\sin^{-1}(2/3)s$

D. None of these

Answer: A

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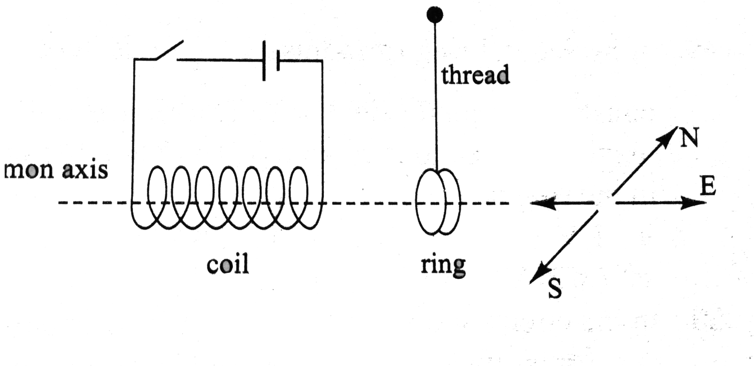
53. An aluminium ring hangs vertically from a thread with its axis pointing east-west. A coil is fixed mear to the ring and coaxial with it.

What is the initial motion of the aluminium ring when the current in the coil is switched on?



A. moves toward E

B. moves toward W

C. moves toward N

D. moves toward S

Answer: A

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54. A coil carrying a steady current is short-circuited. The current in it decreases α times in time t_0. The time constant of the circuit is

A. $\tau = t_0$ ln α

B. $\tau = \dfrac{t_0}{In\alpha}$

C. $\tau = \dfrac{t_0}{\alpha}$

D. $\tau = \dfrac{t_0}{\alpha - 1}$

Answer: B

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55. A solenoid has 2000 turns would over a length of 0.30 m. The area of its cross-section is $1.2 \times 10^{-3} m^2$. If an initial current of 2 A in the solenoid is reversed in 0.25 s, then the emf induced in the coil is

A. $0.6 mV$

B. $60 mV$

C. $48 mV$

D. $0.48 mV$

Answer: C

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56. Two coils X and Y are linked such that emf E is induced in Y when the current in x is changing at the rate $I'(=dI/dt)$. If a current I_0 is now made to flow through Y, the flux linked with X will be

A. EI_0I'

B. $\frac{I_0I'}{E}$

C. $(EI')I_0$

D. $\left(\frac{E}{I'}\right)I_0$

Answer: D

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57. The time constant of an inductance coil is $2.0 \times 10^{-3}s$. When a 90Ω resistance is joined in series, then the time constant becomes $0.5 \times 10^{-3}s$. The inductance and resistance of the coil are

A. $30mH, 30\Omega$

B. $60mH, 30\Omega$

C. $30mH, 60\Omega$

D. $60mH, 60\Omega$

Answer: B

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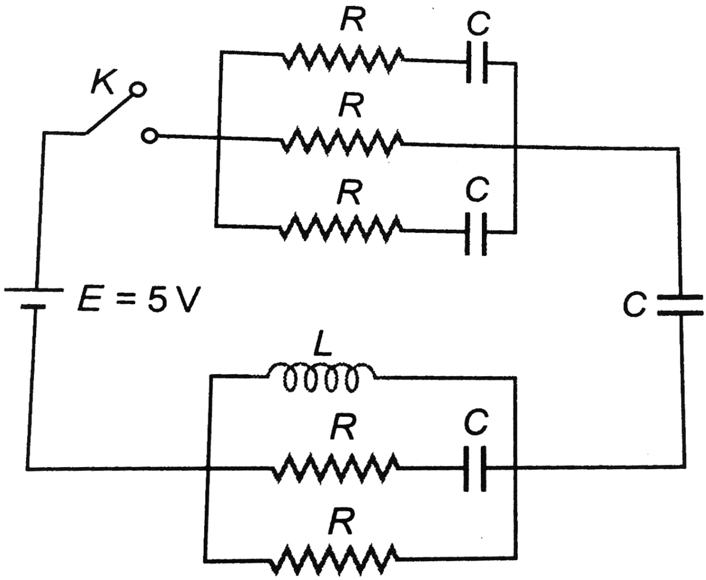
58. Find the current passing through battery immediately after key (K) is closed. It is given that initially all the capacitors are uncharged.

(Given that $R = 6\Omega$ and $C = 4\mu F$)



A. $1A$

B. $5A$

C. $3A$

D. $2A$

Answer: A

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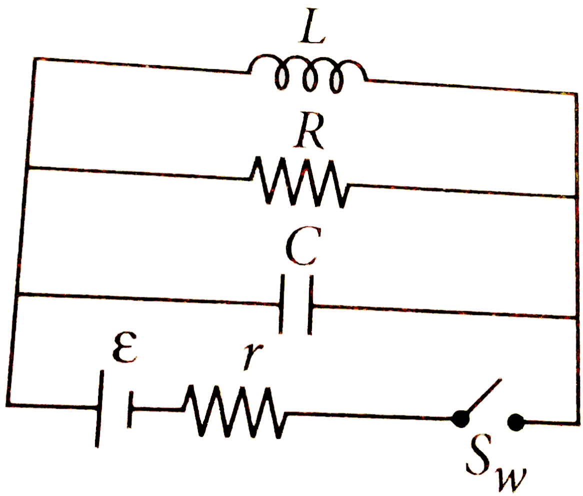
59. A pure inductor L, a capacitor C and a resistance R are connected across a battery of emf ε and internal resistance r as shown in the figure. The switch S_w is closed at t = 0, select the correct alternative.



A. current through resistance R is zero all the time

B. current through resistance R is zero at $t = 0$ and $t \to \infty$

C. maximum charge stored in the capacitor is CE

D. maximum charge stored in the inductor is equal to the maximum energy stored in the capacitor

Answer: B

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60. A simple LR circuit is connected to a battery at time $t = 0$. The energy stored in the inductor reaches half its maximum value at time

A. $\frac{R}{L}$ ln $\left[\frac{\sqrt{2}}{\sqrt{2}-1}\right]$

B. $\frac{L}{R}$ ln $\left[\frac{\sqrt{2}-1}{\sqrt{2}}\right]$

C. $\frac{L}{R}$ ln $\left[\frac{\sqrt{2}}{\sqrt{2}-1}\right]$

D. $\frac{R}{L}$ ln $\left[\frac{\sqrt{2}-1}{\sqrt{2}}\right]$

Answer: C

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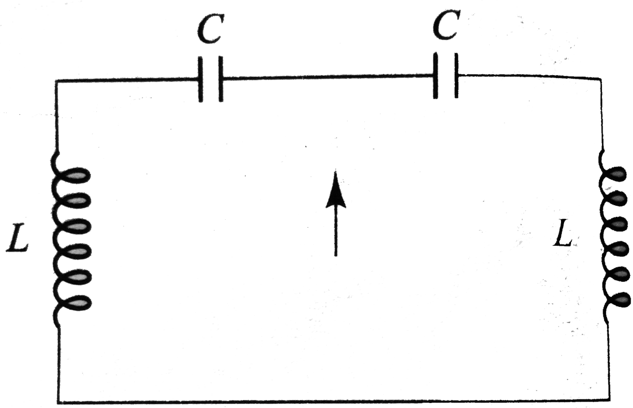
61. The natural frequency of the circuit shows in Fig. is



A. $\dfrac{1}{\sqrt{LC}}$

B. $\dfrac{1}{\sqrt{2LC}}$

C. $\dfrac{2}{\sqrt{LC}}$

D. None of these

Answer: A

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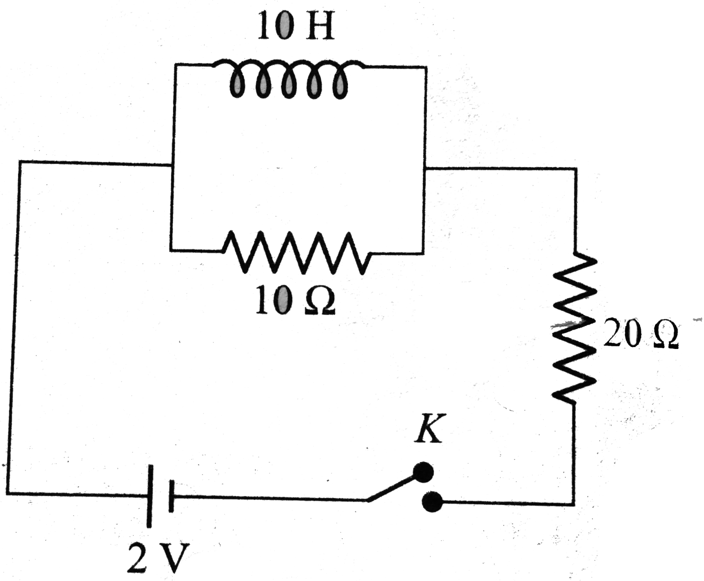
62. Two resistors of 10Ω and 20Ω and an ideal inductor of $10H$ are connected to a $2V$ battery as shows in Fig. key K is inserted at time $t = 0$. The initial $(t = 0)$ and final

$(t \to \infty)$ currents through the battery are



A. $\frac{1}{15}A, \frac{1}{10}A$

B. $\frac{1}{10}A, \frac{1}{15}A$

C. $\frac{2}{15}A, \frac{1}{10}A$

D. $\frac{1}{15}A, \frac{2}{25}A$

Answer: A

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63. A square conducting loop of side L is situated in gravity free space. A small conducting circular loop of redius $r(r < < L)$ is placed at the center of the square loop, with its plane perpendicular to the plane of the square loop. The mutual inductance of the two coils is

A. $\dfrac{2\sqrt{2}\mu_0 I}{L}r^2$

B. $\dfrac{\sqrt{2}\mu_0 I_0}{L}r^2$

C. 0

D. None of these

Answer: C

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64. There is a conducting ring of radius R. Another ring of radius $r(r < < R)$ is kept on the axis of bigger ring such that it's a center lies on the axis of bigger ring at a distance x from the center of bigger ring and its place is perpendicular to the axis. The mutual inductance of the two rings is

A. $\dfrac{\mu_0 \pi R^2 r^2}{(R^2 + x^2)^{3/2}}$

B. $\dfrac{\mu_0 \pi R^2 r^2}{4(R^2 + x^2)^{3/2}}$

C. $\dfrac{\mu_0 \pi R^2 r^2}{16(R^2 + x^2)^{3/2}}$

D. $\dfrac{\mu_0 \pi R^2 r^2}{2(R^2 + x^2)^{3/2}}$

Answer: D

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65. The capacitor of an oscillatory circuit of frequency $10000 Hz$ is enclosed in a container. When the container is evacuated, the frequency changes by$50 Hz$, the delectric constant of the gas is

A. 1.1

B. 1.01

C. 1.001

D. 1.0001

Answer: B

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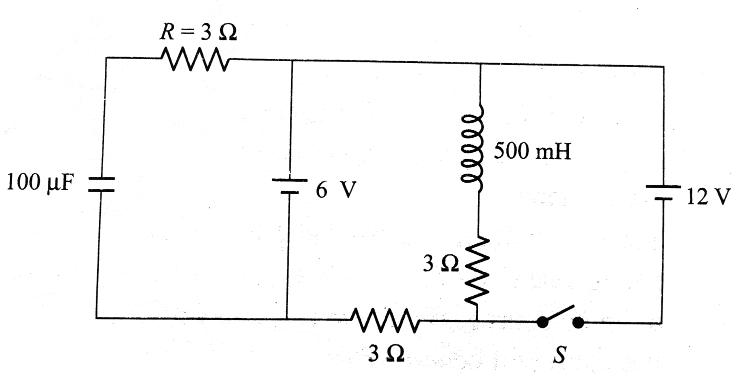
Exercises (multiple Correct)

1. In the given circuit Fig the switch is closed at $t = 0$. Choose the correct answers.



A. Current in the inductor when the circuit reaches the steady state is $4A$.

B. The net change in flux in the inductor is $1.5Wb$.

C. The time constant of the circuit after closing S is $555.55s$

D. The charge stored in the capacitor in steady state is $1.2mC$.

Answer: A::B

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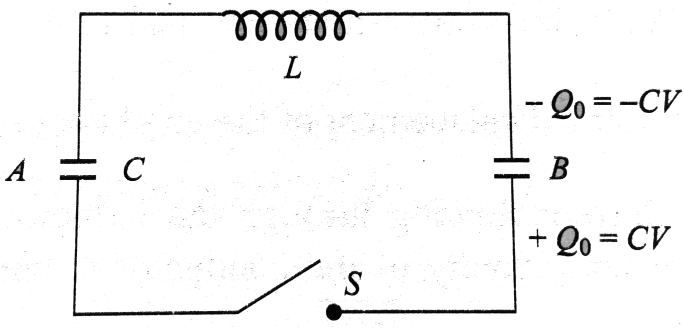
2. An inductor and two capacitors are connected in the circuit as show in Fig Initially capacitor A has no charge and capacitor B has CV charge. Assume that the circuit has no resistance at all. At $t=0$, switch S is closed, then [given

$LC = \frac{2}{\pi^2 \times 10^4} S^2$ and $Cv = 100mC]$



A. when current in the circuit is maximum,

charge on each capacitor is same

B. when current in the circuit is maximum,

charge on capacitor A is twice the

charge on capacitor B

C. $q = 50(1 + \cos 100\pi t)mC$, where q is the charge on capacitor B at time t

D. $q = 50(1 - \cos 100\pi t)mC$, where q is the charge on capacitor B at time t

Answer: A::C

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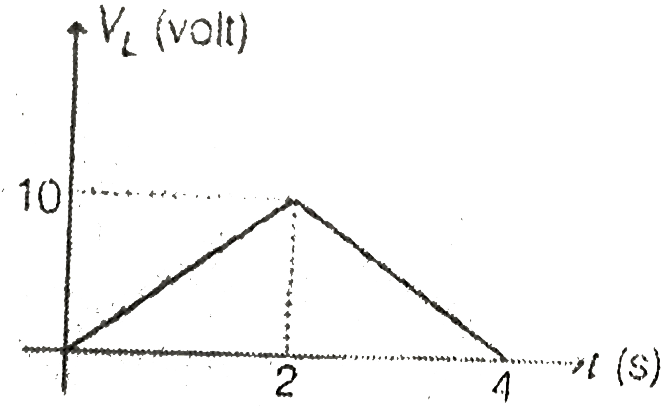
3. The potentiak difference across a 2H inductor as a function of time is shown in the figure. At time t=0, current is zero.

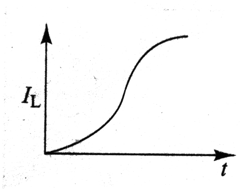


Current at t=s is

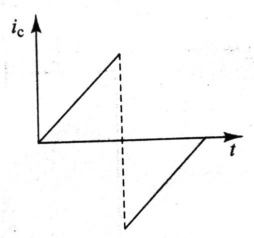
A. Current at $t = 2s$ is $5A$

B. Current at $t = 2s$ is $10A$

C. Current versus time graph across the inductor will be Fig.



D. Current versus time graph across the inductor will be Fig.



Answer: A::C

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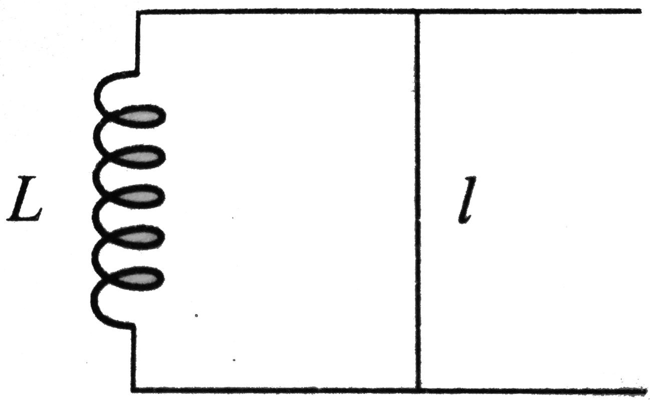
4. Two parallel resistanceless rails are connected by an inductor of inductance L at one end as shows in Fig. A magnetic field B

exists in the space which is perendicular to the plane of the rails. Now a conductor of length l and mass m is placed transverse on the rail and given an inpulse J toward the rightward direction. Then choose the correct option (S).



A. Velocity of the conductor is half of the initial velocity after a displaacement of the conductor $d=\sqrt{\frac{3J^2L}{4B^2l^2m}}$

B. Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i=\sqrt{\frac{3J^2}{4Lm}}$

C. Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d=\sqrt{\frac{3J^2L}{B^2l^2m}}$

D. Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is

$$i = \sqrt{\frac{3j^2}{mL}}$$

Answer: A::B

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5. Two inductors are connected in parallel and switch S is closed at $t = 0$

A. At $t = 0, I_1 = I_2 = 0$

B. At any time t, $\frac{I_0}{I_2} = \frac{L_2}{L_1}$

C. At any time t, $I_1 + I_2 = \frac{\varepsilon}{R}$

D. At $t = \infty$, I_1 and I_2 are independent of

L_1 and L_2

Answer: A::B

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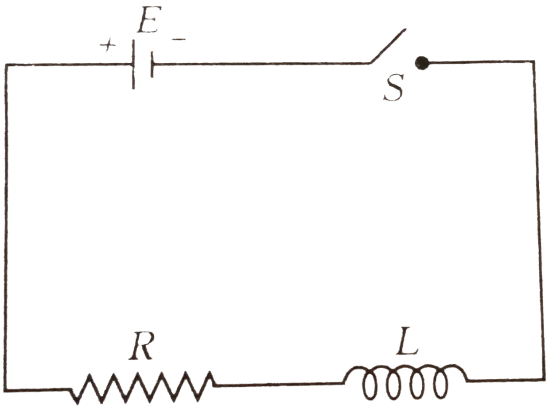
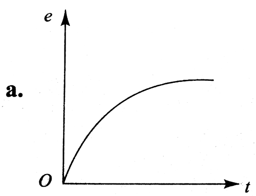
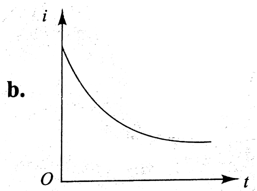
6. Switch S of the circuit shown in figure is

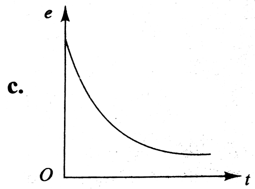
closed at t = 0.

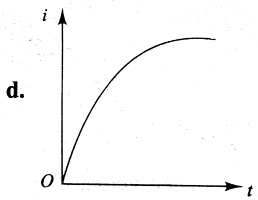


If emf in L is e and i is the current flowing through the circuit at time t, which of the following graphs is corrent?

A. 

B. 

C. 

D. 

Answer: C::D

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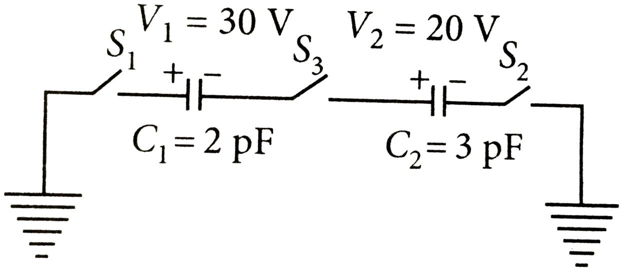
7. For the circuit shown in figure, which of the following statements is ture ?



A. Its time constant is $0.25s$

B. In steady state, current through the inductance will be equal to zero

C. In steady state, current through the battery will be equal to $0.75A$

D. None of these

Answer: A::C

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Exercises (assertion-reasoning)

1. Assertion Two concentric conducting rings of different radii are placed in space. The mutual inductance of both the rings is maximum, if the rings are coplanar.

Reason For two co-axial conducting rings of different radii, the magnitude of magnetic flux in one ring due to current in other ring is maximum when both rings are coplanar.

A. Statement I is True, Statement II is True, Statement II is the correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT the correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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2. Statement I: An eletric lamp is connected in series with a long solenoid of copper with air core and then connected to an ac source. If an iron rod is inserted in the solenoid, the lamp will become dim.

Satement II: If an iron rod is inserted in the solenoid, the inductance of the solenoid increases.

A. Statement I is True, Statement II is True, Statement II is the correct explanation for Statement I.

B. Statement I is True, Statement II is True, Statement II is NOT the correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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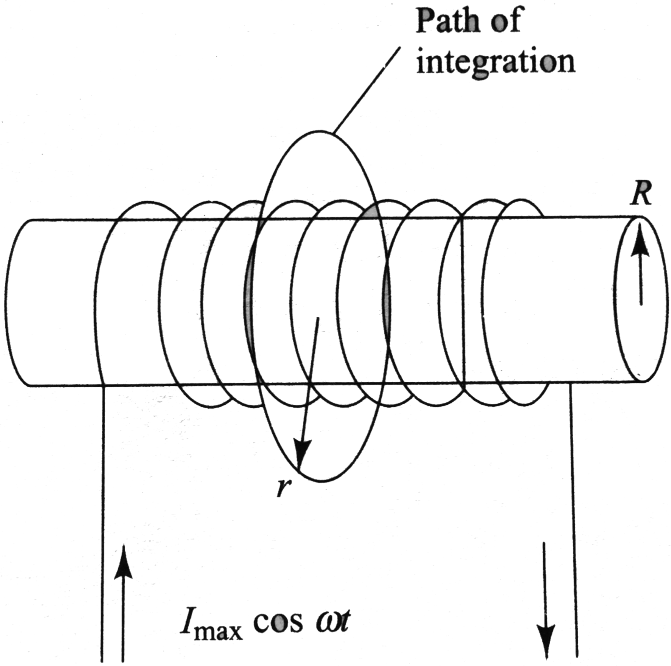
Exercises (linked Compreshension)

1. A long solenoid of radous R has n turns of wire per unit length and carries a time-varying current that varies sinusiodally as $I = I_{\max} \cos \omega t$, where $I_{\max}$ is the maximum current and ω I the angular frequancy of the alternating current source (shows in Fig.)



The magnitude of the induced electric field inside tha solenoid, a distance $r < R$ from its long central axis is

A. $\frac{3\mu_0 n I_{\max} \omega}{2} r \sin \omega t$

B. $\frac{\mu_0 n I_{\max} \omega}{2} r \cos \omega t$

C. $\mu_0 n I_{\max} \omega r \sin \omega t$

D. $\frac{\mu_0 n I_{\max} \omega}{2} r \sin \omega t$

Answer: D

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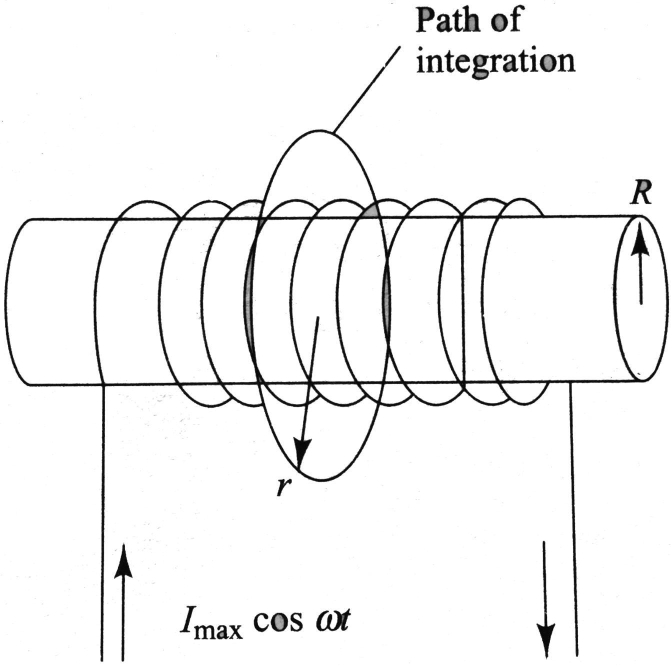
2. A long solenoid of radous R has n turns of wire per unit length and carries a time-varying current that varies sinusiodally as $I = I_{\max} \cos \omega t$, where $I_{\max}$ is the maximum current and ω I the angular frequancy of the alternating current source (shows in Fig.)



The magnitude of electric field outside the solenoid at a distance $r > R$ from its long central axis is

A. $\dfrac{\mu_0 n I_{\max} \omega R^2}{2r} \sin \omega t$

B. $\frac{2\mu_0 n I_{\max} \omega R^2}{r} \sin \omega t$

C. $\frac{\mu_0 n I_{\max} \omega R^2}{3r} \sin \omega t$

D. $\frac{3\mu_0 n I_{\max} \omega R^2}{2r} \sin \omega t$

Answer: A

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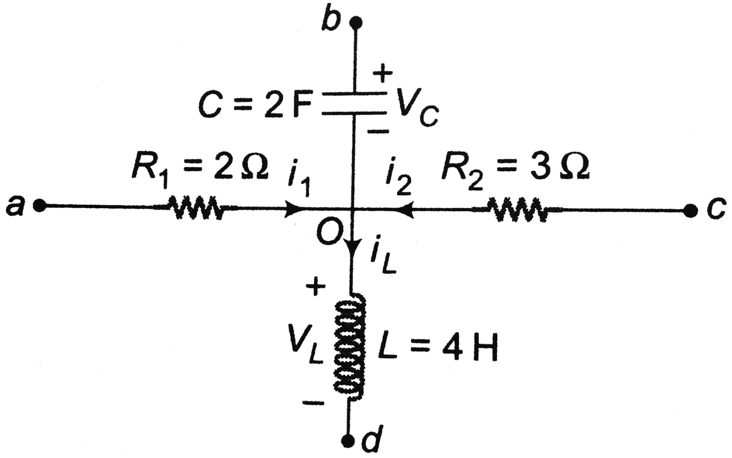
3. In the Figure shown $i_1 = 10e^{-2t} A$, $i_2 = 4A$ and $V_C = 3e^{-2t} V$. Determine



a. i_L and V_L b. V_{ac}, V_{ab}, V_{cd}

A. $\left[2-2\left(1-e^{-2t}\right)\right]A$

B. $\left[2+2\left(1-e^{-2t}\right)\right]A$

C. $\left[3-2\left(1-e^{-2t}\right)\right]A$

D. $\left[2+3\left(1-e^{-2t}\right)\right]A$

Answer: B

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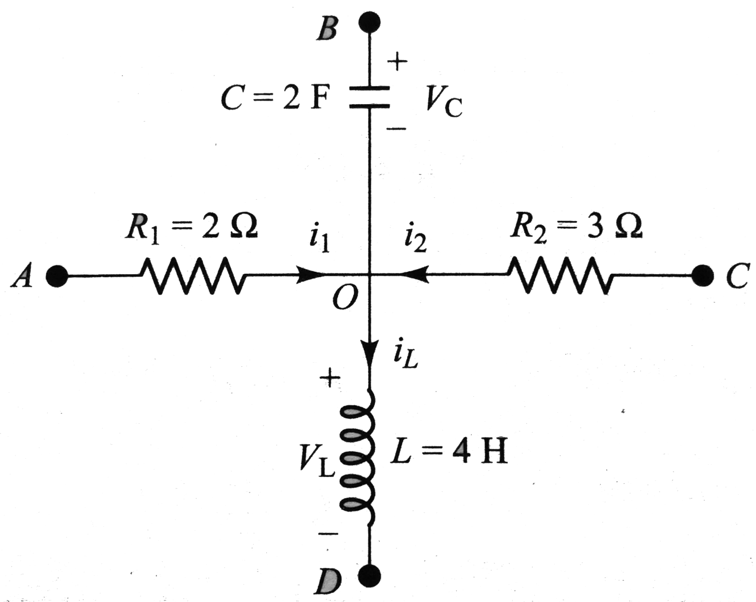
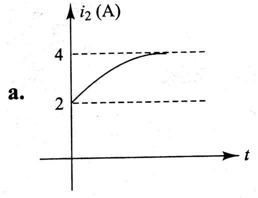
4. In Fig $i_1 = 10e^{-2t}A$, $i_2 = 4A$, and $V_C = 3e^{-2t}V$.

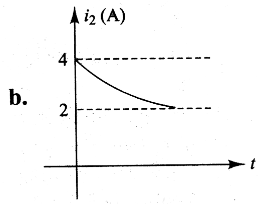


The variation of current in the inductor with time can be represented as

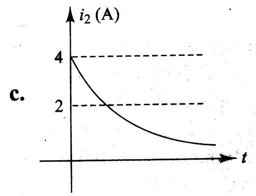
A.



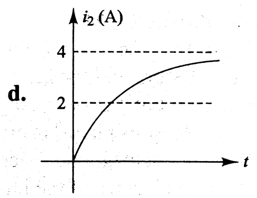
B.



C.



D.



Answer: A

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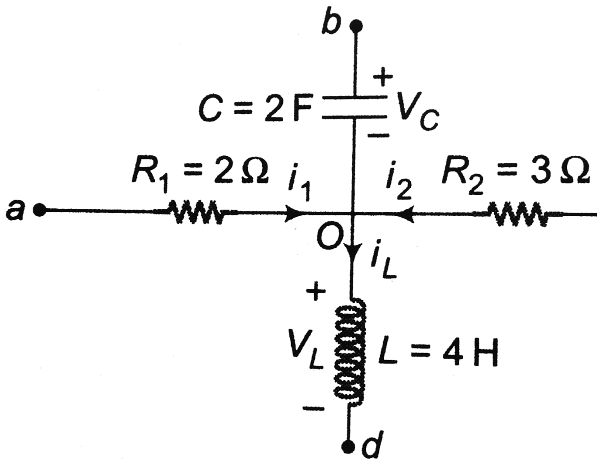
5. In the Figure shown $i_1 = 10e^{-2t}A,\, i_2 = 4A$

and $V_C = 3e^{-2t}V$. Determine



a. i_L and V_L b. V_{ac}, V_{ab}, V_{cd}

A. $8e^{-2t}V$

B. $9e^{-2t}V$

C. $16e^{-2t}V$

D. $18e^{-2t}V$

Answer: C

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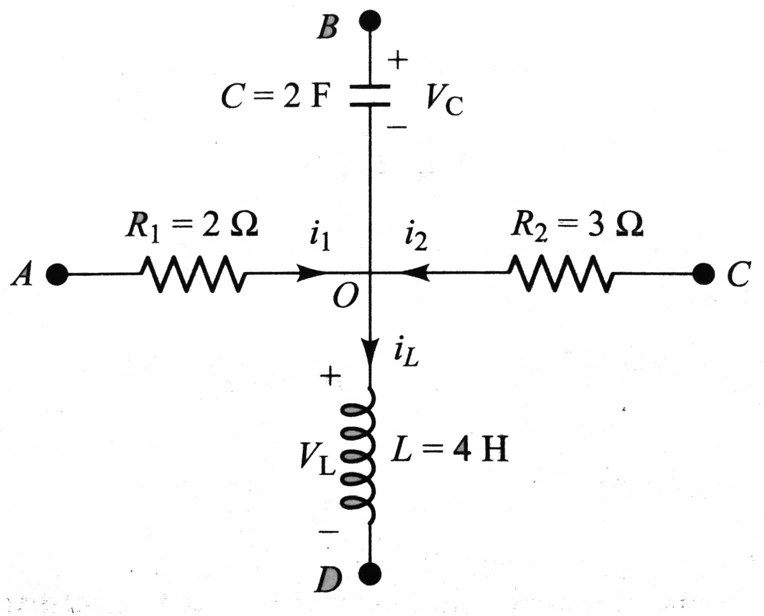
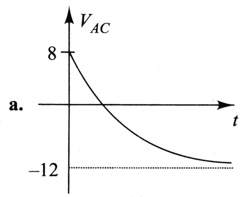
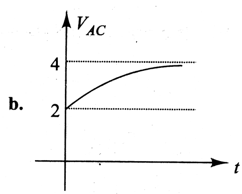
6. In Fig $i_1 = 10e^{-2t}A$, $i_2 = 4A$, and $V_C = 3e^{-2t}V$.

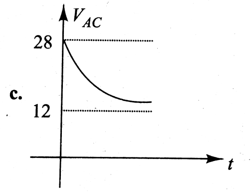


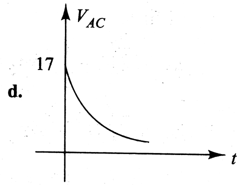
the vartiation of potential difference across A

and $C(V_{AC})$ with time can be respresented as

A. 

B. 

C. 

D. 

Answer: A

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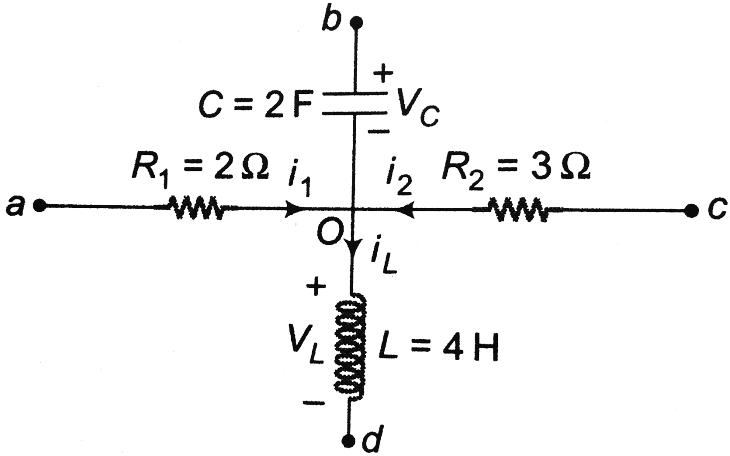
7. In the Figure shown $i_1 = 10e^{-2t}A, i_2 = 4A$ and $V_C = 3e^{-2t}V$. Determine



a. i_L and V_L b. V_{ac}, V_{ab}, V_{cd}

A. $8e^{-2t}V$

B. $\frac{1}{2}e^{-3t}V$

C. $17e^{-2t}V$

D. $16e^{-2t}$V\`

Answer: C

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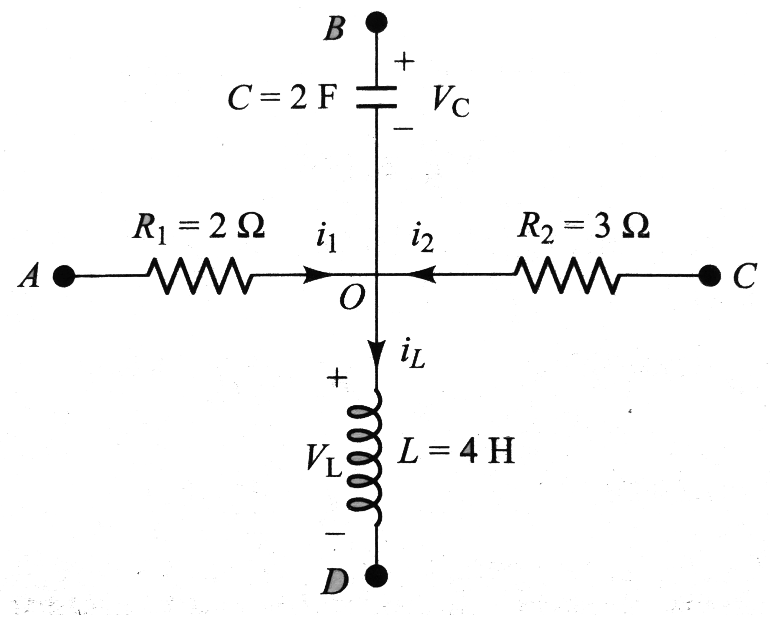
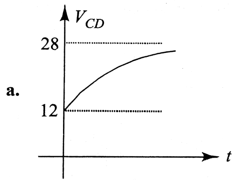
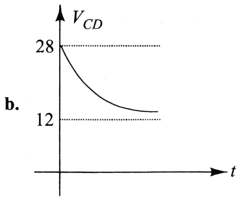
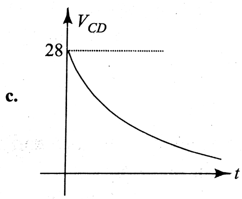
8. In Fig $i_1 = 10e^{-2t}A$, $i_2 = 4A$, and $V_C = 3e^{-2t}V$.

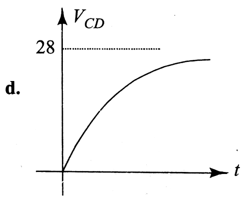


The variation of potential difference across C and $D(V_{CD})$ with time can be expressed as

A. 

B. 

C. 

D. 

Answer: B

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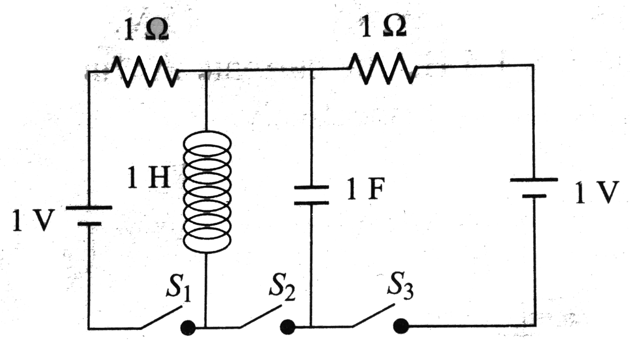
9. In the circuit shows (Fig.) switches S_1 and S_3 have been closed for $1s$ and S_2 remained open. Just after $1s$, switch S_2 is closed and S_1 and S_3 are opened. Find after that instant $(t = 0)$:



the maximum current in the circuit containing inductor and capacitor (only S_2 is closed)

A. $\sqrt{3}\left(1 - \frac{1}{e}\right)$

B. $\sqrt{2}\left(1 - \frac{1}{e}\right)$

C. $\sqrt{3}\left(1 + \frac{1}{e}\right)$

D. $\sqrt{2}\left(1 + \frac{1}{e}\right)$

Answer: B

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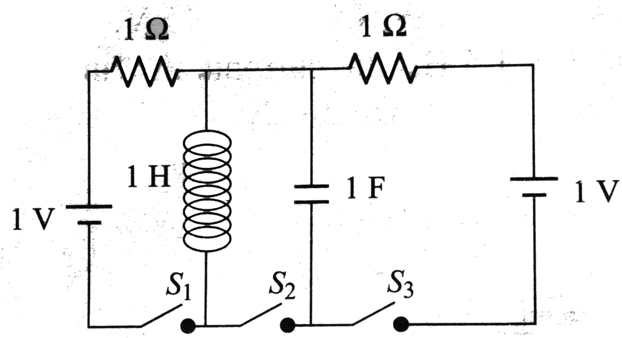
10. In the circuit shows (Fig.) switches S_1 and S_3 have been closed for $1s$ and S_2 remained open. Just after $1s$, switch S_2 is closed and S_1

and S_3 are opened. Find after that instant

$(t = 0)$:



the maximum charge on the capacitor

A. $\sqrt{3}\left(1+\frac{1}{e}\right)$

B. $\sqrt{3}\left(1-\frac{1}{e}\right)$

C. $\sqrt{2}\left(1+\frac{1}{e}\right)$

D. $\sqrt{2}\left(1-\frac{1}{e}\right)$

Answer: D

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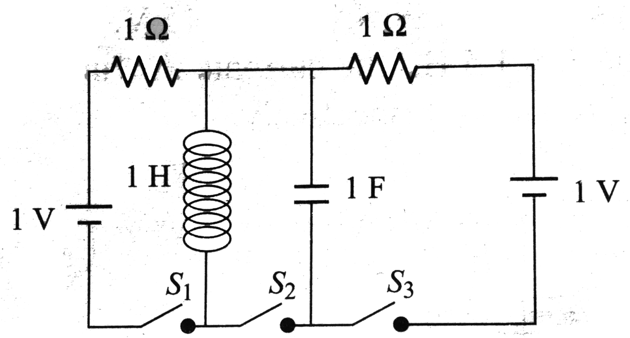
11. In the circuit shows (Fig.) switches S_1 and S_3 have been closed for $1s$ and S_2 remained open. Just after $1s$, switch S_2 is closed and S_1 and S_3 are opened. Find after that instant $(t = 0)$:



the charge on the upper plate of the capacitor

as a funtion of time

A. $\sqrt{2}\left(1-\frac{1}{e}\right)\sin\left(t+\frac{3\pi}{4}\right)$

B. $\sqrt{2}\left(1-\frac{1}{e}\right)\sin\left(t+\frac{\pi}{4}\right)$

C. $\sqrt{3}\left(1-\frac{1}{e}\right)\sin\left(t+\frac{\pi}{4}\right)$

D. $\sqrt{3}\left(1+\frac{1}{e}\right)\sin\left(t+\frac{\pi}{4}\right)$

Answer: A

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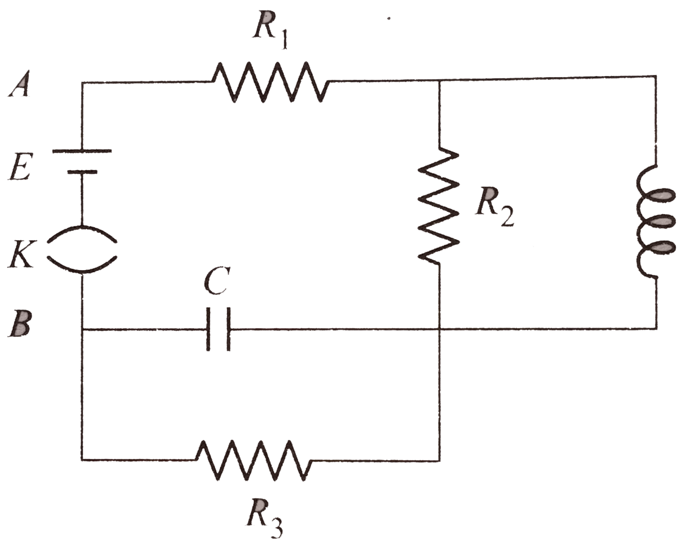
12. In the given (Fig.) all the symbols have their usual meanings. At $t = 0$, key K is closed. Now answer the following questions.



At $t = 0$, the euivalent resistance between A and B is

A. $R_1 + R_2 + R_3$

B. $R_1 + R_2$

C. $R_1 + R_3$

D. indeterminate

Answer: B

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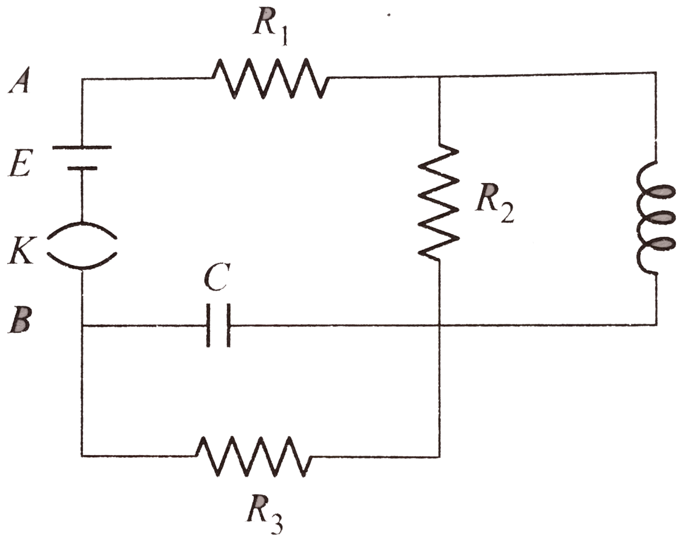
13. In the given (Fig.) all the symbols have their usual meanings. At $t=0$, key K is closed. Now answer the following questions.



At $t \rightarrow \infty$, the euivalent resistance between A and B is

A. $R_1+R_2+R_3$

B. $R_1 + R_2$

C. $R_1 + R_3$

D. None of these

Answer: C

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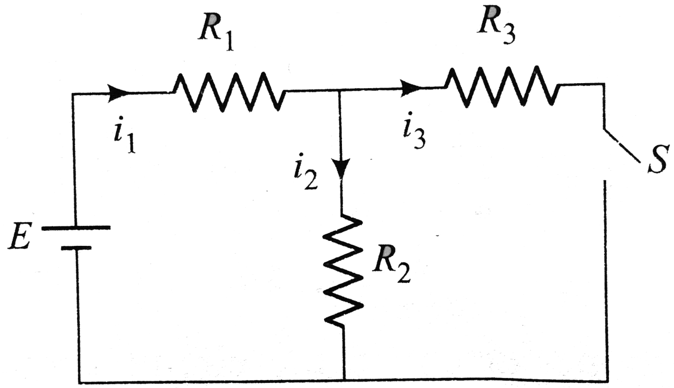
14. In the circuit shows in Fig $E = 15V$, $R_1 = 1\Omega$, $R_2 = 1\Omega$, $R_3 = 2\Omega$, and $L = 1.5H$. The currents flowing through R_1, R_2,and R_3 are i_1, i_2, and i_3, respectively.



Immediately after tuning switch S on,

A. $i_1 = i_2 = 7.5A, i_3 = 0A$

B. $i_1 = i_3 = 5A, i_2 = 0A$

C. $i_1 = i_2 = 9A, i_3 = 0A$

D. $i_1 = i_2 = i_3 = 0A$

Answer: A

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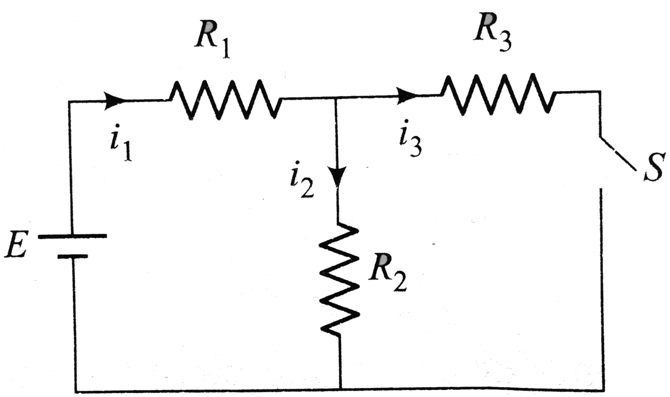
15. In the circuit shows in Fig $E = 15V$, $R_1 = 1\Omega$, $R_2 = 1\Omega$, $R_3 = 2\Omega$, and $L = 1.5H$.

The currents flowing through R_1, R_2,and R_3 are i_1, i_2, and i_3, respectively.

Immediately after turning switch S on,



A. $i_1 = 9A, i_2 = 6A, i_3 = 3A$

B. $i_1 = 9A, i_2 = 3A, i_3 = 6A$

C. $i_1 = 6A, i_2 = 6A, i_3 = 0A$

D. $i_1 = 0A, i_2 = 0A, i_3 = 0A$

Answer: A

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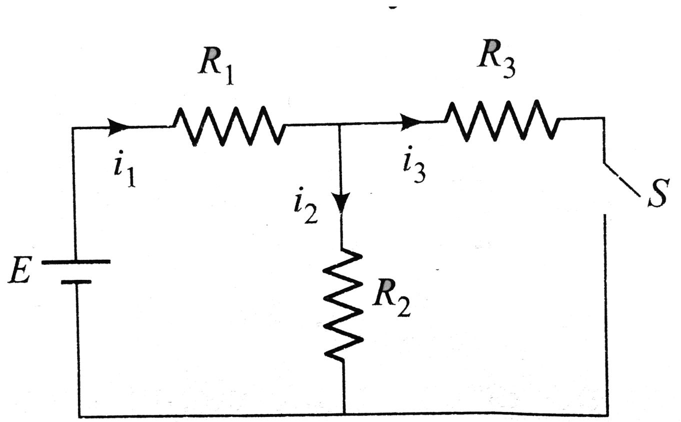
16. In the circuit shows in Fig $E = 15V$, $R_1 = 1\Omega$, $R_2 = 1\Omega$, $R_3 = 2\Omega$, and $L = 1.5H$. The currents flowing through R_1, R_2,and R_3

are i_1, i_2, and i_3, respectively.

Immediately after turning switch S on,



A. $i_3 = 0A$ and $\frac{di_3}{dt} = 0As^{-1}$

B. $i_3 = 0A$ and $\frac{di_3}{dt} \neq 0As^{-1}$

C. $i_3 = 0A$ and the rate at which magnetic

energy stored is not zero

D. None of these

Answer: B

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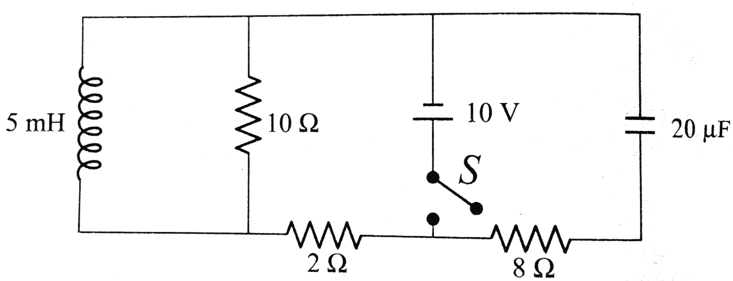
17. In the given at $t = 0$, switch S is closed.



The current through the 10Ω resistor at any instant $t(0 < t < \infty)$ will be

A. $\dfrac{1}{6}e^{-(1000/3)t}$

B. $\frac{5}{6}e^{-(1000/3)t}$

C. $\frac{1}{6}e^{(1000/3)t}$

D. $\frac{6}{5}e^{(1000/3)t}$

Answer: B

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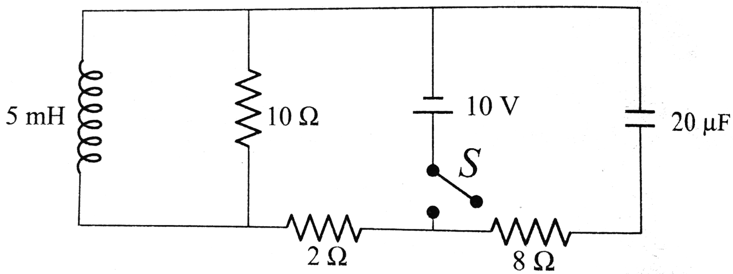
18. In the given at $t = 0$, switch S is closed.



The energy stored in the inductor at any instant $t(0 < t\infty)$ will be

A. $\frac{1}{2}\left[5 - 5e^{-(1000/3)t}\right]^2 mJ$

B. $\frac{125}{2}\left[1 - e^{-(1000/3)t}\right]^2 mJ$

C. $\frac{25}{2}\left[1 - e^{-(1000/3)t}\right]^2 mJ$

D. $\frac{5}{2}\left[1 - e^{-(1000/3)t}\right]^2 mJ$

Answer: B

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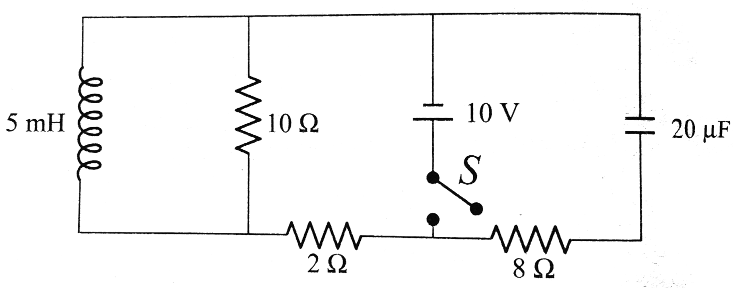
19. In the given at $t = 0$, switch S is closed.



The energy stored in the capacitor and inductor, respectively, at $t \to \infty$ will be

A. $1mJ$ and $62.5mJ$

B. $62.5mJ$ and $1mJ$

C. $2mJ$ and $62.5mJ$

D. $1mJ$ and $60mJ$

Answer: A

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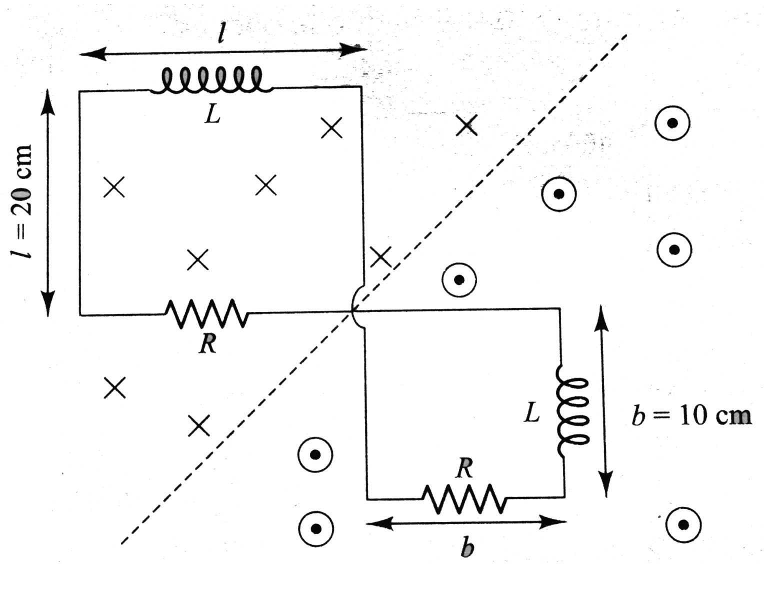
20. In Fig. there is a frame consisting of two square loops having resistors and inductors as shown. This frame is placed in a uniform but time-varying magnetic field in such a way that one of the loops is placed in crossed magentic field and the other is placed in dot magnetic field. Both magnetic fields are perpendicular to the planes of the loops.

If the magnetic field is given by $B = (20 + 10t) Wbm^{-2}$ in both regions $[l = 20cm, b = 10cm,$ and $R = 10\Omega,$ $L = 10H)$,



The direction in induced current in the bigger loop will be

A. clockwise

B. anticlockwise

C. first clockwise for some time, then anticlockwise, and so on

D. first clockwise for some time, then clockwise, and so on

Answer: B

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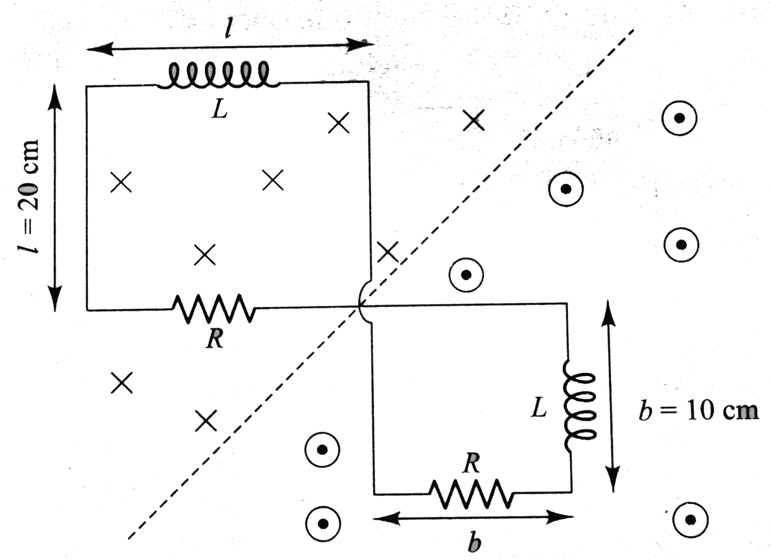
21. In Fig. there is a frame consisting of two square loops having resistors and inductors as shown. This frame is placed in a uniform but time-varying magnetic field in such a way that one of the loops is placed in crossed magentic field and the other is placed in dot magnetic field. Both magnetic fields are perpendicular to the planes of the loops.

If the magnetic field is given by $B = (20 + 10t)Wbm^{-2}$ in both regions $[l = 20cm, b = 10cm,$ and $R = 10\Omega,$

$L = 10H)$,



The induced emf in the frame only due to the vartation of magnetic field will be

A. $0.3V$

B. $0.1V$

C. $0.5V$

D. $0.4V$

Answer: C

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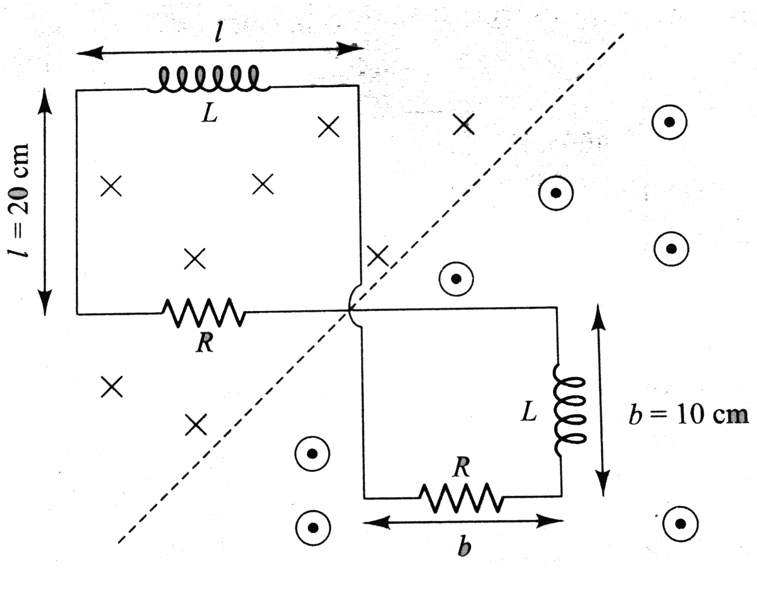
22. In Fig. there is a frame consisting of two square loops having resistors and inductors as shown. This frame is placed in a uniform but time-varying magnetic field in such a way that one of the loops is placed in crossed magentic field and the other is placed in dot magnetic field. Both magnetic fields are perpendicular to the planes of the loops.

If the magnetic field is given by $B = (20 + 10t) Wbm^{-2}$ in both regions $[l = 20cm, b = 10cm,$ and $R = 10\Omega,$ $L = 10H)$,



The current in the frame as a funtion of time will be

A. $\frac{1}{20}(1 - e^{-t})$

B. $\frac{1}{40}(1 - e^{-t})$

C. $\frac{1}{20}e^{-t}$

D. $\frac{1}{10}e^{-t}$

Answer: B

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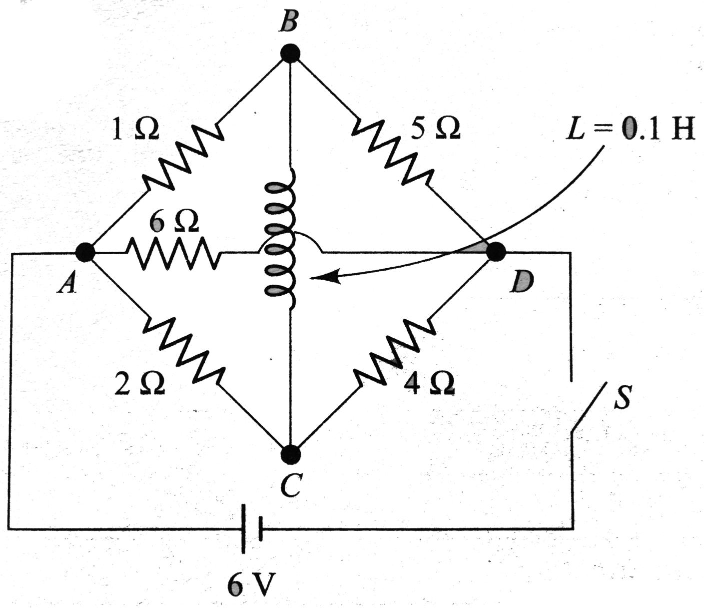
23. there in no current part of this circuit for time $t < o$. Switch S is closed at $t = 0$.



The rate at which the current through the inductor increases initially is

A. zero

B. $10 A s^{-1}$

C. $1 A s^{-1}$

D. $5 A s^{-1}$

Answer: B

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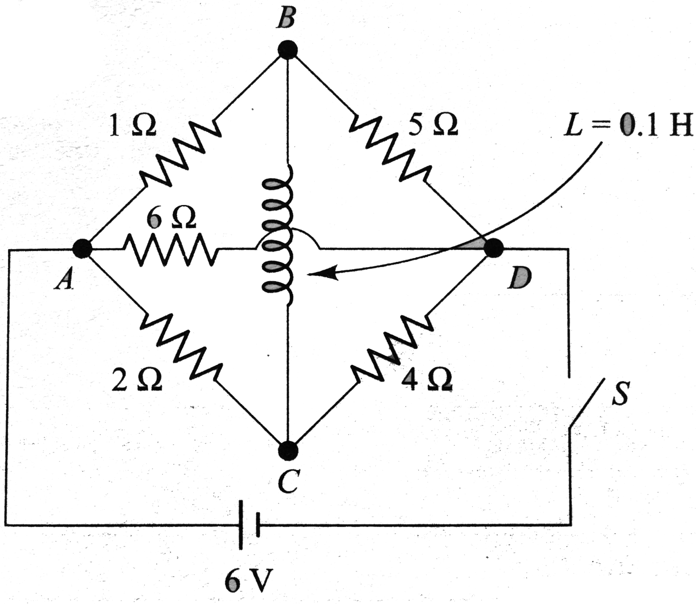
24. there in no current part of this circuit for time $t < o$. Switch S is closed at $t = 0$.



Current through the 6Ω resistor

A. increases linearly with time

B. increase non-linearly with time

C. decreases non-linearly with time

D. remains constant

Answer: D

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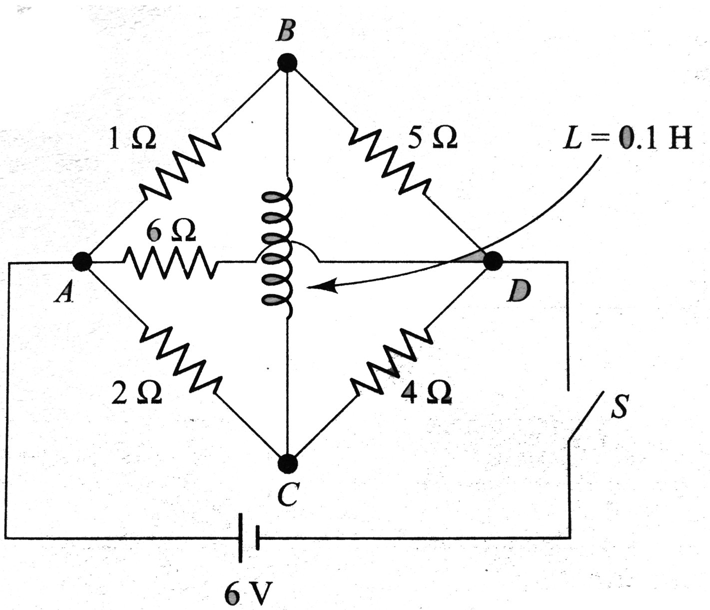
25. there in no current part of this circuit for time $t < o$. Switch S is closed at $t = 0$.



The current through the inductor after a long time will be

A. zero

B. infinite

C. $\frac{6}{13}A$

D. None of these

Answer: C

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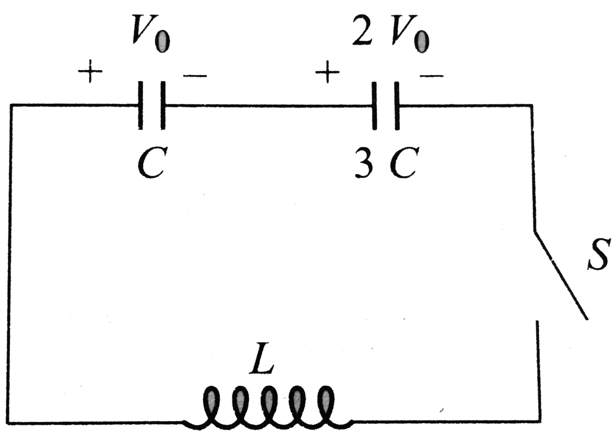
26. Two capacitors of capacitance C and $3C$ are charged to potential difference V_0 and $2V_0$, respectively, and connected to an inductor of inductance L as shows in Fig. Initially, the current in the inductor is zero. Now, switch S is closed.



The maximum current in the inductor is

A. $\frac{3V_0}{2}\sqrt{\frac{3C}{L}}$

B. $V_0\sqrt{\frac{3C}{L}}$

C. $2V_0\sqrt{\frac{3C}{L}}$

D. $V_0\sqrt{\frac{C}{L}}$

Answer: A

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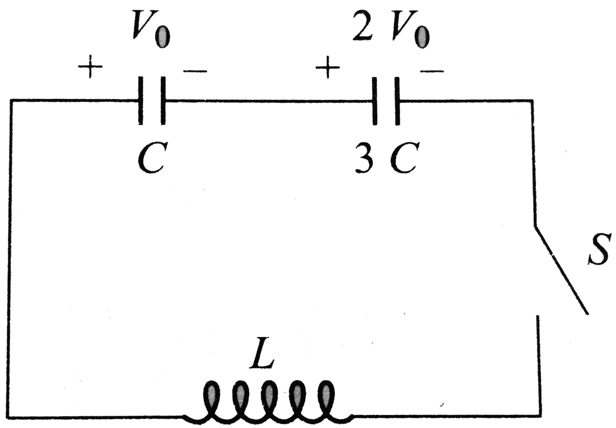
27. Two capacitors of capacitance C and $3C$ are charged to potential difference V_0 and $2V_0$, respectively, and connected to an inductor of inductance L as shows in Fig. Initially, the current in the inductor is zero. Now, switch S is closed.



Potential difference across capacitor of capacitance C when the current in the circuit is maximum is

A. $\frac{V_0}{4}$

B. $\frac{3V_0}{4}$

C. $\frac{5V_0}{4}$

D. None of these

Answer: C

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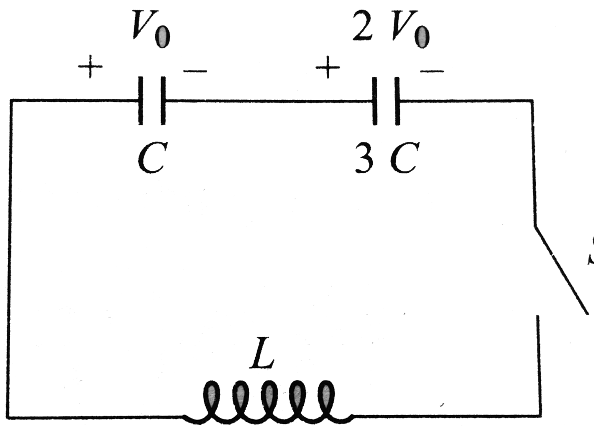
28. Two capacitors of capacitance C and $3C$ are charged to potential difference V_0 and $2V_0$, respectively, and connected to an inductor of inductance L as shows in Fig. Initially, the current in the inductor is zero. Now, switch S is closed.



Potential difference across capacitor of capacitance $3C$ when the current in the circuit is maximum is

A. $\frac{V_0}{4}$

B. $\frac{V_0}{4}$

C. $\frac{5V_0}{4}$

D. None of these

Answer: C

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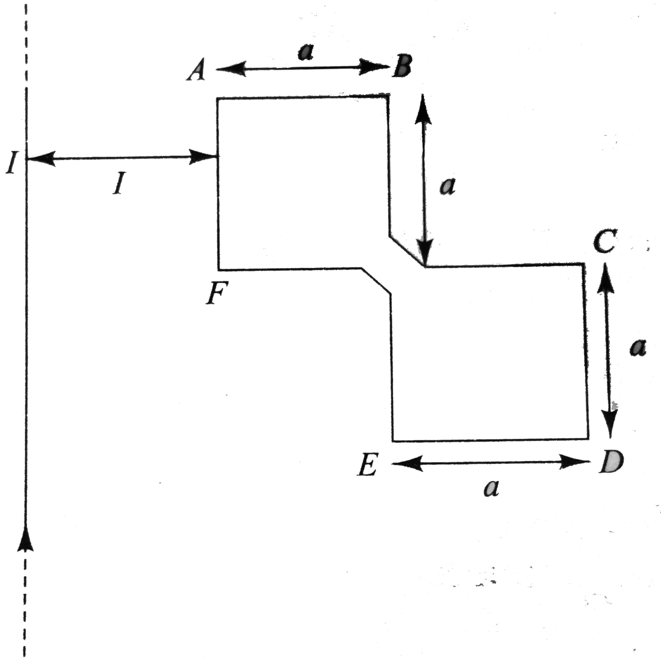
29. In Fig. there is a conducting loop $ABCDEF$ of resistance λ per unit length placed near a long straight current-carrying wire. The dimension are shows in the figure. The long wire lies in the plane of the loop. The current in the long wire varies as $I = I_0(t)$.



The mutual inductance of the pair is

A. $\dfrac{\mu_0 a}{2\pi} In\left(\dfrac{2a+l}{l}\right)$

B. $\dfrac{\mu_0 a}{2\pi} In\left(\dfrac{2a-l}{l}\right)$

C. $\dfrac{\mu_0 a}{\pi} In\left(\dfrac{a+l}{l}\right)$

D. $\frac{\mu_0 a}{\pi} In\left(\frac{a+l}{l}\right)$

Answer: A

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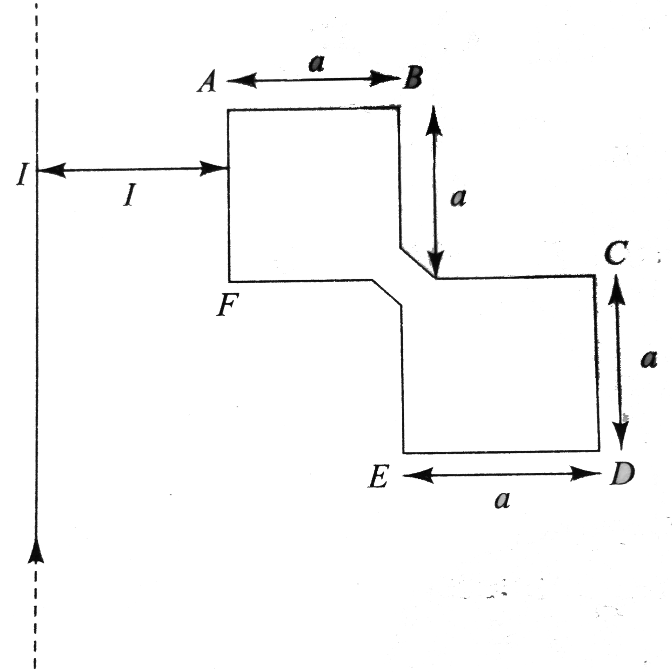
30. In Fig. there is a conducting loop $ABCDEF$ of resistance λ per unit length placed near a long straight current-carrying wire. The dimension are shows in the figure. The long wire lies in the plane of the loop. The current in the long wire varies as $I = I_0(t)$.



The emf induced in the closed loop is

A. $\frac{\mu_0 I_0 a}{2\pi} In\left(\frac{2a+l}{l}\right)$

B. $\frac{\mu_0 I_0 a}{2\pi} In\left(\frac{2a-l}{l}\right)$

C. $\frac{\mu_0 I_0 a}{\pi} In\left(\frac{a+l}{l}\right)$

D. $\frac{\mu_0 a}{\pi} In\left(\frac{a+l}{l}\right)$

Answer: A

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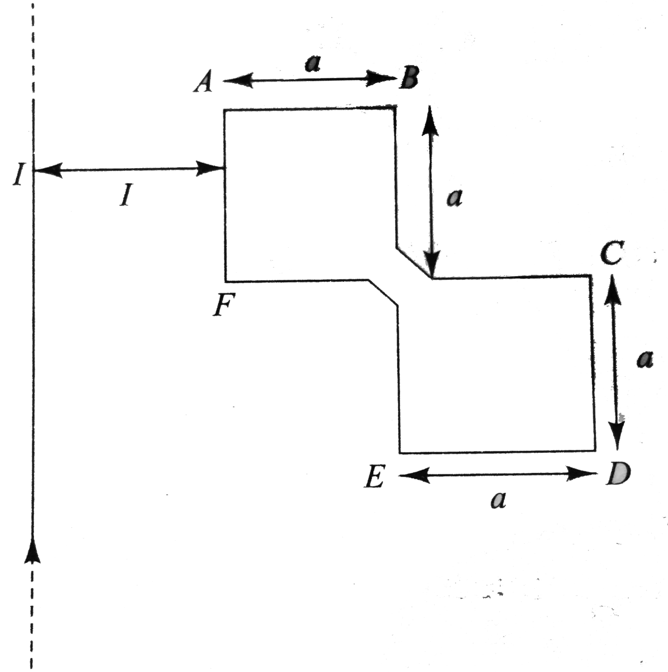
31. In Fig. there is a conducting loop $ABCDEF$ of resistance λ per unit length placed near a long straight current-carrying wire. The dimension are shows in the figure. The long wire lies in the plane of the loop. The current in the long wire varies as $I = I_0(t)$.



The heat produced in the loop in time t is

A. $\dfrac{\left[\frac{\mu_0 I_0}{2\pi} In\left(\frac{a+l}{l}\right)\right]^2 at}{4\lambda}$

B. $\dfrac{\left[\frac{\mu_0 I_0}{2\pi} In\left(\frac{2a+l}{l}\right)\right]^2 at}{8\lambda}$

C. $\dfrac{\left[\frac{\mu_0 I_0}{2\pi} In\left(\frac{a+l}{l}\right)\right]^2 at}{3\lambda}$

D. $\dfrac{\left[\frac{\mu_0 I_0}{2\pi} In\left(\frac{3a+l}{l}\right)\right]^2 at}{6\lambda}$

Answer: B

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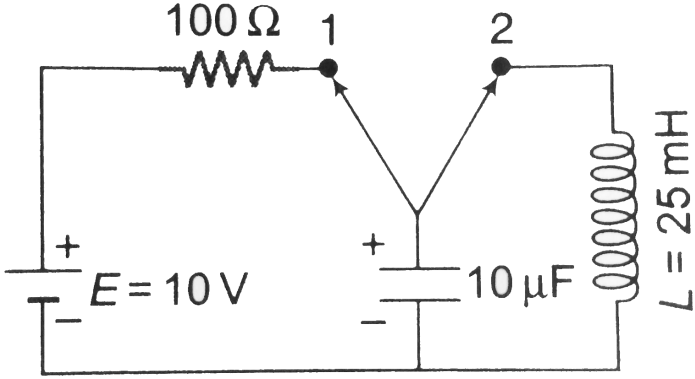
32. Initially, the capacitor is charged to a potential of $5V$ and then connected to position 1 with the shown polarity for $1s$. After $1s$ it is connected across the inductor at position 2



(a) Find the potential across the capacitor after $1s$ of its connection to position 1.

(b) Find the maximum current flowing in the $L-C$ circuit when capacitor is connected across the inductor. Also, find the frequency of LC oscillations.

A. $5\times10^3\left(2+\frac{1}{e}\right)V$

B. $5\times10^3\left(2-\frac{1}{e}\right)V$

C. $5 \times 10^3 \left(1 + \frac{2}{e}\right) V$

D. none of these

Answer: B

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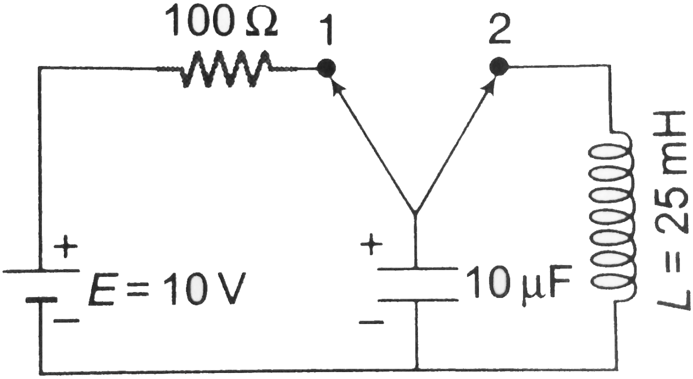
33. Initially, the capacitor is charged to a potential of $5V$ and then connected to position 1 with the shown polarity for $1s$. After $1s$ it is connected across the inductor at position 2



(a) Find the potential across the capacitor after $1s$ of its connection to position 1.

(b) Find the maximum current flowing in the $L-C$ circuit when capacitor is connected across the inductor. Also, find the frequency of LC oscillations.

A. $\left(2-\frac{1}{e}\right)\times 10^4 A$

B. $\left(1+\frac{2}{e}\right)\times 10^4 A$

C. $\left(1 - \frac{2}{e}\right) \times 10^4 A$

D. none of these

Answer: A

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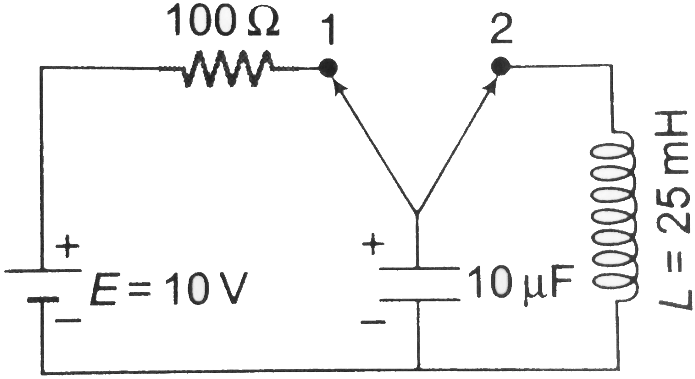
34. Initially, the capacitor is charged to a potential of $5V$ and then connected to position 1 with the shown polarity for $1s$. After $1s$ it is connected across the inductor at position 2



(a) Find the potential across the capacitor after $1s$ of its connection to position 1.

(b) Find the maximum current flowing in the $L-C$ circuit when capacitor is connected across the inductor. Also, find the frequency of LC oscillations.

A. $(20/\pi) Hz$

B. $(2/\pi) Hz$

C. $(40/\pi)Hz$

D. $100/\pi Hz$

Answer: D

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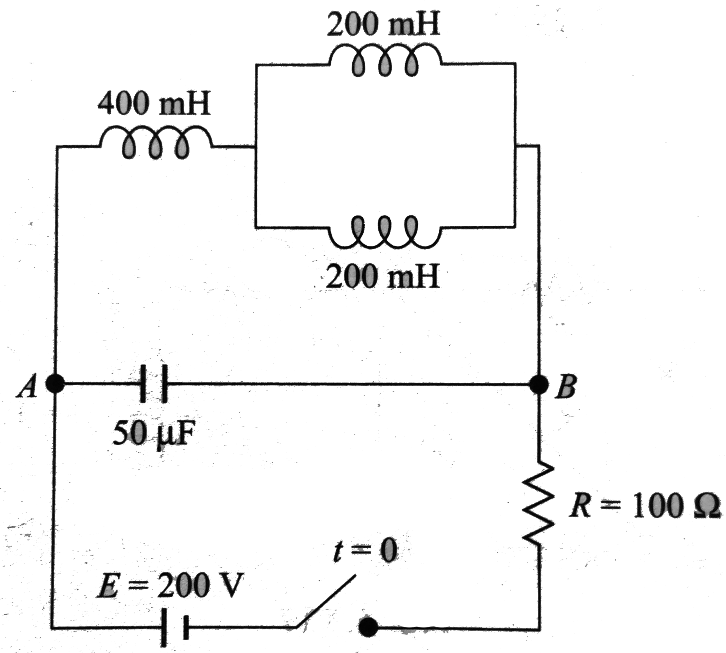
35. In the circuit in Fig. switch S_1 was closed for a long time . At time $t=0$ the switch is opened.



Find the maximum potentail difference across the plates of the capacitor after the switch is opened.

A. $100V$

B. $200V$

C. $300V$

D. $400V$

Answer: B

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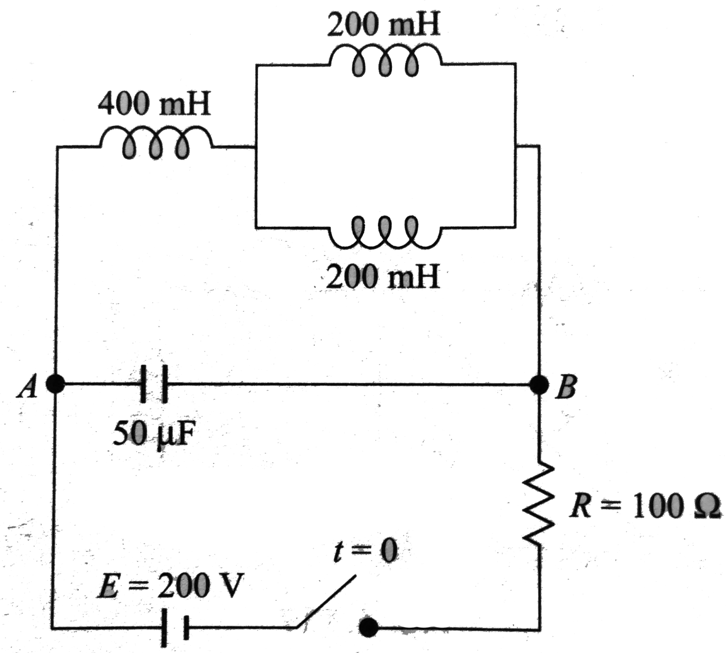
36. In the circuit in Fig. switch S_1 was closed for a long time . At time $t=0$ the switch is opened.



Find the angular frequency of oscillation of the charge on the capacitor.

A. $100 rads^{-1}$

B. $200 rads^{-1}$

C. $300 rads^{-1}$s

D. $400rads^{-1}$

Answer: B

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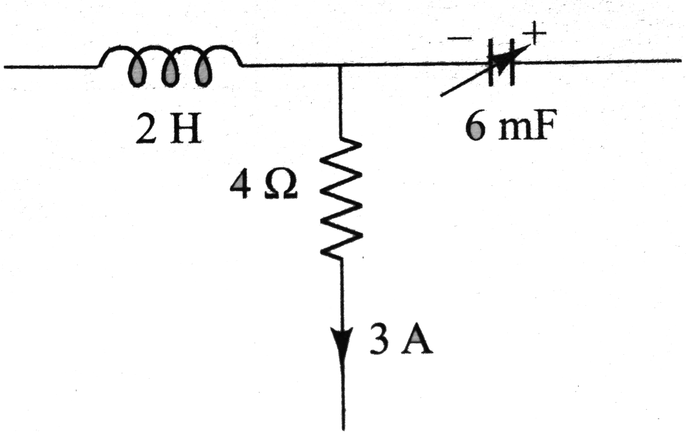
Exercises (integer)

1. Figure shows a part of a bigger circuit. The capacity of the capacitor is $6mF$ and is desaesing at the constate rate $0.5mFs^{-1}$. The potential difference across the capacitor at the shows moment is changing as follows:

$$\frac{dV}{dt} = 2Vs^{-1}, \frac{d^2V}{dt^2} = \frac{1}{2}VS^{-2}$$

The current in the 4Ω resistor is decreasing at the rate of $1mAs^{-1}$. What is the potential difference (in mV) across the inductor at this moment?



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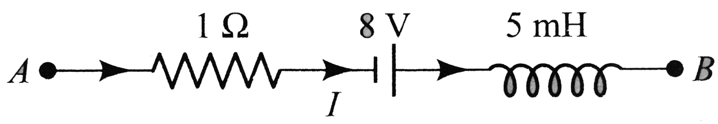
2. In the circuit (Fig.) what is potential difference $V_B - V_A$ (in V) when current I is $5A$ and is decreasing at the rate of $10^3 As^{-1}$



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3. A current of $2A$ is increasing at a rate of $4As^{-1}$ through a coil of inductance $1H$. Find the energy stored in the inductor per unit time in the units of Js^{-1}.

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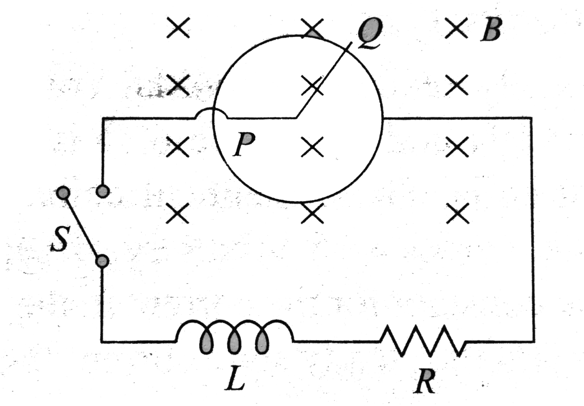
4. Figure shows a circuit having a coil of resistance $R = 2.5\Omega$ and inductance L connected to a conducting rod of radius $10cm$ with its center at P.



Assume that friction and gravity are absent and a constant uniform magnatic field of $5T$ exists as shown in figure. At $t = 0$, the circuit is switched on and simultaneously a time-varying external torque is applied on the rod so that it rotates about P with a constant angular velocity $40 rad s^{-1}$. Find the magnitude of this torque (in mNm) when current reaches half of its maximum value. Neglect the self inductance of the loop formed by the circuit.

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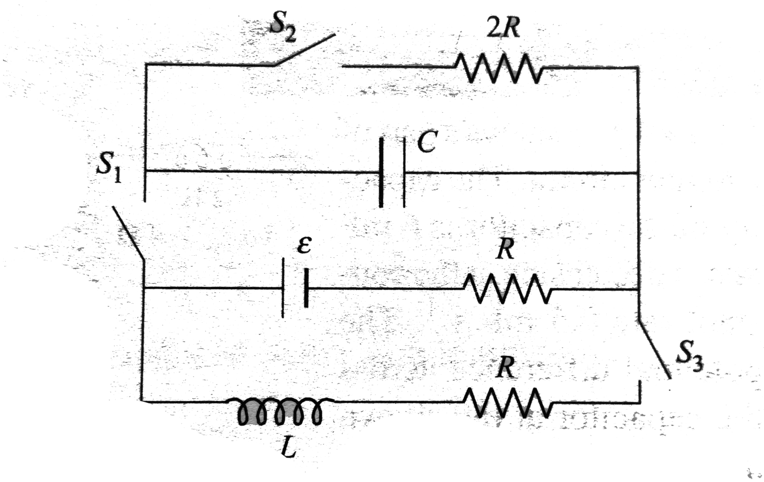
5. In the given circuit, initially switch S_1 is closed, and S_2 and S_3 are open. After charging of capacitor, at $t = 0$, S_1 is opened and S_2 and S_3 are closed. If the relation between inductance, capacitance and resistance is $L = 4CR^2$, tehn find the time (in s) after which current passing through capacitor and inductor will be same (given $R = In2m\Omega, L = 2mH$)



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6. Two colis, 1 and 2 have a mutual inductance $M = 5H$ and resistance $R = 10\Omega$ each. A current flows in coil 1, which varies with time as: $I_1 = 2t^2$, where t is time. Find the total charge (in C) that has flows through coil 2 between $t = 0$ and $t = 2s$.

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7. A long solenoid of diameter $0.1m$ has 2×10^4 turns per metre. At the centre of the solenoid, a $100 -$ turns coil of radius $0.01m$ is placed with its axis coinciding with the constant rate from $+2A$ to $2A$ in $0.05s$. Find the total charge (in μC) flowing through the coil during this time when the resistance of the coil is $40 \neq^2 \Omega$.

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8. A capacitor of capacitnafe $2\mu F$ is charged to a potential difference of 12V. It is then connected across an inductor of inductance 0.6mH. The current in the circuit when the potential difference across the capacitor is 6V is

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Archives (fills In The Blanks)

1. A uniform wound solenoidal coil of self inductance 1.8×10^{-4} henry and resistance 6 ohm is broken up into two identical coils. These identical coils are then connected in parallel across a 15-volt battery of negligible resistance. The time constant for the current in the circuit is.......seconds and the steady state current through the battery is ....amperes.

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2. If ε_0 and μ_0 are, respectively, the electric permittivity and magnetic permeability of free space, ε and μ the corresponding quantities in a medium, the index of refraction of the medium in terms of the above parameters is ________________.

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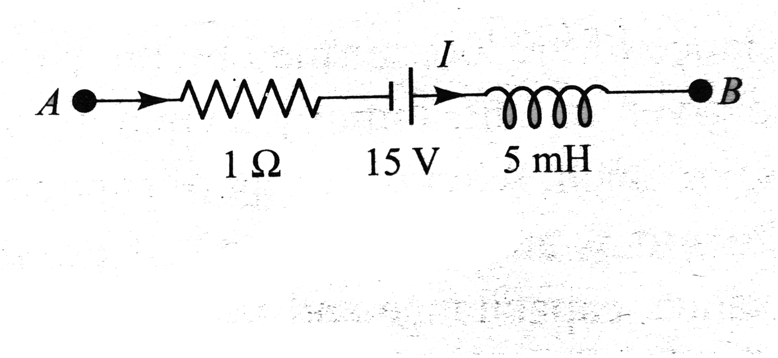
3. The network shows in Fig is part of a complate circuit. If at a certain instant the current (I) is $5A$, and is decreasing at a rate of $10^5 As^{-1}$ then $V_B - V_A = \; - V$.



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Archives (single Correct)

1. A small square loop of wire of side l is placed inside a large square loop of wire of side $L(> > l)$. The loops aer coplanar and their centres coincide. What is the mutual inductance of the system?

A. l / L

B. l^2 / L

C. L / l

D. L^2 / l

Answer: B

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2. A coil of inductance 8.4 mH and resistance $6(\Omega)$ is connected to a 12 V battery. The current in the coil is 1.0 A at approximately the time

A. $500s$

B. $25s$

C. $35ms$

D. $1ms$

Answer: D

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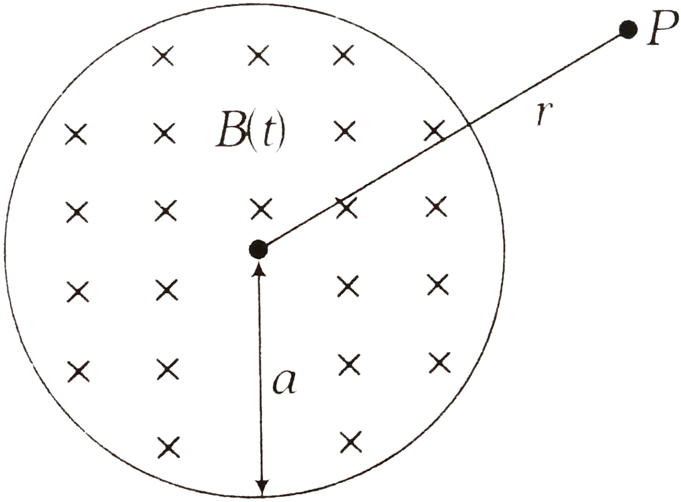
3. A uniform but time-varying magnetic field B(t) exists in a cylindrical region of radius a and is directed into the plane of the paper as shown. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region



A. is zero

B. decreases as $1/r$

C. increases as r

D. decreases as $1/r^2$

Answer: B

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4. A coil of wire having inductance and resistance has a conducting ring placed coaxially within it. The coil is connected to a battery at time t=0, so that a time-dependent current $1_1(t)$ starts following through the coil. If $I_2(t)$ is the current induced in the ring, and B (t) is the magnetic field at the axis of the coil due to $I_1(t)$ then as a function of time $(t > 0)$, the product $I_2(t)B(t)$

A. increases with time

B. decreases with time

C. does not vary with time

D. passes through a mximum

Answer: D

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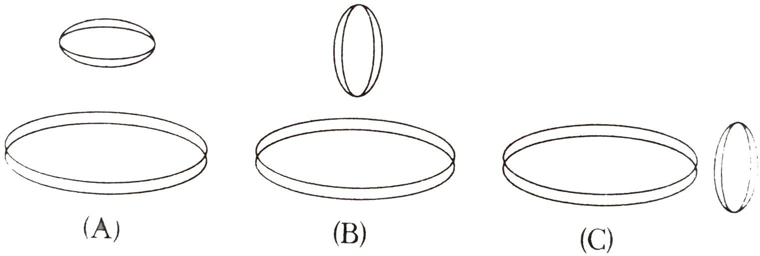
5. Two circular coils can be arranged in any of the three situation shown in figure. Their mutual inductance will be



A. maximum in situation (i)

B. maximum in situation (ii)

C. maximum in situation (iii)

D. the same in all situations

Answer: A

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6. A short-circuited coil is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be quadrupled and the wire radius halved, then the electrical power dissipated would be

A. halved

B. the same

C. doubled

D. quadrupled

Answer: B

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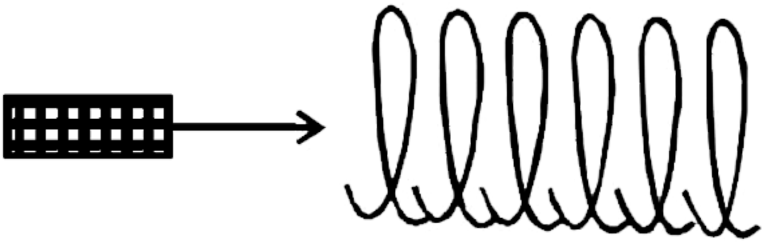
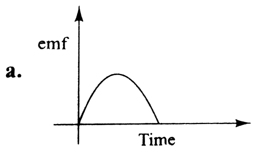
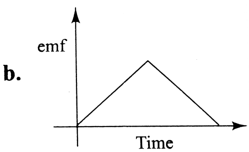
7. A small bar magnet is being slowly inserted with constant velocity inside a solenoid as shown in figure. Which graph best represents the relationship between emf induced with time



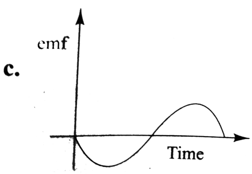
A.

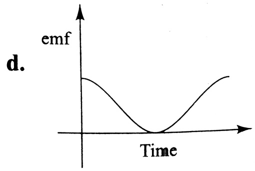


B.



C.



D. 

Answer: C

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8. Which of the field patterns given below is valid for electric field as well as for magnetic field?

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Archives (multiple Correct)

1. Two different coils have self-inductance $L_1 = 8mH, L_2 = 2mH$. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same rate. At a certain instant of time, the power given to the two coils is the same. At that time the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and W_1 respectively. Corrseponding values for the second coil at the same instant are i_2, V_2 and W_2 respectively. Then,

A. $\frac{i_1}{i_2} = \frac{1}{4}$

B. $\frac{i_1}{i_2} = 4$

C. $\frac{W_1}{W_2} = \frac{1}{4}$

D. $\frac{V_1}{V_2} = 4$

Answer: A::C::D

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2. The SI unit of the inductance , the henry can by written as

A. weber//ampere

B. volt-second//ampere

C. joule//(ampere) $\hat{}$ (2)

D. ohm-second

Answer: A::B::C::D

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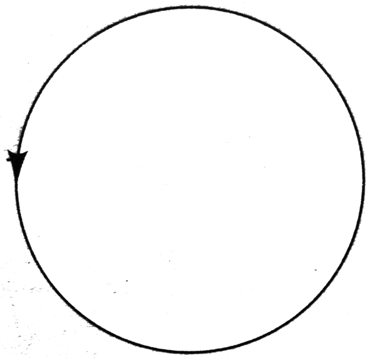
3. A field line is shows in Fig. This field cannot represent



A. Magnetic field

B. Electrostatic field

C. Induced electric field

D. Gravitational field

Answer: B::D

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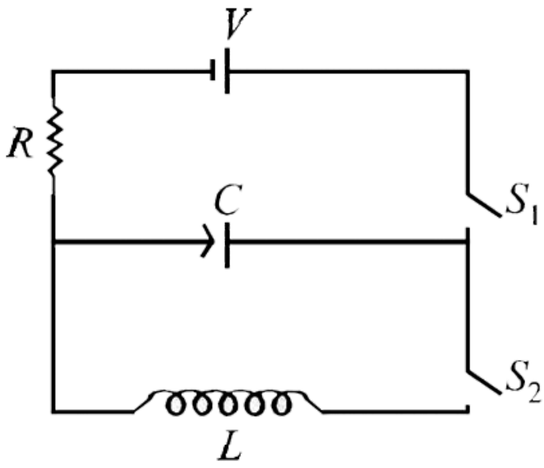
Archives (linked Compreshension)

1. In the given circuit the capacitor (C) may be charged through resistance R by a battery V by closing switch (S_1). Also when (S_1) is opend and (S_2) is closed the capacitor is connected in series with inductor (L).



At the start, the capicitor was uncharged. when switch (S_1) is closed and (S_2) is kept open, the time constant of this circuit is τ. which of the following is correct

A. After time interval τ, charge on the capacitor is $CV/2$

B. After time interval 2τ, charge on the capacitor of $CV\left(1 - e^{-2}\right]$

C. The work done by the voltage source will be half of the heat disspated when the capacitor is fully charged

D. After time interval 2τ, charge on the capacitor is $CV\left(1 - e^{-1}\right]$

Answer: B

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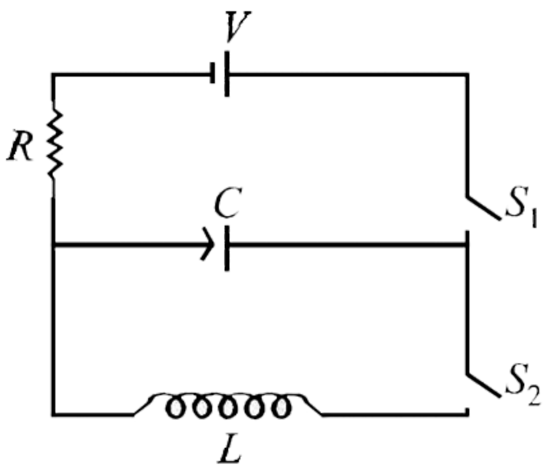
2. In the given circuit the capacitor (C) may be charged through resistance R by a battery V by closing switch (S_1). Also when (S_1) is opend and (S_2) is closed the capacitor is connected in series with inductor (L).



When the capacitor gets charged compleely, (= (S_1) is opened and (S_2) is closed, Then,

A. at $t = 0$, energy stored in the circuit is purely in the from of magnetic energy.

B. at any time $t > 0$ current in the circuit is in the same direction.

C. at $t > 0$, there is no excharge of energy between the inductor and capacitor.

D. at any time $t > 0$, maximum instantaneous current in the circuit may be $V\sqrt{\frac{C}{L}}$.

Answer: D

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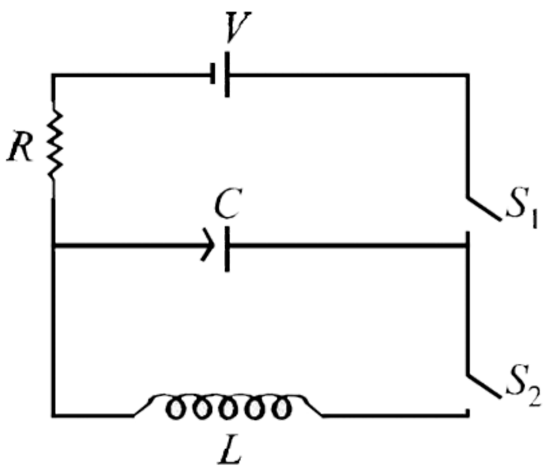
3. In the given circuit the capacitor (C) may be charged through resistance R by a battery V by closing switch (S_1). Also when (S_1) is opend and (S_2) is closed the capacitor is connected in series with inductor (L).



Given taht the total charge stored in the LC circuit is (Q_0). for `Tge0, the charge on the capacitor is

A. $Q = Q_0 \cos\left(\frac{\pi}{2} + \frac{t}{\sqrt{LC}}\right)$

B. $Q = Q_0 \cos\left(\frac{\pi}{2} - \frac{t}{\sqrt{LC}}\right)$

C. $Q = -LC\frac{d^2Q}{dt^2}$

D. $Q = -\frac{1}{\sqrt{LC}}\frac{d^2Q}{dt^2}$

Answer: C

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4. Modern train are based on maglev technology in which trains are magntically levitated, which runs its EDS maglev system. There are coils on both sides of wheels. Due to motion of the train, current induces in the coil of track which levitate it. This is in accordance with Lenz's law. If train lowers down then due to Lenz's law, repulsive force increase due to which train gets uplifted and if it goes much higher then there is a net downward force due to gravity. The advantage of Maglev trains in that there is no friction between the train and the track, thereby reducting power consumption and enabling the train to attain very high speeds. Disavantage of Maglev train is that as it slows down, the electromagnetic forces decreases and it becomes difficult to keep it levitaited and as it moves forward according to Lenz's law there ia an electromagnetic drag force.

What is the advantage of this system?

A. No friction hence no power consumption

B. No electric power is zero

C. Graviatation force is zero

D. Electrostatic force draws the train

Answer: A

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5. Modern train are based on maglev technology in which trains are magntically levitated, which runs its EDS maglev system. There are coils on both sides of wheels. Due to motion of the train, current induces in the coil of track which levitate it. This is in accordance with Lenz's law. If train lowers down then due to Lenz's law, repulsive force increase due to which train gets uplifted and if it goes much higher then there is a net downward force due to gravity. The advantage of Maglev trains in that there is no friction between the train and the track, thereby reducting power consumption and enabling the train to attain very high speeds. Disavantage of Maglev train is that as it slows down, the electromagnetic forces decreases and it becomes difficult to keep it levitaited and as it moves forward according to Lenz's law there ia an electromagnetic drag force.

What is the disadvantage of this system?

A. Train experiences upward force according to Lenz's law

B. Friction force creates a drag on the train

C. Retardation

D. By Lenz's law, the train experiences a drag

Answer: D

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6. Modern train are based on maglev technology in which trains are magntically levitated, which runs its EDS maglev system. There are coils on both sides of wheels. Due to motion of the train, current induces in the coil of track which levitate it. This is in accordance with Lenz's law. If train lowers down then due to Lenz's law, repulsive force increase due to which train gets uplifted and if it goes much higher then there is a net downward force due to gravity. The advantage of Maglev trains in that there is no friction between the train and the track, thereby reducting power consumption and enabling the train to attain very high speeds. Disavantage of Maglev train is that as it slows down, the electromagnetic forces decreases and it becomes difficult to keep it levitaited and as it moves forward according to Lenz's law there ia an electromagnetic drag force.

Which force causes the train to elevate up?

A. Electrostatic force

B. Time varying electing field

C. Magnetic force

D. Induced electric field

Answer: C

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7. A point charges Q is moving in a circular orbit of radius R in the x-y plane with an angular velocity ω. This can be considered as equivalent to a loop carrying a steady current

$\frac{Q\omega}{2\pi}$. S uniform magnetic field along the positive z-axis is now switched on, which increases at a constant rate from 0 to B in one second. Assume that the radius of hte orbit remains constant. The application of hte magnetic field induces an emf in the orbit. The induced emf is defined as the work done by an induced electric field in moving a unit positive charge around a closed loop. It si known that, for an orbiting charge, the magnetic dipole moment is proportional to the angular momentum with a porportionality constant λ. The magnitude of the induced electric field in the orbit at any instant of time during the time interval of the mangnetic field change is

A. $\frac{BR}{4}$

B. $\frac{BR}{2}$

C. BR

D. $2BR$

Answer: B

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8. A point charges Q is moving in a circular orbit of radius R in the x-y plane with an angular velocity ω. This can be considered as equivalent to a loop carrying a steady current $\frac{Q\omega}{2\pi}$. S uniform magnetic field along the positive z-axis is now switched on, which increases at a constant rate from 0 to B in one second. Assume that the radius of the orbit remains constant. The application of the magnetic field induces an EMF in the orbit. The induced EMF is defined as the work done by an induced electric field in moving a unit positive charge around a closed loop. It is known that, for an orbiting charge, the magnetic dipole moment is proportional to the angular momentum with a proportionality constant λ. The charge in the magnetic dipole moment associated with the orbit, at the end of the time interval of the magnetic field charge, is

A. λBQR^2

B. $-\lambda\frac{BQR^2}{2}$

C. $\lambda\frac{BQR^2}{2}$

D. $-\lambda BQR^2$

Answer: B

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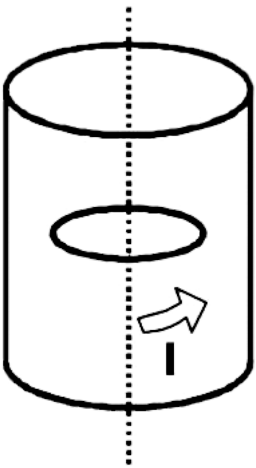
Archives (integer)

1. A long circular tube of length $10m$ and radius $0.3m$ carries a current I along its curved surface as shown . A wire - loop of resistance $0.005 ohm$ and of radius $0.1m$ is placed inside the tube its axis coinciding with the axis of the tube . The current varies as $I = I_0 \cos(300t)$ where I_0 is constant. If the magnetic moment of the loop is $N\mu_0 I_0 \sin(300t)$, then 'N' is



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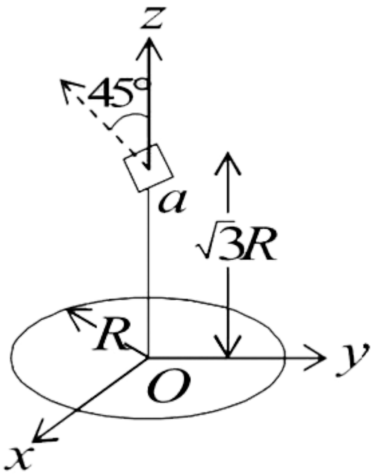
2. A circular wire loop of radius R is placed in the x-y plane centered at the origin O. A square loop of side a(altltR) having two turns is placed with its centre at $= \sqrt{3}R$ along the axis of hte circular wire loop, as shown in figure. The plane of the square loop makes an angle of 45° with respect to the z-axis. If the mutual inductance between the loops is given bu $\frac{\mu_0 a^2}{2^{p/2} R}$, then the value of p is



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Subective Type

1. Two solenoids A and B spaced close to each other and sharing the same cylindrical axis have 400 and 700 turns, respectively. A current of $3.50 A$ in coil A produced an average flux of $300 \mu T-m^2$ through each turn of A and a flux of $90.0 mT-m^2$ through each turn of B.

a. Calculate the mutual inductance of the two solenoids.

b.What is the self inductance of A?

c. What emf is induced in B when the current in A increases at the rate of $0.5 A / s$?

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2. Solenoid S_1 has N turns, radius R_1 and length l. It is so long that its magnetic field is uniform nearly everywhere inside it and is nearly zero outside, Solenoid S_2 has N_2 turns, radius $R_2 < R_1$.and the same length as S_1 It lies inside S_1 with their axes prallel. (a) Assume S_1 carries variable current i. Compute the mutual inductance characterizing the emf induced is S_2. (b) Now assume S_2 carries current i. Compute the mutual inductance to which the emf in S_1 is proportional. (c) State how we results of parts (a) and (b) compare with each other.

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Single correct Answer Type

1. A 2.00-H indductor carries a steady current of 0.500A. When the switch in the circuit is opened,the current is effectively zero after 10.0ms. What is the average induced emf in the inductor during this time interval?

A. 100V

B. 150V

C. 133V

D. 200V

Answer: A

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2. An emf of 25.0 mV is induced in a 500-turn coil when the current is changing is at the rate of 10.0A/s. What is the magnetic flux through each turn of the coil at an instant when the current is 4.0A?

A. $20\mu T. m^2$

B. $10\mu T. m^2$

C. $15\mu T. m^2$

D. $30\mu T. m^2$

Answer: A

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3. The current in a coil changes from 3.50 A to 2.00 A in the same direction in 0.500s. If the average emf induced in the coil is 12.0mV. What is the inductance of the coil?

A. 2.00mH

B. 4.00mH

C. 3.00mH

D. 8.00mH

Answer: B

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4. A self-induced wmf in a solenoid of inductance L changes in time as $\varepsilon = \varepsilon_0 e^{-kz}$. Assuming the charge is finite.find the total charge that passes a point in the wire of the solenoid.

A. $\dfrac{\varepsilon_0}{Lk^2}$

B. $\dfrac{2\varepsilon_0}{Lk^2}$

C. $\dfrac{\varepsilon_0}{2Lk^2}$

D. $\dfrac{3\varepsilon_0}{Lk^2}$

Answer: A

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5. Light of wavelength 24000A is incident on a thin glass plate of refractive index 1.5 such that angle of refraction into plate is 60° .calculate the thickness of plate which will make it appear dark by reflection?

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6. An emf 96.0mV is induced in the windings of a coil when the current in a nearby coil is increasing at the rate of 1.20A/s. The mutual inductance of the two coils is

A. 40mH

B. 20mH

C. 10mH

D. 80mH

Answer: D

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7. Two coils, held in fixed positions have a mutual inductance of $100\mu H$. what is the peak emf in one coil when the current in the other coil is 10 sin (1000t) where i is in amperes and t is in seconds?

A. 2.00V

B. 1.00V

C. 4.00V

D. 3.00V

Answer: B

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8. Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coincidingt. Find the mutual inductane between them assuming $R_2 < < R_1$.

A. $\dfrac{\mu_0 \pi r^2}{R}$

B. $\dfrac{2\mu_0 \pi r^2}{R}$

C. $\frac{\mu_0 \pi r^2}{2R}$

D. $\frac{3\mu_0 \pi r^2}{3R}$

Answer: C

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9. A coil of Cu wire (radius r, self-inductance L) is bent in two concentric turns each having radius $\frac{r}{2}$. The self-inductance now

A. $2L$

B. L

C. $4L$

D. $L/2$

Answer: A

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10. If in a coil rate of change of area is $\frac{5meter^2}{milli\sec ond}$ and current become $1amp$ from $2amp$ in 2×10^{-3} sec. if magnetic field is 1 Tesla then self-inductance of the coil is

A. $2H$

B. $5H$

C. $20H$

D. $10H$

Answer: D

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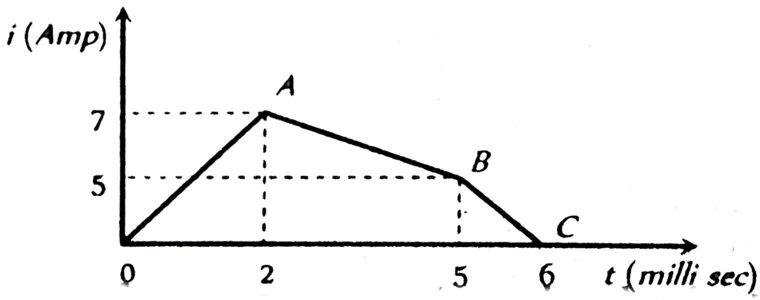
11. The current through a 4.6 H inductor is shown in the following graph. The induced emf during the time interval t = 5 milli - sec to

6 milli - sec will be



A. $10^3 V$

B. $-23 \times 10^3 V$

C. $23 \times 10^3 V$

D. Zero

Answer: C

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12. An alternating current of frequency $200 \mathrm{rad} / \mathrm{sec}$ and peak value of $1 A$ as shown in the figure in applied to the primary of a transformer. If the coefficient of mutual induction between the primary and the secondary is $1.5 H$, the voltage induced in the secondary will be

A. $300 V$

B. $191 V$

C. $220 V$

D. $471V$

Answer: B

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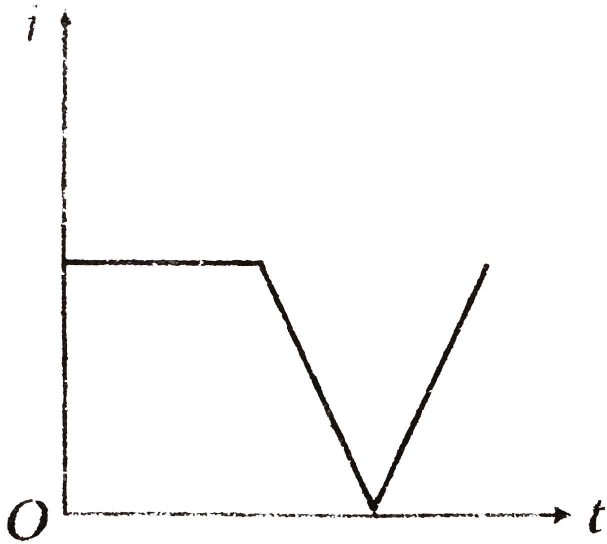
13. The current i in an inducton coil varies with time t according to the graph shown in figure.



Which of the following graphs shows the induced emf (E) in the coil with time?

A.

B.

C.

D.

Answer: C

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14. When a certain curcuit consisting of a constant e.m.f. E an inductance L and a resistance R is closed, the current in it increases with time according to curve 1. After one parameter (E, L or R) is changed, the increase in current is closed second time. Which parameter was changed and in what direction?

A. L is increased

B. L is decreased

C. R is incresed

D. R is decreased

Answer: A

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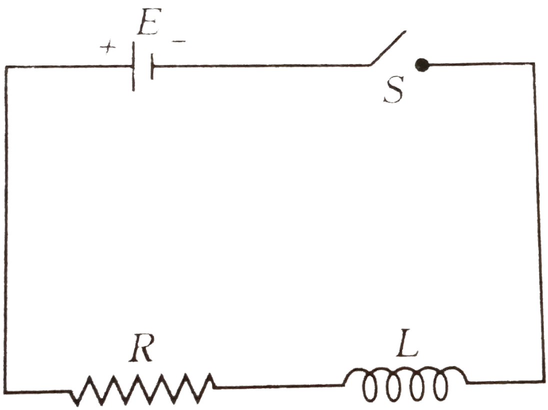
15. Switch S of the circuit shown in figure is closed at t = 0.



If emf in L is e and i is the current flowing through the circuit at time t, which of the following graphs is corrent?

A.

B.

C.

D.

Answer: C

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16. Light of wavelength 12000A is incident on a thin glass plate of refractive index1 such that angle of refraction into plate is 60^{o} .calculate the thickness of plate which will make it appear dark by reflection?

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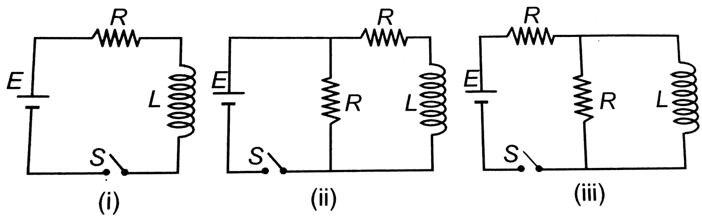
17. In which of the following circuits is the current maximum just after the switch S is closed?



A. (i)

B. (ii)

C. (iii)

D. Both (ii) and (iii)

Answer: B

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18. In an L-R circuit connected to a battery at which energy ius stored in the inductor is plotted against time during the growth of current in the ciruit Which of the following best represents the resulting curve?

A.

B.

C.

D.

Answer: A

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19. In the circuit diagram shown, $R = 10\omega, L = 5mH, E = 10$ V and $i = 1A$. The current is decreasing at the reate of

$10^3 A / S$. Then $(V_A - V_B)$ at this instant is :

A. $10V$

B. $15V$

C. $20V$

D. $25V$

Answer: B

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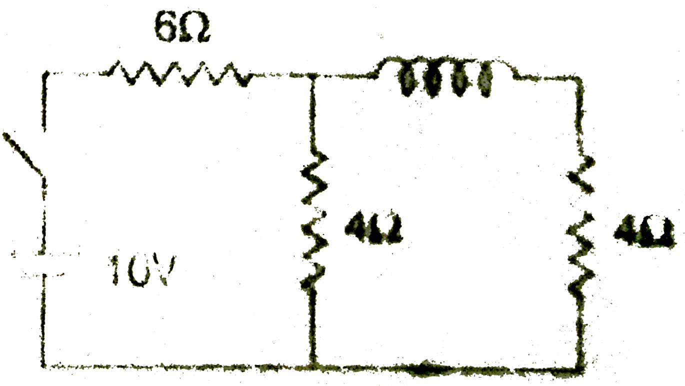
20. In the given circuit find the ratio of $i_1 \text{to} i_2$.

Where is the initial (at t=0) current, and i_2 is

steady state $(at t = \infty)$ current the battery



A. 1.0

B. 0.8

C. 1.2

D. 1.5

Answer: D

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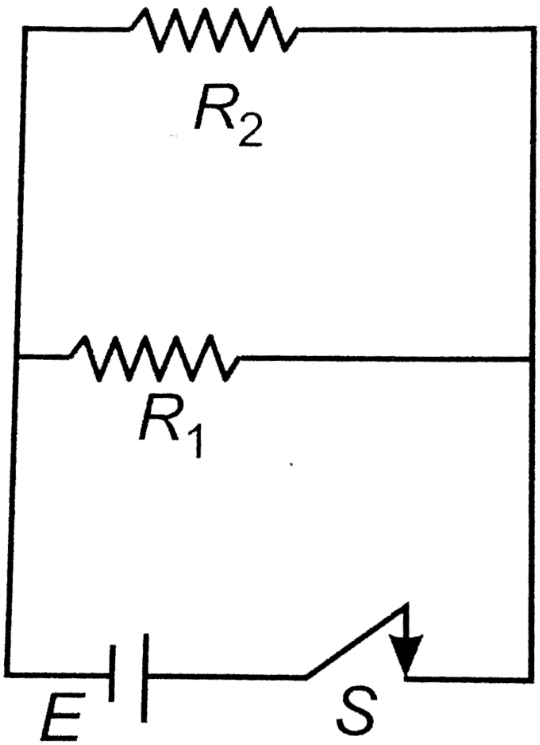
21. Consider the circuit shown in figure. The current through the battery a long time after the switch S is closed is:



A. $\dfrac{E}{R_1}$

B. $\dfrac{E}{R_2}$

C. $\dfrac{E}{R_1 + R_2}$

D. $\frac{E(R_1 + R_2)}{R_1 R_2}$

Answer: C

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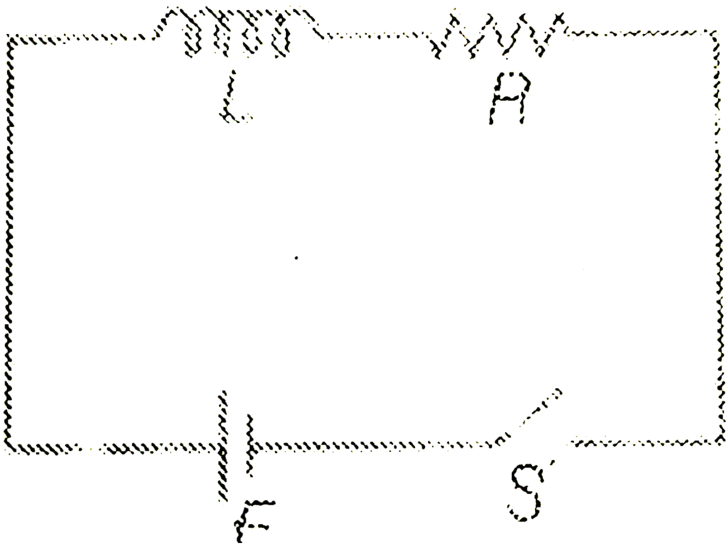
22. In the circuit shown in figure switch S is closed at time t=0. The charge which passes through the battery in one time constant is



A. $\frac{eR^2E}{L}$

B. $E\left(\frac{L}{R}\right)$

C. $\frac{EL}{eR^2}$

D. $\frac{eL}{ER}$

Answer: A

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Multiple Correct Answer

1. The current in a 90mH inductor changes with time as $i = 1.0t^2 - 6t$, where I is in amperes and t is in seconds.

A. the magnitude of the induced emf at t=4.0s is 180 mV

B. the emf zero at time t=3.0s

C. the magnitude of the induced emf at t=4.0s is 360 mV

D. the emf zero at time t=4.0s

Answer: A::B

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2. A $1 - k\Omega$ resistor is connected in series with a $10 - mH$ inductor, a $30V$ battery and an open switch. At time $t = 0$, the switch is suddenly closed.

a. What is the maximum current in this circuit and when does it occur?

b. What are the voltage drops across the inductor and across the resistor $20\mu s$ after the switch is closed?

c. On a single set of axes, sketch the voltage across the resistor and the voltage across the inductor as functions of time. Also, sketch a graph of the current in the circuit as a function of time.

A. the power being supplied by the battery is $20.0W$

B. the power being delivered to the resistor is $20.0W$

C. the power being delivered t the inductor zero

D. the energy stored in the magnetic filed of the indicator is $20.0J$

Answer: A

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3. The switch in figure Iis connected to position a for a long time interval. At $t = 0$, the switch is thrown to position b. After this time , what are

A. the frequency of oscillation of the LC circuit

B. the maximum charge that appears on the capacitor

C. the maximum current in the indictor

D. the total energy the circuit possesses at

$t = 3.00$ s

Answer: A

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Comprehension Type

1. A solenoid of radius 2.50cm has 400turns and a length of 20.0cm. The inductance (L) of this solenoid is _______.

A. 4mH

B. 5mH

C. 3mH

D. 2mH

Answer: D

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2. A solenoid of radius 2.50cm has 400turns and a length of 20.0cm. The current in the coil is changing with time such that an emf of 75X10^(-6) is produced.

The rate of change of current in the solenoid is

A. 38.0mA/s

B. 19.0mA/s

C. 21.0mA/s

D. 50.0mA/s

Answer: A

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3. A technician wraps wire around a tube of length $4\pi^2$ cm having a diameter of 8.00cm. When the windings are evenly spread over the full length of the tube, the result is a solenoid containing 1000turns of wire. If the current in this solonoid increases at the rate of 4.00A/s. the inductance of this solenoid is

A. 32mH

B. 16mH

C. 48mH

D. 8mH

Answer: B

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4. A technician wraps wire around a tube of length $4\pi^2$ cm having a diameter of 8.00cm. When the windings are evenly spread over the full length of the tube, the result is a solenoid containing 1000turns of wire. If the current in this solonoid increases at the rate of 4.00A/s the self-induced emf in the solenoid is

A. 32mV

B. 16mV

C. 64mV

D. 24mV

Answer: C

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5. Consider the circuit shown in figure.

When the switch is in position a, for what value of r wil the circuit have a time costant of $10\mu s$?

A. $2.0kohm$

B. $2.5kohm$

C. $1.0kohm$

D. none of these

Answer: A

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6. Light of wavelength 3000A is incident on a thin glass plate of refractive index1 such that angle of refraction into plate is 60° .calculate the thickness of plate which will make it appear dark by reflection?

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7. A circuit consists of a coil, a switch and a battery, all in series. The internal resistance of the battery is negligible compared with that of the coil. The switch is originally open. It is thrown closed, after a time interval Δt. The current in the circuit reaches $80.0\,\%$ of its final value. The switch then remains closed for a time interval much longer than Δt. The wires connected to the terminals of the battery are then short circuited with another wire and removed from the battery, so that the current is uninterrupted.

At an instant that is a time interval Δt. After the short circuit, the current is what percentage of its maximum value? a)20% b) 8% c) 4% d)10 %

A. $20.0\ \%$

B. $8.0\ \%$

C. $4.0\ \%$

D. $10.0\ \%$

Answer: A

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8. what is the expression of work done for isobaric process?

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Concept Based

1. Light is incident on a glass plate of refractive index 3.0 such that angle of refraction is 60° .Dark band is observed corresponding to the wavelength of 12000 A .If the thickness of glass plate is 1.2×10^{-3} mm. Calculate the order of the interference band for reflected system.

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2. After switch is closed in the LC circuit shown in the figure, the charge on the capacitor is sometimes zero, but at such instants the current in the circuit is not zero. How is this behaviour possible ?

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3. Discuss the similarities between the energy stored in the electric field of charged capacitor and the energy stored in the magnetic field of a current-carrying coil.

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4. In the circuit of figure, the battery emf is ε the resitance is R and the capacitance is C. The switch S is closed for a long time interval, and zero potential difference is measured across the capacitor

After the switch is opened. the potential difference across the capacitor reaches a maximum value of ΔV. What is the value of the inductance?

A. $\frac{C(\Delta V)^2}{2\varepsilon^2}$

B. $\frac{C(\Delta V)^2}{\varepsilon^2}$

C. $\frac{2C(\Delta V)^2}{\varepsilon^2}$

D. $\frac{C(\Delta V)^2}{4\varepsilon^2}$

Answer: A

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5. A $1.00\mu F$ capacitor is charged by a $40.0V$ power supply. The fully charged charged capacitor is then discharged through a $10.0mH$ inductor. Find the maximum current in the resultaing oscillations.

A. $400mA$

B. $800mA$

C. $600mA$

D. $150mA$

Answer: A

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6. The frequency of oscillation of current in the indcutor is

A. $\frac{1}{3\sqrt{LC}}$

B. $\dfrac{1}{6\pi\sqrt{LC}}$

C. $\dfrac{1}{\sqrt{LC}}$

D. $\dfrac{1}{2\pi\sqrt{LC}}$

Answer: A

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7. Light of wavelength 24000A is incident on a thin glass plate of refractive index1 such that angle of refraction into plate is 60° .calculate the thickness of plate which will make it appear dark by reflection?

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8. Two waves of intensity I and 9I are superimposed in such a way that resultant Intensity is 7I .Find the phase difference between them ?

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