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DPP –7 (EMI)

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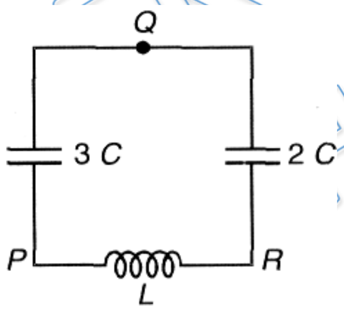
Q 1. Two inductors each of inductance 2L are connected in parallel , their mutual inductance is L . If magnetic field developed by first inductor in second inductor is parallel to magnetic field developed by second inductor in it, net inductance of combination is

(a) 2L (b) 3L/2 (c) 4L (d) L/2

Q 2. Two capacitors of capacitances 3C and 2C are connected in series with an inductor of inductance L. Potential differences across the capacitors are $V_P - V_Q = V_0$, $V_R - V_Q = \frac{7}{2}V_0$. Initial current in the circuit is zero. Energy in capacitor with capacitance 3C when current in the inductor is maximum is



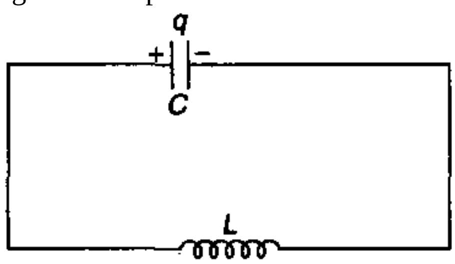
(a) $\frac{3}{2}CV_0^2$ (b) $3\,CV_0^2$ (c) $6\,CV_0^2$ (d) zero

Comprehension (Q.3 TO Q.5)

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.



Q 3. Maximum charge in the capacitor can be:

(a) 6 C (b) 8 C (c) 10 C (d) 12 C

Q 4. Charge in the capacitor will be maximum after time t = ... second.

(a) $2\sin^{-1}\frac{2}{3}$ (b) $2\cos^{-1}\frac{2}{3}$

(c) $2\tan^{-1}\frac{2}{3}$ (d) None

Q 5. Choose the corrent option:

(a) Maximum current in the circuit is 4A

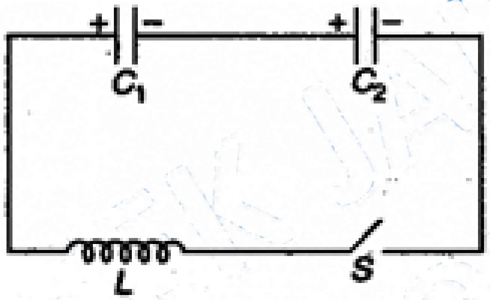
(b) When current is half its maximum value, charge in capacitor is less than half is maximum value

(c) Both (a) and (b)are correct

(d) Both (a) and (b) wrong

Comprehension(Q.6 TO Q.8)

In the figure shown C_1 =1 F, C_2 = 2 F and L = 5 H. Initially C_1 is charged to 50 V and C_2 to 10 V. Switch S is closed at time t = 0. Suppose at some instant charge on C_1 is 20 C with the same polarities as shown in figure.



Q 6. Energy stored in capacitor C_2 at this instant will be:

(a)10 J (b) 15 J (c) 25 J (d) 40 J

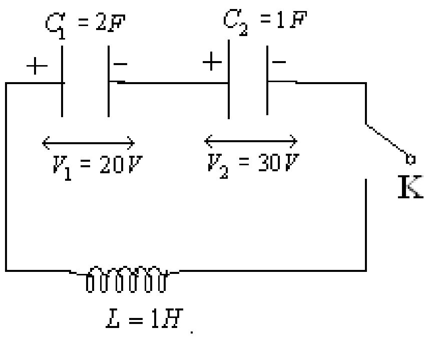
Q 7. Current in the circuit at this instant will be:

(a)10 $\sqrt{2}$A (b)15 $\sqrt{2}$ A (c) 10 A (d) 20 A

Q 8. Maximum current in the circuit will be:

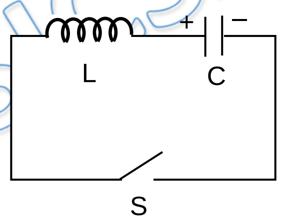
(a) $4\sqrt{30}$ A (b) $16\sqrt{2}$ A (c) $20\sqrt{3}$ A (d) $12\sqrt{6}$ A

Q 9. The figure shows the voltages on the capacitors initially. Now K is closed. Column Ii contains statement that are true when the condition given in Column – I is satisfied. Match them .



	Column I		Column II
(A)	$\left\lvert\frac{di}{dt}\right\rvert$ is maximum	(P)	Current in the inductor is maximum
(B)	$\frac{di}{dt} = 0$	(Q)	Charge on C_1 is maximum
(C)	The electrical energy stored in the capacitor combination is minimum	(R)	Charge on C_2 is maximum
(D)	The magnetic energy stored in the inductor is minimum	(S)	Potential difference across C_1 and C_2 is same

Q 10. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time t = 0. Which of the following statement are correct?



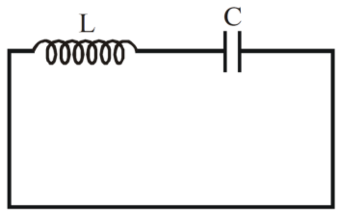
(a) the maximum current in the circuit is $V_0\sqrt{\frac{C}{L}}$

(b) potential across capacitor becomes zero for first time at time $t = \pi\sqrt{LC}$

(c) energy stored in the inductor at time t = $\frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$

(d) maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$

Q 11. In an LC circuit the capacitor has maximum charge q_0. The value of $\left(\frac{dI}{dt}\right)_{max}$ is :



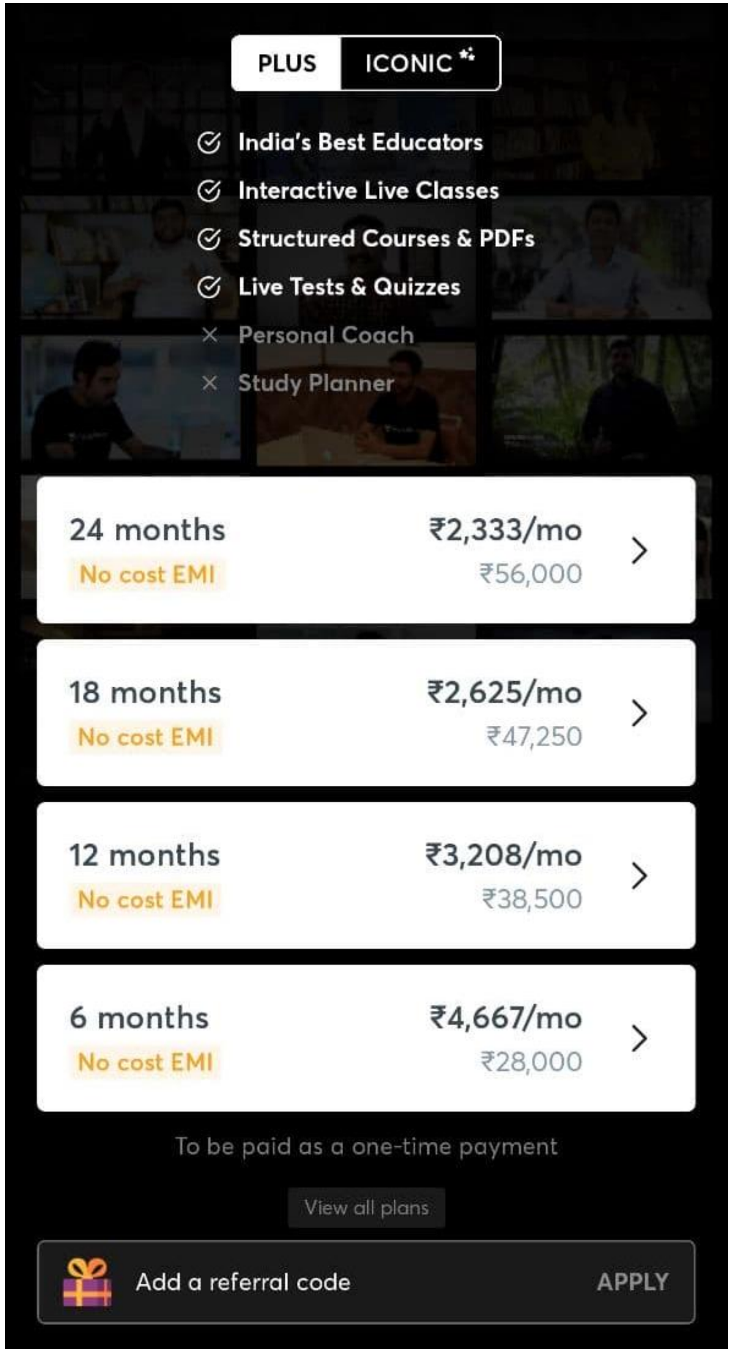
(a) $\frac{q_0}{LC}$ (b) $\frac{q_0}{\sqrt{LC}}$ (c) $\frac{q_0}{2LC}$ (d) $\frac{2q_0}{LC}$

Q 12. Two coils of self inductance 9H and 4H are connected in series combination. If their mutual inductance is not zero , possible values of effective inductance is
(a) 5H
(b) 3H
(c) 20H
(d) 24H

Answer Key

Q.1 b	Q.2 c	Q.3 a	Q.4 d	Q.5 d
Q.6 c	Q.7 b	Q.8 a	Q.10 a, d	Q.11 a
Q.12 a, b, c, d				

Q.9 A-(Q,R) B-(P,S) C-P,S D-(Q,R)



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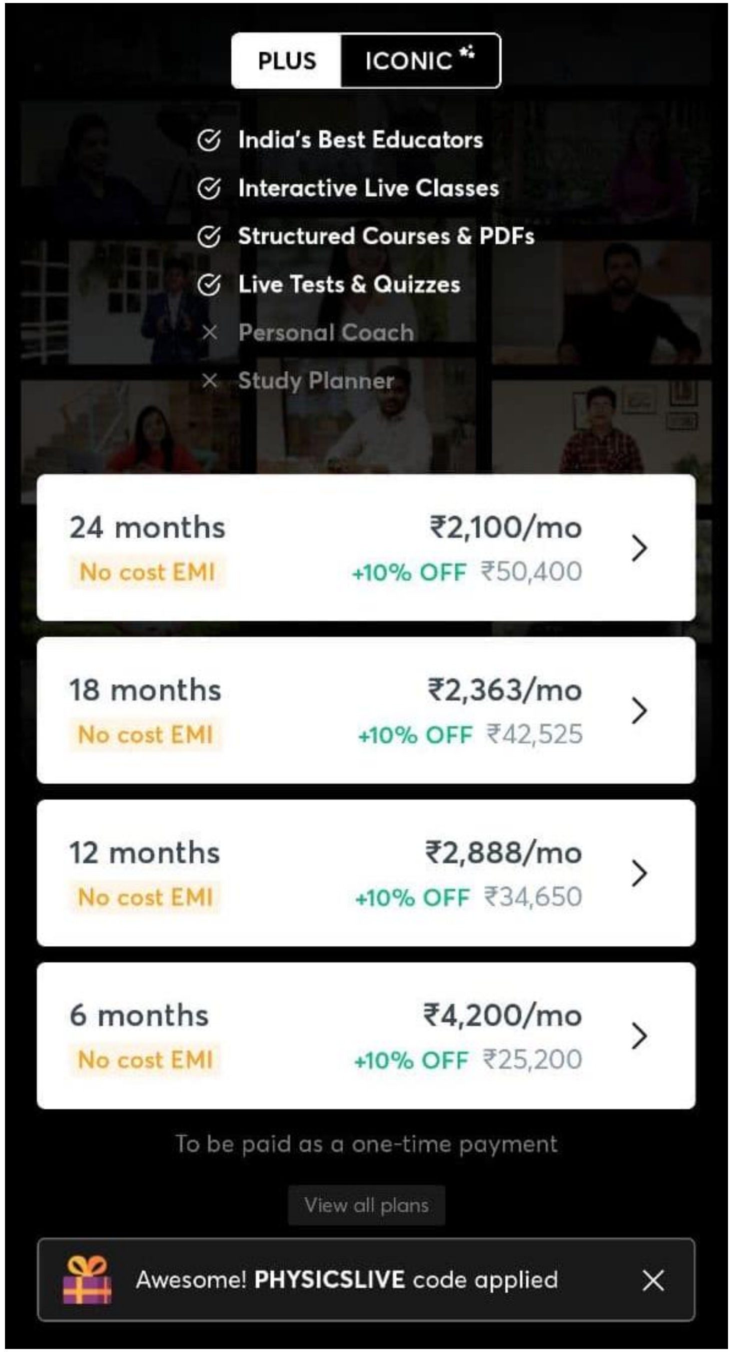

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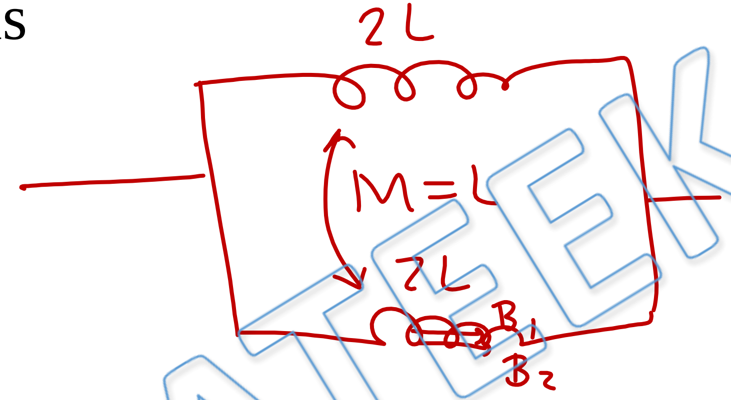
Written Solution

DPP- 7 EMI- Combination of inductor (series and parallel), LC oscillations

By Physicsaholics Team

Q.1) Two inductors each of inductance 2L are connected in parallel , their mutual inductance is L . If magnetic field developed by first inductor in second inductor is parallel to magnetic field developed by second inductor in it, net inductance of combination is



$$L_{eff} = \frac{L_1L_2 - M^2}{L_1+L_2-2M}$$

$$= \frac{2L \times 2L - L^2}{2L+2L-2L}$$

$$= \frac{3L}{2}$$

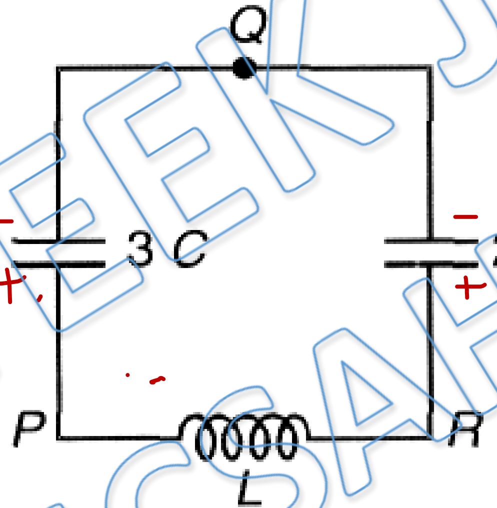
(a) 2L (b) 3L/2 (c) 4L (d) L/2

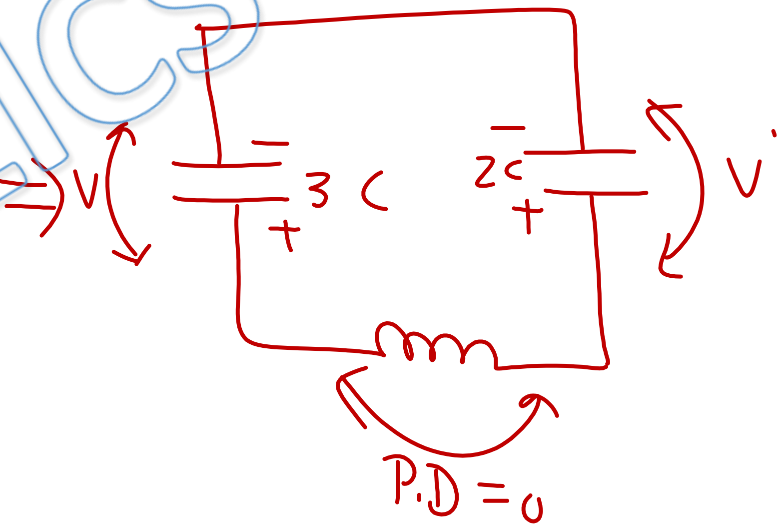
Q.2) Two capacitors of capacitances 3C and 2C are connected in series with an inductor of inductance L. Potential differences across the capacitors are $V_P - V_Q = V_0$, $V_R - V_Q = \frac{7}{2}V_0$. Initial current in the circuit is zero. Energy in capacitor with capacitance 3C when current in the inductor is maximum is

max i

$\Rightarrow \frac{di}{dt} = 0$

$\Rightarrow V_L = 0$





(a) $\frac{3}{2}CV_0^2$ (b) $3CV_0^2$ (c) $6CV_0^2$ ✓ (d) zero

by Conservation of charge →

$3CV_0 + 2C \times \frac{7}{2}V_0 = 3CV + 2CV \Rightarrow V = 2V_0$

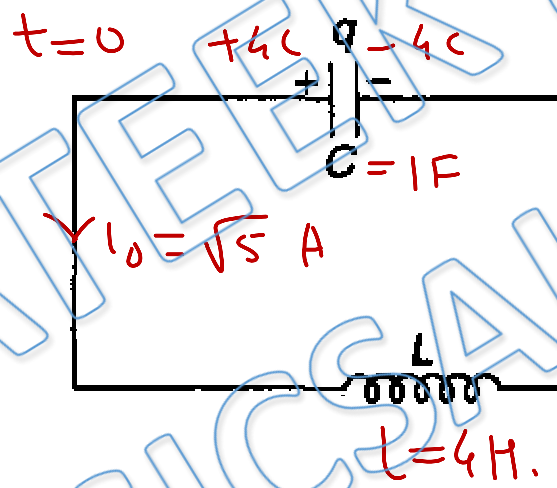
$U_{3C} = \frac{1}{2} \times 3C \times 4V_0^2 = 6CV_0^2$

Comprehension (Q.3 TO Q.5)

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.



Q.3) Maximum charge in the capacitor can be:

Initial energy of capacitor $= \frac{4^2}{2\times1} = 8\,J$

" " " inductor $= \frac{1}{2}\times4\times(\sqrt{5})^2 = 10\,J$

Total energy $= 10 + 8 = 18\,J$

(a) 6 C (b) 8 C (c) 10 C (d) 12 C

max energy of capacitor $= \frac{q_{max}^2}{2C} = 18$

$q_{max}^2 = 36$

$q_{max} = 6\,C$

Q.4) Charge in the capacitor will be maximum after time t = ………….. second.

(a) $2\sin^{-1}\frac{2}{3}$ (b) $2\cos^{-1}\frac{2}{3}$

(c) $2\tan^{-1}\frac{2}{3}$ (d) None

Q.5) Choose the corrent option:

$I_0 = 3A$

at $I = \frac{I_0}{2} = \frac{3}{2} A \Rightarrow U_L = \frac{1}{2} \times 4 \times \frac{9}{4} = \frac{9}{2} J$

total energy $= \frac{1}{2} L I_{max}^2$

$= \frac{1}{2} \times 4 \times 9 = 18 J$

(a) Maximum current in the circuit is 4A

(b) When current is half its maximum value, charge in capacitor is less than half is maximum value

(c) Both (a) and (b)are correct

(d) Both (a) and (b) wrong

$U_c = 18 - 9/2 = \frac{27}{2} J$

$\frac{q^2}{2 \times 1} = \frac{27}{2}$

$q = 3\sqrt{3}\ C$

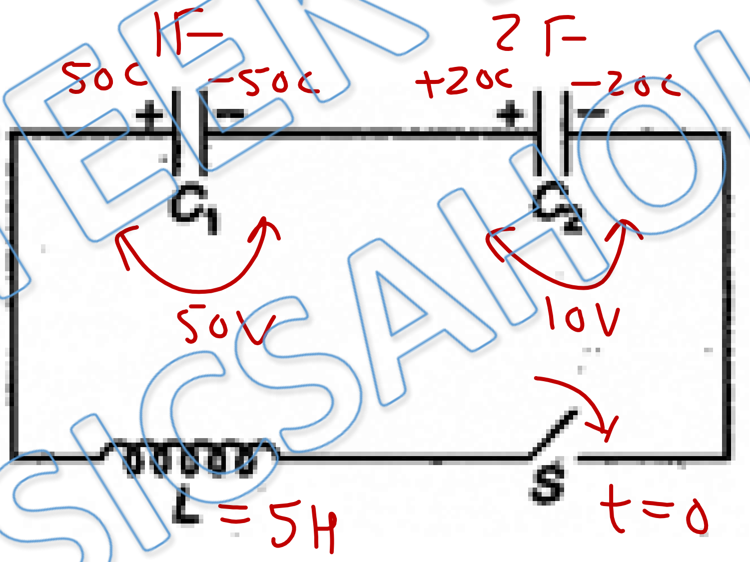
$q_{max} = 6C$

Comprehension (Q.6 TO Q.8)

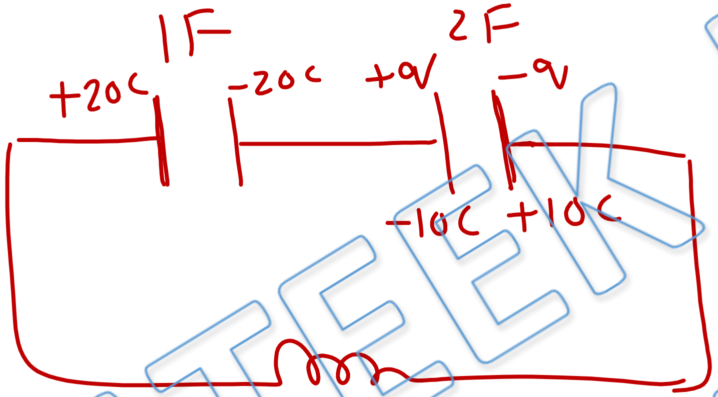
In the figure shown C_1 =1 F, C_2 = 2 F and L = 5 H. Initially C_1 is charged to 50 V and C_2 to 10 V. Switch S is closed at time t = 0. Suppose at some instant charge on C_1 is 20 C with the same polarities as shown in figure.

$U = \frac{1}{2} \times 1 \times 2500 + \frac{1}{2} \times 2 \times 10^2$

$U_{total} = 1350 \text{ J}$



Q.6) Energy stored in capacitor C_2 at this instant will be:



by charge Conservation

$-50 + 20 = -20 + q$

$q = -10C$

(a) 10 J (b) 15 J (c) 25 J ✓ (d) 40 J

$U_2 = \frac{q^2}{2C_2} = \frac{100}{2\times 2} = 25J$

Q.7) Current in the circuit at this instant will be:

total Energy of Capacitors at this instant $= \frac{20^2}{2\times 1} + \frac{10^2}{2\times 2}$

$= 200 + 25$

$= 225$ J

(a) $10\sqrt{2}$ A ~~(b) $15\sqrt{2}$ A~~ ✓ (c) 10 A (d) 20 A

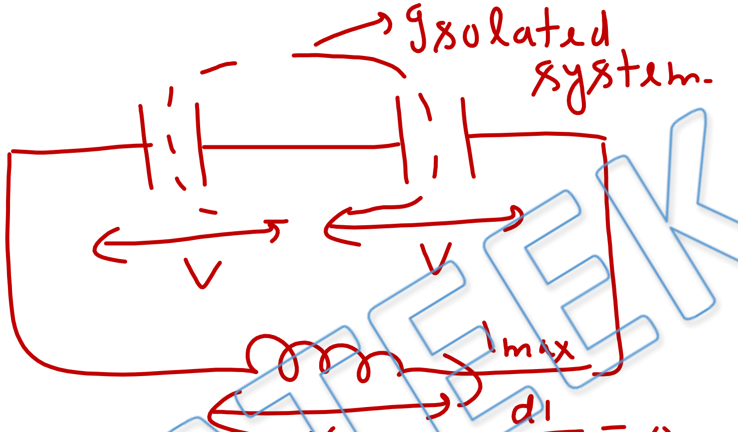
Energy of inductor $\frac{1}{2}Li^2 = 1350 - 225$

$i^2 = \frac{2}{5} \times 1125$

$i^2 = 2 \times 225$

$i = 15\sqrt{2}$

Q.8) Maximum current in the circuit will be:



$V_L = 0$, $\frac{di}{dt} = 0$

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

$$V = \frac{-50 + 20}{1 + 2} = -10V$$

(a) $4\sqrt{30}$ A (b) $16\sqrt{2}$ A (c) $20\sqrt{3}$ A (d) $12\sqrt{6}$ A

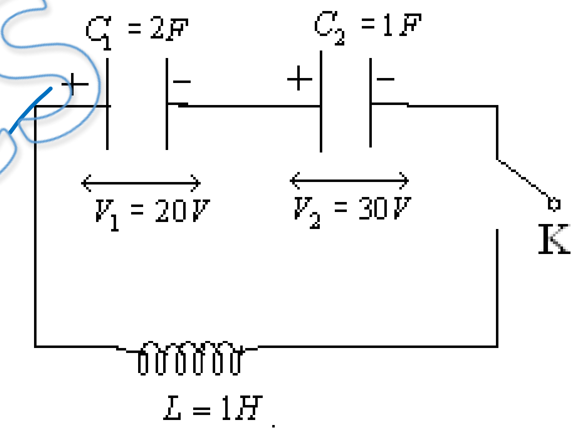
Energy of Combination of Capacitors $= \frac{1}{2} \times 1 \times 100 + \frac{1}{2} \times 2 \times 100$
$= 150J$

$$\frac{1}{2}Li^2 = 1350 - 150 = 1200$$

$$i^2 = \frac{2}{5} \times 1200 = 2 \times 240 = 480 = 16 \times 30$$

$$i = 4\sqrt{30}\ A$$

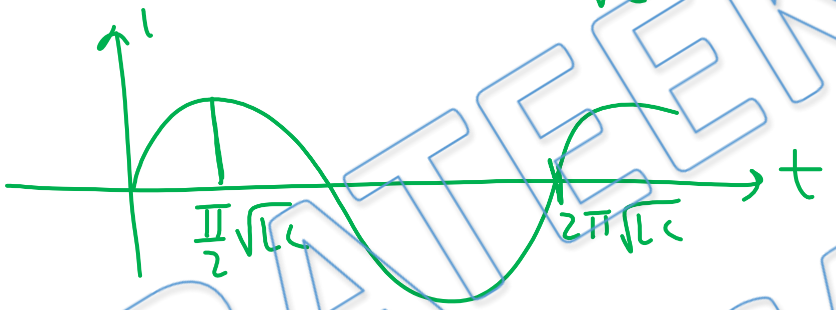
Q.9) The figure shows the voltages on the capacitors initially. Now K is closed. Column Ii contains statement that are true when the condition given in Column – I is satisfied. Match them .

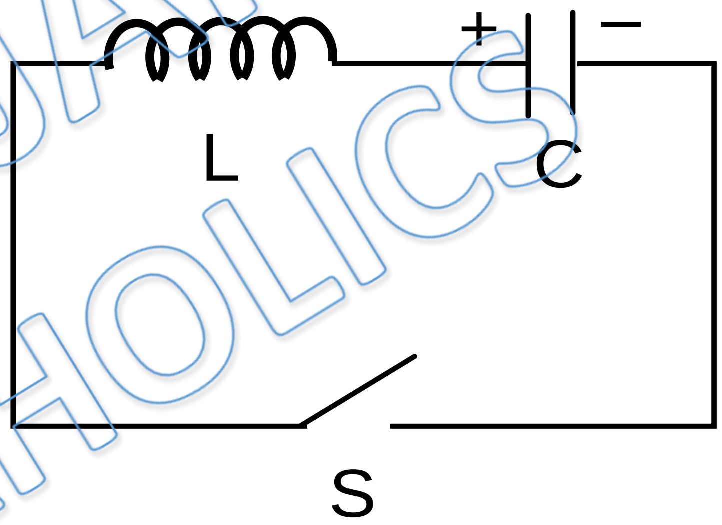


Column I	Column II
(A) $\left\|\frac{di}{dt}\right\|$ is maximum	(P) Current in the inductor is maximum
(B) $\frac{di}{dt} = 0$	(Q) Charge on C_1 is maximum
(C) The electrical energy stored in the capacitor combination is minimum	(R) Charge on C_2 is maximum
(D) The magnetic energy stored in the inductor is minimum	(S) Potential difference across C_1 and C_2 is same

Q.10) A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time t = 0. Which of the following statement are correct?

$I_0 = q_0 \omega = \frac{CV_0}{\sqrt{LC}} = V_0\sqrt{\frac{C}{L}}$





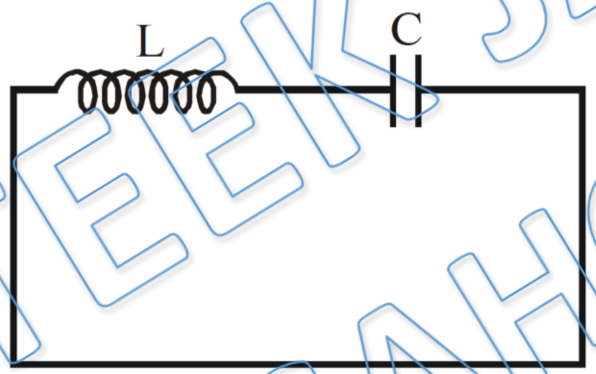
(a) the maximum current in the circuit is $V_0\sqrt{\frac{C}{L}}$

(b) potential across capacitor becomes zero for first time at time $t = \pi\sqrt{LC}$

(c) energy stored in the inductor at time t = $\frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$

(d) maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$

Q.11) In an LC circuit the capacitor has maximum charge q_0. The value of $\left(\frac{dI}{dt}\right)_{max}$ is :



$V_{max\,L} = V_{max\,C}$

$L\left(\frac{dI}{dt}\right)_{max} = \frac{q_0}{C}$

$\left(\frac{dI}{dt}\right)_{max} = \frac{q_0}{LC}$

(a) $\frac{q_0}{LC}$ (b) $\frac{q_0}{\sqrt{LC}}$ (c) $\frac{q_0}{2LC}$ (d) $\frac{2q_0}{LC}$

Q.12) Two coils of self inductance 9H and 4H are connected in series combination. If their mutual inductance is not zero , possible values of effective inductance is

(a) 5H

(b) 3H

(c) 20H

(d) 24H

$L_{eff} = L_1 + L_2 \pm 2M$

$M = K\sqrt{L_1 L_2}$

$M_{max} = \sqrt{L_1 L_2}$

$= \sqrt{9 \times 4}$

$= 6H$

$L_{eff\,min} = 9 + 4 - 12 = 1H$

$L_{eff\,max} = 9 + 4 + 12 = 25H$

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