DPP – 4 (EMI)

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Q 1. An e.m.f. of 5 volt is produced by a self inductance, when the current changes at a steady rate from 3 A to 2 A in 1 millisecond. The value of self inductance is
(a) Zero (b) 5 H
(c) 5000 H (d) 5 mH

Q 2. An average emf of 25 V is induced in an inductor when the current in it is changed from 2.5 A in one direction ot the same value in the opposite direction in 0.1s. Find the self-inductance of the inductor.
(a) 0.5 H (b) 1 H
(c) 5H (d) 50 mH

Q 3. The current in ampere through an inductor is I = (10+20t). Here t is in second. The induced emf in the inductor 4V. The self inductance of the inductor is, L= …..H
(a) 2 (b) 20
(c) 0.2 (d) 0.02

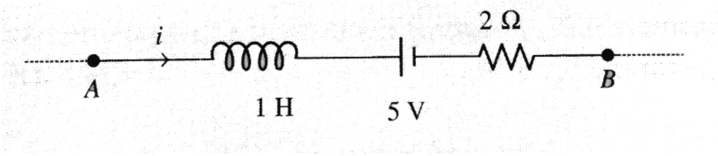
Q 4. In an inductor of inductance L = 100 mH, a current of I = 10 A flowing. The energy stored in the inductor is
(a) 5 J (b) 10 J
(c) 100 J (d) 1000 J

Q 5. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA . This inductor is of inductance
(a) 13.89 H (b) 0.138 H
(c) 1.389 H (d) 138.8 H

Q 6. In what form is the energy stored in an inductor of A coil of inductance L is carrying a steady current i. What is the nature of its stored energy
(a) Magnetic (b) Electrical
(c) Both magnetic and electrical (d) Heat

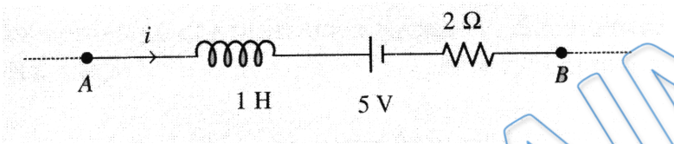
Q 7. A coil of self-inductance 50 henry is joined to the terminals of a battery of e.m.f. 2 volts through a resistance of 10 ohm and a steady current is flowing through the circuit. If the battery is now disconnected, the time in which the current will decay to 1/e of its steady value is
(a) 500 seconds (b) 50 seconds
(c) 5 seconds (d) 0.5 seconds

Q 8. AB is a part of circuit. Find the potential difference $V_A - V_B$ if current I = 2A and is constant



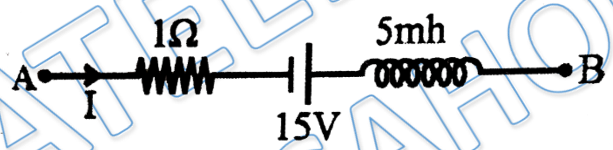
(a) 9V (b) 10 V
(c) 8V (d) zero

Q 9. AB is a part of circuit. Find the potential difference $V_A - V_B$ if
(a) current I = 2A and is increasing at the rate of 1 A/s
(b) current I = 2A and is decreasing at the rate of 1 A/s



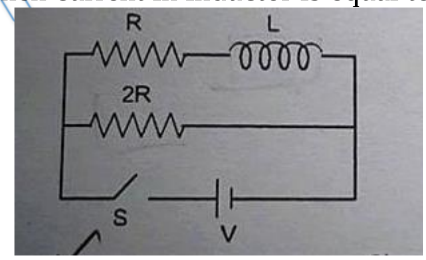
(a) 8V, 9V (b) 8V, 6V
(c) 9V, 8V (d) 10V, 8V

Q 10. If I = 5A and decreasing at a rate of $10^3\ A/sec$, then potential difference $V_B - V_A$ will be



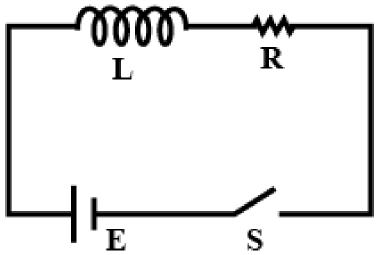
(a) 5V (b) 10V
(c) 15V (d) 20V

Q 11. Consider a L-R circuit shown in figure. There is no current in circuit switch S is closed at t = 0, time instant when current in inductor is equal to current in resistor 2R will be:



(a) $\frac{L}{R}\ln 2$ (b) $\frac{2L}{R}\ln 2$
(c) $\frac{L}{2R}\ln 2$ (d) $\frac{L}{2R}$

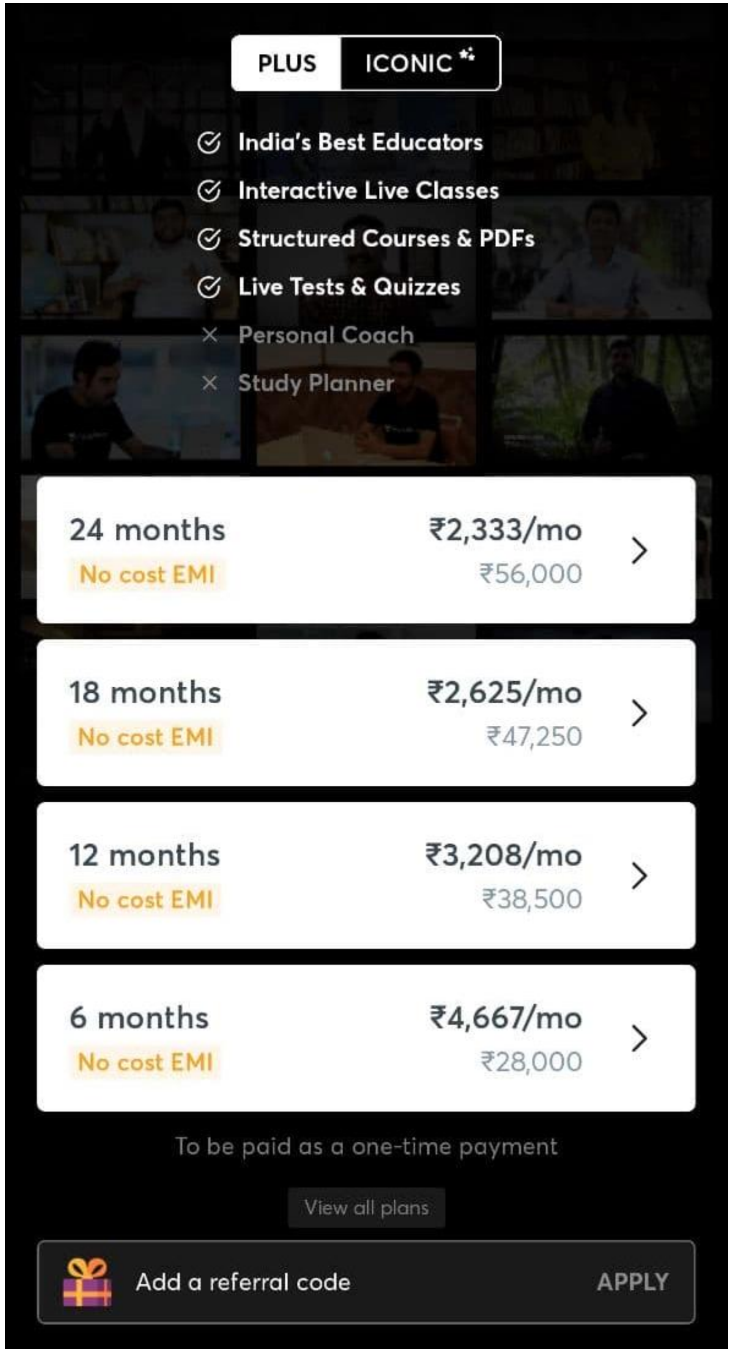
Q 12. In the circuit shown in figure switch S is closed at time t = 0. The charge which passes through the battery in one time constant is



(a) $\frac{eR^2E}{L}$
(b) $E\left(\frac{L}{R}\right)$
(c) $\frac{EL}{eR^2}$
(d) $\frac{eL}{ER}$

Answer Key

Q.1 d	**Q.2 a**	**Q.3 c**	**Q.4 a**	**Q.5 a**
Q.6 a	**Q.7 c**	**Q.8 a**	**Q.9 d**	**Q.10 c**
Q.11 a	**Q.12 c**			



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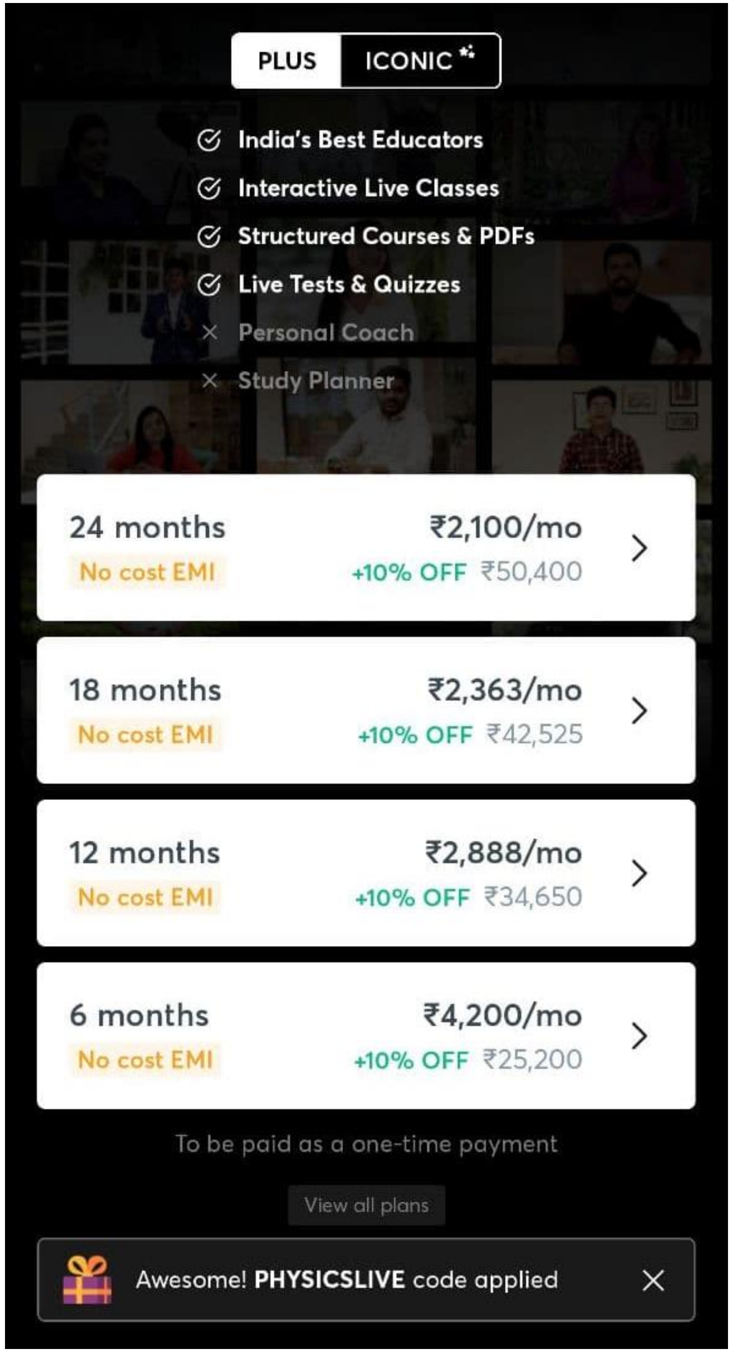

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Written Solution

DPP- 4 EMI: Self inductance, RL Circuit, Energy stored in Inductor

By Physicsaholics Team

Solution: 1

$$\phi = LI$$

$$\varepsilon = -L\frac{dI}{dt}$$

$$5 = -L\left(\frac{2-3}{10^{-3}}\right)$$

$$5 = -L\left(-\frac{1}{10^{-3}}\right)$$

$$L = 5\times10^{-3}\ H$$

$$\boxed{L = 5\ mH}\ \text{Ans.}$$

Ans. d

Solution: 2

$$E = L\frac{dI}{dt}$$

$$\frac{dI}{dt} = \frac{2\times2.5}{0.1} = \frac{5}{0.1} = 50 \text{ Amp/sec}$$

$$25 = L \times 50$$

$$L = \frac{25}{50}$$

$$\boxed{L = 0.5\ H}$$ Ans.

Ans. a

Solution: 3

$$E = L\frac{dI}{dt}$$

$$E = L\frac{d}{dt}(10+20t)$$

$$E = L(20)$$

$$4 = L \times 20$$

$$L = \frac{4}{20} = \frac{1}{5}$$

$$\boxed{L = 0.2\ H}$$ Ans

Ans. c

Solution: 4

$$U = \frac{1}{2} L I^2$$

$$U = \frac{1}{2} \times 100 \times 10^{-3} \times (10)^2$$

$$U = \frac{1}{2} \times 10^{-1} \times 100$$

$$\boxed{U = 5\ J}$$ Ans.

Ans. a

Solution: 5

$$U = \frac{1}{2} L I^2$$

$$25 \times 10^{-3}\ J = \frac{1}{2} \times L \times (60 \times 10^{-3})^2$$

$$L = \frac{50 \times 10^{-3}}{(60)^2 \times 10^{-6}}$$

$$L = \frac{50 \times 10^{-3} \times 10^{6}}{(60)^2}$$

$$L = \frac{50 \times 10^{3}}{36 \times 10^{2}} = \frac{500}{36}$$

$$\boxed{L = 13.89\ H}$$

Ans. a

Solution: 6

An inductor stores energy in its magnetic field.

Ans. a

Solution: 7

$$I = I_0 e^{-t/\tau}$$

$$\tau = L/R$$

for; $I = I_0/e$

$$\frac{I_0}{e} = I_0 e^{-t/\tau}$$

$$\frac{1}{e} = e^{-t/\tau}$$

$$\ln 1/e = -t/\tau \ln e$$

$$-1 = -t/\tau$$

$$\boxed{t = \tau}$$

and $\tau = L/R$

$$= \frac{50}{10}$$

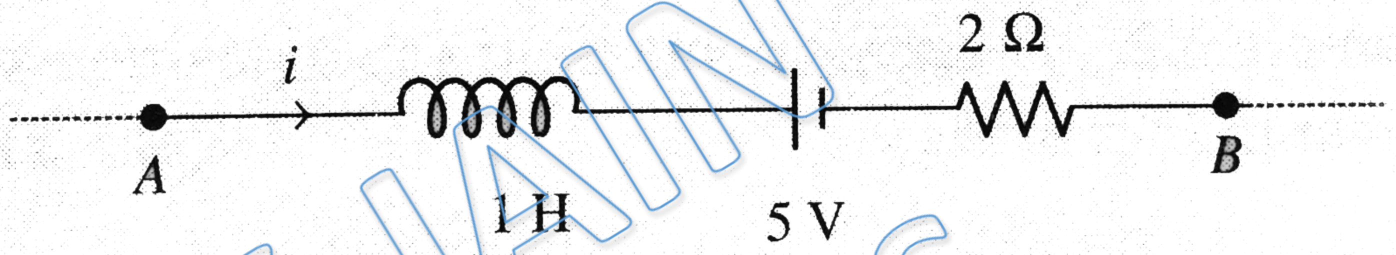
$$\boxed{\tau = 5 \text{ sec}}$$

$\therefore$ time

$$\boxed{t = 5 \text{ sec}}$$ Ans.

Ans. c

Solution: 8



$$V_A - L\frac{dI}{dt} - 5 - IR = V_B$$

$$V_A - V_B = L\frac{dI}{dt} + 5 + IR$$

$$= 1\times(0) + 5 + 2\times 2$$

$$= 0 + 5 + 4$$

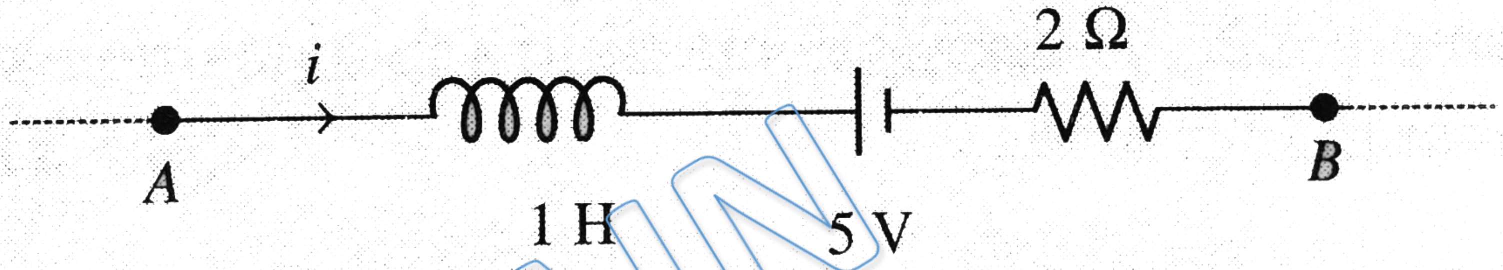
$\because I =$ constant

$\therefore \frac{dI}{dt} = 0$

$$\boxed{V_A - V_B = 9V}$$ Ans.

Ans. a

Solution: 9



Case–1

$I = 2A \; ; \; \frac{dI}{dt} = 1 \, A/s$

$V_A - L\frac{dI}{dt} - 5 - IR = V_B$

$V_A - V_B = L\frac{dI}{dt} + 5 + IR$

$= 1 \times (1) + 5 + 2 \times 2$

$= 1 + 5 + 4$

$\boxed{V_A - V_B = 10 \text{ Volt}}$ Ans.

Case–2

$I = 2A \; ; \; \frac{dI}{dt} = -1 \, A/s$

$V_A - L\frac{dI}{dt} - 5 - IR = V_B$

$V_A - V_B = L\frac{dI}{dt} + 5 + IR$

$= 1 \times (-1) + 5 + 2 \times 2$

$= -1 + 5 + 4$

$\boxed{V_A - V_B = 8 \text{ Volt}}$ Ans.

Ans. d

Solution: 10

$$V_A - IR + 15 - L\frac{dI}{dt} = V_B$$

$$V_A - V_B = IR - 15 + L\frac{dI}{dt}$$

$$I = 5A$$

$$\frac{dI}{dt} = -10^3 \text{ A/sec}$$

$$V_A - V_B = 5\times 1 - 15 + (5\times 10^{-3})(-10^3)$$

$$V_A - V_B = 5 - 15 - 5$$

$$V_A - V_B = -15\text{ V}$$

$$\Rightarrow \boxed{V_B - V_A = 15 \text{ Volt}}$$ Ans.

Ans. c

Solution: 11

$$I_2 = \frac{V}{2R}$$

$$I_1 = (I_1)_{max}\left(1 - e^{-t/\tau}\right)$$

$$(I_1)_{max} = \frac{V}{R}$$

$$I_1 = \frac{V}{R}\left(1 - e^{-t/\tau}\right)$$

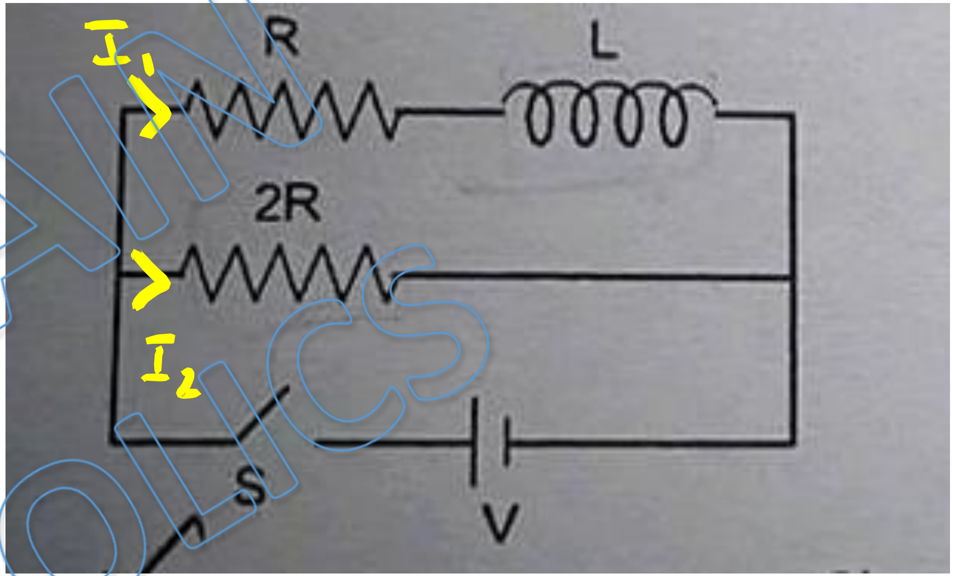
$$\tau = L/R$$

when; $I_1 = I_2 = \frac{V}{2R}$

$$\frac{V}{2R} = \frac{V}{R}\left(1 - e^{-t/\tau}\right)$$

$$\frac{1}{2} = \left(1 - e^{-t/\tau}\right)$$

$$e^{-t/\tau} = 1/2$$



$$e^{-t/\tau} = 1/2$$

$$\ln e^{-t/\tau} = \ln 1/2 \Rightarrow t/\tau = \ln 2$$

$$\boxed{t = \tau \ln 2}$$

$$\boxed{t = \frac{L}{R}\ln 2}$$ Ans.

Ans. a

Solution: 12

$t = 0$ to $t = \tau = \frac{L}{R}$

$$I = I_0\left(1 - e^{-t/\tau}\right)$$

$$\frac{dq}{dt} = \frac{E}{R}\left(1 - e^{-t/\tau}\right)$$

$$\int dq = \int_0^{\tau} \frac{E}{R}\left(1 - e^{-t/\tau}\right) dt$$

$$\Delta q = \frac{E}{R}\left(t - \frac{e^{-t/\tau}}{-1/\tau}\right)_0^{\tau} = \frac{E}{R}\left[t + \tau e^{-t/\tau}\right]_0^{\tau} = \frac{E}{R}\left[\tau + \tau e^{-1} - 0 - \tau\right]$$

$$\Delta q = \frac{E}{R}\left[\tau + \frac{\tau}{e} - \tau\right] = \frac{E}{R}\left[\frac{\tau}{e}\right] = \frac{E}{Re}\left[\frac{L}{R}\right]$$

$$\boxed{\Delta q = \frac{EL}{eR^2}}$$ Ans.

Ans. c

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