Physics 161.002
Clicker Quiz: April 12, 2007

54. The diagram shows an inductor that is part of a circuit. The direction of the emf induced in the inductor is indicated. Which of the following is possible?

A) The current is constant and rightward
B) The current is constant and leftward
C) The current is increasing and rightward
[✓ D)] The current is increasing and leftward
E) None of the above

$\mathcal{E} \propto L\frac{dI}{dt}$ opposes the current change... and as shown is trying to increase I to the right

55. A 10-turn ideal solenoid has an inductance of 3.5 mH. When the solenoid carries a current of 2.0 A the magnetic flux through each turn is:

A) 0
B) 3.5 x 10^(-4) wb
[✓ C)] 7.0 x 10^(-4) wb
D) 7.0 x 10^(-3) wb
E) 7.0 x 10^(-2) wb

$\Phi_B = \#\text{turns}\ \Phi/\text{turn}$

$\therefore \Phi/\text{turn} = \Phi_B/10 = \frac{(3.5\times10^{-3}H)(2A)}{10}$

56. A 10-turn ideal solenoid has an inductance of 3.5 mH. When the solenoid carries a current that is changing at 200 A/s the emf of the solenoid is:

A) 0
B) 0.070 V
[✓ C)] 0.70 V
D) 7.0 V
E) 70 V

$\mathcal{E} \propto \frac{d\Phi_B}{dt} = L\frac{dI}{dt}$

$= (3.5\times10^{-3}H)(200\,A/s) = 0.7V$

57. A long narrow solenoid has length, call it height H, and a total of N turns, each of which has cross-sectional area A. Its inductance is:

A) mu_0 N^2 A H
[✓ B)] mu_0 N^2 A/H
C) mu_0 N A H
D) mu_0 N^2 H/A
E) none of these

$L = \frac{\#\text{turns}\ \Phi/\text{turn}}{I}$

$= N\left(\mu_0 \frac{N}{H}\frac{I}{I}\right)A = \mu_0 N^2 A/H$

58. A flat coil of wire, having 5 turns, has an inductance L. The inductance of a similar coil having 20 turns is:

A) 4L
B) L/4
[✓ C)] 16L
D) L/16
E) L

$$\left.\begin{array}{l} LI \propto (\#\text{turns})\Phi_B/\text{turn} \\ \Phi_B \propto (\#\text{turns})I \end{array}\right\} \therefore L \propto (\#\text{turns})^2$$

63. An 8.0-mH inductor and a 2.0-ohm resistor are wired in series to a 20-V ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. After a long time the current in the resistor and the current in the inductor are:

A) 0, 0
[✓ B)] 10 A, 10 A
C) 2.5 A, 2.5 A
D) 10 A, 2.5 A
E) 10 A, 0

$I_R = V/R = 20V/2\Omega = 10A$

and since in series $I_R = I_L$

64. An 8.0-mH inductor and a 2.0-ohm resistor are wired in series to a 20-V ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. Immediately after the switch is thrown the potential differences across the inductor and resistor are:

A) 0, 20 V
[✓ B)] 20 V, 0
C) 10 V, 10 V
D) 16 V, 4 V
E) unknown since the rate of the current is not given

as $I = \frac{V}{R}(1-e^{-t/\tau}) = 0$ initially

$\therefore V_R = IR = 0 \quad V_L = V - V_R = V$

65. An 8.0-mH inductor and a 2.0-ohm resistor are wired in series to a 20-V ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. A long time after the switch is thrown the potential differences across the inductor and resistor are:

[✓ A)] 0, 20 V
B) 20 V, 0
C) 10 V, 10 V
D) 16 V, 4 V
E) unknown since the rate of change of the current is not given

as $I \rightarrow V/R$ at long time then

$V_R = IR = V \quad V_L = V - V_R = 0$

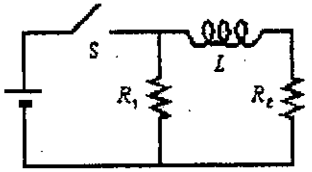
66. If both the resistance and the inductance in an LR series circuit are doubled the new inductive time constant will be:

A) twice the old
B) four times the old
C) half the old
D) one-fourth the old
[✓ E)] unchanged

$\tau = L/R \rightarrow 2L/2R = \tau'$

$\therefore \tau = \tau'$

67. When the switch S in the circuit shown is closed, the time constant for the growth of current in R2 is:

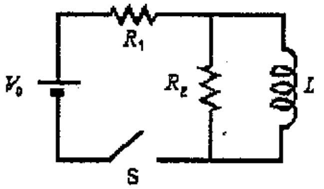


A) L/R1
[✓ B)] L/R2
C) L/(R1 + R2)
D) L x (R1 + R2)/(R1 x R2)
E) (L/R1 + L/R2)/2

Because R_1, and L, R_2 are in parallel with the battery voltage

$\therefore \tau = L/R_2$ (ie no change if R_1 in circuit or not!)

69. Immediately after switch S in the circuit shown is closed, the current through the battery shown is:



A) 0
B) V0/R1
C) V0/R2
[✓ D)] V0/(R1 + R2)
E) V0 x (R1 + R2)/(R1 x R2)

Initially the inductor current is zero. Thus the only current is through R_1 & R_2 (in series)

$\therefore I(0) = V/(R_1+R_2)$

76. An inductance L and a resistance R are connected in series to an ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. The energy stored in the inductor is a maximum:
- A) just after the switch is closed
- B) at the time t = L/R after the switch is closed
- C) at the time t = L/(2R) after the switch is closed
- D) at the time t = 2L/R after the switch is closed
- [✓ E)] a long time after the switch is closed

$PE \equiv U_L = \frac{1}{2} L I^2 \propto I^2$ which is large only at long times.

78. In each of the following operations, energy is expended. The LEAST percentage of returnable electrical energy will be yielded by:
- A) charging a capacitor
- B) charging a storage battery
- [✓ C)] sending current through a resistor
- D) establishing a current through an inductor
- E) moving a conducting rod through a magnetic field

batteries, inductors & capacitors store energy
resistors merely convert electrical power to heat!

79. A current of 10 A in a certain inductor results in a stored energy of 40 J. When the current is changed to 5 A in the opposite direction, the stored energy CHANGES by:
- A) 20 J
- B) 30 J
- C) 40 J
- [✓ D)] 50 J
- E) 60 J

$$\Delta U = \frac{1}{2} L I_i^2 + \frac{1}{2} L I_f^2$$ (add because direction of $I_f \neq$ direction of I_i)

$$= \frac{1}{2} L \left(10A^2 + 5A^2\right) \quad VS \quad U_i = \frac{1}{2} L (10A)^2 \equiv 40J$$

80. A 6.0 mH inductor is in a series circuit with a resistor and an ideal battery. At the instant the current in the circuit is 5.0 A the energy stored in the inductor is:
- A) 0
- [✓ B)] 7.5 x 10^(-2) J
- C) 15 x 10^(-2) J
- D) 30 x 10^(-2) J
- E) unknown since the rate of change of the current is not given

$$U = \frac{1}{2} L I^2 = \frac{(6\times10^{-3} H)}{2} (5A)^2 = 0.075 J$$