10.13: Inductance (Answers)

Check Your Understanding

14.1. $4.77 \times 10^{-2} V$

14.2. a. decreasing;

b. increasing; Since the current flows in the opposite direction of the diagram, in order to get a positive emf on the left-hand side of diagram (a), we need to decrease the current to the left, which creates a reinforced emf where the positive end is on the left-hand side. To get a positive emf on the right-hand side of diagram (b), we need to increase the current to the left, which creates a reinforced emf where the positive end is on the right-hand side.

14.3. 40 A/s

14.4. a. $4.5 \times 10^{-5} H$;

b. $4.5 \times 10^{-3} V$

14.5. a. $2.4 \times 10^{-7} Wb$;

b. $6.4 \times 10^{-5} m^2$

14.6. 0.50 J

14.8. a. 2.2 s;

b. 43 H;

c. 1.0 s

14.10. a. $2.5 \mu F$;

b. $\pi/2 rad$ or $3\pi/2 rad$;

c. 1.4×10^3 rad/s

14.11. a. overdamped;

b. 0.75 J

Conceptual Questions

1. $\frac{Wb}{A} = \frac{T \cdot m^2}{A} = \frac{V \cdot s}{A} = \frac{V}{A/s}$

3. The induced current from the 12-V battery goes through an inductor, generating a large voltage.

5. Self-inductance is proportional to the magnetic flux and inversely proportional to the current. However, since the magnetic flux depends on the current I, these effects cancel out. This means that the self-inductance does not depend on the current. If the emf is induced across an element, it does depend on how the current changes with time.

7. Consider the ends of a wire a part of an **RL** circuit and determine the self-inductance from this circuit.

9. The magnetic field will flare out at the end of the solenoid so there is less flux through the last turn than through the middle of the solenoid.

11. As current flows through the inductor, there is a back current by Lenz's law that is created to keep the net current at zero amps, the initial current.

13. no

15. At $t = 0$, or when the switch is first thrown.

17. 1/4

19. Initially, $I_{R1} = \frac{\varepsilon}{R_1}$ and $I_{R2} = 0$, and after a long time has passed, $I_{R1} = \frac{\varepsilon}{R_1}$ and $I_{R2} = \frac{\varepsilon}{R_2}$.

21. yes

23. The amplitude of energy oscillations depend on the initial energy of the system. The frequency in a **LC** circuit depends on the values of inductance and capacitance.

25. This creates an **RLC** circuit that dissipates energy, causing oscillations to decrease in amplitude slowly or quickly depending on the value of resistance.

27. You would have to pick out a resistance that is small enough so that only one station at a time is picked up, but big enough so that the tuner doesn't have to be set at exactly the correct frequency. The inductance or capacitance would have to be varied to tune into the station however practically speaking, variable capacitors are a lot easier to build in a circuit.

Problems

29. $M = 3.6 \times 10^{-3} H$

31. a. $3.8 \times 10^{-4} H$;

b. $3.8 \times 10^{-4} H$

33. $M_{21} = 2.3 \times 10^{-5} H$

35. 0.24 H

37. 0.4 A/s

39. $\varepsilon = 480\pi sin(120\pi t - \pi/2)V$

41. 0.15 V. This is the same polarity as the emf driving the current.

43. a. 0.089 H/m;

b. 0.44 V/m

45. $\frac{L}{l} = 4.16 \times 10^{-7} H/m$

47. 0.01 A

49. 6.0 g

51.$U_m = 7.0 \times 10^{-7} J$

53. a. 4.0 A;

b. 2.4 A;

c. on R: $V = 12V$; on L: $V = 7.9V$

55. 0.69τ

57. a. 2.52 ms;

b. 99.2Ω

59. a. $I_1 = I_2 = 1.7A$;

b. $I_1 = 2.73A, I_2 = 1.36A$;

c. $I_1 = 0, I_2 = 0.54$;

d. $I_1 = I_2 = 0$

61. proof

63. $\omega = 3.2 \times 10^7 rad/s$

65. a. $7.9 \times 10^{-4} s$;

b. $4.0 \times 10^{-4} s$

67. $q = \frac{qm}{\sqrt{2}}, I = \frac{q_m}{\sqrt{2LC}}$

69. $C=\frac{1}{4\pi^2 f^2 L}$

$f_1=540Hz; C_1=3.5\times 10^{-11}F$

$f_2=;1600Hz; C_2=4.0\times 10^{-12}F$

71. 6.9 ms

Additional Problems

73. proof

Outside, $B=\frac{\mu_0 I}{2\pi r}$ Inside, $B=\frac{\mu_0 Ir}{2\pi a^2}$

$U=\frac{\mu_0 I^2 l}{4\pi}(\frac{1}{4}+ln\frac{R}{a})$

So, $\frac{2U}{I^2}=\frac{\mu_0 l}{P2\pi}(\frac{1}{4}+ln\frac{R}{a})$ and $L=\infty$

75. $M=\frac{\mu_0 l}{\pi}ln\frac{d+a}{d}$

77. a. 100 T;

b. 2 A;

c. 0.50 H

79. a. 0 A;

b. 2.4 A

81. $a. 2.50\times 10^6 V;$

(b) The voltage is so extremely high that arcing would occur and the current would not be reduced so rapidly.

(c) It is not reasonable to shut off such a large current in such a large inductor in such an extremely short time.

Challenge Problems

83. proof

85. a. $\frac{dB}{dt}=6\times 10^{-6}T/s;$

b. $\Phi=\frac{\mu_0 aI}{2\pi}ln(\frac{a+b}{b});$

c. 4.0 nA

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