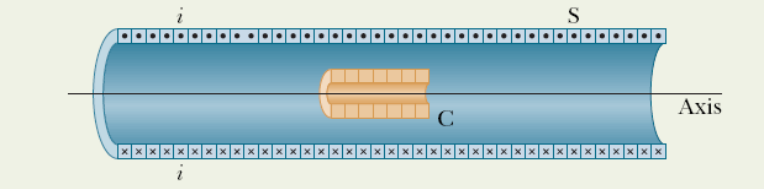
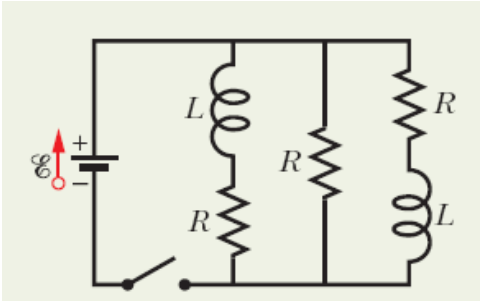
# Chapter 23
# Example Problems

1. The long solenoid S shown in cross section has 220 turns/cm, a diameter of $D$ = 3.2 cm, and carries a current $i$ = 1.5 A. At the center we place a 130-turn closely packed coil $C$ of diameter $d$ = 2.1 cm. The current in the solenoid is reduced to zero at a steady rate in 25 ms. What is the magnitude of the emf that is induced in coil $C$ while the current in the solenoid is changing?




2. A uniform magnetic field is perpendicular to the plane of a circular loop of diameter 10 cm formed from wire of diameter 2.5 mm and resistivity 1.69 x $10^{-8}$ Ω·m. At what rate must the magnitude of **B** change to induce a 10 A current in the loop?

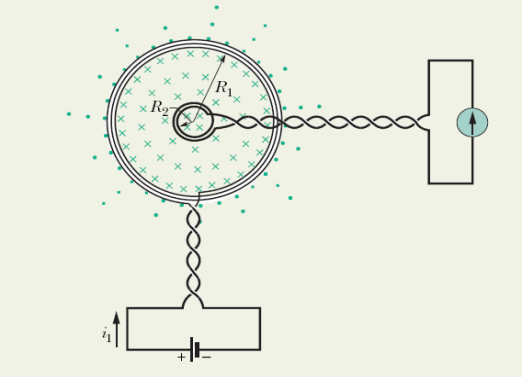
3. The figure shows a circuit that contains three identical resistors with resistance $R$ = 9.0 Ω, two identical inductors with inductance $L$ = 2.0 mH, and an ideal battery with emf of 18 V.



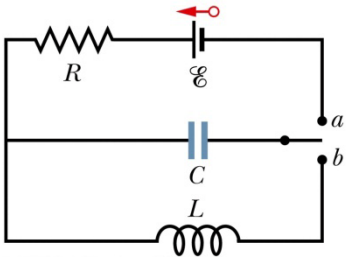

   a. What is the current $i$ through the battery just after the switch is closed?
   b. What is the current $i$ through the battery long after the switch has closed?

4. A coil has an inductance of 53 mH and a resistance of 0.35 Ω. If a 12 V emf is applied across the coil, how much energy is stored in the magnetic field after the current has built up to its equilibrium value?

5. The figure shows two circular close-packed coils, the small being coaxial with the larger and in the same plane. Derive an expression for the mutual inductance M for this arrangement of these two coils, assuming that $R_1 >> R_2$.

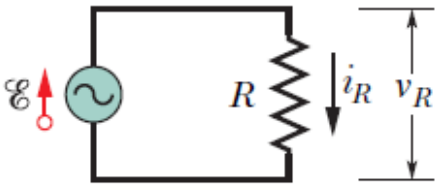



6. In the figure to the right, $C$ = 6.20 μF , $R$ = 14.0 Ω and $L$ = 54.0 mH, and the ideal battery has an emf of 34.0 V. The switch is kept at position a for a long time and thrown to position b.
    a. What is the frequency of the resulting oscillations?
    b. What is the current of the oscillations?



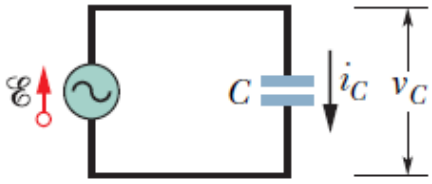
7. A series *RLC* circuit has inductance $L$ = 12 mH, capacitance $C$ = 1.6 μF, and resistance $R$ = 1.5 Ω and begins to oscillate at time $t$= 0.
    a. At what time $t$ will the amplitude of the charge oscillations in the circuit be 50% of its initial value?
    b. How many oscillations are completed with this time?

8. In the circuit below, the resistance $R$ is 200 Ω and the sinusoidal emf device operates at amplitude of 36.0 V and a frequency of 60.0 Hz.

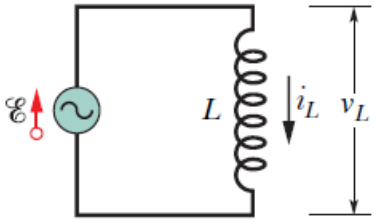



    a. What are the potential difference $v_R(t)$ across the resistor and the amplitude of $V_R$ of $v_R(t)$?
    b. What are the current $i_R(t)$ in the circuit as a function of time and the amplitude of $I_R$ of $i_R(t)$?

9. In the circuit below, the capacitance $C$ is 1.50 μF and the sinusoidal emf device operates at amplitude of 36.0 V and a frequency of 60.0 Hz.
    a. What are the potential difference $v_C(t)$ across the capacitor and the amplitude of $V_C$ of $v_C(t)$?
    b. What are the current $i_C(t)$ in the circuit as a function of time and the amplitude of $I_C$ of $i_C(t)$?




10. The inductance in the circuit below is 230 mH and the sinusoidal alternating emf device operates at amplitude of 36.0 V and a frequency of 60.0 Hz.
    a. What is the potential difference $v_L(t)$ across the inductor and the amplitude of $V_L$ of $v_L(t)$?
    b. What are the current $i_L(t)$ in the circuit as a function of the time and the amplitude of $I_L$ of $i_L(t)$?



11. A series RLC circuit driven with a emf of 120 V at a frequency of 60.0 Hz, contains a resistor with $R$ = 200 Ω, an inductor with inductive reactance of $X_L$ = 80.0 Ω, and a capacitor with capacitive reactance $X_C$ = 150 Ω.
    a. What are the power factor, cos $\Phi$, and the phase constant, $\Phi$, of the circuit?
    b. What is the average rate at which energy is dissipated in the resistance?

12. A transformer has 500 primary turns and 10 secondary turns.
    a. If $V_p$ = 120 V (rms), what is $V_s$ with an open circuit?
    b. If the secondary now has a resistive load of 15 Ω, what is the current in the primary and secondary coils?