

Advanced Problems in Electromagnetic Induction

sec. 30-4 Lenz's Law

•1 A small loop of area  $6.8 \text{ mm}^2$  is placed inside a long solenoid that has 854 turns/cm and carries a sinusoidally varying current  $i$  of amplitude 1.28 A and angular frequency 212 rad/s. The central axes of the loop and solenoid coincide. What is the amplitude of the emf induced in the loop?

•2 In Fig. 30-35, the magnetic flux through the loop increases according to the relation  $\Phi_B = 6.0t^2 + 7.0t$ , where  $\Phi_B$  is in millivebers and  $t$  is in seconds. (a) What is the magnitude of the emf induced in the loop when  $t = 2.0 \text{ s}$ ? (b) Is the direction of the current through  $R$  to the right or left?

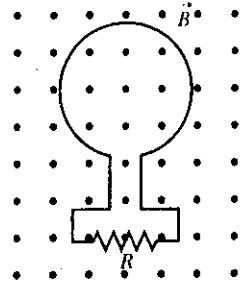


Fig. 30-35 Problem 2.

•3 A wire loop of radius 12 cm and resistance  $8.5 \Omega$  is located in a uniform magnetic field  $\vec{B}$  that changes in magnitude as given in Fig. 30-36. The loop's plane is perpendicular to  $\vec{B}$ . What emf is induced in the loop during time intervals

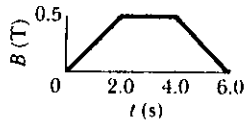


Fig. 30-36 Problem 3.

(a) 0 to 2.0 s, (b) 2.0 s to 4.0 s, and (c) 4.0 to 6.0 s?

•4 A uniform magnetic field  $\vec{B}$  is perpendicular to the plane of a circular loop of diameter 10 cm formed from wire of diameter 2.5 mm and resistivity  $1.69 \times 10^{-8} \Omega \cdot \text{m}$ . At what rate must the magnitude of  $\vec{B}$  change to induce a 10 A current in the loop?

•6 An elastic conducting material is stretched into a circular loop of 12.0 cm radius. It is placed with its plane perpendicular to a uniform 0.800 T magnetic field. When released, the radius of the loop starts to shrink at an instantaneous rate of 75.0 cm/s. What emf is induced in the loop at that instant?

••16 In Fig. 30-45, a wire loop of dimensions  $L = 40.0 \text{ cm}$  and  $W = 25.0 \text{ cm}$  lies in a magnetic field  $\vec{B}$ . What are the (a) magnitude  $\mathcal{E}$  and (b) direction (clockwise or counterclockwise—or "none" if  $\mathcal{E} = 0$ ) of the emf induced in the loop if  $\vec{B} = (4.00 \times 10^{-2} \text{ T/m})y\hat{k}$ ? What are (c)  $\mathcal{E}$  and (d) the direction if  $\vec{B} = (6.00 \times 10^{-2} \text{ T/s})t\hat{k}$ ? What are (e)  $\mathcal{E}$  and (f) the direction if  $\vec{B} = (8.00 \times 10^{-2} \text{ T/m} \cdot \text{s})y\hat{k}$ ? What are (g)  $\mathcal{E}$  and (h) the direction if  $\vec{B} = (3.00 \times 10^{-2} \text{ T/m} \cdot \text{s})x\hat{j}$ ? What are (i)  $\mathcal{E}$  and (j) the direction if  $\vec{B} = (5.00 \times 10^{-2} \text{ T/m} \cdot \text{s})y\hat{i}$ ?

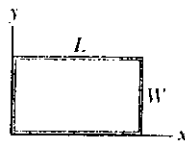


Fig. 30-45 Problem 16.

•••23 As seen in Fig. 30-49, a square loop of wire has sides of length 2.0 cm. A magnetic field is directed out of the page; its magnitude is given by  $B = 4.0t^2y$ , where  $B$  is in teslas,  $t$  is in seconds, and  $y$  is in meters. At  $t = 2.5 \text{ s}$ , what are the (a) magnitude and (b) direction of the emf induced in the loop?

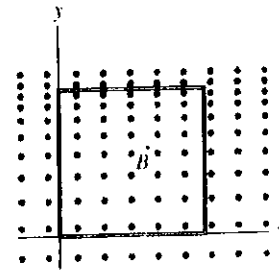


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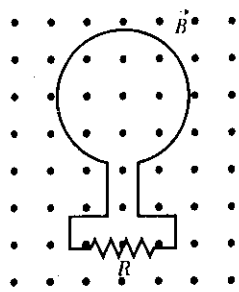


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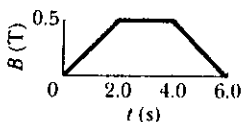


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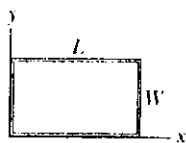


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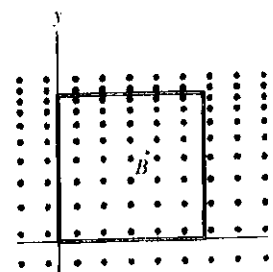


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