•1 A small loop of area 6.8 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?

$$|\mathcal{E}| = \frac{d\phi}{dt} = A\frac{dB}{dt}$$

$$B = \mu_0 n I = \mu_0 n I_0 \sin\omega t$$

$$\frac{dB}{dt} = \mu_0 n \omega I_0 \cos\omega t$$

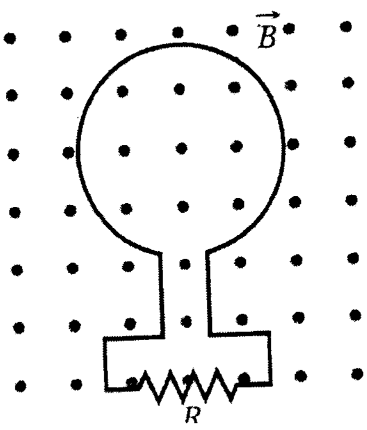
$$|\mathcal{E}| = \underbrace{A\mu_0 n \omega I_0}_{\text{amplitude}} \cos\omega t = \mathcal{E}_0 \cos\omega t$$

$$\text{amplitude} = A\mu_0 n\omega I_0$$

$$= (6.8\times10^{-6})(4\pi\times10^{-7})\left(\frac{854}{0.01}\right) \times (1.28)(212)$$

$$|\mathcal{E}| = 1.98\times10^{-4}\ V$$

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



a) $\phi_B = (6t^2 + 7t) \times 10^{-3}$ Weber.

$|\mathcal{E}| = \frac{d\phi}{dt} = (12t + 7) \times 10^{-3}$ Volt.

$t = 2s$

$|\mathcal{E}| = (24 + 7) \times 10^{-3} = 31 \times 10^{-3}$ V

b) ϕ increases with time
⇒ induced $\vec{B}$ should be inside the page ⇒ I induced to the left (clockwise).

•3 A wire loop of radius 12 cm and resistance 8.5 Ω 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 (a) 0 to 2.0 s, (b) 2.0 s to 4.0 s, and (c) 4.0 to 6.0 s?

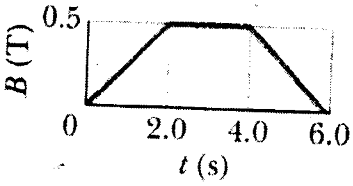


Fig. 30-36 Problem 3.

$$\phi = BA\cos\theta = BA$$

$$\mathcal{E} = -\frac{d\phi}{dt} = -A\frac{dB}{dt}$$

a) $t = 0 \rightarrow 2s$

$$\frac{dB}{dt} = \frac{0.5}{2} = 0.25 \ T/s$$

$$\mathcal{E} = -\pi r^2 \times 0.25 = -\pi (0.12)^2 \times 0.25$$

$$= \boxed{-1.1 \times 10^{-2} V.}$$

b) $t = 2s \rightarrow 4s$

$$\frac{dB}{dt} = 0 \Rightarrow \boxed{\mathcal{E} = 0}$$

c) $t = 4s \rightarrow 6s$

$$\frac{dB}{dt} = -0.25 \ T/s$$

$$\boxed{\mathcal{E} = 1.1 \times 10^{-2} V.}$$

(•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 $1.69 \times 10^{-8}\ \Omega \cdot m$. At what rate must the magnitude of $\vec{B}$ change to induce a 10 A current in the loop?

$$\phi = B A$$

$$\mathcal{E} = -\frac{d\phi}{dt} = -A \frac{dB}{dt}$$

rate of change of $\vec{B}$.

$$|\mathcal{E}| = I R = A \frac{dB}{dt}$$

$$\Rightarrow \frac{dB}{dt} = \frac{IR}{A}$$

$$R = \rho \frac{L}{A} = \frac{1.69 \times 10^{-8} \times (2\pi \times 0.05)}{\pi \times (1.25 \times 10^{-3})^2}$$

$$= 1.1 \times 10^{-3}\ \Omega.$$

$$\frac{dB}{dt} = \frac{10 \times 1.1 \times 10^{-3}}{\pi (0.05)^2} = \boxed{1.4\ T/s.}$$

••20 A rectangular loop (area = 0.15 m^2) turns in a uniform magnetic field, B = 0.20 T. When the angle between the field and the normal to the plane of the loop is $\pi/2$ rad and increasing at 0.60 rad/s, what emf is induced in the loop?

$$\phi = BA\cos\theta$$

$$\mathcal{E} = -\frac{d\phi}{dt} = -BA\frac{d\cos\theta}{dt}$$

$$\mathcal{E} = BA\sin\theta\,\frac{d\theta}{dt}$$

$$\mathcal{E} = (0.2)(0.15)\left(\sin\frac{\pi}{2}\right)(0.6)$$

$$\mathcal{E} = 0.018\ \text{V}$$