



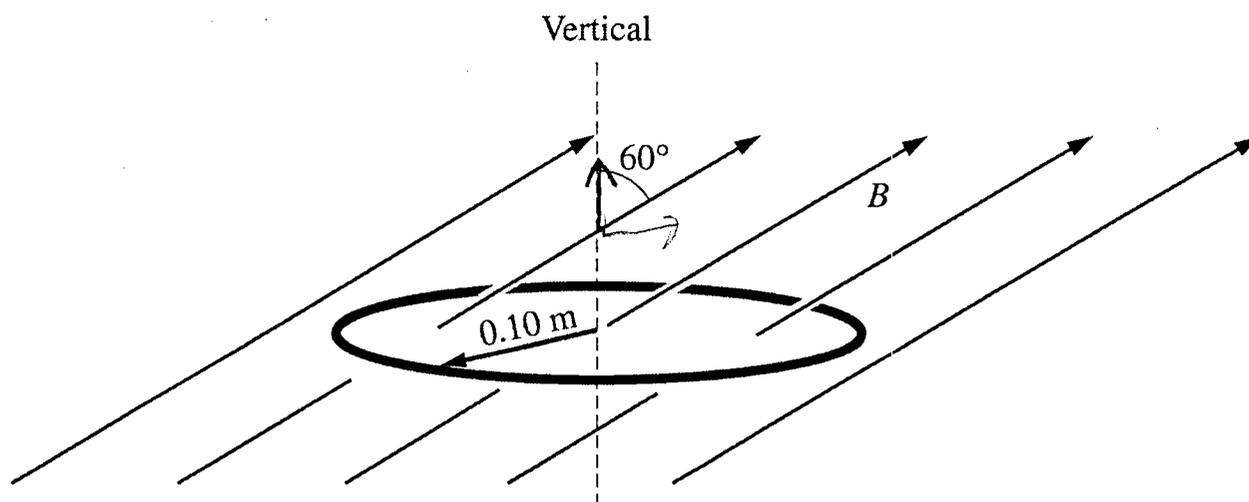
AP[®] Physics C: Electricity & Magnetism 2002 Sample Student Responses

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E&M 3.

A circular wire loop with radius 0.10 m and resistance 50Ω is suspended horizontally in a magnetic field of magnitude B directed upward at an angle of 60° with the vertical, as shown above. The magnitude of the field in teslas is given as a function of time t in seconds by the equation $B = 4(1 - 0.2t)$.

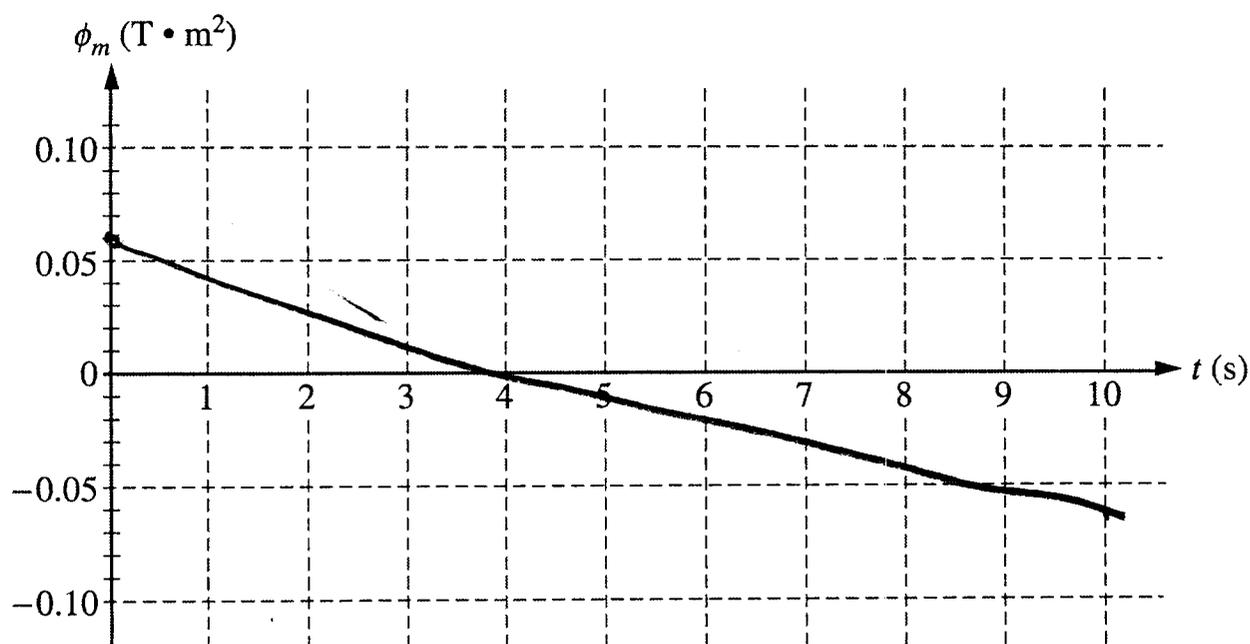
(a) Determine the magnetic flux ϕ_m through the loop as a function of time.

$$\phi = \int B \cdot da = \int B da \cos 60 = \frac{1}{2} \int B \cdot da = \frac{1}{2} BA = \frac{1}{2} B \pi r^2$$

$$\phi = (4(1 - 0.2t)) \cdot 0.0157$$

$$= 0.0628(1 - 0.2t)$$

(b) Graph the magnetic flux ϕ_m as a function of time on the axes below.



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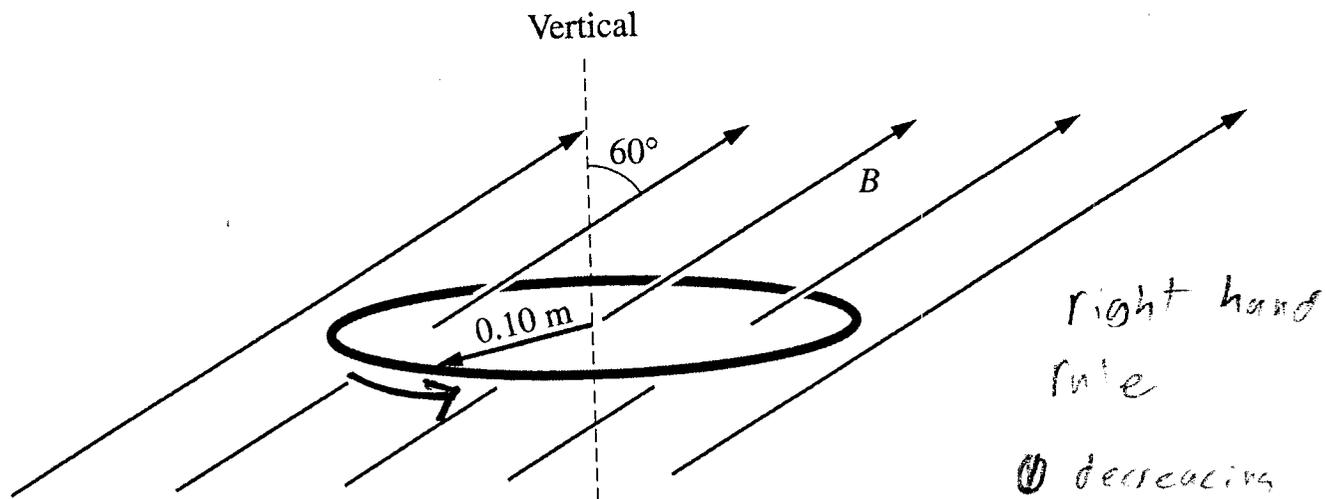
(c) Determine the magnitude of the induced emf in the loop.

$$\begin{aligned} \mathcal{E} &= \frac{d\Phi}{dt} = \frac{d(0.0628(1-2t))}{dt} \\ &= 0.0628 \cdot 2 = 0.1256 \end{aligned}$$

(d) i. Determine the magnitude of the induced current in the loop.

$$\frac{V}{R} = IR = \frac{0.1256}{50} = 2.5 \times 10^{-4}$$

ii. Show the direction of the induced current on the following diagram.



(e) Determine the energy dissipated in the loop from $t = 0$ to $t = 4$ s.

$$\begin{aligned} P &= IV \\ &= 0.1256 \cdot 2.5 \times 10^{-4} = 3.16 \times 10^{-5} \end{aligned}$$

$P \cdot t = \text{Energy dissipated} = 1.26 \times 10^{-5}$

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