SAMPLE PROBLEM A

Induced emf and Current

PROBLEM

A coil with 25 turns of wire is wrapped around a hollow tube with an area of 1.8 m^2. Each turn has the same area as the tube. A uniform magnetic field is applied at a right angle to the plane of the coil. If the field increases uniformly from 0.00 T to 0.55 T in 0.85 s, find the magnitude of the induced emf in the coil. If the resistance in the coil is 2.5 Ω, find the magnitude of the induced current in the coil.

SOLUTION

1. DEFINE

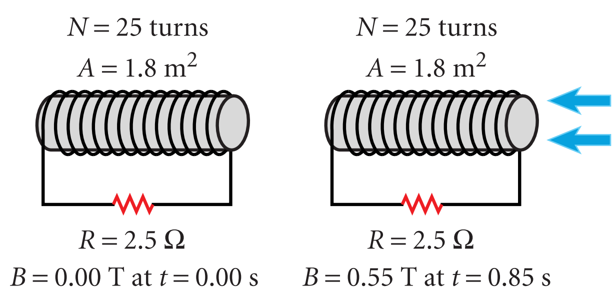
Given: $\Delta t = 0.85$ s $\quad A = 1.8$ m^2 $\quad \theta = 0.0°$ $\quad N = 25$ turns

$B_i = 0.00$ T $= 0.00$ V•s/m^2 $\quad B_f = 0.55$ T $= 0.55$ V•s/m^2

$R = 2.5\ \Omega$

Unknown: emf = ? $\quad I = ?$

Diagram: Show the coil before and after the change in the magnetic field.



2. PLAN

Choose an equation or situation: Use Faraday's law of magnetic induction to find the induced emf in the coil.

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta[AB\cos\theta]}{\Delta t}$$

Substitute the induced emf into the definition of resistance to determine the induced current in the coil.

$$I = \frac{\text{emf}}{R}$$

Rearrange the equation to isolate the unknown: In this example, only the magnetic field strength changes with time. The other components (the coil area and the angle between the magnetic field and the coil) remain constant.

$$\text{emf} = -NA\cos\theta\frac{\Delta B}{\Delta t}$$

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