

6.9 A circular-loop TV antenna with 0.04 m^2 area is in the presence of a uniform-amplitude 300 MHz signal. When oriented for maximum response, the loop develops an emf with a peak value of 30 (mV). What is the peak magnitude of \mathbf{B} of the incident wave?

Solution: TV loop antennas have one turn. At maximum orientation, Eq. (6.5) evaluates to $\Phi = \int \vec{B} \cdot d\vec{s} = \pm BA$ for a loop of area A and a uniform magnetic field with magnitude $B = |\mathbf{B}|$. Since we know the frequency of the field is $f = 300 \text{ MHz}$, we can express B as $B = B_0 \cos(\omega t + \alpha_0)$ with $\omega = 2\pi \times 300 \times 10^6 \text{ rad/s}$ and α_0 an arbitrary reference phase. From Eq. (6.6),

$$V_{\text{emf}} = -N \frac{d\Phi}{dt} = -A \frac{d}{dt} [B_0 \cos(\omega t + \alpha_0)] = AB_0 \omega \sin(\omega t + \alpha_0).$$

V_{emf} is maximum when $\sin(\omega t + \alpha_0) = 1$. Hence,

$$30 \times 10^{-3} = AB_0 \omega = 0.04 \times B_0 \times 6\pi \times 10^8,$$

which yields $B_0 = 0.4 \text{ (nA/m)}$.
