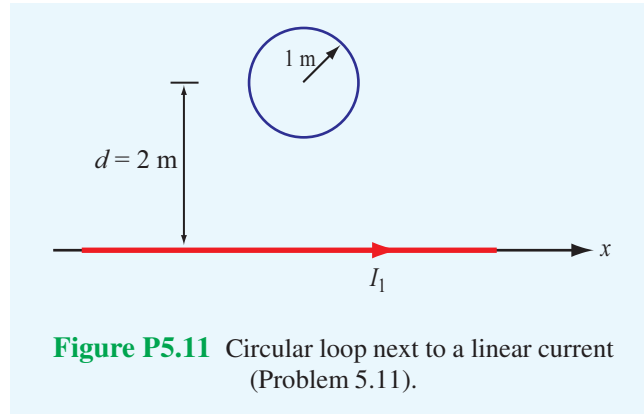


5.11 An infinitely long wire carrying a 25-A current in the positive x -direction is placed along the x -axis in the vicinity of a 20-turn circular loop located in the x - y plane (Fig. P5.11). If the magnetic field at the center of the loop is zero, what is the direction and magnitude of the current flowing in the loop?



Solution: From Eq. (5.30), the magnetic flux density at the center of the loop due to



Figure P5.11 (b) Direction of I_2 .

the wire is

$$\mathbf{B}_1 = \hat{\mathbf{z}} \frac{\mu_0}{2\pi d} I_1$$

where $\hat{\mathbf{z}}$ is out of the page. Since the net field is zero at the center of the loop, I_2 must be clockwise, as seen from above, in order to oppose I_1 . The field due to I_2 is, from Eq. (5.35),

$$\mathbf{B} = \mu_0 \mathbf{H} = -\hat{\mathbf{z}} \frac{\mu_0 N I_2}{2a}.$$

Equating the magnitudes of the two fields, we obtain the result

$$\frac{N I_2}{2a} = \frac{I_1}{2\pi d},$$

or

$$I_2 = \frac{2a I_1}{2\pi N d} = \frac{1 \times 25}{\pi \times 20 \times 2} = 0.2 \text{ A}.$$