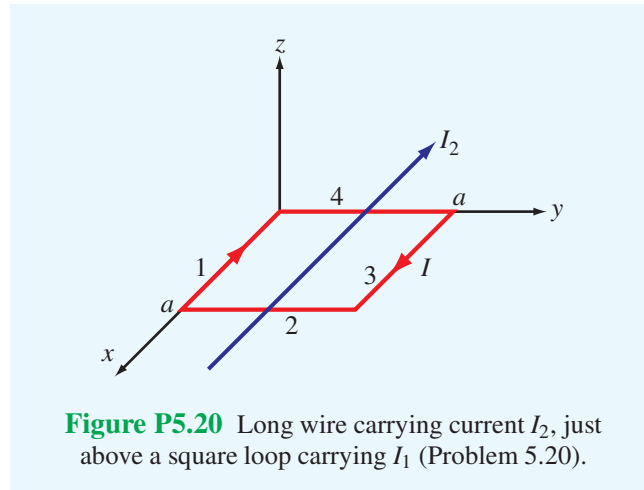


**5.20** A square loop placed as shown in Fig. P5.20 has 2-m sides and carries a current  $I_1 = 5$  A. If a straight, long conductor carrying a current  $I_2 = 20$  A is introduced and placed just above the midpoints of two of the loop's sides, determine the net force acting on the loop.



**Figure P5.20** Long wire carrying current  $I_2$ , just above a square loop carrying  $I_1$  (Problem 5.20).

**Solution:** Since  $I_2$  is just barely above the loop, we can treat it as if it's in the same plane as the loop. For side 1,  $I_1$  and  $I_2$  are in the same direction, hence the force on side 1 is attractive. That is,

$$\mathbf{F}_1 = \hat{\mathbf{y}} \frac{\mu_0 I_1 I_2 a}{2\pi(a/2)} = \hat{\mathbf{y}} \frac{4\pi \times 10^{-7} \times 5 \times 20 \times 2}{2\pi \times 1} = \hat{\mathbf{y}} 4 \times 10^{-5} \text{ N}.$$

$I_1$  and  $I_2$  are in opposite directions for side 3. Hence, the force on side 3 is repulsive, which means it is also along  $\hat{\mathbf{y}}$ . That is,  $\mathbf{F}_3 = \mathbf{F}_1$ .

The net forces on sides 2 and 4 are zero. Total net force on the loop is

$$\mathbf{F} = 2\mathbf{F}_1 = \hat{\mathbf{y}} 8 \times 10^{-5} \text{ N}.$$