40. We establish coordinates such that the two sides of the right triangle meet at the origin, and the $\ell_y = 50$ cm side runs along the $+y$ axis, while the $\ell_x = 120$ cm side runs along the $+x$ axis. The angle made by the hypotenuse (of length 130 cm) is $\theta = \tan^{-1}(50/120) = 22.6°$, relative to the 120 cm side. If one measures the angle counterclockwise from the $+x$ direction, then the angle for the hypotenuse is $180° - 22.6° = +157°$. Since we are only asked to find the magnitudes of the forces, we have the freedom to assume the current is flowing, say, counterclockwise in the triangular loop (as viewed by an observer on the $+z$ axis. We take $\vec{B}$ to be in the same direction as that of the current flow in the hypotenuse. Then, with $B = |\vec{B}| = 0.0750$ T,

$$B_x = -B\cos\theta = -0.0692 \text{ T} \qquad \text{and} \qquad B_y = B\sin\theta = 0.0288 \text{ T} .$$

(a) Eq. 29-26 produces zero force when $\vec{L} \parallel \vec{B}$ so there is no force exerted on the hypotenuse. On the 50 cm side, the B_x component produces a force $i\ell_y B_x \hat{\text{k}}$, and there is no contribution from the B_y component. Using SI units, the magnitude of the force on the ℓ_y side is therefore

$$(4.00 \text{ A})(0.500 \text{ m})(0.0692 \text{ T}) = 0.138 \text{ N} .$$

On the 120 cm side, the B_y component produces a force $i\ell_x B_y \hat{\text{k}}$, and there is no contribution from the B_x component. Using SI units, the magnitude of the force on the ℓ_x side is also

$$(4.00 \text{ A})(1.20 \text{ m})(0.0288 \text{ T}) = 0.138 \text{ N} .$$

(b) The net force is

$$i\ell_y B_x \hat{\text{k}} + i\ell_x B_y \hat{\text{k}} = 0 ,$$

keeping in mind that $B_x < 0$ due to our initial assumptions. If we had instead assumed $\vec{B}$ went the opposite direction of the current flow in the hypotenuse, then $B_x > 0$ but $B_y < 0$ and a zero net force would still be the result.