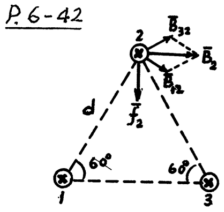
[Cheng 6-42] Calculate the force per unit length on each of three equidistant, infinitely long, parallel wires 0.15 (m) apart, each carrying a current of 25 (A) in the same direction. Specify the direction of the force.

Solution: The three wires are shown in the diagram below.



The three currents in the wires are equal $I_1 = I_2 = I_3 = 25\,(\text{A})$, while the distance between them is $d = 0.15\,(\text{m})$.

The magnetic flux density at wire 2 is

$$\begin{aligned}\mathbf{B}_2 &= \mathbf{a}_x 2B_{12}\cos 30^\circ \\ &= \mathbf{a}_x \frac{\sqrt{3}\mu_0 I}{2\pi d}.\end{aligned}$$

Force per unit length on wire 2 is

$$\begin{aligned}\mathbf{f}_2 &= -\mathbf{a}_y I B_2 \\ &= -\mathbf{a}_y \frac{\sqrt{3}\mu_0 I^2}{2\pi d} \\ &= -\mathbf{a}_y 1150\mu_0 \\ &= -\mathbf{a}_y 1.44\times 10^{-3}\,(\text{N/m}).\end{aligned}$$

The forces on all three wires are equal in magnitude and all point towards the center of the triangle.

Answer: The force on one of the wires is

$$\mathbf{F} = -a_y 1.44 \times 10^{-3}\,(\text{N/m}).$$

The forces on all three wires are equal in magnitude and all point towards the center of the triangle.