The wires have a mass/unit length of 0.0125 kg/m.

What is current in each wire if cable hanging at an angle of 60° with the vertical?

Back to section 28.4 and your statics course.

The wires are in equilibrium. Make a force diagram:

\[
\begin{align*}
F_x &= T_x = T \cos \theta \\
F_y &= T_y = T \sin \theta \\
F_B &= ILB \quad (p.1075)
\end{align*}
\]

Balance the x forces:

\[
F_B = T_x = ILB = T \sin \theta
\]

Balance the y forces:

\[
mg = T \cos \theta
\]

From y forces we get

\[
T = \frac{mg}{\cos \theta}
\]

So putting into x gets us:

\[
ILB = \left( \frac{mg}{\cos \theta} \right) \sin \theta = mg \tan \theta
\]
or solving for our unknown I:

\[ I = \frac{mg}{lB} \]

\[ \text{Note the m is the given mass per unit length value!} \]

we have

\[ I = \left( \frac{m}{l} \right) \frac{g}{B} \]

what is B? Well from Ampere's law or in problem from above we get

\[ B \cdot d\ell = M_0 I \]

\[ B = \frac{M_0 I}{2\pi r} \]

so

\[ I = \left( \frac{m}{l} \right) \frac{g}{B} \tan \theta = \frac{2\pi r (m/l) \tan \theta}{M_0 I} \]

\[ I^2 = \frac{2\pi r (m/l) \tan \theta}{M_0} \]

\[ I = \sqrt{\frac{2\pi r (m/l) \tan \theta}{M_0}} \]

Now we plug in given:

\[ 8.36 \times 10^{-3} \text{ m} \quad \text{(from below)} \]

\[ I = \frac{2\pi r (0.0125 \text{ kg/s}) (9.80 \text{ m/s}^2) \tan (6.00^\circ)}{(4\pi r \times 10^{-7} \mu \text{s}^2/\text{A}^2)} \]

\[ \frac{1.0764 \times 10^{-4}}{2 \times 10^{-7}} \text{ A}^2 \approx 5.38 \times 10^{-5} \text{ A}^2 \]

\[ (4\text{m})(\sin 60^\circ) = 4.00 \text{ cm} \]

\[ r = 2 \times (4\text{m})(\sin 60^\circ) = 8.36 \times 10^{-3} \text{ m} \]

\[ I = 23.2 \text{ A} \]