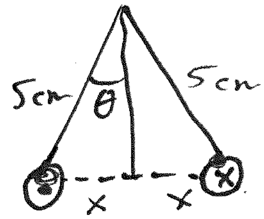
Ch. 12 Prob. 32

$$\frac{\text{mass}}{\text{length}} = 30\,g/m = \frac{m}{L}$$

$$\theta = 6.0^\circ$$



Given the angle + length we ~~can~~ can find the distance between the wires.

$$\sin\theta = \frac{x}{h} \rightarrow x = h\sin\theta = (5\,cm)\sin 6.0^\circ$$

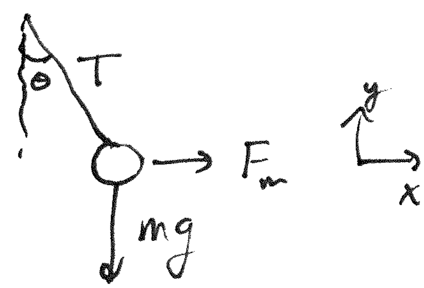
$$x = 0.523\,cm$$

Distance is $r = 2x = 2(0.523\,cm) = 1.046\,cm$

$$= 1.046 \times 10^{-2}\,m$$

$$\frac{F_m}{l} = \frac{\mu_0 I_1 \cdot I_2}{2\pi r} \xrightarrow{I_1 = I_2 = I} \frac{F}{l} = \frac{\mu_0 I^2}{2\pi r}$$

Make a free-body diagram on one of the wires



$$\vec{T} = -T\sin\theta\,\hat{i} + T\cos\theta\,\hat{j}$$

$$\vec{F}_m = F_m\,\hat{i}$$

$$\vec{W} = -mg\,\hat{j}$$

$$\Sigma \vec{F} = 0 \rightarrow -T\sin\theta\,\hat{i} + T\cos\theta\,\hat{j} + F_m\,\hat{i} - mg\,\hat{j} = 0$$

$$\div L \rightarrow -\frac{T}{L}\sin\theta\,\hat{i} + \frac{T}{L}\cos\theta\,\hat{j} + \frac{F_m}{L}\hat{i} - \frac{mg}{L}\hat{j} = 0$$

x-dir| $-\frac{T}{L}\sin\theta + \frac{F_m}{L} = 0 \rightarrow \frac{T}{L} = \frac{F_m}{L\sin\theta}$

y-dir| $\frac{T}{L}\cos\theta - \frac{mg}{L} = 0$

$$\rightarrow \frac{F_m}{L\sin\theta}\cos\theta = \frac{mg}{L}$$

But $\frac{F_m}{L} = \frac{\mu_0 I^2}{2\pi r} \longrightarrow \frac{\mu_0 I^2}{2\pi r\tan\theta} = \frac{mg}{L}$

~~$I^2 = (30\times10^{-3}\,kg/m)$~~ $\Rightarrow I^2 = \left(\frac{m}{L}\right)\frac{g\,2\pi r\tan\theta}{\mu_0}$

Ch. 12 Prob 32

$$I^2 = \left(\frac{m}{l}\right) g \frac{2\pi r \tan\theta}{\mu_0}$$

$$I = \sqrt{\left(\frac{m}{l}\right) g \frac{2\pi r \tan\theta}{\mu_0}} = \sqrt{\left(30\times10^{-3}\frac{kg}{m}\right)\left(9.80\frac{m}{s^2}\right)\frac{2\pi\left(1.046\times10^{-2}\,m\right)\tan(6.0^\circ)}{\left(4\pi\times10^{-7}\,\frac{T\cdot m}{A}\right)}}$$

$$I = \sqrt{1616\,A^2} = \boxed{40.2A}$$