Phys102 Assignment Cover Sheet

First Name:_____ Last Name:_____ Mark: _____

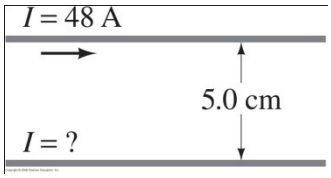
Student ID:_____ Date: _____ Section: _____

Phys102 Written Assignment #6

Due Wed/Thur Nov 3/4, by the end of your tutorial.

Textbook (Giancoli, SFU edition), page756, question #58.

58. A long horizontal wire carries a current of 48 A. A second wire, made of 1.00-mm-diameter copper wire and parallel to the first, is kept in suspension magnetically 5.0 cm below (Fig. 28–57). (*a*) Determine the magnitude and direction of the current in the lower wire. (*b*) Is the lower wire in stable equilibrium? (*c*) Repeat parts (*a*) and (*b*) if the second wire is suspended 5.0 cm *above* the first due to the first's magnetic field.



[Solution]

(*a*) We set the magnetic force, using Eq. 28-2, equal to the weight of the wire and solve for the necessary current. The current must flow in the same direction as the upper current, for the magnetic force to be upward.

$$F_M = \frac{\mu_0 I_1 I_2}{2\pi r} 1 = \rho g \left(\frac{\pi d^2}{4} \ell \right)$$

$$I_2 = \frac{\rho g \pi^2 r d^2}{4\mu_0 I_1} = \frac{\left(8900\,\text{kg/m}^3\right)\left(9.80\,\text{m/s}^2\right)\pi^2\left(0.050\,\text{m}\right)\left(1.00\times10^{-3}\,\text{m}\right)^2}{2\left(4\pi\times10^{-7}\,\text{T}\,\square\,\square\,\square.0\,\text{A}\right)} = \boxed{360\,\text{A, right}}$$

(*b*) The lower wire is in unstable equilibrium, since if it is raised slightly from equilibrium, the magnetic force would be increased, causing the wire to move further from equilibrium.

(*c*) If the wire is suspended above the first wire at the same distance, the same current is needed, but in the opposite direction, as the wire must be repelled from the lower wire to remain in equilibrium. Therefore the current must be 360 A to the left. This is a stable equilibrium for vertical displacement since if the wire is moved slightly off the equilibrium point the magnetic force will increase or decrease to push the wire back to the equilibrium height.