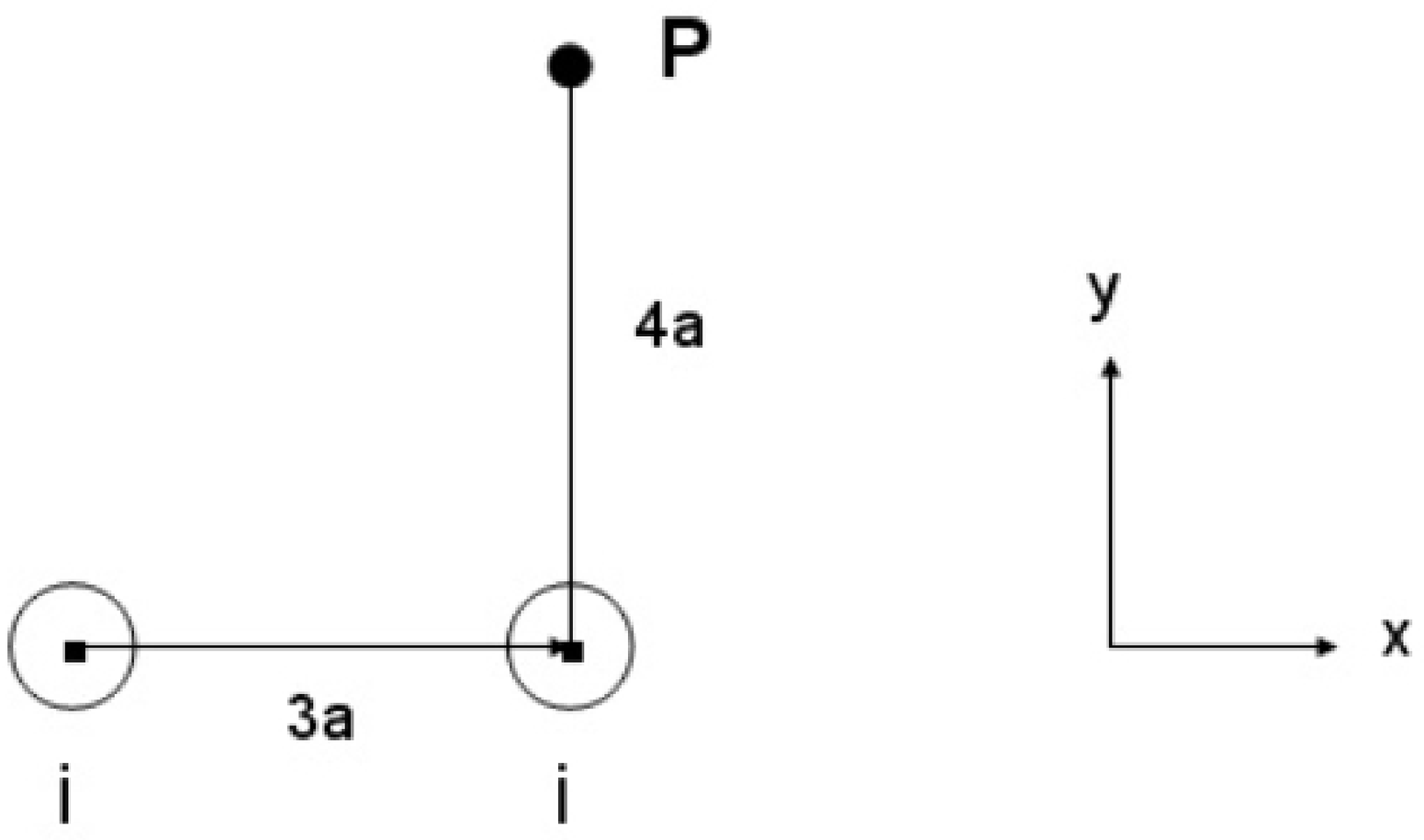
Homework VI - PHY2061

1.) **In class we considered a problem (B field from two wires in some 'symmetric geometrical arrangement') like sample problem 33-3. Consider instead the arrangement below, where two long wires carring currents (both equal to 'i') are coming out of the diagram, with the x-y plane in the diagram. What is B_x, the total field in the x-direction, at point P from the B-field contributions from both wires taken together, i. e. $B_x=B_{x1}+B_{x2}$? Please include the sign of B_x. (The two currents both go thru the x-axis, a distance of 3 a apart, while point P is in the y-direction above the right wire a distance of 4 a.)**



2. **Suppose there is an ideal solenoid, with 1000 turns/cm (beware units.)**
How many amperes of current must flow in this ideal solenoid to create a field of 1 T in the center of the solenoid?

3. **Using the current from problem 3 above, we want to calculate the Joule heating ($=i^2R$) in the coil from the energy loss of the current flowing through the resistance of the wire. To do this, knowing the resistivity ρ of copper wire is 1.69 10^{-8} Ωm from chapter 29, you need to find the total resistance R of the wire from R=ρL/A, where A is the cross sectional area of the wire (πr^2 or $\pi d^2/4$) and L is the total length of the wire.**
a. Assume a 10 cm long coil with a 1 cm inner diameter (close to an "ideal" solenoid), i. e. a total of 1000 turns/cm * 10 cm = 10,000 turns of wire. Assume 40 gauge wire, diameter d= 0.08 mm (beware units), so there are 125 (=1 cm/0.08mm)

turns in one layer per cm, so to get 1000 turns/cm you have to have 8 layers of wire. If the solenoid on which the wire is wrapped is 1 cm diameter, 8 layers of 0.08 mm diameter wire make the outer diameter of the 8 layers of wire wrapped around the solenoid about 1.064 cm. Assume therefore an average wire coil diameter of 1.032 cm, so *each* turn has a length of 2□r or □d=3.24 cm (beware units.) On the entire solenoid, there are 10,000 turns.
Calculate the total length L of the wire wrapped around the solenoid.

b.) calculate the total R of the wire in the solenoid.

c.) what is the Joule heating? (If you've kept track of your powers of 10, you should get units of kilowatts. This is why you don't generate a 1 T field from copper wire!)

4. In the text, and in class on Thursday, there is a discussion of the magnetic field inside a wire using Ampere's law with the assumption that "a uniform distribution" of the current in the wire gives the fraction of the current inside a radius 'r', where the diameter of the wire is R and r<R, as being □r^2/□R^2. Suppose instead that the current is distributed in a wire such that the current inside a radius 'r' is proportional to r/R. Calculate the field inside the wire as a function of 'r' and draw a graph of your result.