Homework set 5

1. Some superconductors are characterized by the statement that $\mathbf{B} = 0$ within the superconductor. Let such a material occupy the region of space z < 0. A thin, long, straight wire carrying current I is oriented parallel to this surface, at a distance a from the surface, i.e. it occupies the line z = a, y = 0.



- Find **B** everywhere. Hint: An image method is appropriate for this problem
- Find the force per unit length on the wire. (This calculation shows how a magnet can be suspended above a superconductor, or conversely, by magnetic forces.
- Find the surface current density on the superconductor.

2 An infinitely long hollow iron cylinder of permeability μ , and cross section defined by concentric circles of radii a, b (a < b) is placed in a uniform magnetic field directed perpendicular to the axis of the cylinder. Show that the flux of magnetic induction B through the cylinder is changed by inserting the cylinder in the field, by the ratio

$$\frac{b^2(\mu+1)^2 - a^2(\mu-1)^2}{2\mu \left(b^2(\mu+1) - a^2(\mu-1)\right)}$$



- **3.** Jackson problem 5.3.
- 4. Jackson problem 5.7.