NYU Physics 2 — Problem Set 7

Due by Friday 2002 March 22 at 1pm at Irene Port’s office in Meyer 424.

Problem 1
When a telegraph cable was first laid across the Atlantic Ocean, the telegraph signal current traveled one way through the telegraph cable and returned through the Atlantic Ocean. Make an estimate of the total resistance $R$ of the return path through the ocean using the resistivity of sea water ($\rho = 0.2 \ \Omega \ m$) and some assumptions about the geometry of the Atlantic ocean. Give your answer in $\Omega$. If the telegraph cable itself was a single strand of copper ($\rho = 2 \times 10^{-8} \ \Omega \ m$) wire, and the engineers wanted it to contribute only half of the total resistance of the full circuit, what diameter would they have to have made the wire? Your answers to these questions need not be precise, but state any assumptions or approximations you make.

Problem 2
A reasonable model of a real battery is that it behaves like a perfect source of voltage $E$ but with some internal resistance $R_{int}$, connected in series. A resistor $R$ connected across this “real” battery will dissipate power $P$. What is the power dissipation as a function of applied resistance $R$, and at what resistance $R = R_{max}$ is that power dissipation maximized? Show all your work.

Problem 3
Sketch the magnetic field $\vec{B}$ lines for a small bar magnet, with the $N$ pole at one end and the $S$ pole at the other. Be sure to mark the directions of the field lines. The field of the bar magnet is maintained by (essentially) permanent coherent currents running in the metal. Draw on your diagram typical paths of the flowing current. Be sure to indicate which direction those currents travel (defining current to be the flow of positive charge).