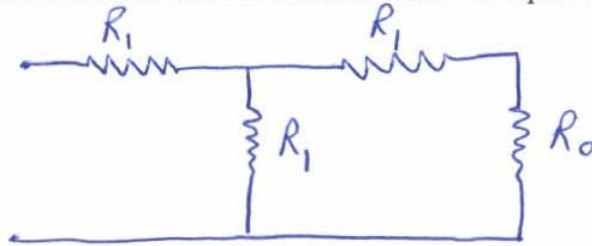


### Physics 2020 Assignment 8

- We have  $5 \times 10^{10}$  doubly charged positive ions per  $\text{cm}^3$ , all moving west with a speed of  $10^7$  cm/sec. In the same region, there are  $10^{11}$  electrons per  $\text{cm}^3$  moving northeast with a speed of  $10^8$  cm/sec.
  - What is the direction of the current density?
  - What is the magnitude of the current density in esu/sec/ $\text{cm}^2$ ?
  - What is the magnitude of the current density in amps/meter<sup>2</sup>?
- In a 6 GeV electron synchrotron, electrons travel around the machine in an approximately circular path 240 meters long. It is normal to have about  $10^{11}$  electrons circling on this path during a cycle of acceleration. The speed of the electrons is practically that of light. What is the current?
- The first telegraphic message crossed the Atlantic in 1858, by a cable 3000 km long laid between Newfoundland and Ireland. The conductor in this cable consisted of seven copper wires, each of diameter 0.73 mm, bundled together and surrounded by an insulating sheath. Calculate the resistance of the conductor. Use  $3 \times 10^{-6}$  ohm cm for the resistivity of the copper, which was of somewhat dubious purity.
- In the circuit below, if  $R_0$  is given, what value must  $R_1$  have in order that the input resistance between the terminals shall be equal to  $R_0$ ?



- If the voltage at the terminals of an automobile battery drops from 12.3 to 9.8 volts when a 0.5 ohm resistor is connected across the battery, what is the internal resistance? (Read about the internal resistance in Chapter 4 of Purcell's Electricity and Magnetism.)
- Two graphite rods are of equal length. One is a cylinder of radius  $a$ . The other is conical, tapering linearly from radius  $a$  at one end to radius  $b$  at the other. Show that the end to end electrical resistance of the conical rod is  $a/b$  times that of the cylindrical rod. Hint: Consider the rod made up of thin, disklike slices, all in series.