Department of Physics
Year 1 Tutorials
Module Phys123
Electricity and Magnetism

Tutorial 4

Issued	Thursday 4th November
Hand in to tutors	Wednesday 18th November 16:00
Tutorials	Friday 19th November

See the Year 1 Notice Board for tutorial groups, tutors, locations and times of tutorials.

Problems

1. A copper wire is carrying a current of 1 mA. How many electrons pass a point in the wire in one minute?
   If the radius of the wire is 1 mm, calculate the magnitude of the current density.
   Given that the number of conduction electrons in copper is 8.47×10^{28} m^{-3}, what is the drift speed of the electrons?
   A five metre length of this wire is used to connect the positive terminal of a battery to a light bulb via a switch, and a further 5 m length is used to link the other side of the bulb to the negative terminal of the battery. When the switch is closed, how long does it take on average for an electron to travel from the battery to the bulb? Why does the light come on much more quickly than this time would suggest?

2. A wire that is 50 cm long has a resistance of 10 mΩ. If the radius of the wire is 0.5 mm, calculate the resistivity and conductivity of the material from which the wire is made.

3. When a solar cell is connected to a 500 Ω resistor, the potential difference across the resistor is 0.10 V. When it is connected across a 1000 Ω resistor, the potential difference across the resistor is 0.15 V. Calculate the emf and the internal resistance of the solar cell.
   The solar cell has an area of 5 cm^2 and receives light energy at a rate of 20 Wm^{-2}, what is the efficiency of the solar cell in converting light energy to thermal energy in the 1000 Ω resistor?

4. A battery with an emf of 3 V and an internal resistance of 2 Ω is connected in parallel with a battery with an emf of 6 V and an internal resistance of 4 Ω, and both are connected across an 8 Ω resistor, as shown in the diagram. Using Kirchoff's rules at the junction A and in the left- and right-hand loops in the circuit, calculate the currents i_1 and i_2 and the current through the 8 Ω resistor.