Resistivity

A.C. Norman
ACN.Norman@radley.org.uk

1. Find the length of constantan wire, radius 5.0×10^{-2} cm, needed to make a $3.0\,\Omega$ resistor. ($\rho = 4.9 \times 10^{-7}\,\Omega$m)

2. A piece of wire has a resistance, R. What will be the resistance of a wire of the same material which is three times as long and twice as thick?

3. A block of carbon, 1.0 cm by 2.0 cm by 5.0 cm, has a resistance of $0.015\,\Omega$ between its two smaller faces. What is the resistivity of carbon?

4. A piece of lead wire is connected in parallel with a piece of iron wire of the same diameter but twice as long. If a current of 0.90 A flows through the combination. Find the current in each wire. ($\rho_{\mathrm{Fe}} = 1.2 \times 10^{-7}\,\Omega$m, $\rho_{\mathrm{Pb}} = 2.1 \times 10^{-7}\,\Omega$m).

5. In 1881, the ohm was made a base unit (rather than a derived unit like it is today). It was defined as being represented (at a conference in 1893) by a column of mercury of cross-section $1\,\mathrm{mm}^2$ at the temperature of melting ice, having length 106.300 cm and mass 14.5421 g.

   (a) What is the density of mercury?

   (b) What is its resistivity?

   (c) How accurately was the ohm defined at this time? (i.e. 1 part in 100, 1 part in 100 000...)

6. This 1881 ohm (the 'practical ohm') was chosen to be 10^9 abΩ [*Nature* Vol. 24, 512 (1881)], because the original abΩ was very small (it was defined in 1838 for electrical usage as the 'ohmad'). This ohmad was defined as the resistance of one foot of number 11 copper wire (which has diameter 0.0907 inch) - definition based on familiar wires was natural at the time, as the telegraph was critically affected by the resistance of its wires, which set the interval at which repeater stations had to be provided. The resistivity of copper is 6.58×10^{-7} ohm-inch. How big was the original abΩ in modern Ω?

7. A wire of uniform cross-section has a resistance of R. If it is drawn to three times the length, but the volume remains constant, what will be its resistance?

8. Two resistors, $20\,\Omega$ and $60\,\Omega$, in parallel are connected in series with $25\,\Omega$ resistor. If this combination is then connected to 160 V mains, what is

   (a) The current in the $20\,\Omega$ resistor

   (b) The p.d. across the $25\,\Omega$ resistor?