Resistivity and Electrical Resistance

Name & Set

Material	Resistivity ($\times 10^{-8}$ Ω m)
Copper	1.7
Iron	11.5
Tungsten	5.0
Nichrome	108.0
Aluminium	3.2

1 The cross-sectional area of the live rail of an electric railway is 57 cm^2 and it is made of iron. Neglecting the effect of joints, calculate the resistance of 1 kilometre of the rail to two significant figures.

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_____ [2]

2 The leads used in our physics labs are each made up from 50 individual stands of copper wire each of which has a diameter 0.1mm. Calculate

(a) the resistance of 1m of each strand, and

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_____ [2]

(b) the resistance per metre of lead.

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_____ [2]

3 The table below is a selection of some of the specifications to be found in a manufacturer's catalogue of wires for use in electrical circuits.

Carry out calculations necessary to complete the table.

	Substance	Wire diameter / mm	Resistance per unit length / Ωm^{-1}	Resistivity / Ωm
(i)	Copper	0.9		1.7×10^{-8}
(ii)	Copper		0.55	1.7×10^{-8}
(iii)	Manganin	0.45	2.6	
(iv)	Constantan	0.45	3.1	
(v)	Constantan	0.2		47×10^{-8}
(vi)	Nichrome	0.45	7.0	

(i) _____

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_____ [2]

(ii) _____

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_____ [2]

(iii) _____

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_____ [2]

(iv) _____

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_____ [2]

(v) _____

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_____ [2]

(vi) _____

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_____ [2]

4 Using the resistivity of copper given in the table at the start of this section calculate the resistance of a lump of copper having a volume of one cubic centimetre,

(a) when it is in the form of a wire of diameter 0.02 cm, and

[3]

(b) when in the form of a square sheet 2.5 mm thick, the current passing through the sheet perpendicularly to its largest faces.

[3]

5 A strain gauge works on the principle that the electrical resistance of a conductor will change if its dimensions change. Confirm that this really happens by calculating the percentage change in the resistance of a wire made of aluminium which is 1 m long and has a diameter of 0.2 mm if its axial length increases by 2 mm. Assume that there is change in the diameter of the wire.

[2]

6 Two wires, A and B, have lengths that are in the ratio of 4:5, diameters that are in the ratio 2:1 and are made of materials with resistivities in the ratio of 3:2. Calculate the ratio of the resistance of A to the resistance of B.

[2]

7 Given that the resistivity of aluminium is twice that of copper, and that the density of aluminium is one-third that of copper, find the ratio of masses of aluminium and copper conductors which have equal length and equal resistance.

[2]

8 X and Y are reels of wire of the same material. A 1m length of wire from reel X has a resistance of 6 Ω. The wire from reel Y has a cross-sectional area three times that of the wire from reel X.

Calculate

(a) the resistance of:

(i) 4 m of wire from X,

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_____ [2]

(ii) 1 m of wire from Y.

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_____ [2]

(b) the length of wire from reel Y having a resistance of 10 Ω.

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_____ [2]

9 (a) Calculate the ratio of resistances of two wires, one of iron and the other of copper, which have the same dimensions.

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_____ [2]

(b) If these wires are connected in series across a PSU and the pd. across them is increased, then the wire made of iron becomes glowing hot before the copper one does. On the other hand, if they are connected to one another in parallel across the PSU, the reverse happens. Explain these observations.

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_____ [2]

10 A nominal 2 Ω resistor is found on test to have a resistance that is actually 10% *above* this value. Calculate

(a) the resistance and (b) the length of constantan wire of resistance per unit length 7 Ωm^{-1} that should be joined in *parallel* with the resistor so that the resulting combination has a resistance of exactly 2.0 Ω?

(a) resistance

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_____ [2]

(b) length

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_____ [2]

11 If a particular wire were stretched until it is twice its original length, by how much, if at all, would its resistance change? Work out the ratio of final resistance to initial resistance. Assume that the cross section of the wire remains circular.

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_____ [2]

12 A wire having a resistance of 10 Ohms is drawn through a die so that its final length is four times its original length. What will be its new resistance?

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_____ [2]

13 A wire made of a particular metal has twice the resistivity, twice the diameter and twice the length of a wire made from another metal. Calculate the ratio of the resistances of the two wires.

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_____ [2]

14 (a) Explain what is meant by

(i) the electrical resistance of a conductor, and

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_____ [2]

(ii) the resistivity of the material of a conductor.

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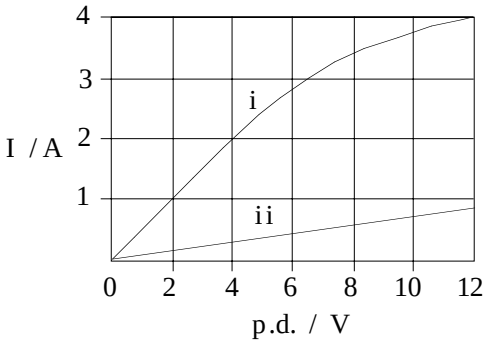
_____ [2]

(b) The graphs show how the current varies with applied potential difference across

(i) a 12 V, 36 W filament lamp, and

(ii) a metre length of nichrome wire of cross section 0.08 mm^2 .

Using the graphs, find the ratio of the values of the electrical resistance of the filament lamp to that of the nichrome wire



(1) when the potential difference across them is 12 V,

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_____

_____ [2]

(2) when the potential difference across them is 0.5 V.

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_____ [2]

How does the resistance of the filament lamp change as the current increases? Suggest a physical explanation for this change.

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_____ [2]

(c) The resistivity of copper is about 1.8×10^{-8} Ωm at 20 °C. Show, using the information given in (b) above, that the resistivity of nichrome is approximately 60 times this value. Explain why, in a domestic circuit containing an electric fire element and a connecting cable, only the element becomes appreciably hot.

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_____ [2]

(London Jan. 1979)