Resistance & Resistivity

Question paper 4

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Current of Electricity
Sub Topic	Resistance & Resistivity
Paper Type	Theory
Booklet	Question paper 4

Time Allowed: **52 minutes**

Score: **/43**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** A uniform wire has length L and constant area of cross-section A.
The material of the wire has Young modulus E and resistivity ρ.
A tension F in the wire causes its length to increase by ΔL.

For this wire, state expressions, in terms of L, A, F, ΔL and ρ for

(i) the stress σ,

..... [1]

(ii) the strain ε,

..... [1]

(iii) the Young modulus E,

..... [1]

(iv) the resistance R.

..... [1]

(b) One end of a metal wire of length 2.6 m and constant area of cross-section $3.8 \times 10^{-7}\,m^2$ is attached to a fixed point, as shown in Fig. 4.1.

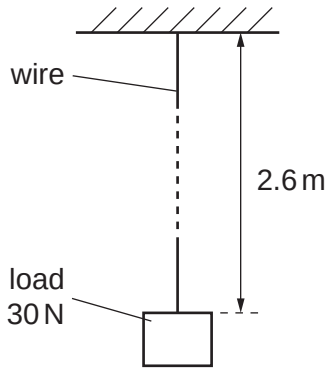

Fig. 4.1

The Young modulus of the material of the wire is 7.0×10^{10} Pa and its resistivity is $2.6 \times 10^{-8}\,\Omega$ m.
A load of 30 N is attached to the lower end of the wire. Assume that the area of cross-section of the wire does not change.
For this load of 30 N,

(i) show that the extension of the wire is 2.9 mm,

[1]

(ii) calculate the change in resistance of the wire.

change = ... Ω [2]

(c) The resistance of the wire changes with the applied load.
Comment on the suggestion that this change of resistance could be used to measure the magnitude of the load on the wire.

.....

.....

..... [2]

2 The variation with temperature of the resistance R_T of a thermistor is shown in Fig. 6.1.

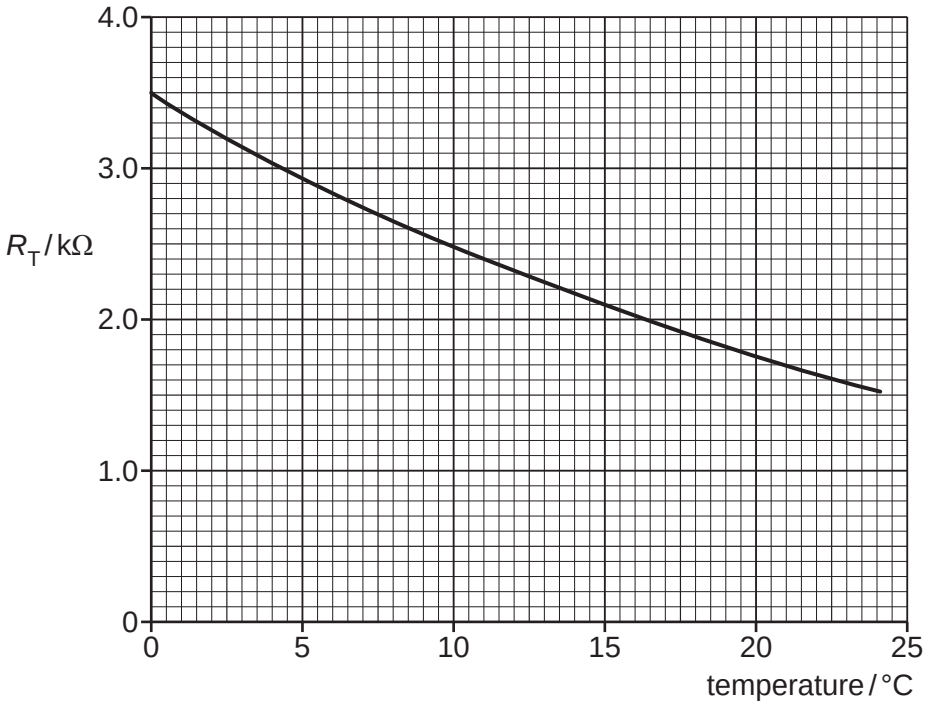

Fig. 6.1

The thermistor is connected into the circuit of Fig. 6.2.

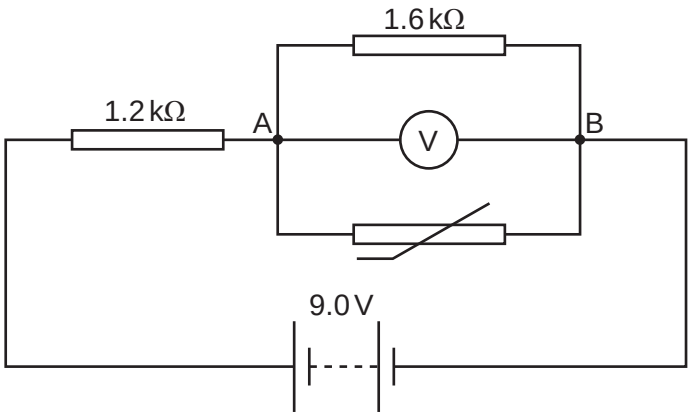

Fig. 6.2

The battery has e.m.f. 9.0V and negligible internal resistance. The voltmeter has infinite resistance.

(a) For the thermistor at 22.5 °C, calculate

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the reading on the voltmeter.

voltmeter reading = ...V [2]

(b) The temperature of the thermistor is changed. The voltmeter now reads 4.0V. Determine

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the temperature of the thermistor.

temperature = ... °C [2]

(c) A student suggests that the voltmeter, reading up to 10 V, could be calibrated to measure temperature.

Suggest two disadvantages of using the circuit of Fig. 6.2 with this voltmeter for the measurement of temperature in the range 0 °C to 25 °C.

1. .....

.....

2. .....

.....

[2]

3 An electric heater is to be made from nichrome wire. Nichrome has a resistivity of $1.0 \times 10^{-6}\,\Omega\,\text{m}$ at the operating temperature of the heater.
The heater is to have a power dissipation of 60 W when the potential difference across its terminals is 12 V.

(a) For the heater operating at its designed power,

(i) calculate the current,

current = ... A [2]

(ii) show that the resistance of the nichrome wire is 2.4 Ω.

[2]

(b) Calculate the length of nichrome wire of diameter 0.80 mm required for the heater.

length = ... m [3]

(c) A second heater, also designed to operate from a 12V supply, is constructed using the same nichrome wire but using half the length of that calculated in **(b)**.
Explain quantitatively the effect of this change in length of wire on the power of the heater.

.....

.....

.....

.....[3]

4 A uniform wire has length L and area of cross-section A.
The wire is fixed at one end so that it hangs vertically with a load attached to its free end, as shown in Fig. 4.1.

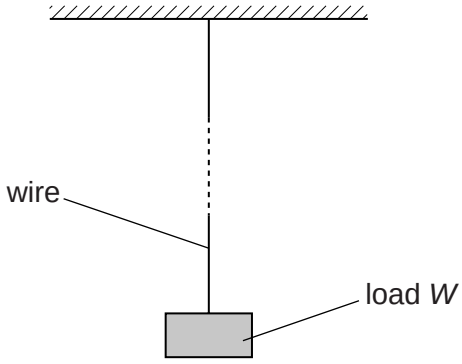

Fig. 4.1

When the load of magnitude W is attached to the wire, it extends by an amount e. The elastic limit of the wire is not exceeded.

The material of the wire has resistivity ρ.

(a) (i) Explain what is meant by extends *elastically*.

.....

.....

..... [2]

(ii) Write down expressions, in terms of L, A, W, ρ and e for

1. the resistance R of the unstretched wire,

R = ... [1]

2. the Young modulus E of the wire.

E = ... [1]

(b) A steel wire has resistance 0.44 Ω. Steel has resistivity 9.2×10^{-8} Ω m.

A load of 34 N hung from the end of the wire causes an extension of 7.7×10^{-4} m.

Using your answers in **(a)(ii)**, calculate the Young modulus *E* of steel.

E = ... Pa [3]

5 An aluminium wire of length 1.8 m and area of cross-section $1.7 \times 10^{-6}\,m^2$ has one end fixed to a rigid support. A small weight hangs from the free end, as illustrated in Fig. 9.1.

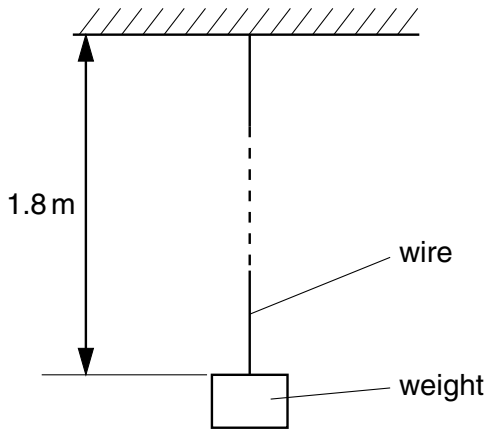

Fig. 9.1

The resistance of the wire is 0.030 Ω and the Young modulus of aluminium is 7.1×10^{10} Pa.

The load on the wire is increased by 25 N.

(a) Calculate

(i) the increase in stress,

increase = ... Pa

(ii) the change in length of the wire.

change = ... m
[4]

(b) Assuming that the area of cross-section of the wire does not change when the load is increased, determine the change in resistance of the wire.

change = ... Ω [3]