Examiner only

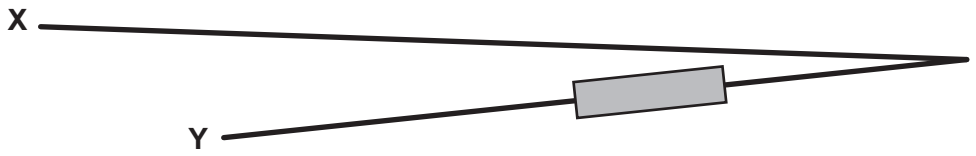
SECTION B

Task B4 (45 minutes)

Two wires of different materials are joined together. You are going to carry out an investigation to determine the position of the join.

Repeat readings are not required for this task. An additional measurement is required for part *(e)*(ii).

(a) (i) Complete the following diagram to show the circuit that has been set up for you. [2]



(ii) Write a plan to describe how you would use your circuit to investigate how resistance varies with length starting from point **X**. [3]

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(b) Take readings and present your results in a table. [4]

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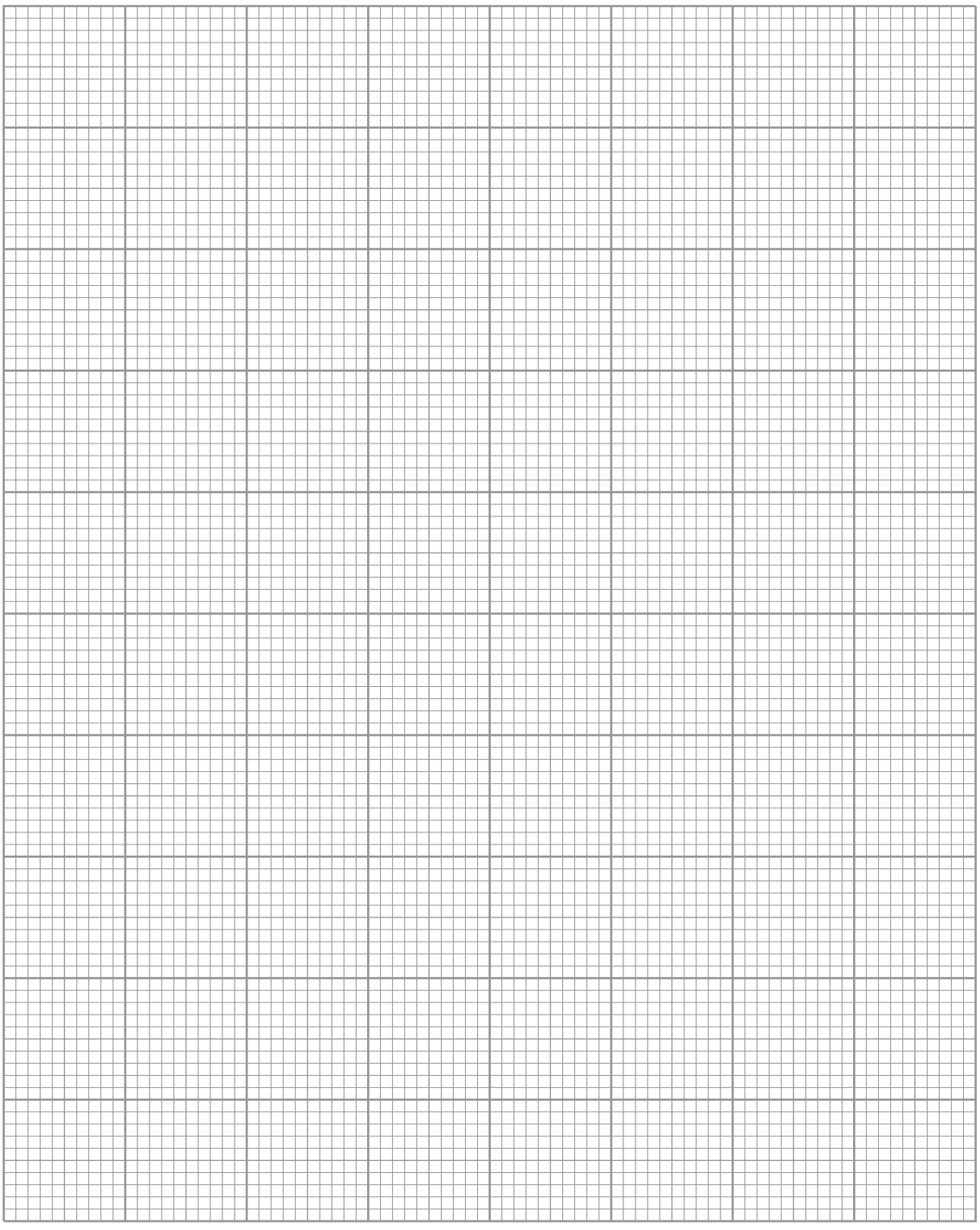
(c) Plot a graph of resistance (vertical axis) against length (horizontal axis). Your graph is expected to consist of 2 straight lines with 2 distinct gradients. [5]



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(d) Use your graph to determine the distance from point **X** of the join in the wires. [2]

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You are now going to determine the resistivity of one of the wires.

(e) (i) Determine the gradient of the graph for the wire starting at **X**. [3]

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(ii) The value of resistivity for different materials is given in the following table.

Material	Resistivity (Ωm) (at 20°C)
Platinum	1.06×10^{-7}
Nichrome	1.10×10^{-6}
Tin	1.09×10^{-7}
Constantan	4.90×10^{-7}
Zinc	5.90×10^{-8}

Resistivity, ρ, is given by the equation:

$$\rho = \frac{RA}{l}$$

where R is the resistance, l is the length and A is the cross-sectional area of the wire.

Using the equation above and by measuring the diameter of the wire, determine the material of the wire starting at **X**. [5]

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END OF PAPER

SECTION B

TASK B4

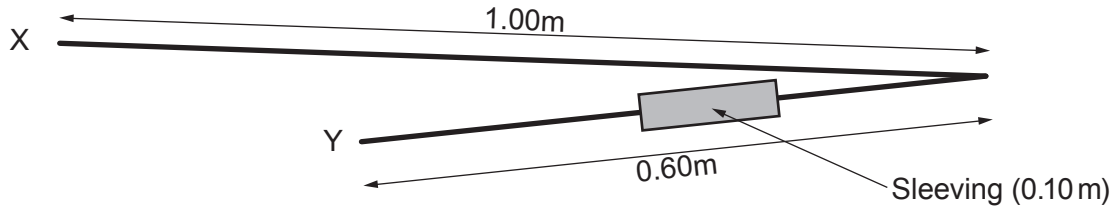
Candidates will investigate two wires of different materials that are joined together.

For both tests allow candidates access to the apparatus for the full 45 minutes if required.

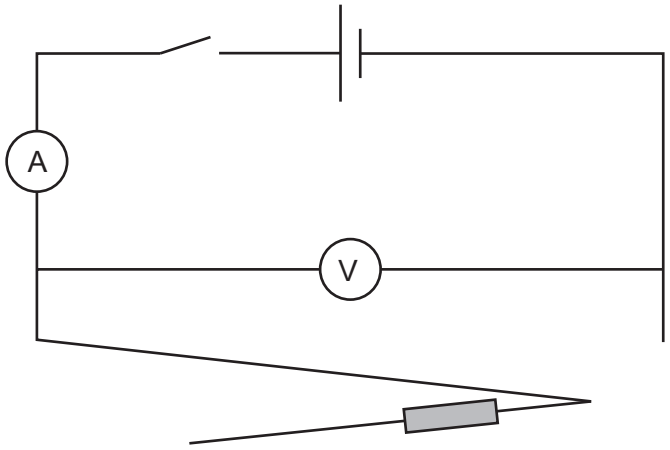
Test 1:

- Joined wire with ends labelled X and Y
- Switch
- Ammeter – resolution ± 0.01 A
- Voltmeter – resolution ± 0.01 V
- 1.5 V battery
- Connecting wires and crocodile clips
- Metre ruler – resolution ± 1 mm
- Callipers – resolution ± 0.01 mm

The joined wire can be made from 1.05 m of 30 swg constantan wire joined firmly (soldered) to 0.55 m of 30 swg nichrome wire to make a joined wire 1.60 m long. The joined wire is to be concealed by a 10 cm length of earth sleeving which is available from any electrical supplier. The joined wire should be mounted firmly e.g. on a piece of batten which allows distances to be measured. The free end of the constantan wire should be clearly labelled X and the free end of the nichrome wire labelled Y.



The following circuit should be set up for each candidate:



Supervisors can instruct candidates not to short circuit and drain the battery by placing both connectors at point X.

Test 2:

The apparatus is as for Test 1 except that the labelling of X and Y should be reversed.

TEST 1 – MARK SCHEME

SECTION B

B4

(a) (i) Circuit diagram drawn with correct symbols (ignore positions of voltmeter and ammeter for this mark). *(1)*
Voltmeter and ammeter correctly positioned. *(1)* [2]

(ii) Change length and measure V and I. *(1)*
Reference to $R = \frac{V}{I}$. *(1)*
Suitable intervals and full 1.60 m length used. *(1)* [3]
All the above cannot be awarded from the table.

(b) Clear headings (length or l / current or I / voltage or pd or V / resistance or R) and correct units on all columns. *(1)*
Values of voltage; current; given in increasing values of length. *(1)*
Resistance calculated correctly. *(1)*
All data given to 2 d.p. maximum. *(1)* [4]

(c) Graph of resistance against length plotted with axes labelled and correct units given on both axes. *(1)*
Suitable scale chosen so that all data points occupy at least half the graph paper. *(1)*
All points plotted correctly to within ½ small square division. *(1)*
1 good line of best fit consistent with the data. *(1)*
2 good distinct lines of best fit drawn showing difference in gradient. *(1)* [5]

(d) Distance correctly read from the graph. *(1)*
Unit and value given to the nearest mm. *(1)* [2]

(e) (i) Large triangle used *(1)* (should be close to extremities of the line of best fit for wire starting at X) [or 2 equivalent suitable points clearly indicated on the graph].
Correct values used for gradient calculation. *(1)*
Gradient calculated correctly. *(1)* If wire starting at Y do not award this mark. [3]

(ii) Realising that gradient of the graph = $\frac{\rho}{A}$ (can be implied anywhere in the answer) or using data values from the line of the graph. *(1)*
Measuring the diameter of the wire starting at X. *(1)* No unit or sig fig penalty.
Correct calculation of the cross-sectional area. *(1)* No unit or sig fig penalty.
Calculating a value for resistivity. *(1)* No unit or sig fig penalty.
Penalise here for calculation errors e.g. powers of 10.
Correct conclusion that the wire is constantan. *(1)* Ignore errors of powers of 10. [5]
(Candidates need to calculate a value for resistivity before conclusion mark can be awarded.)

Total [24]

TEST 2 – Mark Scheme as TEST 1

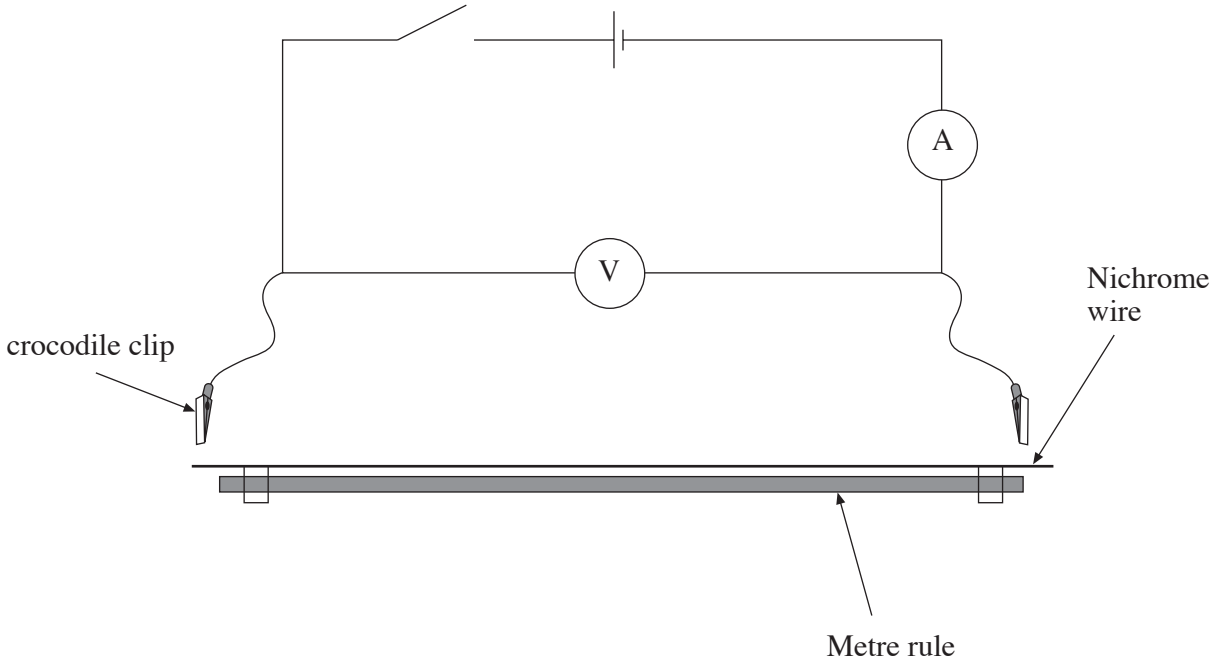
Except:

A2*(c)* 2nd mark: Value of m = 0.160 kg. Unit required. *(1)* (Accept 0.155–0.165.)

TASK A3 (15 minutes)

Repeat readings are not required for this task.

You are going to carry out an investigation to determine the resistivity, ρ, of nichrome wire. The following circuit has been set up for you.



(a) (i) Attach the crocodile clips, one to each end and determine a value for the resistance of the nichrome wire. [2]

$$R = \frac{V}{I}$$

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(ii) Your value for the resistance of the wire is slightly greater than the actual value. Explain why. [1]

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Examiner only

(b) Determine the diameter of the wire and use this value to calculate the cross sectional area of the wire in **metres^2**. [3]

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(c) Use the equation,

$$R = \frac{\rho l}{A}$$

to determine the resistivity, ρ, of the wire. Remember to include appropriate units with your answer. [2]

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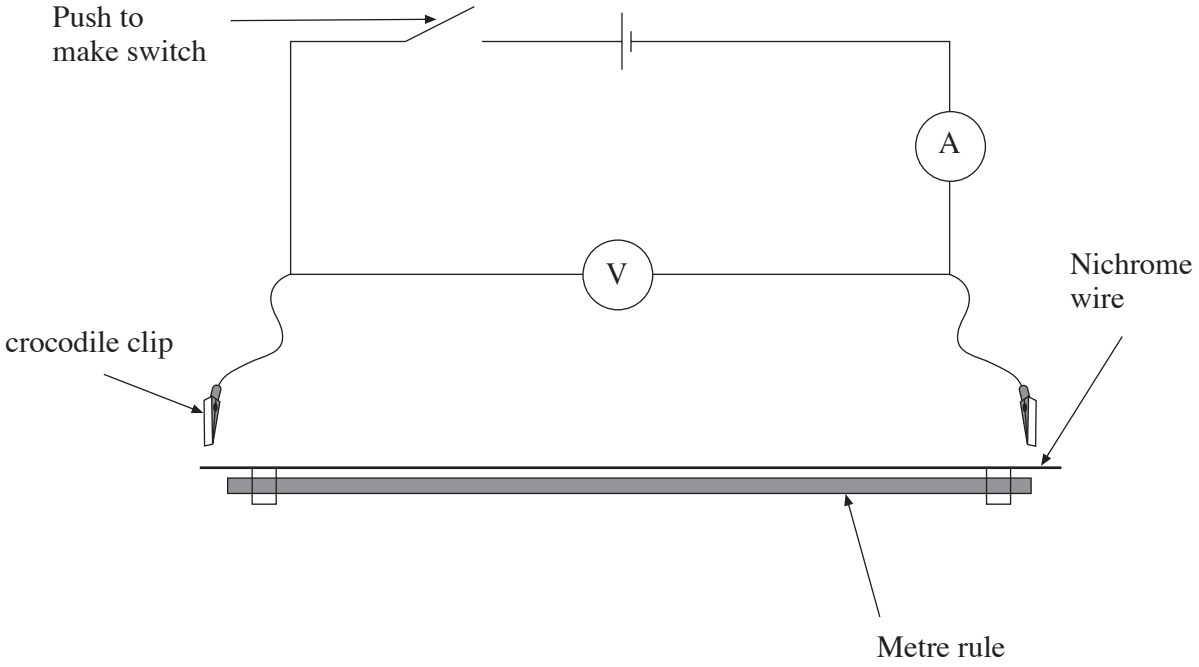
TASK A3

The candidates will be expected to determine the resistivity of a length of wire.

Test 1

The following circuit should be set up for the candidates with a 1 metre length of nichrome wire swg 30 diameter 0.32mm attached to the metre rule using sticky tape. A short length of the wire (approx 2-3cm) should overhang each end so that the crocodile clips can easily be attached.



Equipment needed

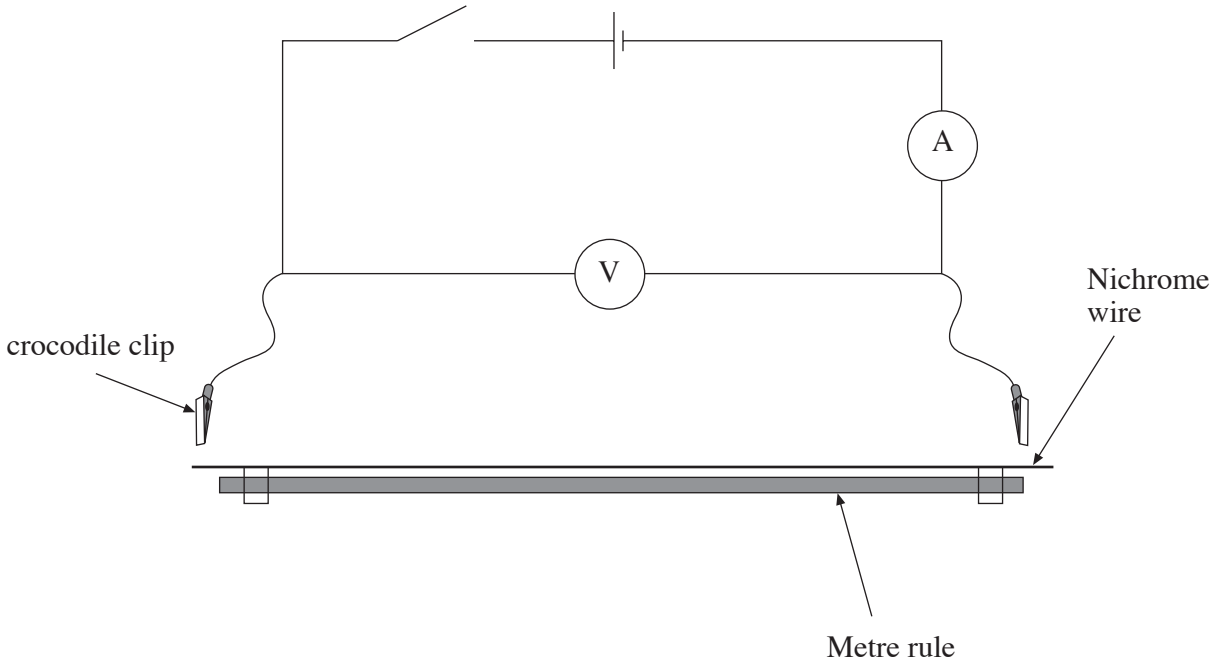
1 × 30 swg nichrome wire of length ~ 1.05 m
1 × metre rule
1 × micrometer / vernier callipers with a resolution of 0.01 mm
1 × 1.5V 'D' type battery with holder and a means of attaching it to two 4 mm leads
6 × leads with 4 mm plugs / stacking plugs as appropriate
2 × crocodile clips [could be soldered / screwed to ends of 2 of the leads]
1 × push-to-make switch
1 × ammeter ± 0.01A
1 × voltmeter ± 0.01V

Test 2:

The apparatus is as for **Test 1** except that 34 or 36 swg constantan wire should be used.

TASK A3 (15 minutes)

You are going to carry out an investigation to determine the resistivity, ρ of nichrome wire. The following circuit has been set up for you.



(a) (i) Attach the crocodile clips, one to each end and determine a value for the resistance of the nichrome wire. [2]

$$R = \frac{V}{I}$$

Voltage and current given to 2 d.p. (1)

Resistance calculated correctly with units (1)

(ii) Your value for the resistance of the wire is slightly greater than the actual value. Explain why. [1]

Less
Because of lead resistance
*[**or** contact resistance] - answer **and** explanation required. (1)*

(b) Determine the diameter of the wire and use this value to calculate the cross sectional area of the wire in **metres^2**. [3]

Thickness given to the resolution of the instrument (1)

Radius calculated / πr^2 / $\frac{\pi d^2}{4}$ *used (1) [or by impl.]*

Area given in metres^2 to no more than 3 significant figures (1)

(c) Use the equation,

$$R = \frac{\rho l}{A}$$

to determine the resistivity, ρ , of the wire. Remember to include appropriate units with your answer. [2]

ρ calculated correctly (1) e.c.f.

Units Ωm (1)

[N.B. Data Book value = $1{\cdot}08 \times 10^{-6}$ Ωm]