1)

(a) Write an equation for resistivity ρ of a material in terms of the length L of a conductor, its cross-sectional area A and its resistance R.

.....

..... **[1]**

(b) Fig. 4.1 shows a cube made from a material of resistivity ρ.

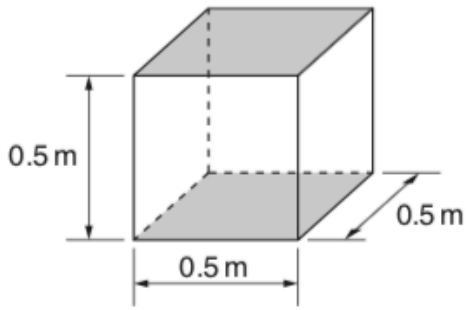


Fig. 4.1

Determine the resistance between any two opposite faces of the cube in terms of the resistivity ρ.

resistance = ... **[2]**

(c) A metal rod has volume $1.6 \times 10^{-5}\,m^3$, length 5.3×10^{-2} m and resistance $7.8 \times 10^{-5}\,\Omega$.

(i) Show that the cross-sectional area of the rod is $3.0 \times 10^{-4}\,m^2$.

[1]

(ii) Calculate the resistivity of the metal.

resistivity = ... Ω m **[2]**

(d) State and explain how your answer to **(c)(ii)** would change, if at all, when the volume of the metal rod is halved but the length is kept the same.

.....

.....

..... **[2]**

[Total: 8]

2)

A student wishes to measure the resistivity of glass. A teacher suggests that its resistivity is of the order of $10^6\,\Omega\,\text{m}$ which is very large.

Resistivity ρ is defined by the equation

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

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

The student is given a number of sheets of glass of the same thickness and of different areas.

Design a laboratory experiment to determine the resistivity of glass. You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to

(a) the procedure to be followed,

(b) how the glass would be connected to the circuit,

(c) the measurements that would be taken,

(d) the control of variables,

(e) how the data would be analysed,

(f) any safety precautions that you would take. [15]

3)

A student is asked to determine the resistivity of iron using a length of iron wire.

Describe an experiment which could be carried out to achieve this.

Include

- a statement of the measurements to be taken,
- a list of the apparatus required,
- a diagram of the apparatus,
- an explanation of how the measurements will be used to determine the resistivity,
- one precaution the student should take to improve the accuracy of the result.

(7)

4 A student wishes to measure the resistivity of glass. A teacher suggests that its resistivity is of the order of $10^6\,\Omega$ m which is very large.

Resistivity ρ is defined by the equation

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

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

The student is given a number of sheets of glass of the same thickness and of different areas.

Design a laboratory experiment to determine the resistivity of glass. You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to

(a) the procedure to be followed,

(b) how the glass would be connected to the circuit,

(c) the measurements that would be taken,

(d) the control of variables,

(e) how the data would be analysed,

(f) any safety precautions that you would take. [15]

5 A student wishes to determine the resistivity of aluminium.

The resistivity ρ of a conductor is defined as

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

for a conductor of resistance R, cross-sectional area A and length l.

Fig. 1.1 shows the typical dimensions of a strip of aluminium of lengths c, d and t. The resistivity of aluminium is about $10^{-8}\,\Omega$m.

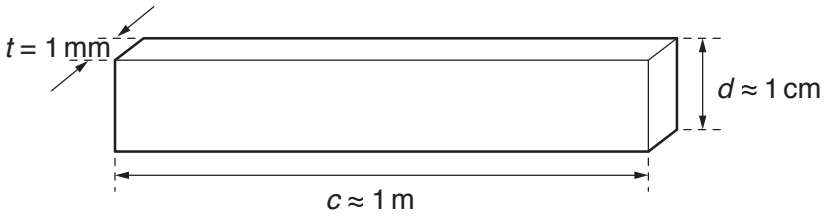


Fig. 1.1 (not to scale)

Design a laboratory experiment to determine the resistivity of aluminium using this strip. The usual apparatus of a school laboratory is available, including a metal cutter.

You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to

(a) the procedure to be followed,

(b) the measurements to be taken,

(c) the control of variables,

(d) the analysis of the data,

(e) the safety precautions to be taken.

[15]

This question requires practial equipment.

6 In this experiment, you will determine the resistivity of a metal in the form of a wire.

(a) (i) Measure and record the diameter d of the short sample of wire that is attached to the card. You may remove the wire from the card.

d = ...[1]

(ii) Calculate the cross-sectional area A of the wire, in m^2, using the formula

$$A = \frac{\pi d^2}{4}.$$

A = ... m^2

(b) (i) Using the wire attached to the metre rule, set up the circuit shown in Fig. 1.1.

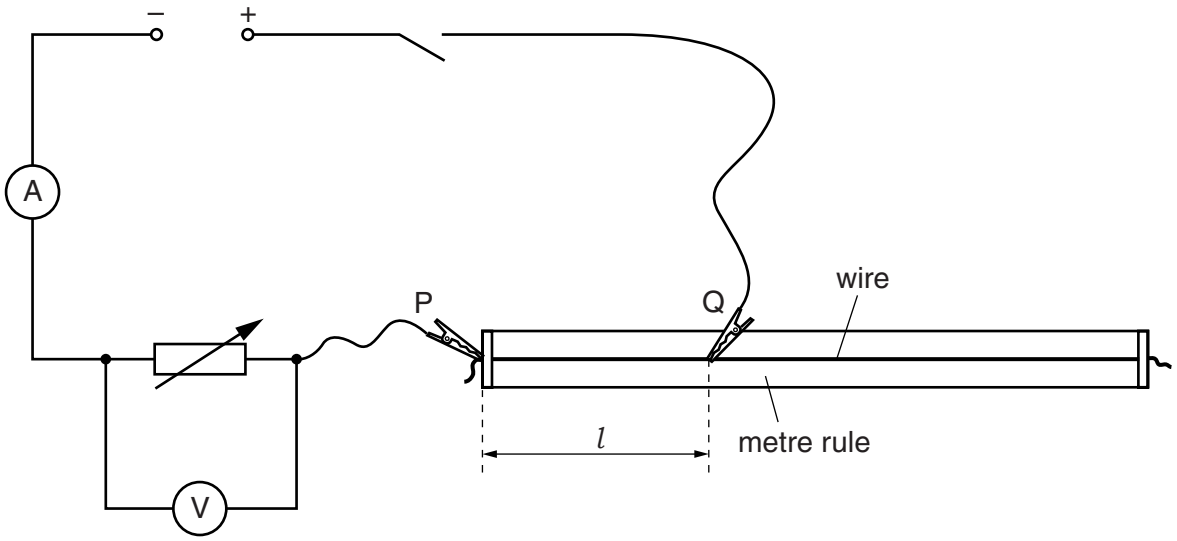


Fig. 1.1

There are two crocodile clips labelled P and Q.
P will remain in the same position throughout the experiment.
Q can be moved to different positions along the wire.

(ii) Position the slider approximately half-way along the rheostat (variable resistor).

(iii) Attach Q approximately half-way along the wire.

(iv) Switch on the power supply.

(v) Measure and record the length l of wire between P and Q.
Record the voltmeter reading V.

l = ... m

V = ... V
[1]

(vi) Record the ammeter reading I.
(1 mA = 0.001 A)

I = ... A

(vii) Switch off the power supply.

(c) (i) Reposition Q at a new distance l from P.

(ii) Switch on the power supply.

(iii) Adjust the slider on the rheostat until the ammeter reading is the same value as in **(b)(vi)**.

(iv) Measure and record the length l of wire between P and Q.
Record the voltmeter reading V.

l = ... m

V = ... V

(v) Switch off the power supply.

(d) Repeat **(c)** until you have six sets of readings of l and V.

For each value of l, adjust the slider on the rheostat so that the ammeter reading I remains constant at the value in (b)(vi).

You may find it helpful to copy your value from **(b)(vi)** here.

I = ... A

Include values of $\frac{V}{l}$ and $\frac{1}{l}$ in your table.

[10]

(e) (i) Plot a graph of $\frac{V}{l}$ on the y-axis against $\frac{1}{l}$ on the x-axis. [3]

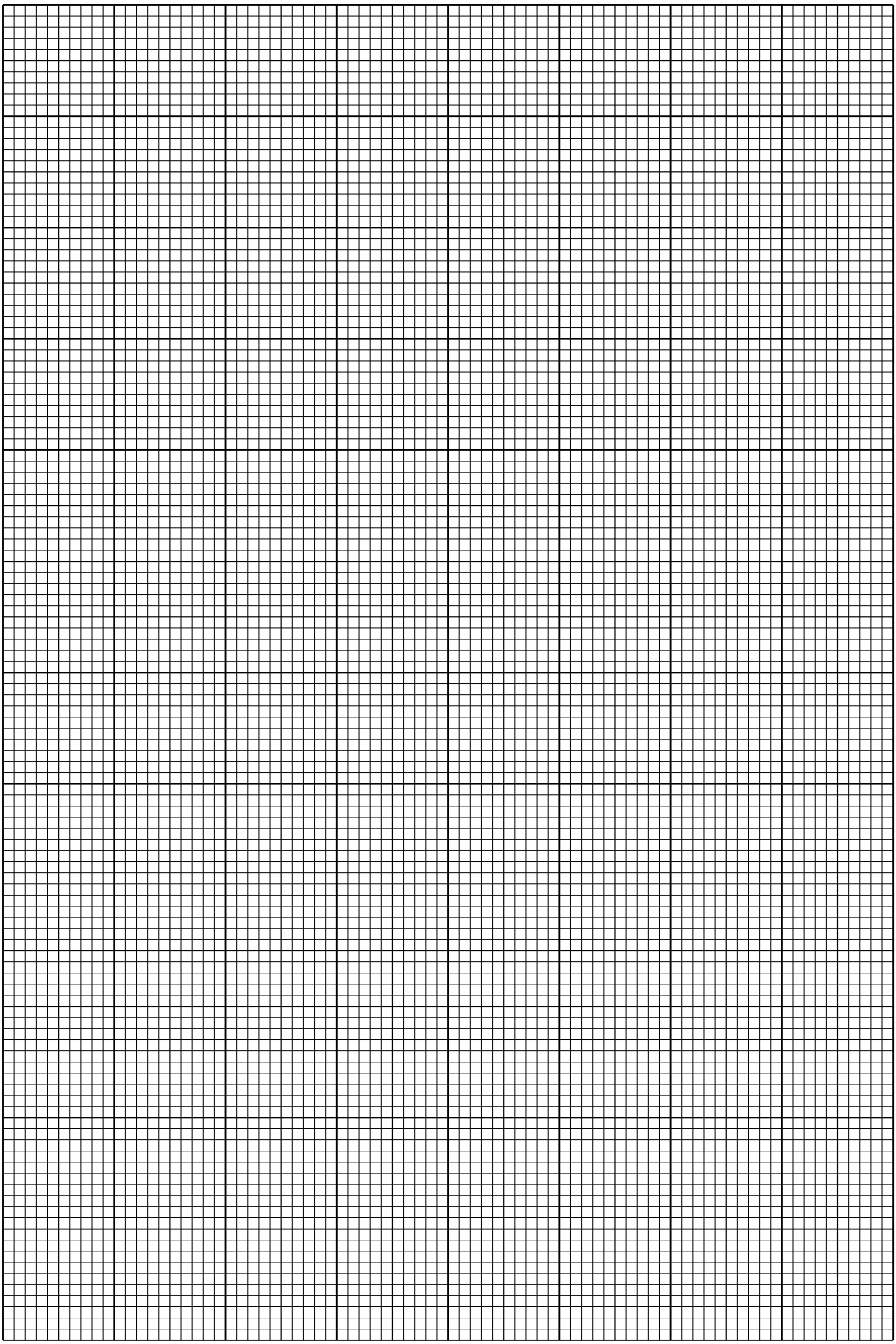
(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]



(f) The quantities V and l are related by the equation

$$\frac{V}{l} = \frac{M}{l} - N$$

where M and N are constants.

(i) Use your answers in **(e)(iii)** to determine values for M and N.

M = ... V

N = ... V m^{-1}

[1]

(ii) The resistivity ρ of the material of the wire, in Ω m, can be found using the relationship

$$\rho = \frac{NA}{I}.$$

Using your answers in **(a)(ii)**, **(b)(vi)** and **(f)(i)**, calculate a value for ρ.

ρ = ... Ω m [1]

Tis question requires practical equipment

7 In this experiment, you will determine the resistivity of a metal in the form of a wire.

(a) (i) Measure and record the diameter d of the short sample of wire that is attached to the card. You may remove the wire from the card.

d = ...

(ii) Calculate the cross-sectional area A of the wire using the formula

$$A = \frac{\pi d^2}{4}.$$

A = ...

(b) (i) Set up the circuit shown in Fig. 1.1 and close the switch.

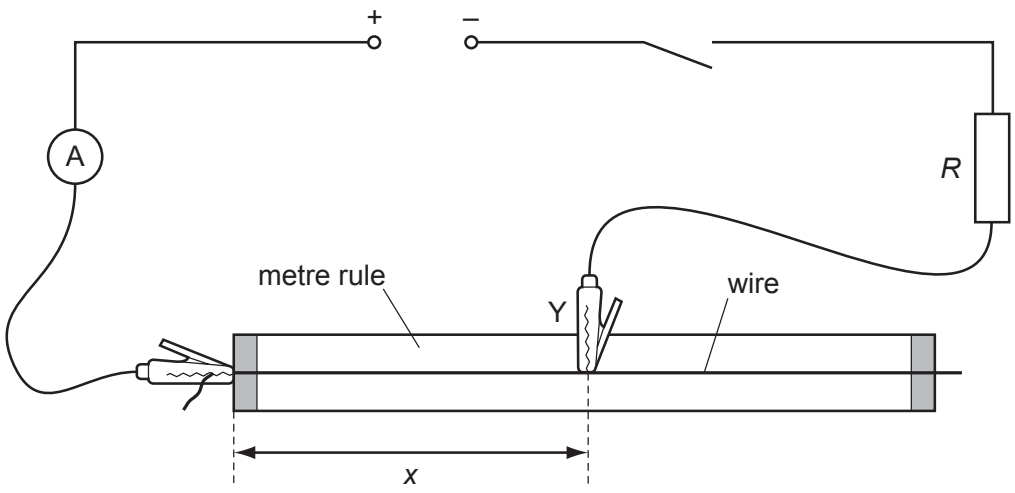


Fig. 1.1

(ii) Position the crocodile clip labelled 'Y' half-way along the wire.

(iii) Measure and record the distance x of wire between the two crocodile clips, and the ammeter reading I.

x = ...

I = ...

(c) Change *x* and repeat **(b)(iii)** until you have six sets of readings of *x* and I.

Include values of $\frac{1}{I}$ in your table.

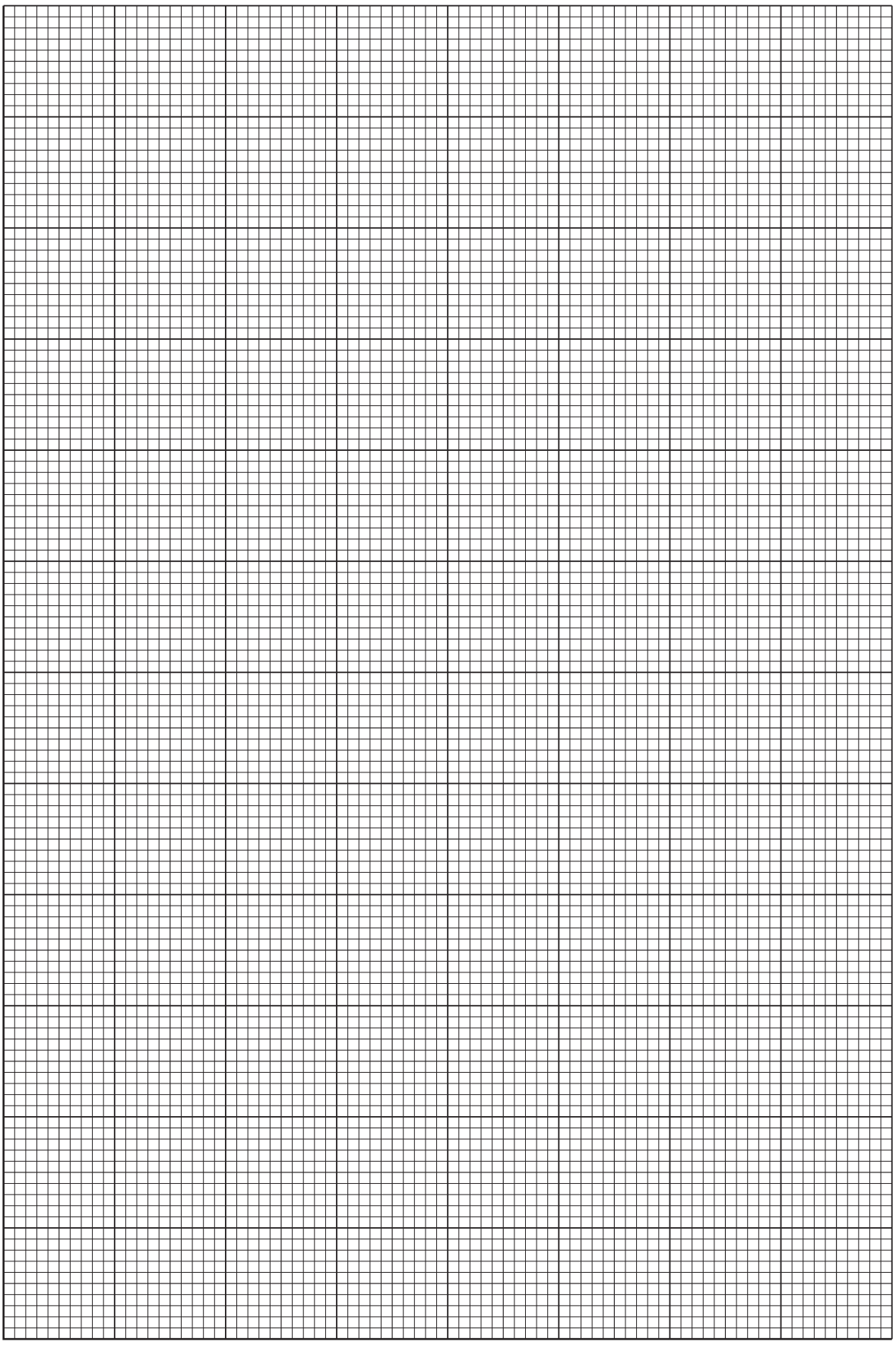
(d) **(i)** Plot a graph of $\frac{1}{I}$ on the *y*-axis against *x* on the *x*-axis.

(ii) Draw the straight line of best fit.

(iii) Determine the gradient and *y*-intercept of this line.

gradient = ...

y-intercept = ...



(e) The quantities I and x are related by the equation

$$\frac{1}{I} = Mx + N$$

where M and N are constants and

$$\frac{M}{N} = \frac{\rho}{AR}$$

where ρ is the resistivity of the material of the wire and the resistance R of the fixed resistor is given on a card.

Use your answers in **(a)(ii)** and **(d)(iii)** to determine a value for ρ.

ρ = ...