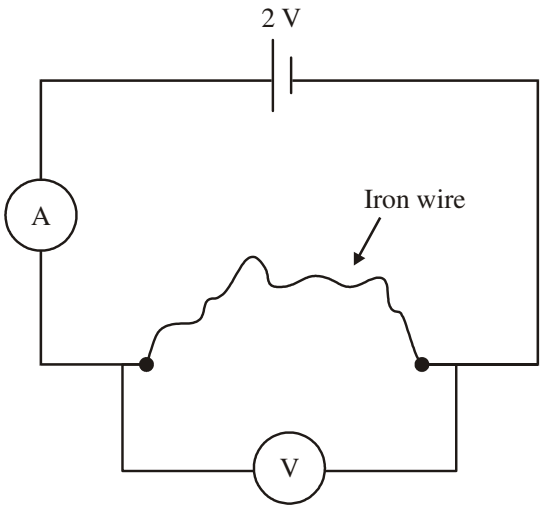
St Peter's RC High School

# HW One

## Resistivity and Potential Dividers

36 min
36 marks

**1.** A student carries out an experiment to determine the resistivity of iron using the circuit shown below.




He uses iron wire with a diameter of 0.50 mm.

Show that the cross-sectional area of this wire is about $2 \times 10^{-7}$ $m^2$.

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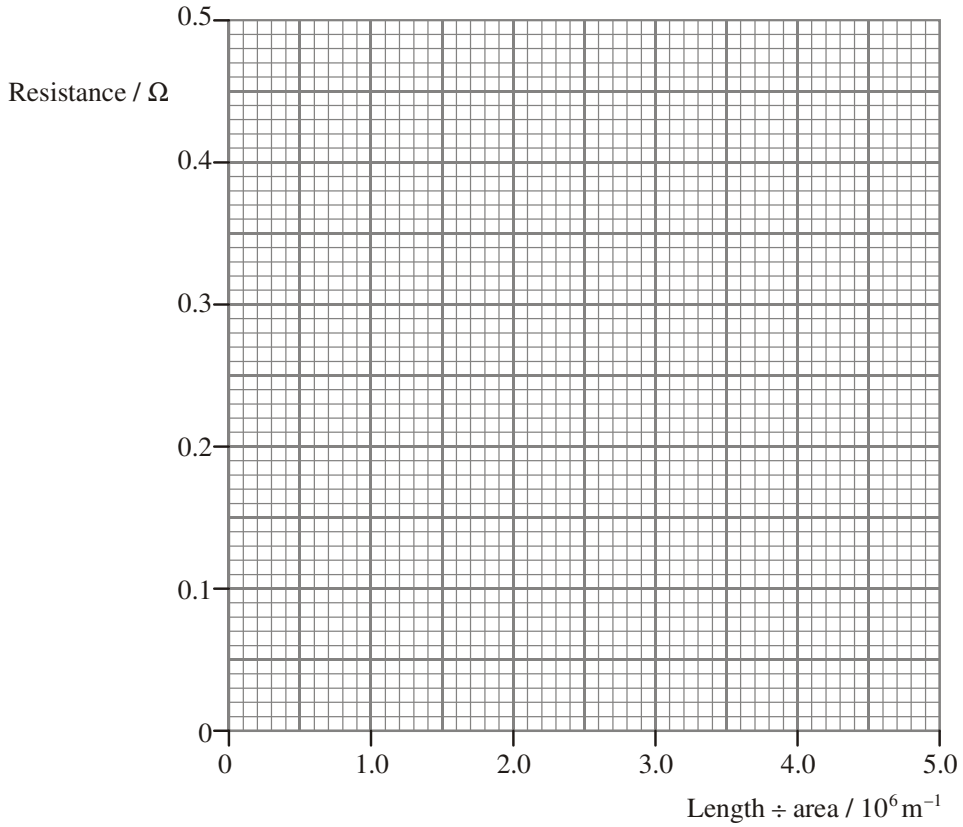
**(2)**

The table shows the results he obtained.

| Resistance / Ω | Length / m | Length ÷ area /$10^6$ $m^{-1}$ |
|---|---|---|
| 0.00 | 0.00 | |
| 0.10 | 0.10 | |
| 0.14 | 0.20 | |
| 0.18 | 0.30 | |
| 0.24 | 0.40 | |
| 0.30 | 0.50 | |
| 0.36 | 0.60 | |
| 0.42 | 0.70 | |
| 0.48 | 0.80 | |

Complete the third column and use the data to plot a graph of resistance against length ÷ area on the grid below.




**(3)**

Draw the line of best fit and use this to calculate the resistivity of iron.

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Resistivity = .....

**(4)**

Suggest an explanation for the anomalous results obtained in this experiment.

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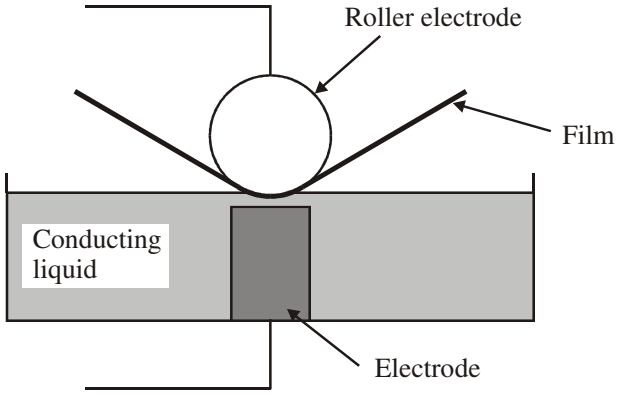
**(2)**

**(Total 11 marks)**

**2.** To preserve food effectively, packaging film must isolate food from bacteria in the environment. The film is thoroughly inspected for holes, but many inspection techniques can damage it.

A new technique has been developed to check the film. The film is passed between a roller electrode and a conducting liquid, in which a second electrode is placed, as shown below. The resistance between the two electrodes is measured; even a pinhole in the film can greatly reduce this resistance by filling with the liquid and creating a conducting path.




Complete the diagram above showing a circuit you could use to measure this resistance.

**(2)**

For undamaged film the resistance measured between the electrodes is very high. Show that when a circular hole of diameter $1.0 \times 10^{-4}$ m is present and fills with the conducting liquid the resistance measured is about 170 Ω. Assume that the resistance through the liquid between the lower electrode and the film is so small it can be ignored.
Resistivity of conducting liquid = $2.7 \times 10^{-3}$ Ω m, film thickness = $5.0 \times 10^{-4}$ m.

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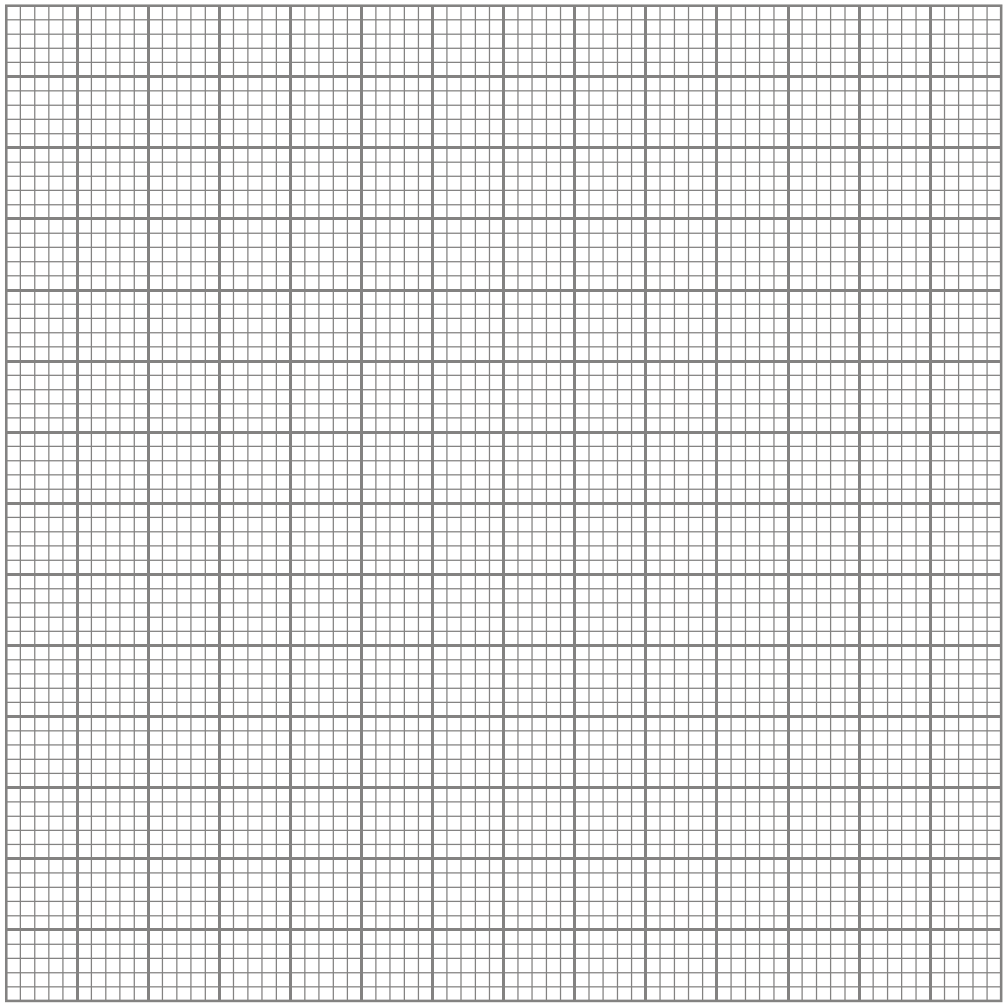
**(3)**

Using this technique, the following values of resistance were obtained.

| Diameter of hole / mm | Resistance / Ω |
|---|---|
| 0.2 | 43.0 |
| 0.4 | 10.7 |
| 0.6 | 4.8 |
| 0.8 | 2.7 |
| 1.0 | 1.7 |

Plot a graph of resistance against diameter from these results on the grid below.



**(4)**

Use the graph to determine the diameter of the hole which gives a resistance of 30 Ω.

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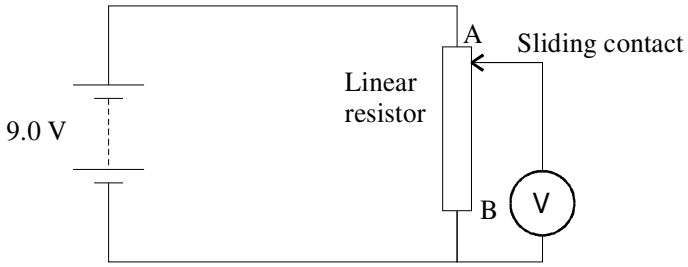
**(1)**

**(Total 10 marks)**

**3.** A student wants to provide lighting for a model house which she has made. She needs 3.0 V for her lamps but only has a 9.0 V battery, so uses a linear resistor AB in the circuit below. The linear resistor is made from a high resistance uniform conductor.




What is the name of the device AB when it is used in this manner?

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**(1)**

State the voltmeter reading when the sliding contact is at:

A .....  B .....

**(2)**

The student moves the sliding contact until the voltmeter reads 3.0 V.

Add an arrow labelled X to the diagram to show where the sliding contact must be placed.

**(1)**

The student replaces the voltmeter with a 3.0 V lamp but the lamp does not light. Explain why the lamp does not light.

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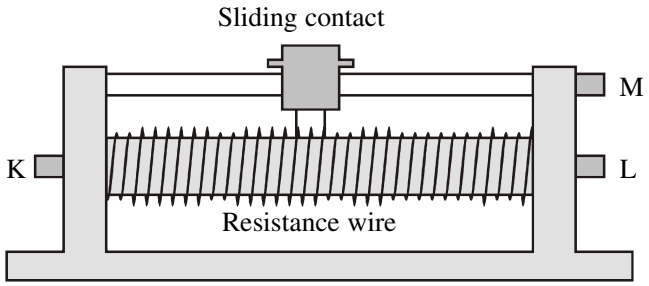
**(3)**

**(Total *7* marks)**

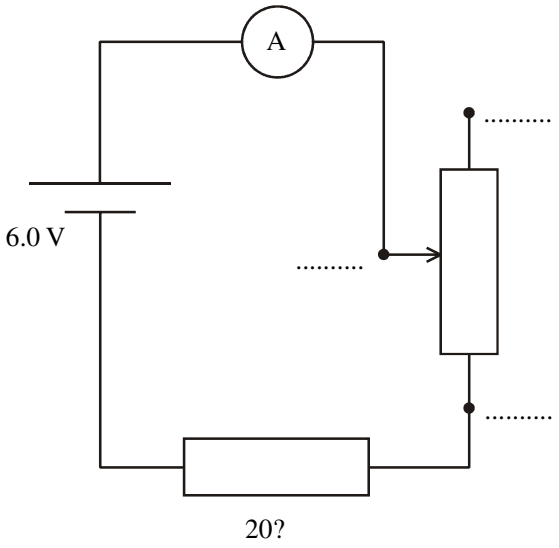
**4.** A variable resistor consisting of a wire and sliding contact has three terminals labelled K, L and M.

**Figure 1**




The variable resistor is connected in series with a 6.0 V supply of negligible internal resistance, an ammeter and a 20 Ω fixed resistor.

**Figure 2**




(a) Label the terminals K, L and M on Figure 2.

**(1)**

(b) (i) The variable resistor has a maximum resistance of 10 Ω. The resistance of the fixed resistor is 20 Ω. Determine the potential difference across the resistor when the sliding contact is at the mid-point of the variable resistor.

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Potential difference = .....

**(3)**

(ii) What assumption have you made about the ammeter?

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**(1)**

(c) The same components can be used in a second circuit to vary the potential difference across the fixed resistor fully from 0 V to 6.0 V. Draw the circuit diagram for this potential divider arrangement.

**(3)**
**(Total 8 marks)**