New Specification

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED
General Certificate of Education
2010

Physics

Assessment Unit A2 3
Practical Techniques
(Internal Assessment)
Session 1

[AY231]

AY231

WEDNESDAY 12 MAY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Turn to page 2 for further Instructions and Information.

Question Number	Marks: Teacher Mark	Marks: Examiner Check
1		
2		
3		
Total Marks		

5523

INSTRUCTIONS TO CANDIDATES

Answer **all** questions in this paper. Rough work and calculations must also be done in this paper. Except where instructed, do not describe the apparatus or the experimental procedures. The Supervisor will tell you the order in which you are to answer the questions. Not more than 30 minutes are to be spent in answering each question. You may be told to start with the experimental tests in Section A, or with the single question in Section B.
Section A consists of two experimental tests. A 28-minute period is allocated for you to use the apparatus. Two minutes is allocated to the supervisor to prepare the station for the next candidate. At the end of the 30-minute period you will be instructed to move to the area set aside for your next question. Section B consists of one question in which you will be tested on aspects of planning and design.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.
All questions carry 20 marks each.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each part question.
You may use an electronic calculator.

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Section A

Teacher Mark	Examiner Check	Remark

1 In this experiment you will investigate the equilibrium conditions of a suspended metre rule.

The aims of this experiment are:

- to keep the metre rule horizontal by adjusting the position and magnitude of the masses attached to it;
- to use the results to plot a linear graph;
- to use this graph to find the value for the mass of the metre rule; and
- to calculate a value for the density of the wood of the metre rule.

Apparatus

The apparatus shown in **Fig 1.1** has been set up for you. The metre rule is suspended from two identical springs at fixed points P and Q. The mass *M*, 50 g, is set at the 20 cm mark on the metre rule. **The position of *M* is not changed throughout the experiment**. You are now to attach a 100 g mass to either loop near point Q and adjust its position until the lower metre rule is horizontal.

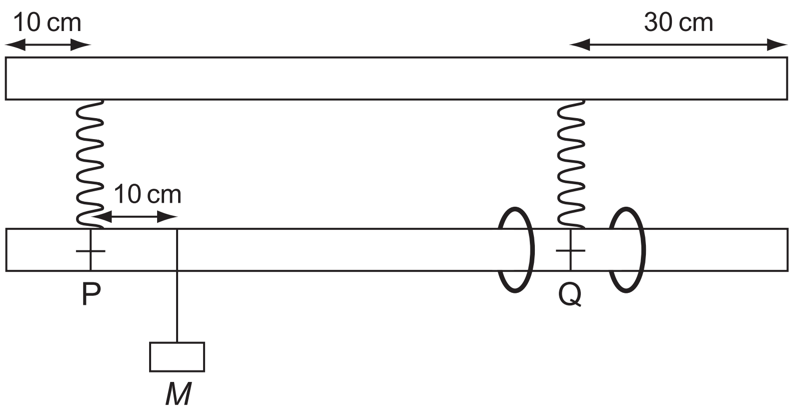

Fig. 1.1

(a) With $M = 50$ g, position the 100 g mass on the metre rule, as described, so that the rule is horizontal.

(i) Describe how you ensured that the rule was horizontal using only the apparatus with which you have been provided.

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____ [1]

Teacher Mark	Examiner Check	Remark

(ii) Measure the horizontal distance, *d*, **from the right hand end of the metre rule to the loop holding the 100 g mass**. Record your result in **Table 1.1**. Obtain 4 further values for *d* by increasing *M* each time by 50 g. Record your results, including the one for *M* = 50 g in **Table 1.1**. You do not need to take repeat readings.

Table 1.1

M/g	*d*/cm
50	
100	
150	
200	
250	

[5]

(b) Plot a graph of *M* (y axis) against *d* (x axis) on the grid of **Fig 1.2** on page 6. Choose a suitable scale for the *d* axis, starting from the zero, plot the points and draw the best fit line. [4]

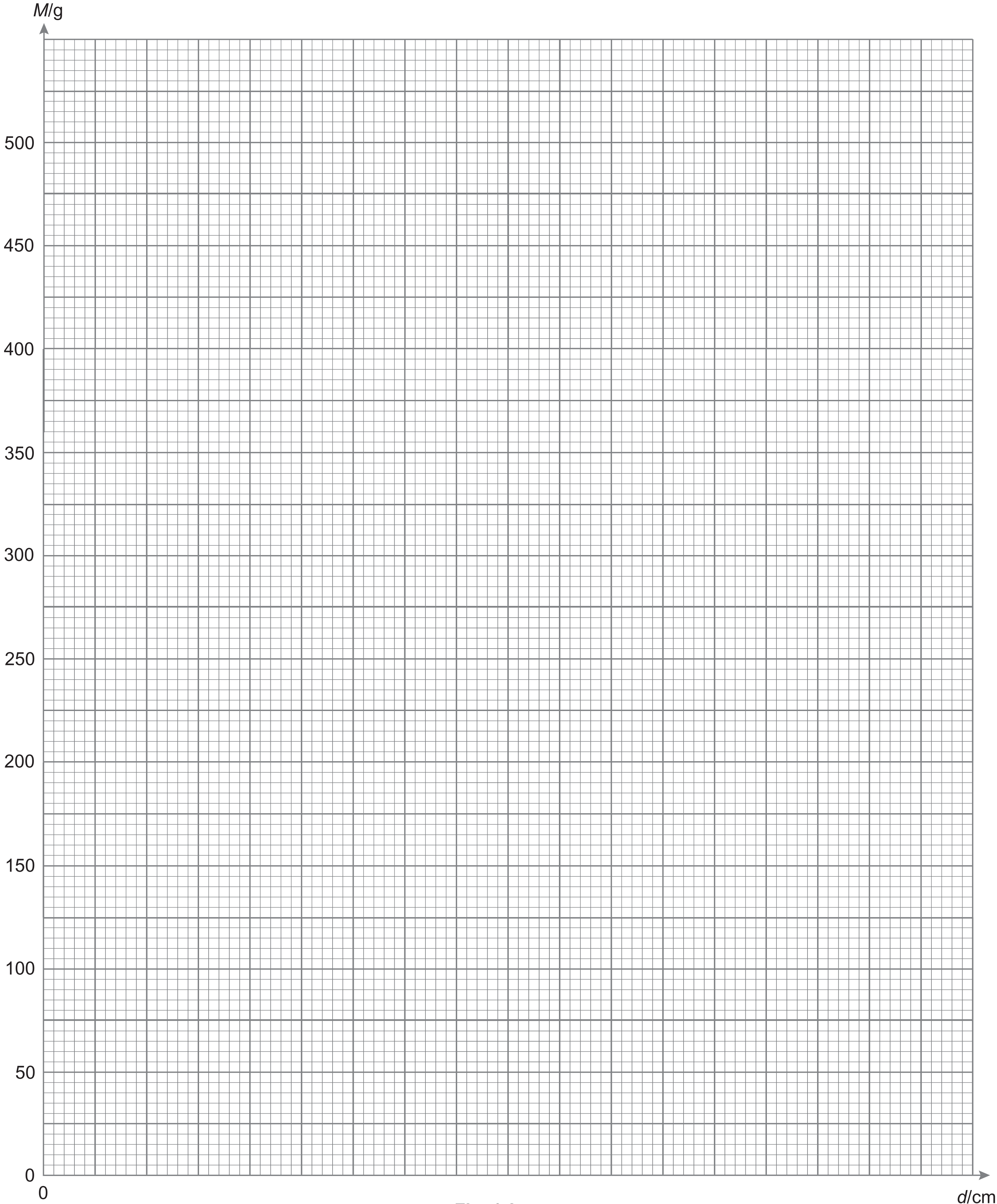

Fig. 1.2

The straight line that you have drawn is described by **Equation 1.1**

$$M = kd + \left(\frac{600 + B}{2}\right) \quad \textbf{Equation 1.1}$$

where k is a constant and B is the mass of the metre rule in grams.

(c) (i) How would you determine a value for k from your graph?

(You are not required to calculate a value for k.)

____

____ [1]

(ii) Use your graph to find a value for B, the mass of the metre rule.

Mass = ______________ g [3]

Teacher Mark	Examiner Check	Remark

(d) The density of a material can be calculated using **Equation 1.2**.

$$density = \frac{mass}{volume} \quad \textbf{Equation 1.2}$$

Teacher Mark	Examiner Check	Remark

(i) The length of the metre rule can be assumed to be exactly 100 cm. Use the vernier callipers provided to take suitable measurements from which you can calculate the density of the wood that the metre rule is made from. Record your measurements including their associated absolute uncertainty in **Table 1.2**. Do not repeat values.

Table 1.2

Measurement	Uncertainty	Unit

[3]

(ii) Which of these measurements will contribute most to the overall percentage uncertainty in your measurement of density? Explain your answer.

____

____ [1]

(iii) Calculate a value for the density of wood.

Density of wood = _______________ $g\,cm^{-3}$ [2]

2 In this experiment you will investigate the period of oscillation of a pendulum.

The aims of the experiment are:

- to obtain the period of oscillation of a pendulum at different heights above the desk;
- to plot a graph of your results; and
- to calculate values for two unknown constants *P* and *R*.

The apparatus shown in **Fig 2.1** has been set up for you.

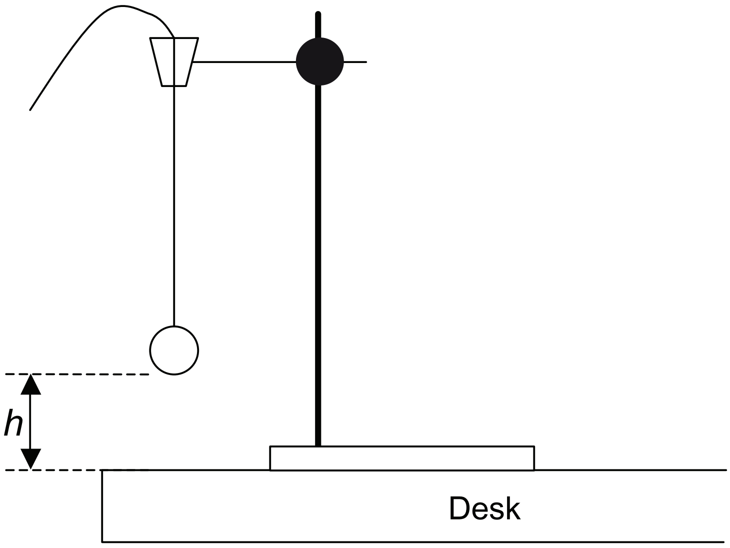

Fig. 2.1

(a) Measure the height, *h*, from the desk to the bottom of the pendulum bob. Record this height in **Table 2.1** on page 10. Displace the pendulum bob slightly and allow it to oscillate with small amplitude. Take readings to allow you to determine *T*, the period of the oscillation. Insert any headings needed in the wide column of **Table 2.1** and record your measurements.

Change the height, *h*, by pulling the thread through the split cork at the suspension point. Repeat the procedure for four further values of *h* up to a maximum of 0.40 m.

Teacher Mark	Examiner Check	Remark

Teacher Mark	Examiner Check	Remark

Table 2.1

h/m		T/s	

[4]

Theory

The relationship between T and h is given by **Equation 2.1**

$$T = 2\pi\sqrt{\frac{R-h}{P}} \quad \textbf{Equation 2.1}$$

where R and P are constants.

(b) You are to draw a suitable straight line graph which may be used to find the values of R and P.

Equation 2.1 has been modified by squaring to give **Equation 2.2**

$$T^2 = \frac{4\pi^2 R}{P} - \frac{4\pi^2 h}{P} \quad \textbf{Equation 2.2}$$

(i) Compare **Equation 2.2** with the equation of a straight line and state the quantities you intend to plot on your graph.

Vertical axis ________________

Horizontal axis ________________ [2]

(ii) In order to plot this graph, you **will** need to calculate the values of a further quantity. Head the last column in **Table 2.1** appropriately, carry out the calculations and tabulate the results in this column. [2]

Teacher Mark	Examiner Check	Remark

(iii) Label the axes of the graph grid of **Fig 2.2** on page 12 consistent with **(b)(i)** and choose suitable scales. Plot the points and draw the best fit straight line. [5]

(iv) 1 Use the graph to find the value of P and enter the value below.

P = _______________

Units of P = _______________ [4]

2 Use **Equation 2.1** to calculate a value for R.

R = _______________

Units of R = _______________ [3]

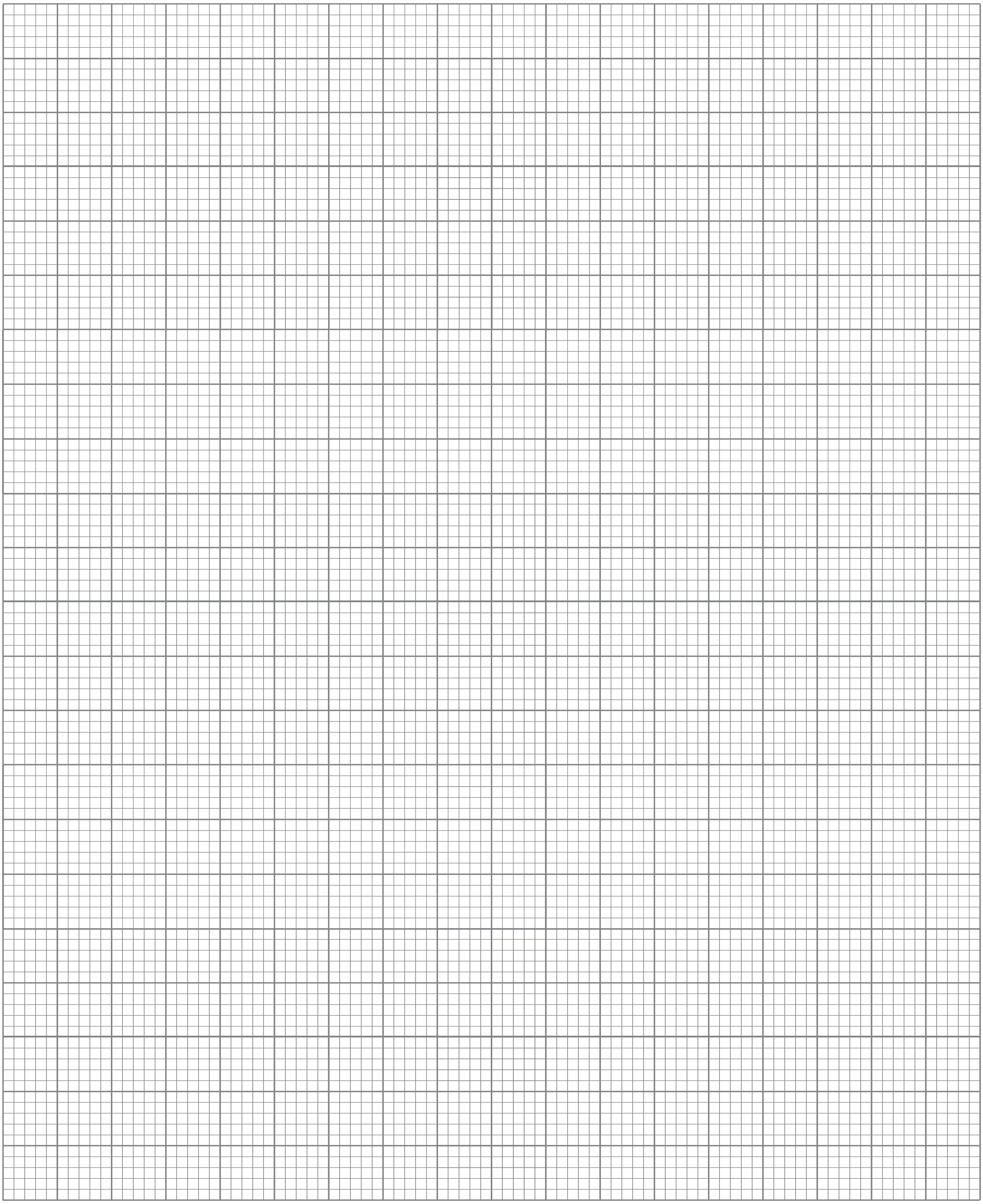

Fig. 2.2

Section B

Teacher Mark	Examiner Check	Remark

3 In this question you will plan an experiment to calculate the energy gap for a thermistor by measuring how the resistance of the thermistor changes with temperature. The resistance R is related to the absolute temperature T by **Equation 3.1** where A is a constant and B another constant related to the energy gap.

$$R = Ae^{-BT} \quad \textbf{Equation 3.1}$$

(a) (i) Describe the experiment you could carry out to determine the thermistor's resistance, using the ammeter-voltmeter method, at different temperatures. In your answer you should include:

- a labelled diagram of both the apparatus and circuit used;
- the procedure, and the measurements that are taken to obtain the results; and
- processing of results to give a series of values of resistance and absolute temperature.

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____ [6]

Teacher Mark	Examiner Check	Remark

(ii) Other than repeating the experiment, describe and explain one aspect of your experimental procedure that leads to more reliable results.

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____ [2]

(b) **(i)** Sketch the graph of R against T that you would expect if **Equation 3.1** is correct.

[1]

(ii) Take the natural logs (ln) of both sides of **Equation 3.1** in order to obtain an equation in the form of a straight line graph $y = mx + c$.

____ [1]

(c) A value of A is required from the experimental results. Describe how this would be obtained from a straight line graph. Include in your answer what quantities you are plotting on the y and the x axis of your graph and then how A is found from the graph.

(i) y axis ____________________

x axis ____________________ [2]

(ii) Explain how a value for A is determined using the graph.

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____

____ [2]

(d) The energy gap E_g is related to constant B by **Equation 3.2**

$$B = \frac{E_g}{2k} \quad \textbf{Equation 3.2}$$

where k is the Boltzmann constant.

Describe how a value for E_g can be obtained from your graph and **Equation 3.2**.

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____ [2]

(e) The ammeter and voltmeter that are to be used in the experiment are digital. The ammeter reading before the circuit is turned on is 0.00 A. The voltmeter reads 0.0 V. Describe how you would calculate the absolute uncertainty in the value of the resistance of the thermistor at a temperature T.

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____ [4]

Teacher Mark	Examiner Check	Remark

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