Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education

Centre Number

Candidate Number

Physics

Assessment Unit AS 3B (Theory)

assessing

Practical Techniques and Data Analysis

[SPH32]

SPH32

Assessment

Assessment Level of Control:
Tick the relevant box (✓)

Controlled Conditions	
Other	

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You may use an electronic calculator.
In question 3 of this paper a protractor will be required.

12580

1 An experiment was carried out using a converging lens. The distance **p** between the object and the lens was changed and the distance **q** between the object and its image was recorded. The results are shown in **Table 1.1**.

Table 1.1

p / cm	q / cm
5.5	55.0
6.0	36.2
7.6	24.5
13.4	21.2
16.0	23.0
19.8	26.4

(a) On **Fig. 1.1**, plot a graph of distance **q** against distance **p** and draw a line of best fit for the data. [8]

Mark your points clearly using a ⊙ or a **+**.

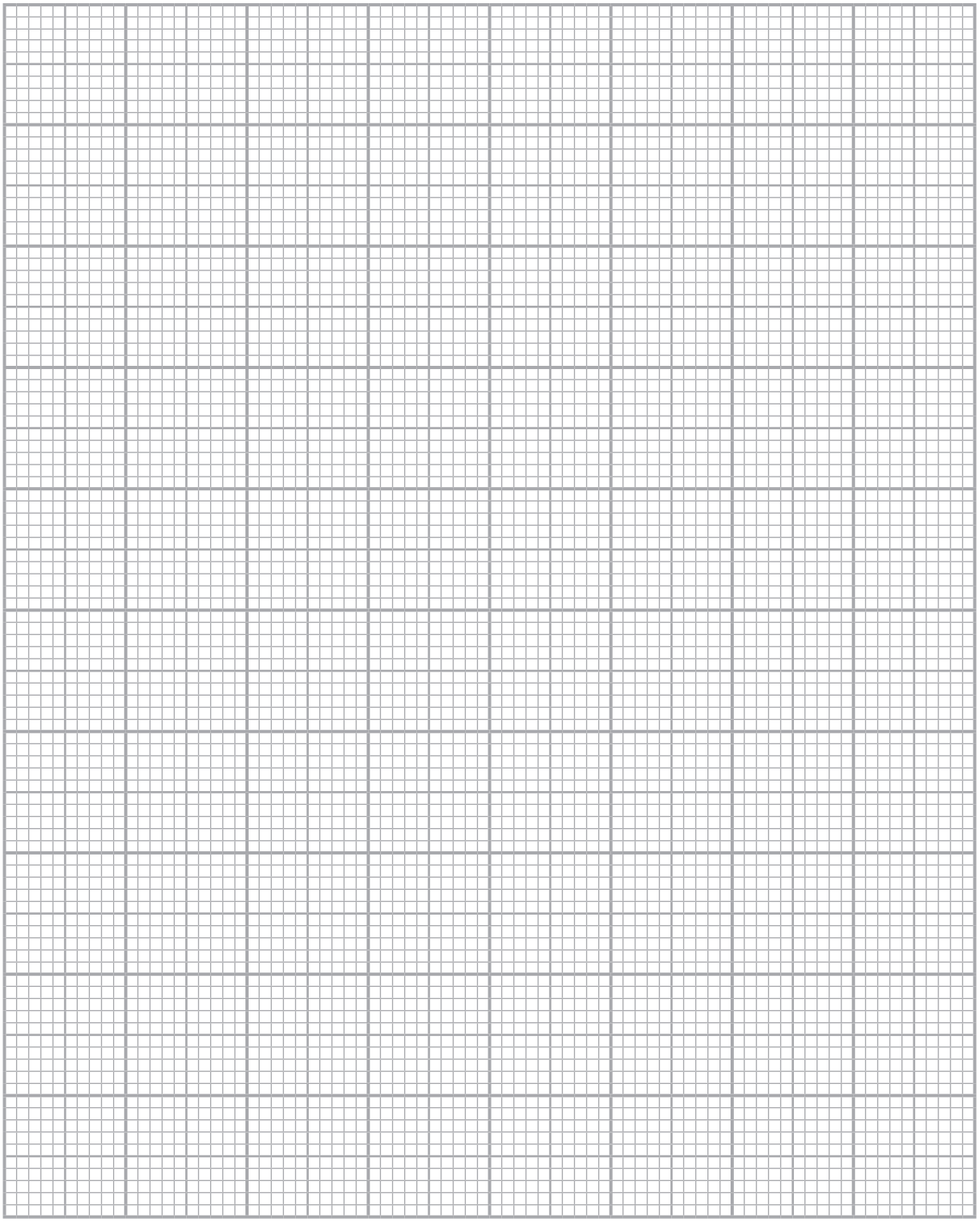

Fig. 1.1

[Turn over

The smallest distance between an object and its image is when the object is at a distance of twice the focal length from the lens.

(b) (i) Use your graph to estimate a value for the focal length of the lens used in this experiment.

Focal length = _____ cm [2]

(ii) Describe one way the experiment could have been improved in order to obtain a more accurate value for the focal length of the lens using this graphical method.

_____

_____ [1]

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(Questions continue overleaf)

[Turn over

2 The period **T** of oscillation of a mass **M** suspended on a spring and displaced is given by **Equation 2.1**

$$T = \sqrt{AM + B} \qquad \textbf{Equation 2.1}$$

where **A** and **B** are unknown constants.

Table 2.1 provides experimental data on the oscillation time of the mass-spring system as the suspended mass **M** is increased.

Table 2.1

M / kg	Time for 20 oscillations / s				T / s
	$20T_1$	$20T_2$	$20T_3$	$20T_{mean}$	
0.300	12.77	12.75	13.0		
0.450	14.31	14.28	14.36		
0.600	15.64	15.46	15.62		
0.750	16.89	18.25	16.92		
0.900	18.07	17.81	17.96		

(a) (i) State which value of **20T** has been incorrectly **recorded**.
Explain your reasoning.

_____

_____ [1]

(ii) State which value of **20T** has been incorrectly **timed**.
Explain your reasoning.

_____

_____ [1]

(b) (i) Determine the mean time for 20 oscillations for the suspended mass M = 0.900 kg. Insert the value in the appropriate place in **Table 2.1**. [1]

(ii) Using the mean time calculated in **(b)(i)**, determine the periodic time for this mass. Insert the value in the appropriate place in **Table 2.1**. [1]

(c) A linear graph is to be plotted with **M** on the x axis. On **Fig. 2.1** state the quantity to be plotted on the y axis along with the unit. Sketch the graph you would expect to obtain.

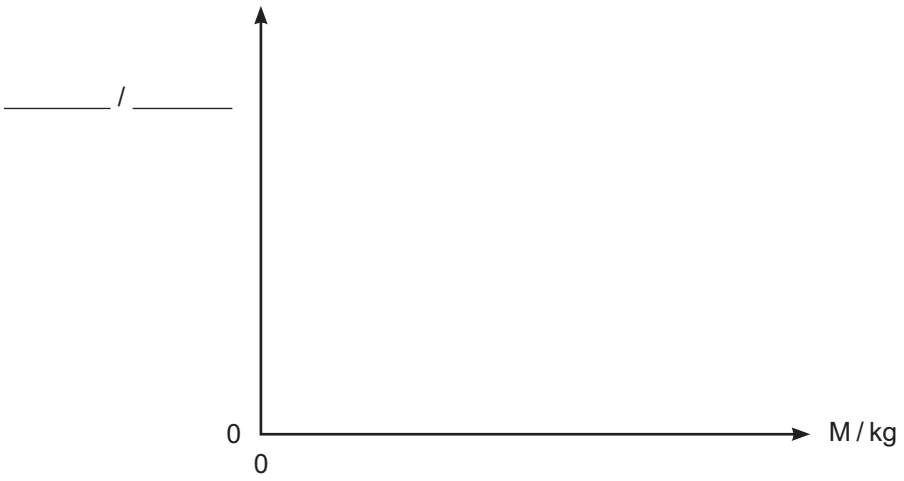

Fig. 2.1

[2]

(d) Determine the units of the unknown constants **A** and **B** in **Equation 2.1**.

Unit of **A** = _____

Unit of **B** = _____ [2]

[Turn over

3 A student completed an experiment to determine the refractive index of perspex. **Fig. 3.1** shows the outline of a 60° prism with an incident ray. A ray of light was shone through the prism along the incident ray. A series of × marks the path of the ray that emerged from the prism.

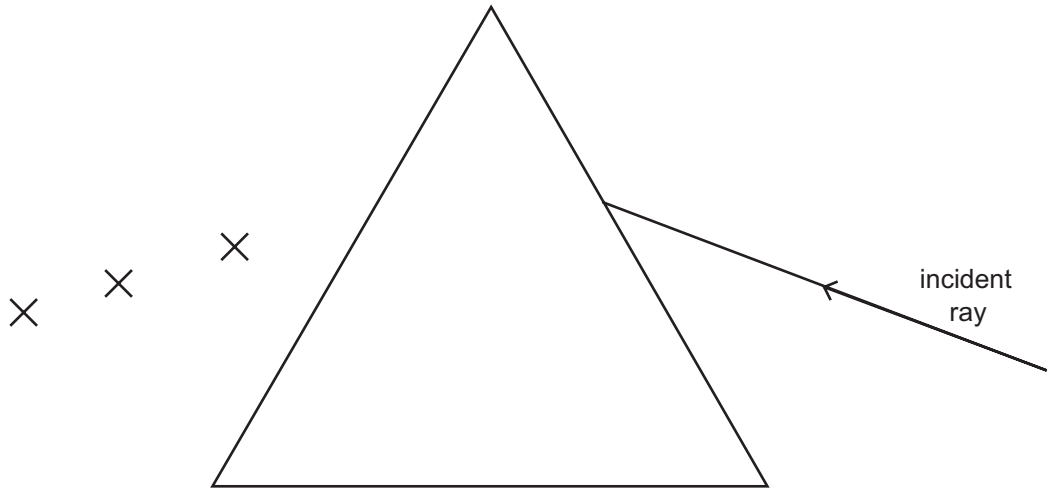

Fig. 3.1

(a) Complete the diagram by drawing the ray of light as it moves through the prism and exits the other side. [2]

The refractive index of perspex **n** is given by **Equation 3.1**.

$$\mathbf{n} = \frac{\sin \mathbf{i}}{\sin \mathbf{r}} \qquad \textbf{Equation 3.1}$$

(b) (i) Use a protractor to measure the angle of incidence **i** and angle of refraction **r** as the ray **enters** the prism in **Fig. 3.1**. Use these results to calculate the refractive index of perspex to three significant figures.

Refractive index = _____ [3]

(ii) State the absolute uncertainty in the measurement of an angle using a protractor.

_____ ° [1]

(iii) Use the absolute uncertainty to calculate the maximum value of the refractive index of perspex that would be valid from your results.

Maximum refractive index = _____ [2]

(iv) Use this maximum value to calculate the percentage uncertainty in your value of refractive index.

Percentage uncertainty = _____ % [2]

(v) Using only the completed diagram for the single ray in **Fig. 3.1**, describe how the student could improve the reliability of the refractive index value calculated in **(i)**.

_____

_____ [1]

[Turn over

4 A student measured the resistance of various lengths of nichrome wire of constant diameter. **Fig. 4.1** shows a graph of the results.

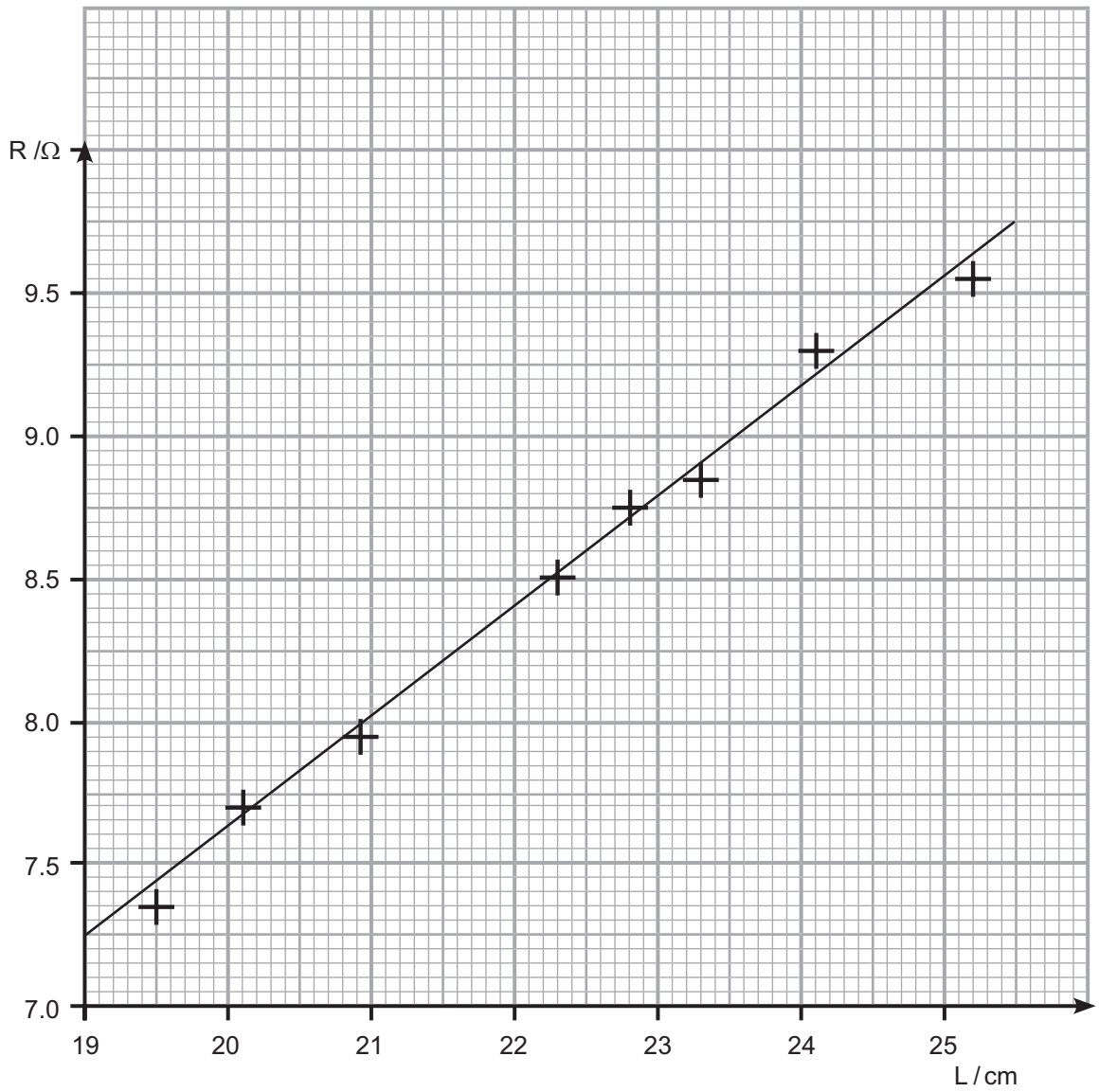

Fig. 4.1

(a) How can the results shown in **Fig. 4.1** be used to confirm that the resistance of the wire is proportional to the length of the wire?

_____

_____ [1]

The equation relating the resistance **R** of a piece of wire of length **L** is given by **Equation 4.1**.

$$\mathbf{R = kL} \qquad \textbf{Equation 4.1}$$

(b) Use the graph drawn in **Fig. 4.1** to determine the constant **k** in $\Omega\,m^{-1}$.

k = _____ $\Omega\,m^{-1}$ [4]

(c) Determine the absolute uncertainty in the value of **k**.

Absolute uncertainty = ± _____ $\Omega\,m^{-1}$ [3]

[Turn over

5 A liquid was heated and then left to cool. The temperature of the liquid was recorded over a period of time and the results were plotted as shown in **Fig. 5.1**.

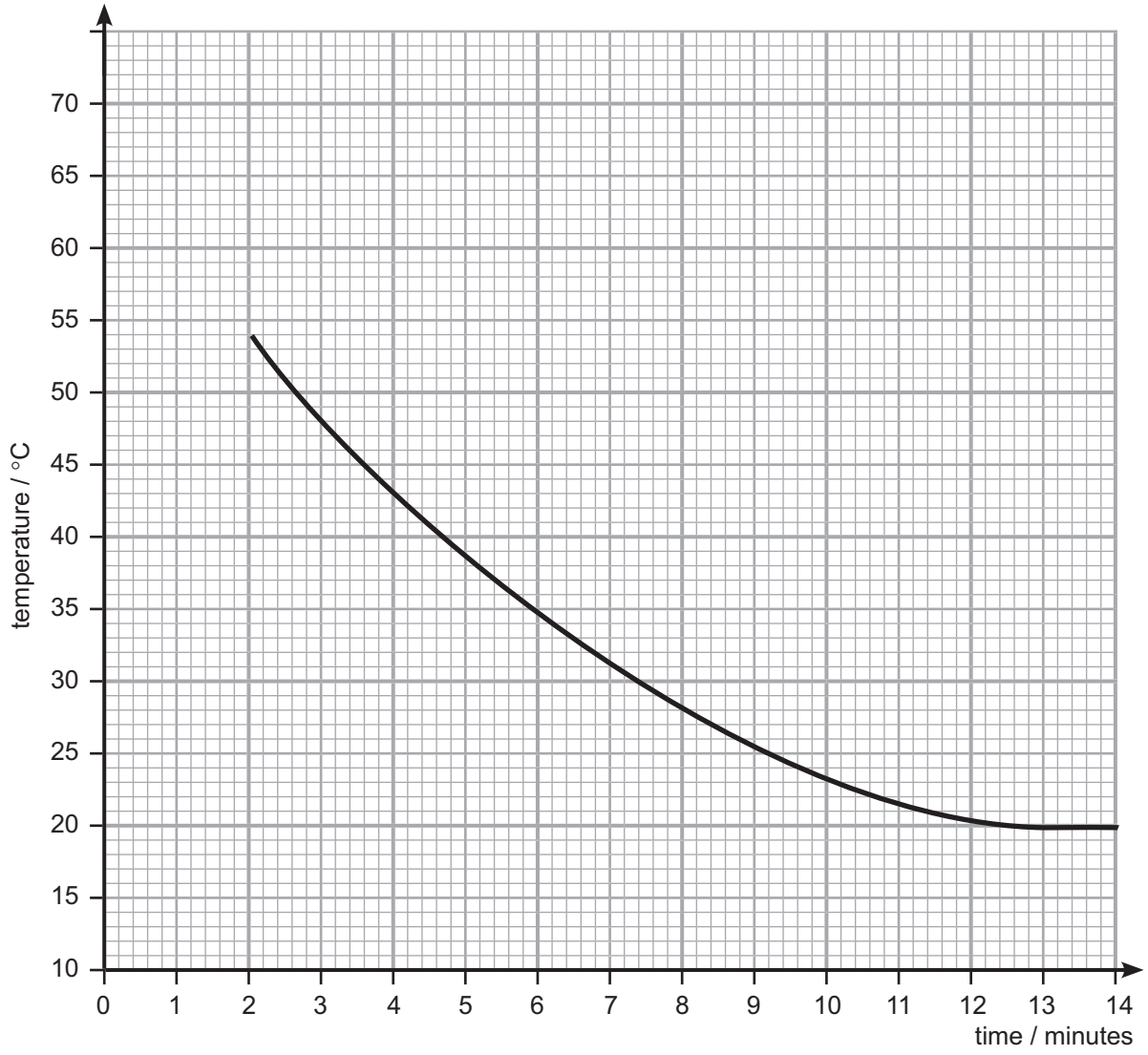

Fig. 5.1

(a) Use the graph in **Fig. 5.1** to determine:

(i) The temperature of the liquid when the timing was started.

Temperature = _____ °C [2]

(ii) The temperature of the room in which the liquid was left to cool.

Room temperature = _____ °C [1]

(b) Does the rate of change of temperature increase, decrease or remain constant during this experiment?
Explain your answer using the graph in **Fig. 5.1**.

_____

_____ [2]

[Turn over

6 A student carries out an experiment to determine the resistance–temperature characteristic of a negative temperature coefficient (ntc) thermistor.

An ohmmeter is used to directly measure the resistance of the thermistor.

The thermistor is placed in a water bath and the temperature is varied.
The practical arrangement is shown in **Fig. 6.1**.

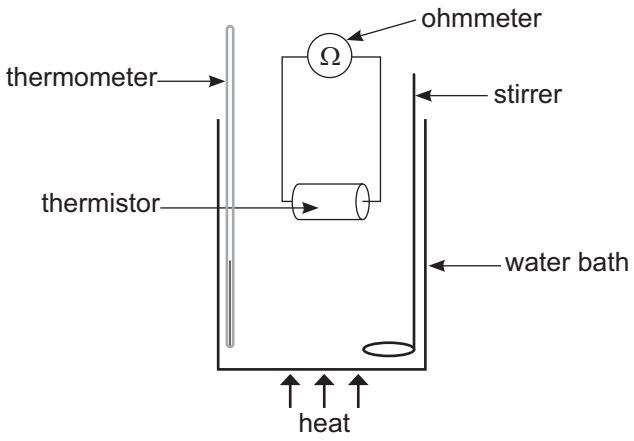

Fig. 6.1

(a) Draw the correct circuit symbol for the thermistor in the space below.

[1]

(b) Give one advantage and one limitation of using a water bath to indirectly heat the thermistor.

Advantage _____

_____

Limitation _____

_____ [2]

(c) What is the purpose of stirring the water as it is heated?

_____

_____ [1]

(d) The ohmmeter is set to a range 0–200 kΩ, showing one decimal place. At the beginning of the experiment, it displays a reading of 88.3 kΩ.

When the temperature of the thermistor increases, its resistance drops to 84 Ω.

(i) What reading is displayed on the ohmmeter?

Resistance = _____ kΩ [2]

(ii) What adjustment should be made to make this value more precise?

_____

_____ [1]

THIS IS THE END OF THE QUESTION PAPER

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
Total Marks	

Examiner Number