

General Certificate of Education  
June 2007  
Advanced Level Examination



**PHYSICS (SPECIFICATION B)**

**PHB6/TN**

**Unit 6**

**Instructions to Supervisors**

**STRICTLY CONFIDENTIAL**

**It is the responsibility of the Examinations Officer to ensure that these Instructions to Supervisors are given immediately to the Supervisor of the practical exercises.**

**These Instructions are strictly confidential and must be kept in safe custody by the Examinations Officer or by the Supervisor. They should be given to the Invigilator for the duration of the actual assessment and afterwards returned to the Examinations Officer. The Invigilator must ensure that when the Instructions are not in use, they are returned and kept in safe custody. Additional copies of these Instructions cannot be supplied by AQA.**

**No copies of the relevant question paper should be given to the Supervisor at any time leading up to the examination.**

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## INSTRUCTIONS TO THE SUPERVISOR OF THE PRACTICAL EXERCISES

### General

- 1 The instructions and details of materials contained in this document are for the use of the Supervisor **and are strictly confidential**. After use, these Instructions must be kept in safe custody by the Examinations Officer until after the issue of results (in March or August as appropriate).
- 2 **The Supervisor has now been granted access to the question papers for both Exercise 1 (PHB6/1) and Exercise 2 (PHB6/2) as part of these Instructions. All the relevant questions are printed to enable the Supervisor to carry out the experimental parts of the Exercises in order to ensure that the apparatus and materials obtained are satisfactory and to seek advice from AQA if there are any problems. The Instructions must be returned to safe custody at the earliest possible moment after the Supervisor has ensured that all is in order.**
- 3 Candidates are allowed 1 hour 30 minutes for each of Exercises 1 and 2.
- 4 Exercise 1 (PHB6/1) is undertaken at a time suited to the circumstances of the centre, but under examination conditions. It is preferred that all candidates at a given centre undertake Exercise 1 at the same time.
- 5 About two weeks before candidates at a particular centre undertake Exercise 1, each candidate should be given a copy of the Preliminary Material (Information for Candidates) (PHB6/PM). This gives details of the general subject area of this assessment. The information is given to all candidates so that those undertaking the assessment early are not disadvantaged.
- 6 Exercise 2 (PHB6/2) is a timetabled practical examination and should be undertaken on the stipulated day. In a centre with a large number of candidates, it may be necessary for two or more examination sessions to be organised for Exercise 2. Candidates waiting for their session must be fully invigilated in a separate room throughout the period from the time of the first session until they enter the examination room. Candidates completing their session before the published starting time for the examination must similarly be invigilated.
- 7 For Exercise 2, centres may provide sufficient sets of apparatus for half their candidates to work on Question 1, while the other half work on Question 2. Under strict supervision, the groups of candidates change over after 45 minutes. It will be necessary to allow a short period of time whilst the change over takes place. During this time the apparatus should be returned to its original state, ready for use by the next group of candidates. A similar short delay for the same purpose will be needed in centres running two or more sessions.
- 8 The exercises are **not** open-book examinations – candidates must **not** have access to textbooks, course notes, etc. However, the question papers for both exercises include the AS and A2 Formulae Sheets.
- 9 AQA will provide graph paper for both exercises. For PHB6/1 a question paper and separate 8-page answer book will be provided. For PHB6/2 a combined question paper/answer booklet will be provided. All other materials required for the assessment must be provided by the centre.

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- 10** A suitable laboratory, or laboratories, must be reserved for the practical exercises. Enough apparatus and materials must be prepared to ensure that in the case of failure of a set of apparatus, a substitute is available so that the candidate does not lose time. Unauthorised persons not involved in the preparation for the examination must not be allowed to enter. Candidates must not be admitted until the specified time for commencement of the examination. The examination room must be cleared of candidates immediately after the examination.
- 11** The apparatus and materials for each candidate must be arranged neatly, and ready to use, on the laboratory bench. No attempt should be made to connect together any parts or to wire up any electrical circuits except when specifically stated in these Instructions.
- 12** Clear instruction must be given by the Supervisor to all candidates at the beginning of each examination concerning the organisation of the examination in the laboratory and the amount of time allowed for the examination. Candidates must also be instructed that all readings must be entered in the answer book provided and all working must be shown. **Scrap paper must not be used.**
- 13** If a candidate is unable to perform any experiment, or is performing an experiment incorrectly, the Supervisor is expected to give the minimum help required to enable the candidate to proceed. In this instance, a note bearing the candidate's name and number must be attached to the candidate's script reporting to the Examiner the extent of the help given. Any failure in the apparatus should also be reported to the Examiner. **No help should be given with the analysis of the experimental data.**

It is not the wish of the Examiner that a candidate should waste time because of, for example, an incorrect electrical connection. The Examiner wishes to test the candidate's ability to perform an experiment and carry out the subsequent analysis.

- 14** Candidates' scripts **and**, where appropriate, the question papers for PHB6/1 should be collected at the end of each exercise. Under no circumstances should candidates be permitted to remove question papers from the examination room. Note that candidates will require separate sheets of A4 graph paper which should be secured to the script for the appropriate exercise using a treasury tag.
- 15** Used question papers must be returned to the safe custody of the Examinations Officer, by whom they should be retained until after the issue of results.
- 16** **Candidates' scripts for Exercise 1 must be stored securely until the stipulated date for Exercise 2. Scripts for the two exercises should be collated and sent together to the Examiner.**
- 17** If a candidate is absent on the stipulated date for Exercise 2, their script for Exercise 1 should still be sent to the Examiner. The flexibility in the timing for Exercise 1 should make it possible for all candidates to be given an opportunity to undertake Exercise 1.
- 18** The Supervisor is required to report details concerning the experiment, apparatus or materials to the Examiner on the *Supervisor's Report* located at the end of this document. ***This Supervisor's Report must be attached to the topmost script before despatch to the Examiner.***

Details must be given on the *Supervisor's Report* if the apparatus or materials provided differ from that detailed in this document. Where specific information or data about apparatus or materials is

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requested in these Instructions, it is important that it is given accurately. In some cases it may represent the only means available to the Examiner of assessing the accuracy of a candidate's work.

Centres may make copies of this *Supervisor's Report* for attachment to individual scripts if necessary. If all the information cannot easily be included on the *Supervisor's Report*, separate sheets of paper, bearing the candidates' names and numbers, can be attached to the relevant candidates' scripts.

In case of difficulty the Supervisor should telephone the Senior Subject Officer for A Level Physics, David Baker, at AQA (Manchester Office), telephone number 0161 953 1180, or e-mail [dbaker@aqa.org.uk](mailto:dbaker@aqa.org.uk).

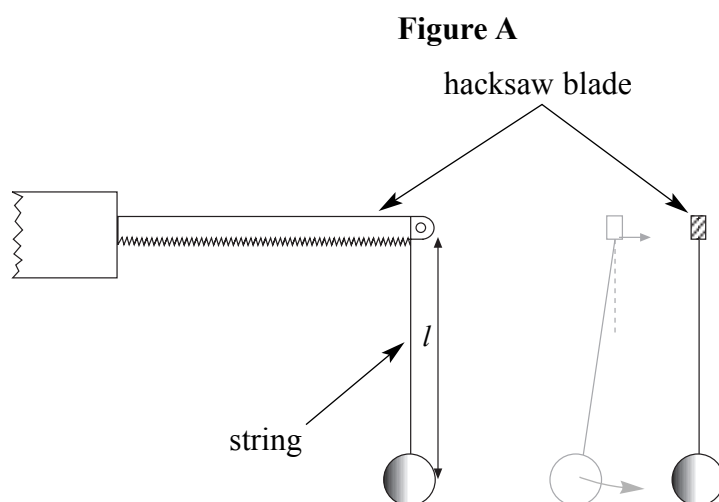
## Exercise 1

Candidates will be required to make measurements of the period of a pendulum.

### Apparatus and materials

- (a) pendulum bob tied to a suitable thread of length 70 cm
- (b) hacksaw blade
- (c) two small blocks of wood
- (d) suitable rigid clamping arrangements for the wooden blocks
- (e) stopclock or stopwatch, reading to 0.01 s
- (f) metre ruler

Figure A shows the arrangement.



The hacksaw blade should be sandwiched between the wooden blocks which should be clamped firmly together either using a retort stand, boss and clamp standing on the bench, or a G-clamp fixed rigidly to the bench. 25 cm of the blade should protrude beyond the edges of the wooden blocks. The teeth of the blade should be left exposed and facing downwards as this helps the candidates to define the length of the thread accurately. They are warned about the safety aspects of the blade in the question paper.

Candidates should meet the apparatus with the pendulum bob and thread lying on the bench; they are required to attach the pendulum to the blade themselves. **Figure A** shows the arrangement of the apparatus whilst the candidates are taking readings.

When the pendulum is 50 cm long, the free end of the hacksaw blade needs to deflect with an amplitude of about 1.5 cm. The mass of the pendulum bob should be chosen to produce this effect and the bob mass will depend on the stiffness of the hacksaw blade.

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## Exercise 2

### Question 1

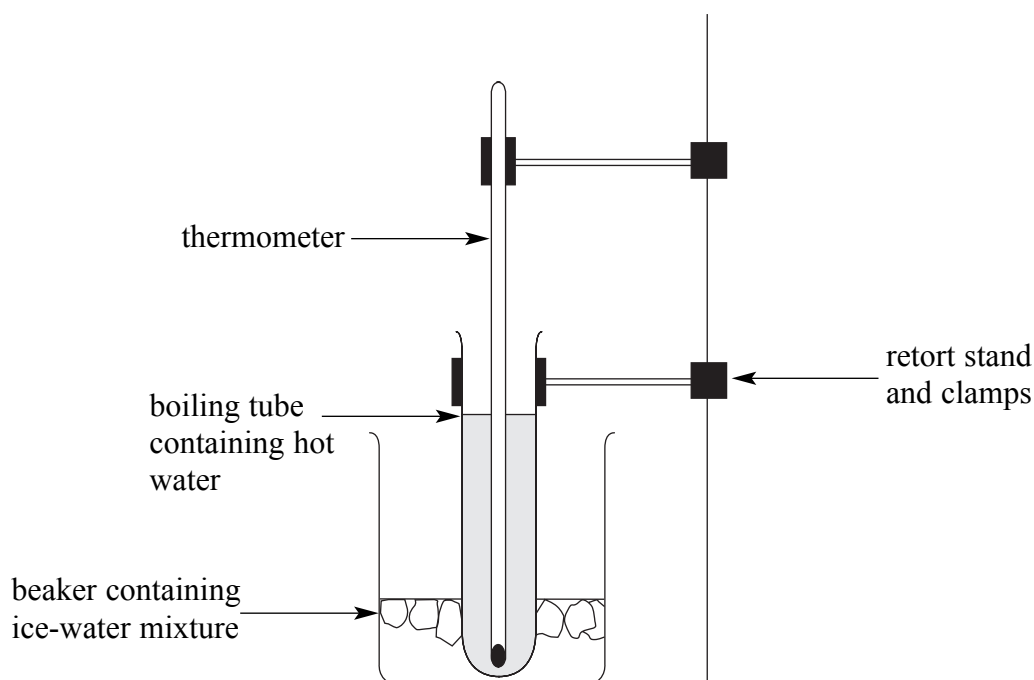
Candidates will be required to record the variation of temperature with time for a mass of water.

#### Apparatus and materials

- (a) boiling tube that can hold 40 ml of water
- (b) 250 ml glass beaker
- (c) retort stand, 2 bosses and 2 clamps
- (d) stopclock or stopwatch
- (e) about 100 ml of an ice–water mixture
- (f) about 40 ml of hot water
- (g)  $-10$  to  $100^{\circ}\text{C}$  thermometer

The general arrangement is shown in **Figure B**.

**Figure B**



Candidates should meet the apparatus with the beaker containing the ice–water mixture, and the boiling tube and the thermometer already clamped in their stand in the beaker. The boiling tube should almost rest on the bottom of the beaker. The thermometer should not quite touch the bottom of the boiling tube.

Candidates are instructed to ask for their hot water only when they are ready to begin taking readings. At this point the supervisor should add about 40 ml of hot water at 70 °C to the boiling tube. Hot water is most conveniently provided with a water bath but any other arrangement is equally acceptable. It is also convenient to pre-mark the 40 ml level on the side of the tube with tape or wax crayon. However, the bottom of the manufacturer's brand logo is at about the 40 ml mark on a number of boiling tubes on the market.

Supervisors from centres with large numbers of candidates may wish to obtain help to provide the hot water quickly for the candidates.

Candidates should **not** be provided with a means for stirring the water.

## Question 2

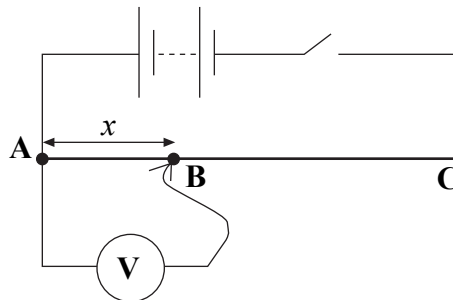
Candidates will be required to take measurements from a metre length of constantan wire.

### Apparatus and materials

- (a) 1.10 m length of 26 SWG (0.457 mm diameter) constantan wire attached along the length of a metre ruler
- (b) means to achieve an electrical connection at each end of the wire and at point **B**
- (c) variable power supply capable of supplying 3 V dc
- (d) SPST switch
- (e) dc voltmeter, suitable for measuring in the range 0 - 3.0 V, digital or analogue
- (f) 1.5 V cell in a suitable holder
- (g) 1.25 V, 0.05 A filament lamp in a suitable holder
- (h) connecting leads

The initial circuit arrangement is shown in **Figure C**. The bulb and cell are not used initially.

**Figure C**



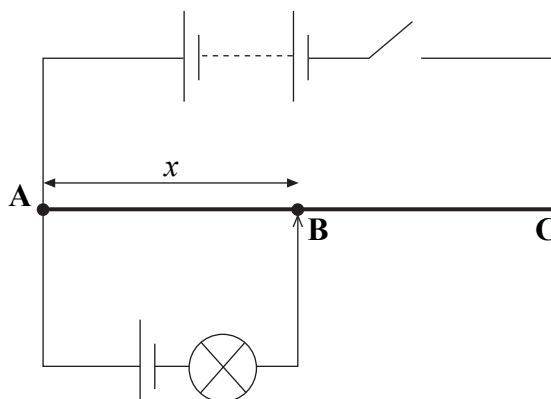
The candidate should meet the circuit set up but switched off. If a digital voltmeter is used, it should be switched on. The power supply should be pre-set to a value where the reading on the voltmeter is 1.5 V at about half way along the wire. Alteration of the supply setting by the candidate should not be possible.

A number of ways of attaching the wire to the metre ruler are possible and this is at the discretion of the centre. In trials, the wire was attached at four points along the ruler with sellotape and connections were achieved with crocodile clips, however centres that still retain potentiometers may wish to use them. Another alternative is to mount the wire on a length of wood using 4 mm pillar-mounted terminal sockets and to attach either a ruler or a printed scale to the wood. The connection at **B** can be conveniently made using a crocodile clip or a traditional sliding connection (jockey).



During the experiment candidates are instructed to remove the voltmeter connection at **A** and replace it with a cell and bulb combination (**Figure D**).

**Figure D**



The cell–bulb combination between **A** and **B** should be pre-wired for candidates and there should be no possibility of the cell being reversed by the candidate or the combination being wired up incorrectly. The use of a 4 mm plug (labelled **A**) in the cell lead and a crocodile clip at **B** will help to avoid this. Equally, securing the connection between cell and bulb so that it cannot be easily taken apart will also help.

**END OF TEACHERS NOTES**

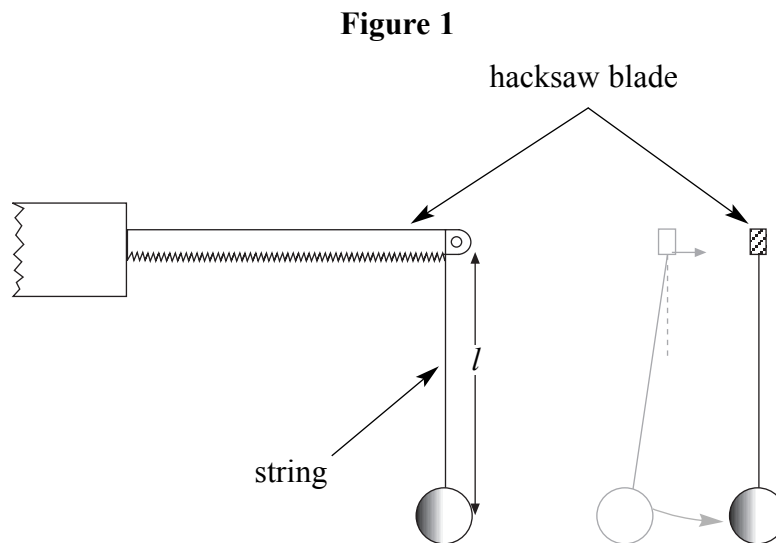
### Exercise 1

- 1 This question is about a pendulum swinging from a non-rigid support.

You are provided with a pendulum bob which can be attached by a length of thread to the end of a flexible hacksaw blade.

Set up a pendulum suspended from the hacksaw blade as shown in **Figure 1**. You should attach the thread to the blade at the point where the teeth begin.

The teeth of the hacksaw blade have been left unprotected as this will help you to define the length of the thread accurately. However you should take care when using the arrangement because of the danger from the sharp edges.



Set the length,  $l$ , of the pendulum (measured to the centre of the bob) to 0.50 m.

- (a) Displace the pendulum bob as shown in **Figure 1** and allow it to swing as a pendulum. The hacksaw blade will also move from side to side with the same time period as the pendulum. If there is an additional fast vibration of the blade, damp this out with your finger on the blade without touching the pendulum thread itself.

Determine the period of oscillation of the pendulum bob for small amplitude oscillations. (2 marks)

- (b) (i) Calculate the time period for a simple pendulum of length 0.50 m attached to a rigid support.  
gravitational acceleration =  $9.8 \text{ m s}^{-2}$
- (ii) Comment on the values you have obtained in parts (a) and (b) (i) and explain any differences between them. (5 marks)

- (c) The displacement of the bob,  $x$ , from its equilibrium position is related to the time since the start of the motion,  $t$ , by the relationship

$$x = A \cos \omega t$$

- (i) Explain the significance of  $A$ .
- (ii) Name the physical quantity represented by  $\omega$  and explain its meaning. (4 marks)
- (d) You are to take measurements of the time period,  $T$ , of the pendulum for a range of lengths of the pendulum sufficient to plot a graph.
- (i) Record all your measured values in an appropriate table. You should include a further column in your table in which to record values of  $T^2$ .
- (ii) Calculate and record corresponding values of  $T^2$  in your table. (13 marks)
- (e) Plot a graph of  $T^2$  (y-axis) against  $l$  (x-axis). (5 marks)
- (f) It is suggested that  $T$  is related to  $l$  by the relationship

$$T^2 = \frac{4\pi^2}{g} l + \frac{4\pi^2}{g} k$$

where  $g$  is the gravitational acceleration and  $k$  is a constant.

Use your graph to calculate a value for  $g$ . (5 marks)

- (g) (i) Calculate  $k$ .
- (ii) State the S.I. unit of  $k$ .
- (iii) Suggest the physical significance of  $k$ . (5 marks)

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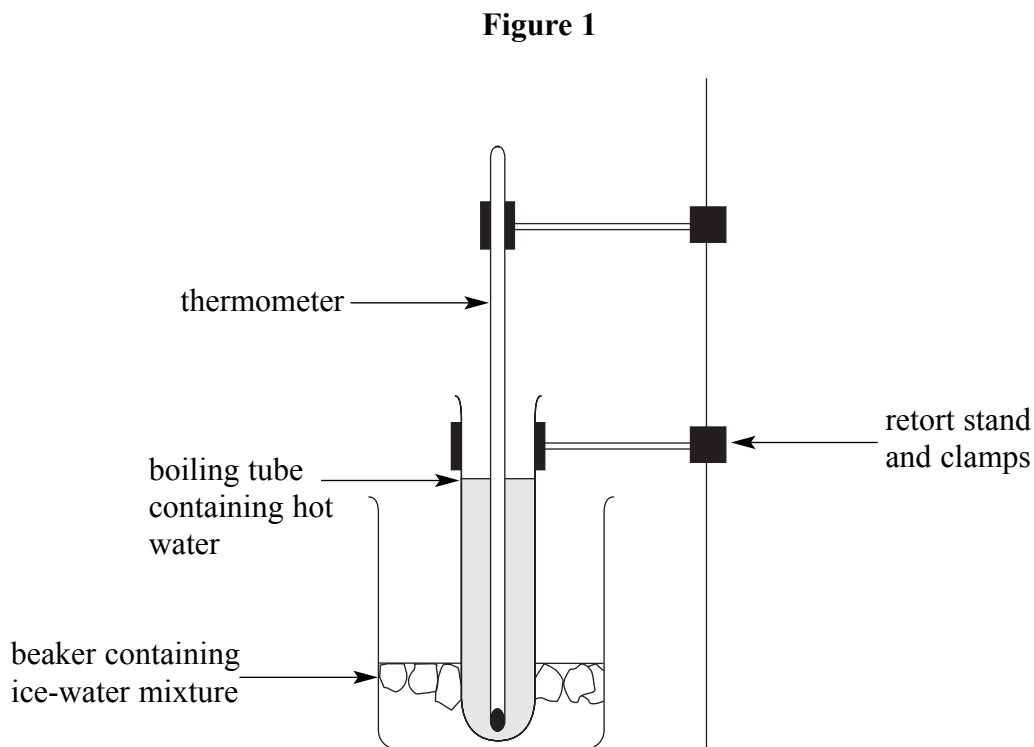
## Exercise 2

- 1 This question is about the way in which a hot body can be cooled by melting ice.

You will be provided with about 0.04 kg of water at a temperature of about 70 °C in a boiling tube mounted in a beaker containing an ice-water mixture at 0 °C.

When you are ready to begin, ask your supervisor for your hot water.

**Figure 1** shows how the arrangement should look whilst you take readings.



- (a) Start the stopclock and take readings of the temperature every 15 s for 2 minutes.  
**You are not required to repeat the readings.**
- (b) It is suggested that under certain conditions the temperature of the water falls exponentially with time.
- (i) Describe a technique that can be used to test this suggestion.
  - (ii) Use the proposed technique to test whether your data obey the suggestion that the temperature falls exponentially with time.
  - (iii) State your conclusion clearly.
- (c) You were provided with  $40 \pm 5$  g of hot water. Assume that all the energy required to melt the ice in the beaker was supplied by the cooling water in the boiling tube.

*(4 marks)*

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Calculate the mass of ice that melted during your experiment from the moment you began timing until you took the last reading. Set out the steps in your calculation clearly.

specific heat capacity of water	= $(4.2 \pm 0.1) \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$	
specific latent heat of melting of ice	= $(3.4 \pm 0.1) \times 10^5 \text{ J kg}^{-1}$	(3 marks)

- (d) (i) Estimate the absolute uncertainty in one of your temperature readings.
- (ii) Estimate the absolute uncertainty in the temperature difference between the first and last readings from your table in part (a).
- (iii) Estimate the percentage uncertainty in your answer to part (c). (4 marks)
- (e) Suggest changes to this experiment that will allow the estimate of the mass of ice melted by the hot water to be improved. In your answer, you should consider changes to the apparatus, the experimental method and the analysis.

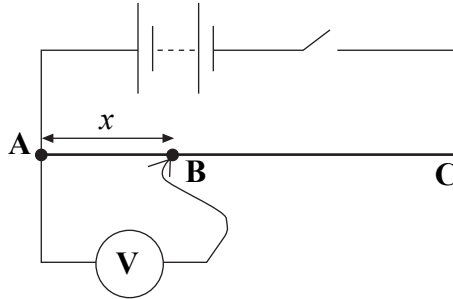
Two of the 8 marks are available for the quality of your written communication. (8 marks)

**Turn over for the next question**

**Turn over ►**

- 2 **Figure 2** shows a diagram of the circuit that has been set up for you. The connection between the voltmeter and the wire **AC** is made using a lead terminating in a crocodile clip.

**Figure 2**



**Switch on the circuit.**

- (a) (i) Take and record readings that will enable you to sketch a graph of the potential difference  $V_{AB}$  against  $x$  where  $V_{AB}$  is the potential difference between points **A** and **B** and  $x$  is the length of wire between **A** and **B**.

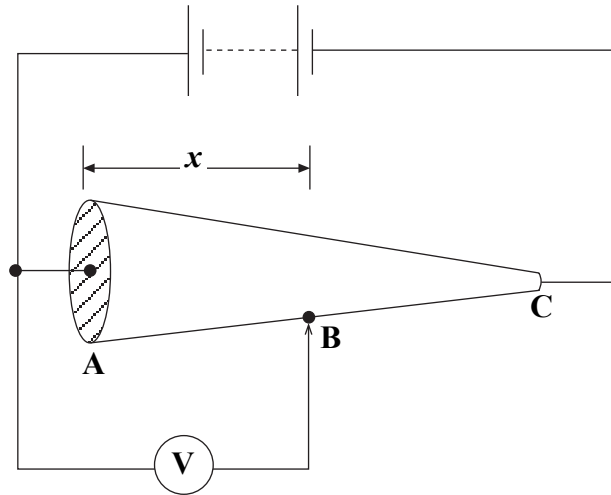
**Switch off the circuit when you have finished making measurements.**

- (ii) Without plotting points, sketch a graph to show the relationship between  $V_{AB}$  and  $x$ . (5 marks)
- (b) Your wire has a uniform cross-sectional area of  $1.7 \times 10^{-7} \text{ m}^2$  and a resistivity of  $4.5 \times 10^{-7} \Omega \text{ m}$ .

Calculate the resistance of 0.010 m of the wire. (2 marks)

- (c) You are now to consider what would happen if the uniform wire in part (a) were to be replaced with a tapered wire of circular cross-section as shown in **Figure 3**.

**Figure 3**



- (i) Draw another line on your sketch in part (a) (ii) to show the new relationship you would expect between  $V_{AB}$  and  $x$ . Label this line clearly **TAPER**. You should assume in your answer that the power supply has **no** internal resistance.
- (ii) Explain why this second line has the shape you have drawn. (4 marks)

**Turn over for the next question**

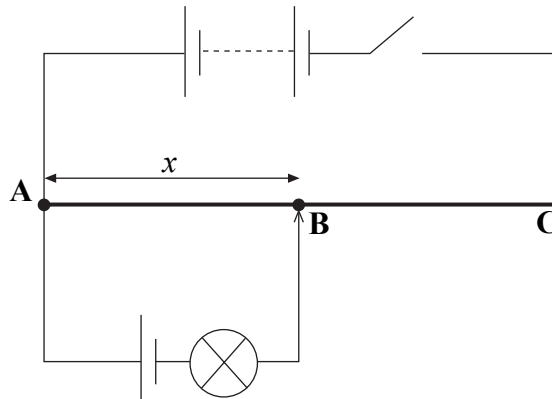
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- (d) Now remove the voltmeter from the circuit by disconnecting the lead at **A**.

You have also been supplied with a 1.5 V cell and a light bulb that have already been connected together. Do not attempt to separate the cell and bulb.

Connect the free lead attached to the cell to point **A**. **Figure 4** shows the circuit diagram for the final arrangement.

**Figure 4**



**Switch the circuit on before you begin to take readings.**

Make a connection to the wire with the crocodile clip near the middle of the wire (the exact position does not matter). The bulb should not light at this position.

- (i) **Reduce**  $x$  in steps of about 0.05 m until the bulb just begins to glow.

Record the value of  $x$  between 0 and 0.5 m at which the bulb just begins to glow.

- (ii) Return the clip to the middle of the wire and this time **increase**  $x$  in steps of about 0.05 m until the bulb just begins to glow.

Record the value of  $x$  between 0.5 m and 1.0 m at which the bulb just begins to glow.

*(1 mark)*

**Switch the circuit off.**

- (e) Explain why the bulb does not light when the connection is made in the centre of the wire. Go on to explain the behaviour of the circuit as the connection is moved from one end of the wire to the other.

Two of the 7 marks are available for the quality of your written communication. *(7 marks)*



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General Certificate of Education  
June 2007  
Advanced Level Examination

**PHYSICS (SPECIFICATION B)  
UNIT 6**

**PHB6/TN**

**SUPERVISORS REPORT**

**Your attention is drawn to paragraph 18 on page 3 of these Instructions**

**When completed by the Supervisor, this Report must be attached firmly to the topmost script, before despatch to the Examiner.**

**Information to be provided by the centre**

**Exercise 1:** Typical values for the period of the pendulum-hacksaw combination when the length of the pendulum is 50 cm

**Exercise 2:**

**Question 1:** No information required

**Question 2:** Typical values of  $x$  at which the bulb just begins to glow in part (d)

**Comments:**

Supervisor's Signature.....

Centre Number .....

Date .....

Centres may make copies of this Supervisor's Report for attachment to individual scripts where necessary.

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