General Certificate of Education
June 2008
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) **PHB3/TN**

Instructions to Supervisors

CONFIDENTIAL

OPEN ON RECEIPT

The examination will be held on Wednesday 14 May 2008 1.30 pm to 3.30 pm.

- It is the responsibility of the Examinations Officer to ensure that these *Instructions to Supervisors* are given immediately to the Supervisor of the practical examination.
- These instructions are provided to enable centres to make appropriate arrangements for the examination.
- These instructions explain how to set up the equipment for all questions.
- The questions are printed in these instructions.
- Centres are at liberty to make any reasonable minor modifications to the apparatus which may be required for the successful working of the experiment but a note of all such modifications must be noted on the *Supervisor's Report*. Any such modifications must permit the experiment to be carried out in the specified manner.

INSTRUCTIONS TO THE SUPERVISOR OF THE PRACTICAL EXAMINATION

General

1 These instructions and details of materials contained in this document are for the use of the Supervisor and **are strictly confidential**. In no circumstances should information concerning the content of this document, apparatus or materials be given before the examination to a candidate or other unauthorised person. 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).

Using information for any purpose beyond that permitted in this document is potentially malpractice. Guidance on malpractice is contained in the JCQ document *Suspected Malpractice in Examinations and Assessments: Policies and Procedures*.

2 The Supervisor has been granted access to the questions in PHB3 to aid the practical set up as part of these instructions. This is 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. These instructions must be returned to safe custody at the earliest possible moment after the Supervisor has ensured that all is in order.

3 In a centre with a large number of candidates it may be necessary for two or more examination sessions to be organised. 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.

4 A suitable laboratory, or laboratories, must be reserved for the examination and kept locked throughout the period of preparation. Unauthorised persons not involved in the preparation for the examination must not be allowed to enter. Candidates completing their session before the published starting time for the examination must be similarly invigilated.

5 The examination paper contains three compulsory questions. Candidates are allowed 30 minutes on each of Questions 1 and 2, and 1 hour on Question 3.

6 Centres may provide sufficient sets of apparatus for half their candidates to work on Questions 1 and 2, while the other half work on Question 3. Under strict supervision, the groups of candidates change-over after 1 hour. 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.

Whatever arrangement is adopted, 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.

7 AQA will provide the question paper/answer books and A4 graph paper for use in Question 3. All other materials required must be provided by the centre.

8 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 wire up any electrical circuits except when specifically stated in these instructions.

9 Clear instruction must be given by the Supervisor to all candidates at the beginning of the examination concerning the organisation of the examination in the laboratory and the amount of time allowed for each question. Candidates must also be instructed that all readings must be entered in the question paper/answer book provided and all working must be shown. **Scrap paper must not be used**.

10 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. **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.

Any failure in the apparatus should also be reported to the Examiner.

11 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 those detailed in this document. Where specific information or data about apparatus or materials is 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 be included on the *Supervisor's Report*, separate sheets of paper, bearing the candidate's name and number, can be attached to the relevant candidate's script.

12 Note that candidates will require a separate sheet of A4 graph paper for Question 3. The graph paper for each candidate should be secured to their question paper/answer book using a treasury tag before despatch to the Examiner.

In case of difficulty the Supervisor should telephone the Assistant Subject Officer for GCE Physics, Philip Bridgehouse at AQA (Manchester Office), telephone 0161 953 1180,
or email physics-gce@aqa.org.uk.

Question 1

Candidates will be required to use a diffraction grating to measure the wavelength of the red light emitted by a filament lamp.

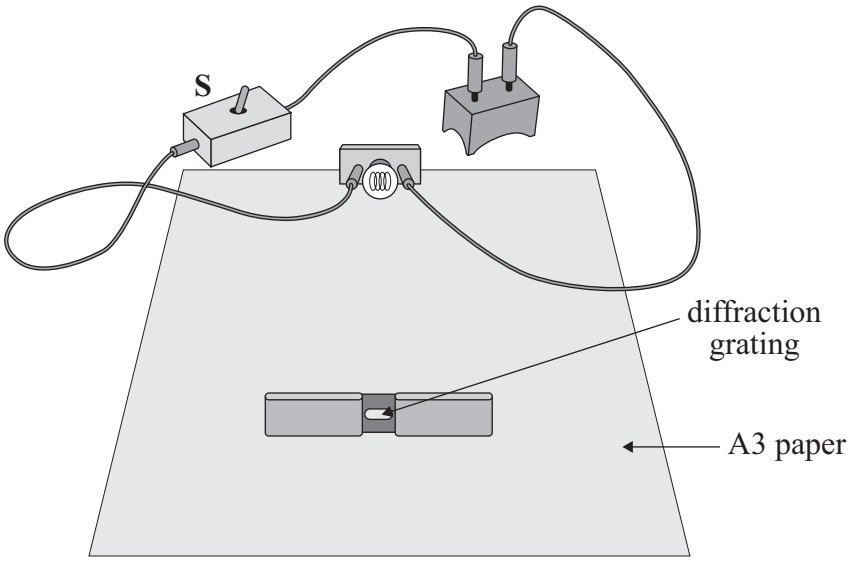
Apparatus and materials

The following items should be supplied for each candidate:

(a) mes filament lamp and power supply (e.g. 1.5 V, 200 mA with a 1.5 V cell)
(b) switch labelled **S**
(c) supply of connecting leads
(d) transmission diffraction grating of between 80 and 600 lines mm^{-1}
(e) two optical pins
(f) piece of soft board or thick cardboard approx A3 dimensions
(g) sheet of plain A3 paper attached to item (f) so as to prevent movement (a fresh sheet must be supplied for each candidate)
(h) 30 cm ruler
(i) supply of Blu-Tack
(j) card labelled with number of lines per mm of grating used
e.g. "number of lines per mm on grating = 300"

The apparatus should be provided set up as shown in **Figure A**. The grating should be positioned approximately 20 cm from the lamp using Blu-Tack. Initially the switch should be in the off position. The lamp holder should be firmly fixed in place.

Figure A



NB It is unnecessary for candidates within a centre to each have a grating with the same spacing.

If a grating with more than one window is to be used the outer windows should be covered up.

Question 2

Candidates will be required to make measurements to allow them to estimate the resistivity of a metal and observe how it changes as the temperature is increased.

Apparatus and materials

The following items should be supplied for each candidate:

(a) approximately 2 m length of plastic coated *garden wire** with ends bared
(b) approximately 10 cm length of dowel of diameter approximately 10 mm
(c) digital multimeter
(d) switch
(e) two connecting leads, each with one end terminated by a crocodile clip
(f) glass beaker
(g) supply of hot water (with temperature about 70 °C)
(h) liquid in glass thermometer
(i) card labelled with diameter of wire in mm to one decimal place e.g. "diameter of wire = 1.1 mm"
(j) ruler

50 turns of the wire should be carefully wound around the dowel without any over-wrapping; the two bared ends should be exposed so as to allow connections to the multimeter to be made using the crocodile clips. The connections must be made outside the water to avoid a short circuit occurring. The beaker should be of a size suitable to allow the coiled wire to be immersed in water leaving the bared ends above the water surface.

The multimeter should be supplied switched off. Candidates should be told which scale to use (e.g. 200 Ω scale).

Candidates should be supplied with the hot water on request.

**Garden wire* can be obtained from garden centres and stores such as Woolworths and Tesco – it is normally used for tying up plants and is covered in green plastic.

Question 3

Candidates will be required to investigate oscillations of a bent wire.

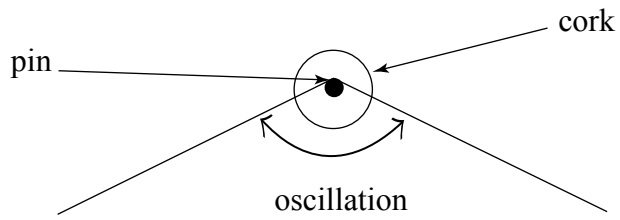
Apparatus and materials

The following items should be supplied for each candidate:

(a) 30 cm length of thick wire (such as used for a metal coat hanger)
(b) protractor
(c) cork
(d) large optical pin
(e) half-metre ruler
(f) stopwatch or stopclock with minimum precision of 0.1 s
(g) retort stand, boss and clamp
(h) supply of A4 paper for finding θ

The pin should be inserted into the cork and clamped in a manner to allow the wire to oscillate in a vertical plane as shown **Figure B**.

Figure B



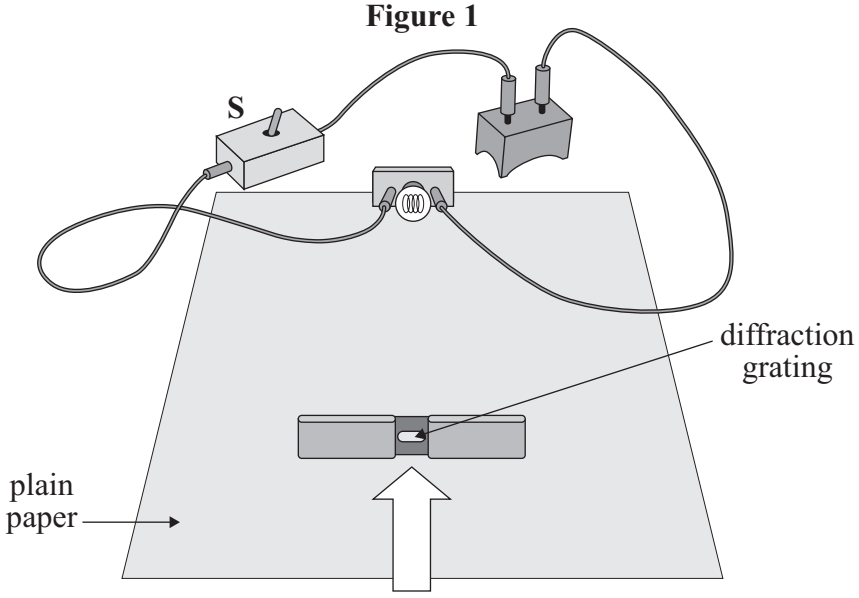
If stiff wire is used it is permissible to use pliers to score the centre of the wire to allow easy bending without the wire snapping. Thick copper wire may be used if desired. The wire should be provided unbent.

Items (a) and (h) should be replaced for each candidate using the apparatus.

1 You are going to use a diffraction grating to measure the wavelength of the red light emitted by a filament lamp.

The arrangement shown in **Figure 1** is set up for you.

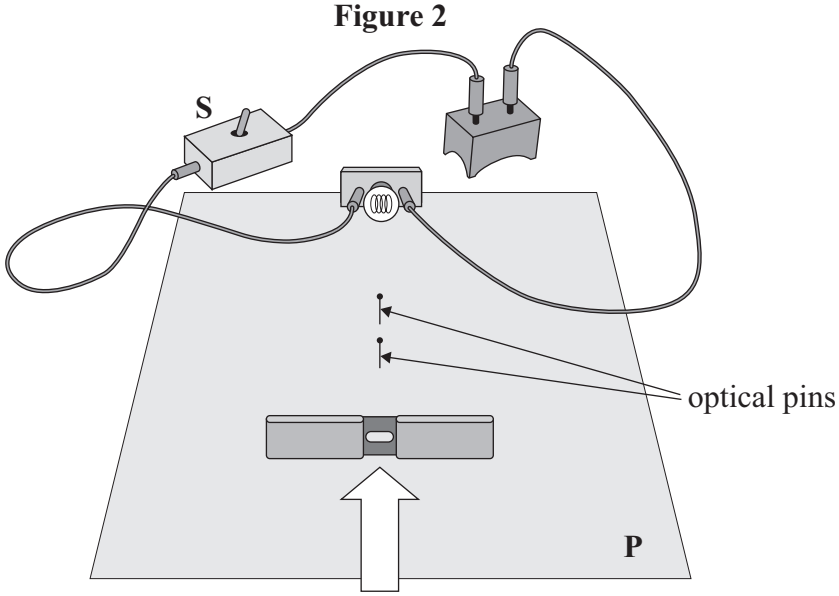
Figure 1



1 (a) (i) Close the switch **S** and look at the filament lamp through the diffraction grating.

Describe what you see.

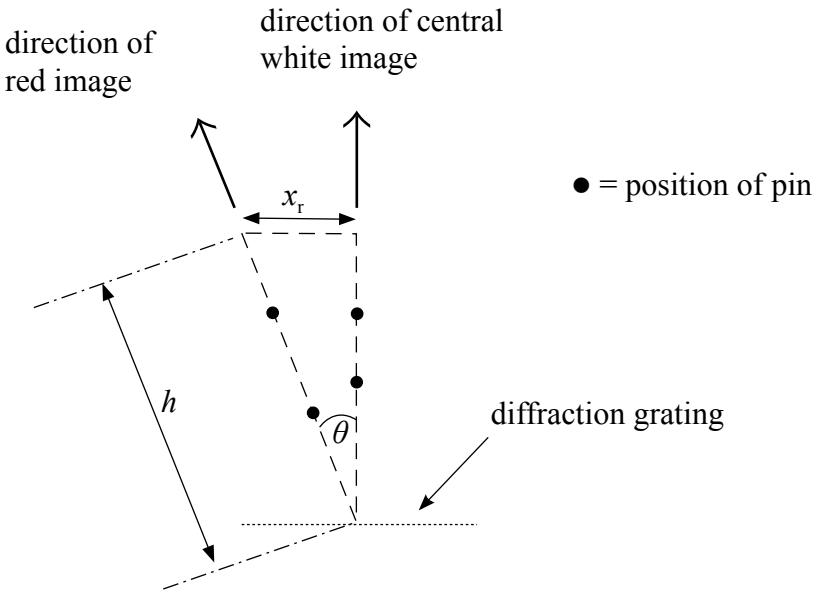
Figure 2



1 (a) (ii) Stick a pair of optical pins into the paper so that they are lined up with the central white image of the filament of the lamp when viewed through the grating as shown in **Figure 2**. Remove the pins, making sure that their positions are clearly marked.

1 (a) (iii) Using the pins again, line them up with the centre of the first order red image on one side of the filament image viewed in part (a)(ii). Again make sure that the pin positions are clearly marked.

Figure 3



1 (a) (iv) Remove the lamp, grating and pins. Using the position of the pins marked in parts (a)(ii) and (a)(iii) draw a right angled triangle on the paper **P** as shown in **Figure 3**.

1 (a) (v) Showing your working clearly calculate a value for sin θ where θ is the angle shown in **Figure 3**.

1 (a) (vi) Using the diffraction grating equation, calculate the wavelength of the red light emitted by the filament lamp.

The number of lines per mm for your grating is given on the card next to your apparatus. *(9 marks)*

1 (b) (i) Estimate the absolute uncertainties in x_r and h shown in **Figure 3**.

1 (b) (ii) Calculate the percentage uncertainties in these quantities.

1 (b) (iii) Calculate the percentage uncertainty in your calculated wavelength for red light. Neglect any uncertainty in the grating spacing. *(5 marks)*

1 (c) Suggest and explain **two** changes to the experiment you have performed in part (a) that would improve the reliability of your measurement of the wavelength.

Two of the 6 marks in this question are available for the quality of your written communication. *(6 marks)*

2 You are going to make measurements to allow you to estimate the resistivity of a metal and observe how it changes when the temperature is increased.

2 (a) Use the multimeter to measure the resistance R of the wire. Record R. *(1 mark)*

2 (b) (i) The wire has been wound on a wooden rod. Use a ruler to measure the diameter d of the rod. Record your value.

2 (b) (ii) There are 50 turns of wire on the rod.
Use your measurement of d to estimate the length l of the sample of wire.
Show your working.

2 (b) (iii) State whether your estimate is likely to be too large or too small.
Give **two** reasons to support your statement. *(5 marks)*

2 (c) Resistivity is given by the equation $\rho = \frac{RA}{l}$.

2 (c) (i) State the meaning of the symbols in this equation.

2 (c) (ii) The diameter of your wire is given on a card near your apparatus. Use this value and the measurements you made earlier to estimate the resistivity of the metal.
(3 marks)

2 (d) (i) Measure and record the room temperature.

2 (d) (ii) Reconnect the multimeter to the ends of the sample of wire. Fully immerse your sample of wire in the hot water provided by the Supervisor, making sure that the crocodile clip connections are above the water surface.
Record the new resistance of the wire and the temperature of the water.
Do not repeat these readings.

2 (d) (iii) From your data in parts (a), d(i) and d(ii), sketch a graph to suggest how the **resistivity** of the metal changes with temperature.

2 (d) (iv) State the limitations of your sketch graph and go on to explain, in terms of charge carriers, why you expected the resistivity to change with temperature.

Two of the 6 marks in this part of this question are available for the quality of your written communication.
(10 marks)

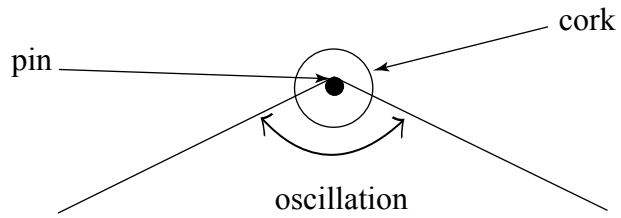
3 You are to investigate oscillations of a bent wire.

3 (a) Measure and record the length, L, in metres of the wire when it is straight.

(3 marks)

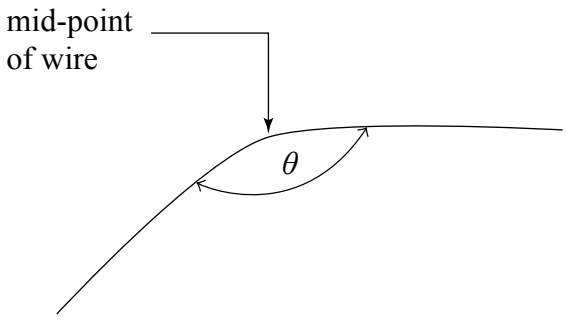
3 (b) Carefully bend the wire at its mid-point to form an angle θ of approximately 140° as shown in **Figure 4**.

Figure 4



3 (b) Trace the shape of your wire onto a separate sheet of paper. Remove the wire and use a ruler to construct lines which will help you to measure θ as shown in **Figure 5**. Measure and record your value for θ.

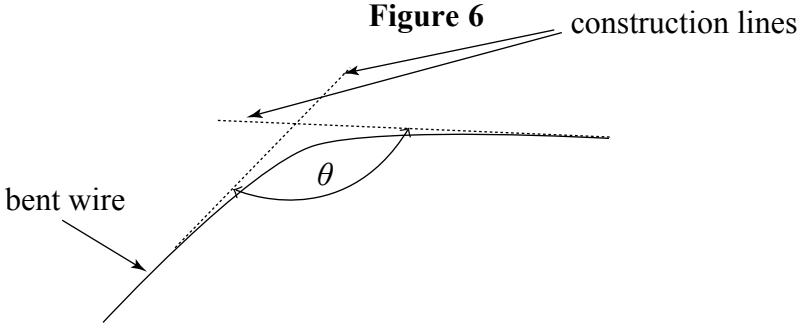
Figure 5



(1 mark)

3 (c) Suspend the wire so that it balances on the horizontally clamped pin as shown in **Figure 6.** Displace and release it so that it oscillates in the way shown in **Figure 6**.

Figure 6



3 (c) (i) Take and record appropriate readings and find the period of oscillation, T, of the wire at the angle measured in part (b).

3 (c) (ii) Explain how you made sure that your value for T was accurate.

(4 marks)

3 (d) In the space below construct a table in which to record all the readings you need to obtain 6 sets of values of θ (as shown in **Figure 5**) and T.
Include further columns in your table or draw a second table to include T^2, $\cos\frac{\theta}{2}$ and where $\frac{\theta}{2}$ is half the angle of the bend in the wire. *(4 marks)*

3 (e) Take the readings to complete the table. You should include your original values for θ and T. Your range of values of θ should vary between 140° and 60°. You are advised to use additional values of θ of approximately 130°, 115°, 100°, 80° and 60°. **The exact values are not critical.** *(13 marks)*

3 (f) Plot a graph of T^2 (along the y-axis) against $\frac{1}{\cos\frac{\theta}{2}}$

You should use a false origin for each axis.
Draw the best straight line through your plotted points. *(7 marks)*

3 (g) (i) Calculate the gradient of your line.

3 (g) (ii) The relationship between T and θ can be written in the form

$$T^2 = 4\pi^2 k\left(\frac{1}{\cos\frac{\theta}{2}}\right)$$

By comparing this equation with the equation of a straight line
$y = mx + c$, use your value for the gradient to calculate a value for k.

3 (g) (iii) State the unit for k. *(6 marks)*

3 (h) Consider the points on your plotted graph and explain why values of θ suggested in part (e) were not equally spaced.

(1 mark)

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PHYSICS (SPECIFICATION B) **PHB3/TN**
Unit 3

SUPERVISOR'S REPORT

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

Question 1 number of lines per mm of grating provided (by candidate if different)

Question 2 typical resistance of 50 turns of wire at room temperature

Question 3 No information is required

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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