General Certificate of Education
Advanced Level Examination
June 2011

Physics PHA6/B6/XTN
(Specifications A and B)

Unit 6 Investigative and Practical Skills in A2 Physics
Route X Externally Marked Practical Assignment (EMPA)

Instructions to Supervisors
Confidential

To be given immediately to the teacher(s) responsible for GCE Physics

Open on receipt

- **These instructions are provided to enable centres to make appropriate arrangements for the Unit 6 Externally Marked Practical Assignment (EMPA).**
- **It is the responsibility of the Examinations Officer to ensure that these *Instructions to Supervisors* are given immediately to the Supervisor of the EMPA.**

INSTRUCTIONS TO THE SUPERVISOR OF THE EXTERNALLY MARKED PRACTICAL ASSIGNMENT

General

Security / confidentiality

The instructions and details of the EMPA materials are strictly confidential. In no circumstances should information concerning apparatus or materials be given before the examination to a candidate or other unauthorised person.

The EMPA supplied by AQA at AS and at A2 for a given academic year must only be used in that academic year. It may be used for practice in later academic years.

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.

The Examinations Officer should give copies of the Instructions to Supervisors (PHA3/B3/XTN and/or PHA6/B6/XTN) to the teacher entrusted with the preparation of the examination upon receipt.

Material from AQA

For each EMPA, AQA will provide:

- *Instructions to Supervisors*
- Section A Part 1 and Part 2 question paper/answer booklets
- Section B EMPA written test papers.

Preparation / Centre responsibility

This practical assessment should be carried out after candidates have acquired the necessary skills and after the appropriate sections of the specification have been taught so that candidates are familiar with any specialist apparatus involved.

The assessment must be carried out between the dates specified by AQA.

It is the responsibility of the centre to ensure that each of the specified practical activities works with the materials provided to the candidates.

The assessment and management of risks are the responsibility of the centre.

Practical Skills Verification (PSV)

Candidates must undertake the five practical activities specified, in order for them to demonstrate in the EMPA that they can use apparatus appropriate to the teaching of Physics at this level. In doing so, candidates will be familiar with the equipment and skills they will use in the EMPA. The teacher must confirm on the front cover of the Section B Written Test that this requirement has been met.

Section A: Part 1 and Part 2

- Candidates should work individually and be supervised throughout. They should not discuss their work with other candidates at any stage.
- The work can be carried out in normal timetabled lessons and at a time convenient to the centre. Teachers will be in the best position to judge how many sessions are appropriate for candidates in their own centre.
- The candidates' work must be handed to the teacher at the end of each practical session and kept securely until the next stage of assessment.
- There is no specified time limit for Part 1 or Part 2 of Section A, however candidates should be informed by the Supervisor of the expected timescale and timetable arrangements involved in carrying out the EMPA. Candidates must also be instructed that all readings must be entered in the question paper/answer booklet provided and all working must be shown. **Scrap paper must not be used.**

Sharing equipment / working in groups

Candidates are to work individually. Where resources mean that equipment has to be shared, the teacher should ensure that the candidates complete the tasks individually. Where appropriate, spare sets of apparatus should be prepared to ensure that time is not lost due to failure of equipment.

Centres may choose to provide sufficient sets of apparatus for the candidates to work on Section A in a circus format with some candidates completing the questions in reverse order. In such cases the changeover should be carefully supervised and the apparatus returned to its original state before being used again.

Practical sessions

Before the start of the test the apparatus and materials for each candidate should be arranged, ready for use, on the bench. The apparatus should not be assembled unless a specific instruction to do so is made in these Instructions.

If a candidate is unable to perform any experiment, is performing an experiment incorrectly, or is carrying out some unsafe procedure, the Supervisor is expected to give the minimum help required to enable the candidate to proceed. In such instances, the *Supervisor's Report* should be completed with the candidate's name and number, reporting to the Examiner the nature and extent of the assistance given. No help may be given to candidates unable to proceed with the analysis of their experimental data.

Any failure of equipment that, in the opinion of the Supervisor, may have disadvantaged any candidate should be detailed in the *Supervisor's Report*.

Turn over ►

Section B: EMPA written test

- The Section B EMPA written test should be taken as soon as convenient after completion of Section A.
- This test must be carried out under controlled conditions and must be completed in a single uninterrupted session.
- When carrying out the Section B EMPA written test, candidates should be provided with their completed copy of Section A Part 2 question paper/answer booklet.
- Supervisors should ensure that candidates understand that Section A Part 2 is for reference only and they must not make any written alterations to this previous work while undertaking Section B.
- The duration of the Section B EMPA written test is 1 hour 15 minutes except where candidates have been granted additional time by AQA.

Administration

Candidates must not bring any paper-based materials into any session or take any assessment materials away at the end of a session. Mobile phones or other communication devices are not allowed.

Modifications

The equipment requirements for the experimental tasks are indicated in these Instructions. Centres are at liberty to make any reasonable minor modificiations to the apparatus which may be required for the successful working of the experiment but it is advisable to discuss these with the Assessment Advisor or with AQA. A written explanation of any such modification must be given in the *Supervisor's Report*.

Absent candidates

Candidates absent for any Part of Section A should be given an opportunity to carry out the Practical exercises before attempting the Section B EMPA written test. In extreme circumstances, when such arrangements are not possible, the teacher can supply a candidate with class data. In this case, there will be no evidence for Part 1 or Part 2, so no marks can be awarded for Section A.

Redrafting

Candidates may make only one attempt at a particular EMPA and redrafting is **not** permitted at any stage during the EMPA.

The Supervisor's Report

Details should be given on the *Supervisor's Report* (page 23) if

- any part of the equipment provided differs significantly from that specified in these Instructions
- any help is given to candidates in the event of any failure of or difficulties with the equipment.

Supervisors must also include any numerical data that is specified in these Instructions. This may involve the Supervisor performing an experiment before the test and collecting certain data. Such data should be given to the uncertainty indicated. Note that the Examiners may rely heavily on such data in order to make a fair assessment of a candidate's work.

Security of assignments

Candidates' scripts and any other relevant materials, printed or otherwise, should be collected and removed to a secure location at the end of each session. Under no circumstances should candidates be allowed to remove question papers from the examination room.

Once completed, each candidate's completed EMPA should be collated in the following order:
- Section A Part 1
- Section A Part 2
- Section B EMPA written test.

The assembled material should then be secured using a treasury tag.

Completed EMPAs are to be treated in the same manner as other completed scripts and should be kept under secure conditions before their despatch to the Examiner.

Submission of materials to the AQA Examiner

By the specified deadline centres should assemble and then despatch the following materials:
- collated candidates' scripts, in candidate number order
- the *Supervisor's Report* (page 23 of these Instructions) if required by the Examiner.

Section A Part 1: Question 1
Candidates are to investigate how the amplitude of a simple pendulum diminishes as its energy becomes absorbed.

Apparatus
- golf ball to serve as the bob of a simple pendulum of length 1.25 ± 0.02 m; the method of attachment of the thread is at the discretion of the centre but a suitable method was found to involve drilling a small hole along the diameter of the golf ball, inserting a rawl plug, and attaching a small threaded hook
- retort stand of rod length at least 600 mm, boss and clamp
- two rectangular pieces of sheet material, eg plywood, to secure the top of the pendulum thread in the clamp
- one standard house brick; the normally-exposed face of the brick should have a fairly smooth finish (ie do not provide a used brick that is badly weathered or damaged)
- large set-square and half-metre ruler

Construct the pendulum and suspend so that the thread hangs about 15 cm from the edge of the bench with the underside of the golf ball about 5 cm above the floor.
Ensure that there is sufficient space to either side so that the pendulum can be set in motion in a plane parallel to the edge of the bench when displaced from the position shown in **Figure 1** in Section A Part 1of the question paper / answer booklet, and then released.

The remaining equipment should be placed on the bench for the candidates' use.

The examiners require no information for this question.

Section A Part 1: Question 2
Candidates are required to measure the output voltage of a solar cell as the intensity of light incident on it is varied by passing the light through two identical polarising filters.

Apparatus
- two 50 mm × 50 mm squares of Polaroid; Griffin Education supply unmounted square Polarising filters 100 mm × 100 mm (PSH-790-050F) in pairs, thus eight filters can be obtained from one pair
- A4 card for construction of the fixed scale and for mounting filter F2
- solar cell (photo-voltaic type) eg Rapid 37-0430, suitably mounted so that the sensitive side of the cell lies in a horizontal plane facing upwards; a suitable arrangement uses the carcass of an ABS box of dimensions 75 × 50 × 25 mm (Rapid 30−0500) with the cell taped to the carcass and the leads of the solar cell passing through holes made in the side of the box
- 12 V, 48 W round bulb, in suitable holder; the bulb holder should be clamped so that the axis of the bulb is vertical and the round end of the lamp is pointing downwards
- switched variable voltage power supply for the lamp
- 100 mm length of plastic cylindrical pipe; the type required is underground drain or soil pipe 110 mm in diameter
- digital voltmeter capable of reading up to 50 mV in 0.1 mV increments; a $3\frac{1}{2}$ digit LCD multimeter set to the 200 mV range will be adequate
- retort stand of height at least 500 mm, fitted with a boss and clamp
- a small amount of Blu-Tack so that candidates may secure the circular scale on top of the cylindrical tube.

Tape down one Polaroid filter to the sensitive side of the mounted solar cell and then mask off the surrounding part to create a window of dimensions 40 mm × 40 mm, through which only plane polarised light can be incident upon the solar cell. Tape the mounted cell to the bench with the sensitive side, covered by the filter, uppermost. The method of assembly is illustrated in **Figure 3** in the Section A Part 1 of the question paper / answer booklet.

Photocopy **Template 1**, identified as ‘filter F2’ in the question paper / answer booklet and reproduced on **page 10** of these Instructions, onto 1 piece of A4 card. Cut out both circular shapes and remove the shaded circles at the centre of each.
Take one of these and place it, printed side down, on the bench. Tape 1 Polaroid square on to the card so that the square completely covers the circular hole.
It is **not necessary** to align the square so that any edge is aligned with the notch on the edge of the card. Using paper glue, stick the circular shapes to each other so the filter is sandwiched between them and the printed surfaces are facing outwards. Use the notch on each card to line up the shapes so that the arrows marked on each side point in the same direction.

Cut out the rectangular outline on **Template 2**, identified as ‘circular scale’ in the question paper and reproduced on **page 11** of these Instructions, and use paper glue to stick this to stiff card or mounting board. Use a craft knife to remove the shaded area to leave a circular window of diameter 60 mm at the centre.

Cut a small notch in the rim of one end of the plastic pipe then place the pipe over the solar cell so that the connecting leads to pass through the notch in the rim. It is advisable to tape down the plastic pipe to the bench.

Connect the leads from the solar cell to the voltmeter and set the voltmeter to the specified range. Place the circular scale, printed side uppermost, so that it is on top of and coaxial with the drainpipe. Position the lamp directly above this arrangement and adjust the pd across the lamp and/or the vertical height of the lamp (ensuring that the lamp is at least 50 mm above the circular scale) until the voltmeter reading is about 30 mV. Once this has been established, tape over the setting of the power supply.

Turn over ▶

Position filter F2 centrally on the circular scale and confirm that the voltmeter reading varies continuously as the scale is rotated.
In a test, the voltmeter reading varied in a sinusoidal pattern as the scale was rotated through 360°. Two full cycles of this variation were seen and the reading varied between 16 mV and 23 mV.

Once the apparatus performs as specified, place all the movable apparatus to one side and switch off the lamp. Candidates are instructed not to change the height of the clamped lamp.

The examiners require no information for this question.

Section A Part 2
Candidates are to investigate the absorption of light as it passes through a solution of ink.
If the solar cell was used in Part 1, remove the Polaroid filter taped over the sensitive side.

Apparatus
The following is as specified for Section A Part 1: Question 2
- solar cell (photo-voltaic type) eg Rapid 37-0430, suitably mounted so that the sensitive side of the cell lies in a horizontal plane facing upwards
- 12 V, 48 W round bulb, in suitable holder; the bulb holder should be clamped so that the axis of the bulb is vertical and the round end of the lamp is pointing downwards
- switched variable voltage power supply for the lamp
- 100 mm length of plastic cylindrical pipe; the type required is underground drain or soil pipe, 110 mm in diameter
- digital voltmeter capable of reading up to 500 mV in 1 mV increments, a $3\frac{1}{2}$ digit LCD multimeter set to the 2 V range will be adequate
- retort stand of height at least 500 mm, fitted with a boss and clamp

Additional apparatus required
- one 600 ml squat form glass beaker; although incidental, this may be graduated in 100 ml intervals and be provided with a spout; the diameter should be such that the beaker fits inside the plastic cylindrical pipe – the dimensions of the beaker used in trials were *height* (from base to rim) = 125 mm; *rim diameter* = 100 mm; *body diameter* = 90 mm
- measuring cylinder, glass or plastic, to read up to 25 ml in 0.5 ml increments
- measuring cylinder, glass or plastic, to read up to 100 ml in 1 ml increments
- plastic jug (graduations not necessary) or beaker (spout preferred) to contain the ink solution; to make up the solution 10 ml of Parker *Quink* Permanent Black fountain pen ink was added to 500 ml of tap water (*Quink* ink is available in 57 ml bottles, enough for 5 or 6 candidates)
- a rectangle of black cartridge paper

Tape the cell to the bench with the sensitive side uppermost and position the plastic pipe, as used in Part 1, around the cell. It is advisable to tape down the plastic pipe to the bench.

Place the empty 600 ml beaker over the solar cell, ie inside the plastic pipe. Form a rectangle of black cartridge paper into a tube and insert this between the beaker and pipe; the height of this tube should extend to the rim of the beaker, as shown in **Figure 4** Section A Part 2 of the question paper / answer booklet.

Connect the leads from the solar cell to the voltmeter and set the voltmeter to the specified range. Position the lamp directly above this arrangement and adjust the pd across the lamp and/or the vertical height of the lamp (ensuring that the lamp is at least 5 mm above the rim of the beaker) until the voltmeter reading is between 350 and 400 mV. Once this has been established, tape over the setting of the power supply.

Using a 3 ml plastic pipette or similar, transfer approximately 10 ml of ink to 500 ml of clean water in the jug and stir to mix. The concentration of the ink solution is not critical; it was found that when 135 ml of solution was added the voltmeter reading fell to about 90% of the initial value and adding all 500 ml reduced the reading to about 80% of the initial value.

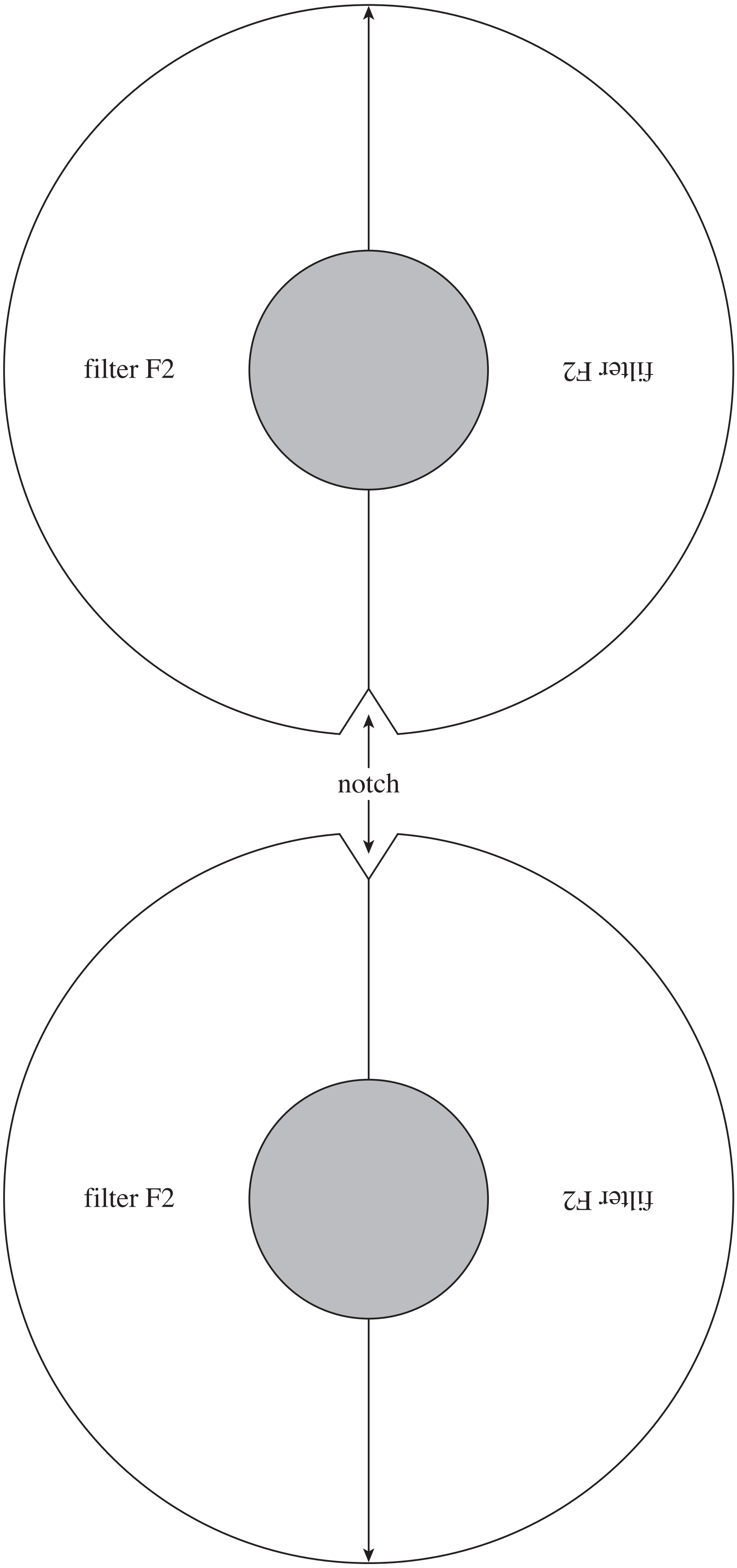
Once the apparatus performs as specified, return all the ink solution to the jug, and rinse and dry the beaker (and any measuring cylinders used). Place all the movable apparatus to one side and switch off the lamp. Candidates are instructed not to change the height of the clamped lamp.

The examiners require no information for this question.

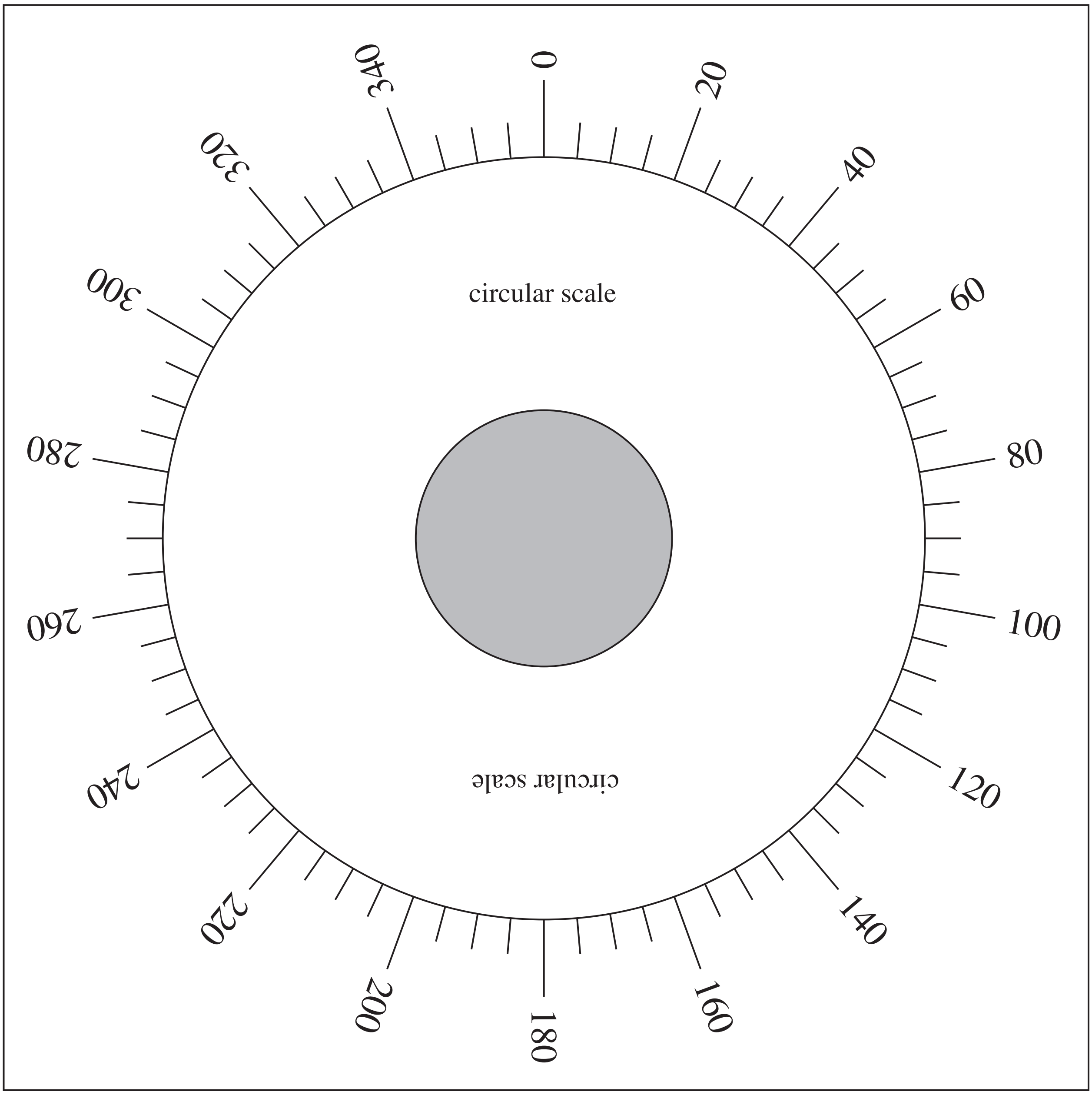
Note that when completing Section B the written the test candidates should be provided with their completed copy of Section A Part 2, whereas candidates' copies of Section A Part 1 should **not** be made available to them.

Turn over ▶

Template 1



Template 2



Turn over ▶

Do not write outside the box

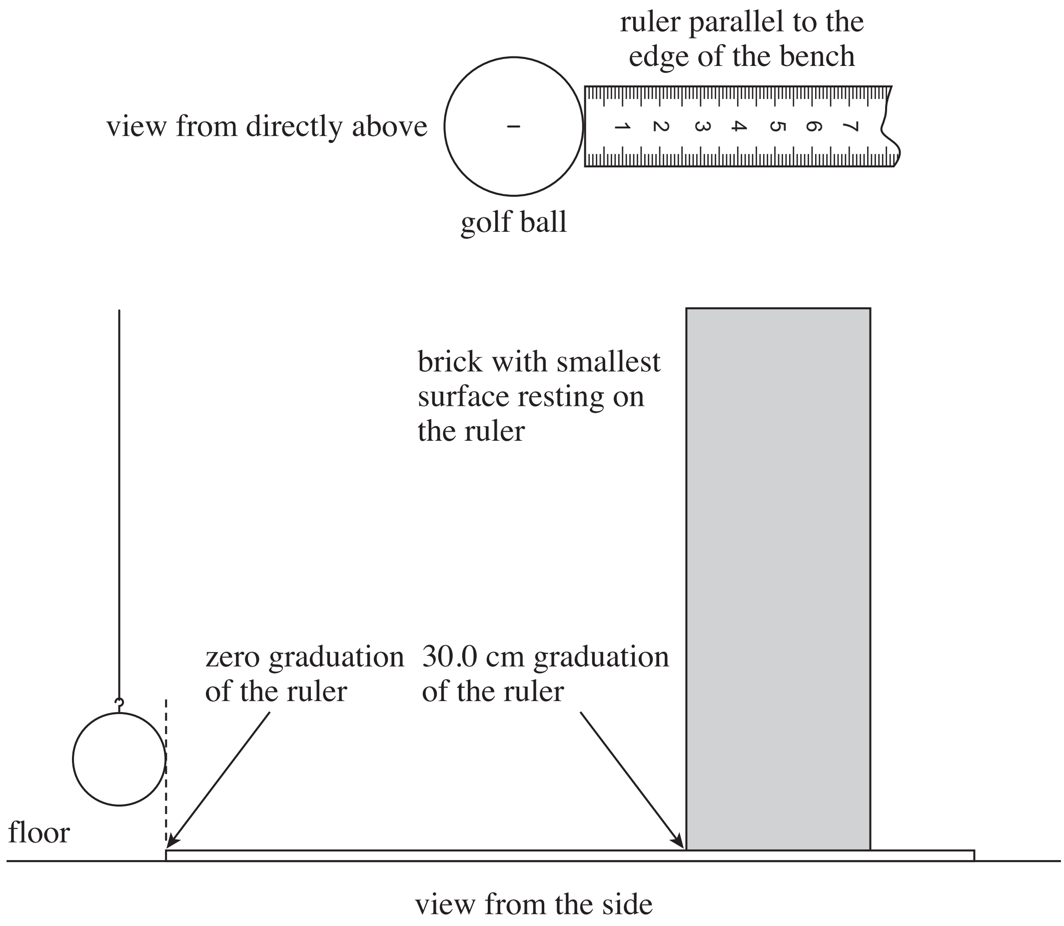
Section A Part 1

1 You are to investigate how the amplitude of a simple pendulum diminishes as its energy becomes absorbed by the surrounding air.

A golf ball is suspended from a string to form a simple pendulum.
Do not adjust the length of the pendulum or the height above the floor of the clamped end of the thread.
Put the ruler on the floor with the graduated face uppermost.
Place the brick on the ruler so the smallest surface of the brick is in contact with the ruler and a smooth vertical face of the brick faces the golf ball.
This nearest face of the brick should be 30.0 cm from the golf ball, as shown in **Figure 1**.

The axis of the ruler should be parallel to the edge of the bench and the zero graduation directly below the edge of the golf ball closest to the brick.

Figure 1



Do not write outside the box

1 (a) Keeping the string straight, pull the golf ball to one side, so it touches the brick. Release the golf ball so that it performs simple harmonic motion in a vertical plane, directly above the ruler.

1 (a) (i) Record in the table below, A_n, the amplitude of the oscillation of the golf ball after n oscillations have been completed; use the values n = 10, 20 and 30 indicated in the table.
The table has been partly completed for you.

Use the additional columns in the table as required, to record repeated measurements.

	A_n the amplitude of the pendulum after n oscillations					
n	**A_n / cm**	**A_n / cm**				**mean A_n / cm**
0	30.0	30.0				30.0
10						
20						
30						

1 (a) (ii) Determine the mean value of A_n after 10, 20 and 30 oscillations of the pendulum. Record these data in the right-hand column of the table.

1 (a) (iii) Use your data to calculate ΔA_{10}, the uncertainty in A_{10}, the amplitude after 10 oscillations.

(2 marks)

1 (b) Textbooks suggest that under certain conditions the amplitude of a simple pendulum subject to air damping should decrease exponentially.

A teacher says that if the suggestion is correct, then

$$\frac{A_n}{A_{n+10}} = \text{constant.}$$

Perform suitable calculations with your data from part (a) to test the teacher's idea. State and explain your conclusion.

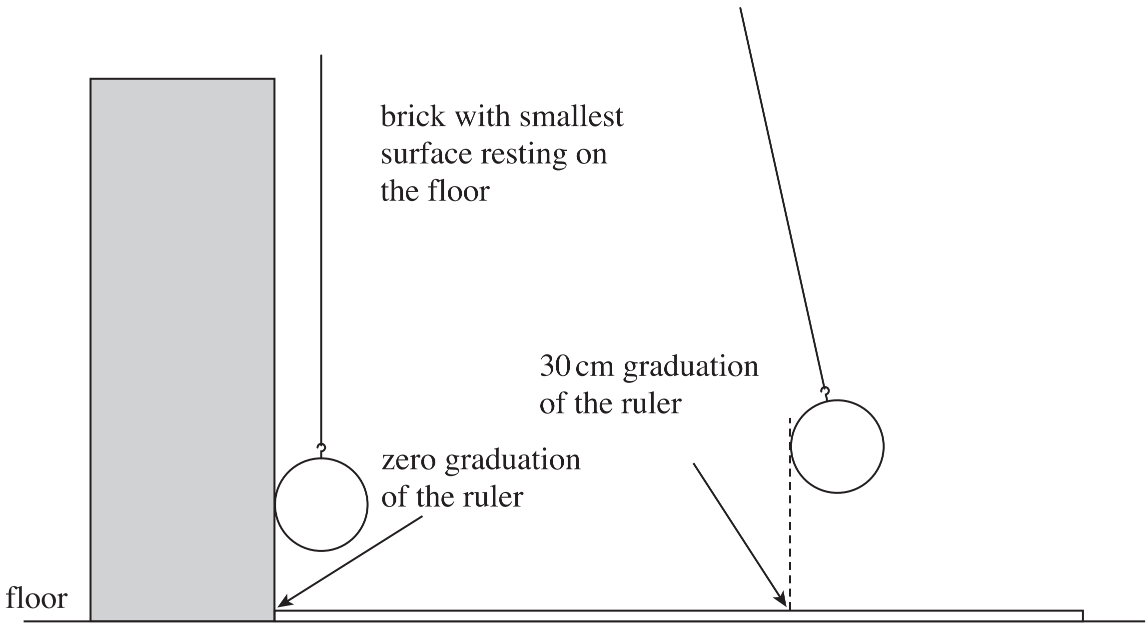
(2 marks)

Turn over ▶

1 (c) Using the same apparatus as in part (a), a student designs a different experiment in which energy is absorbed.

The apparatus is to be arranged as shown in **Figure 2** so that when at the equilibrium position, the golf ball rests against the brick.
The ruler is parallel to the bench and perpendicular to the brick. The graduated face of the ruler is uppermost with the zero graduation in contact with the brick.

Figure 2



Keeping the ball vertically above the ruler and the string straight, the golf ball is pulled to one side until displaced 30.0 cm horizontally and then released so it swings back to strike the brick.

A student intends to measure B, the amplitude of the oscillation of the golf ball after it has rebounded from the brick and intends to investigate whether the amplitude of the oscillation of the golf ball decreases exponentially.

The student intends to check this by calculating $\frac{B_n}{B_{n+1}}$, where B_n is the amplitude after striking the brick n times, and B_{n+1} is the amplitude after striking the brick $(n + 1)$ times.

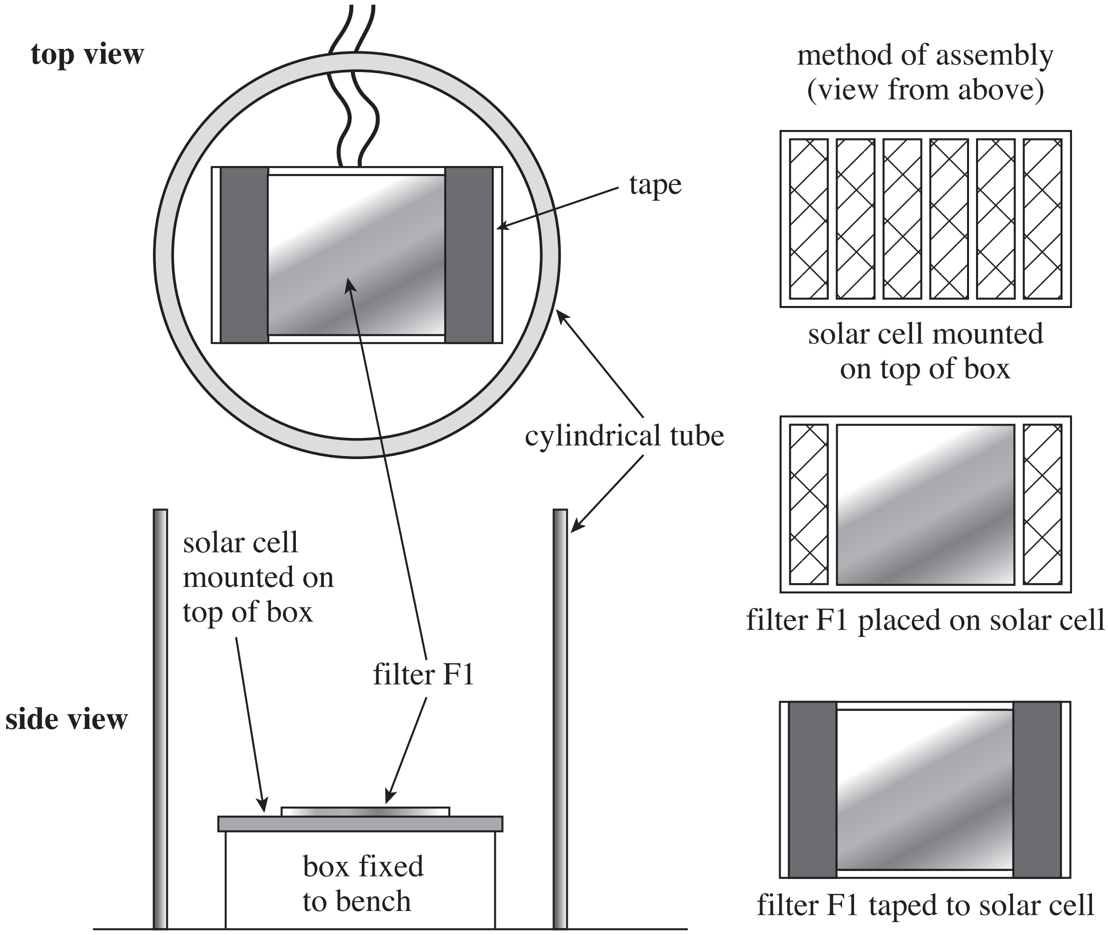
Use the apparatus provided for part (a) to try out the student's idea and hence identify **two** difficulties in the procedure.

(2 marks)

6

2 You are to measure the output voltage of a solar cell as the intensity of light incident on it is varied by passing the light through two identical polarising filters.
The general arrangement and method of assembly is shown in top and side view in **Figure 3**.

Figure 3



Filter F1 has been taped to the surface of the solar cell that is sensitive to light.
The cell has been mounted on a box which has been fixed to the bench.
A cylindrical tube has been placed around this arrangement to shield it from unwanted light.

Place the circular scale centrally on top of the cylindrical tube with the printed side uppermost and fix this to the tube using Blu-Tack.

Position the clamped light source so that the lamp is directly above the hole in the circular scale.
Do not adjust the height of the lamp or the output voltage of the power supply.

The filter F2 has been mounted between two pieces of circular card.

2 (a) (i) Position this card centrally on the circular scale so that θ, the direction of the arrow = 0°. Switch on the lamp then read and record the voltmeter reading V_0.

Question 2 continues on the next page

2 (a) (ii) Keeping the card centrally on the scale, increase θ in 20° steps to obtain further values of V to complete the table.
Switch off the lamp once you have completed these measurements.

(1 mark)

2 (b) Adding a suitable scale to the vertical axis, plot on the grid a graph of your results from part (a)(ii).

(2 marks)

2 (c) (i) Read from your graph, and record below, V_{max} and V_{min}, the maximum and minimum values of V.

2 (c) (ii) Hence estimate the amplitude, A, of the variation V with θ.

2 (c) (iii) Identify and explain from your graph any value of θ for which the experimental arrangement is most sensitive to changes in θ.

(3 marks)

2 (d) A student performs the experiment but fails to keep the edge of the card containing the filter F2 centrally on the circular scale.

2 (d) (i) State and explain the effect this may have on the readings of V.

2 (d) (ii) State **one** procedure that the student could take so that this error can be avoided.

(3 marks)

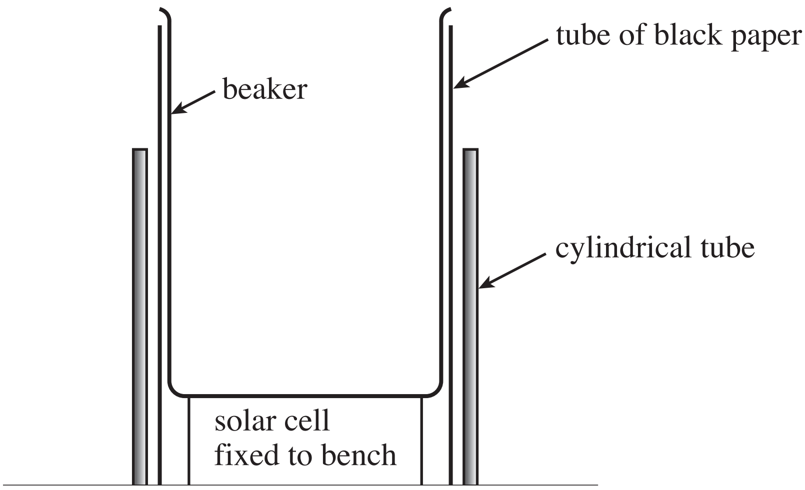
9

END OF SECTION A PART 1

Section A Part 2

1 In this experiment you are to investigate the absorption of light as it passes through a solution of ink. The apparatus you will use is shown in **Figure 4**.

Figure 4



The solar cell and the cylindrical tube have been taped to the bench.
Do not remove the beaker or the tube of black paper from within the cylindrical tube.

Position the clamped lamp so that it is coaxial with the beaker.
Do not adjust the height of the lamp or the output voltage of the power supply.

The output voltage of the solar cell is shown on the digital voltmeter.
Do not change the range setting of the voltmeter.

Switch on the lamp and monitor the voltmeter reading over a short interval of time, eg 20 seconds, so that either the reading reaches a steady value or so you can determine the range, and hence the mean value, V_0, of the reading.

1 (a) Read and record V_0.

(1 mark)

1 (b) You are provided with approximately 500 ml of a solution of ink and two measuring cylinders of different capacity and resolution.
You are to record the voltmeter reading, V, as the volume of ink solution in the beaker, Q, is varied.

1 (b) (i) Transfer **between 90 ml and 100 ml** of the solution to the **larger** measuring cylinder.
Note the volume of the solution in this measuring cylinder before carefully pouring this into the beaker.
Record Q, the volume of the solution in the beaker.
Read and record the (mean) voltmeter reading, V.

1 (b) (ii) Transfer between **20 ml and 25 ml** of the solution to the **smaller** measuring cylinder.
Note the volume of the solution in the measuring cylinder before carefully pouring this into the beaker.
Record *Q*, the new volume of the solution in the beaker then read and record the corresponding (mean) voltmeter reading, *V*.
Increase *Q* in increments of between 20 ml and 25 ml, recording the voltmeter reading, *V*, at each stage, until *Q* is about 200 ml.

1 (b) (iii) Transfer between **40 ml and 70 ml** of the solution to the **larger** measuring cylinder.
Note the volume of the solution in this measuring cylinder before carefully pouring this into the beaker.
Record *Q* and *V* then continue, increasing *Q* in increments of between 40 ml and 70 ml, measuring the voltmeter reading, *V*, at each stage, until all the solution has been transferred to the beaker.

You should record all the data required to complete part (b) of this question.
Note that you will not be expected to record repeat readings of the measurements made in part (b).

Measurements and observations.

(6 marks)

1 (c) Plot, on the grid, a graph with ln(*V*/mV) on the vertical axis and *Q* on the horizontal axis. You should draw a straight line of best fit through the plotted points.
Record below the data you will plot on your graph.

(9 marks)

END OF SECTION A PART 2

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Section B

Answer **all** the questions in the spaces provided.

The time allowed is 1 hour 15 minutes.

You will need to refer to the work you did in Section A Part 2 when answering these questions.

1 (a) (i) Determine the gradient, G, of your graph of $\ln(V/\text{mV})$ against Q.

1 (a) (ii) Read and record the vertical intercept from your graph.

(3 marks)

1 (b) A student claims that an analogy can be made between the experiment in which light is absorbed by the ink solution and an experiment in which ionising radiation is absorbed by different thicknesses of metal plates.
Using the analogy, she suggests that the output voltage of the solar cell, V, is given by

$$V = Pe^{-\lambda Q},$$

where P and λ are constants.

1 (b) (i) If the student's analogy is correct, describe the form that a graph of $\ln(V/\text{mV})$ against Q should take and explain how the values of P and λ may be deduced from the graph.

1 (b) (ii) Explain whether the qualitative and quantitative evidence obtained from your graph confirms the student's analogy.

(6 marks)

9

2 (a) (i) Describe **one** difficulty you experienced when measuring the volume of the ink solution.

2 (a) (ii) Explain **one** precaution you took to reduce the uncertainty when measuring the volume of ink solution in the measuring cylinders.
You may wish to use a sketch to illustrate your answer.

(2 marks)

2 (b) Having transferred between 90ml and 100 ml of ink solution to the beaker, students A and B did not follow the instructions about which measuring cylinders they should then use.
Student A used only the **larger** measuring cylinder (capacity 100 ml, 1 ml graduations).
Student B used only the **smaller** measuring cylinder (capacity 25 ml, 0.5 ml graduations).

2 (b) (i) Give a disadvantage of the procedure followed by student A.

2 (b) (ii) Give a disadvantage of the procedure followed by student B.

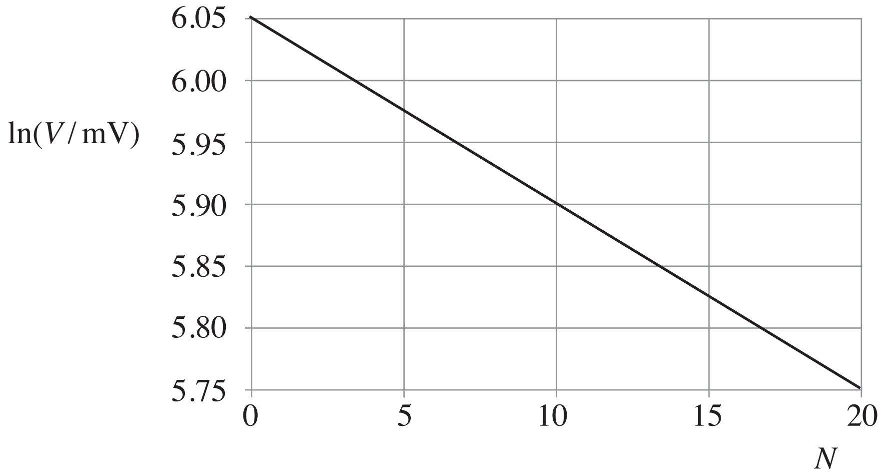
(2 marks)

4

3 A student adapts the experiment to investigate how light is absorbed by glass.
The student uses a varying number of glass microscope slides (up to a maximum of 20 slides) placed in a single stack on top of the solar cell to produce different thicknesses of the glass.

The student plots a graph of his results, as shown in **Figure 5**.
Note that N = number of glass microscope slides placed on top of the solar cell.

Figure 5



Assuming that the output voltage of the solar cell is directly proportional to the light intensity incident upon it, the student intends to determine the half-value thickness of glass, ie the thickness of glass that would reduce the output voltage by half.

3 (a) Use the information provided in the student's graph to calculate $N_{0.5}$, the value of N equivalent to the half-value thickness of the glass.

(3 marks)

3 (b) To determine the half-value thickness of the glass in mm, the student needs to make one additional measurement.

3 (b) (i) Identify the measurement the student needs to make and explain how this is used to determine the half-value thickness of the glass.

The student uses a micrometer screw gauge to make the additional measurement.

3 (b) (ii) Identify **one** procedure that can be used to reduce the effect of random errors when making the measurement.

3 (b) (iii) Identify **one** procedure that can be used to detect, and hence correct, for possible systematic errors in the measurements made with the micrometer screw gauge.

(3 marks)

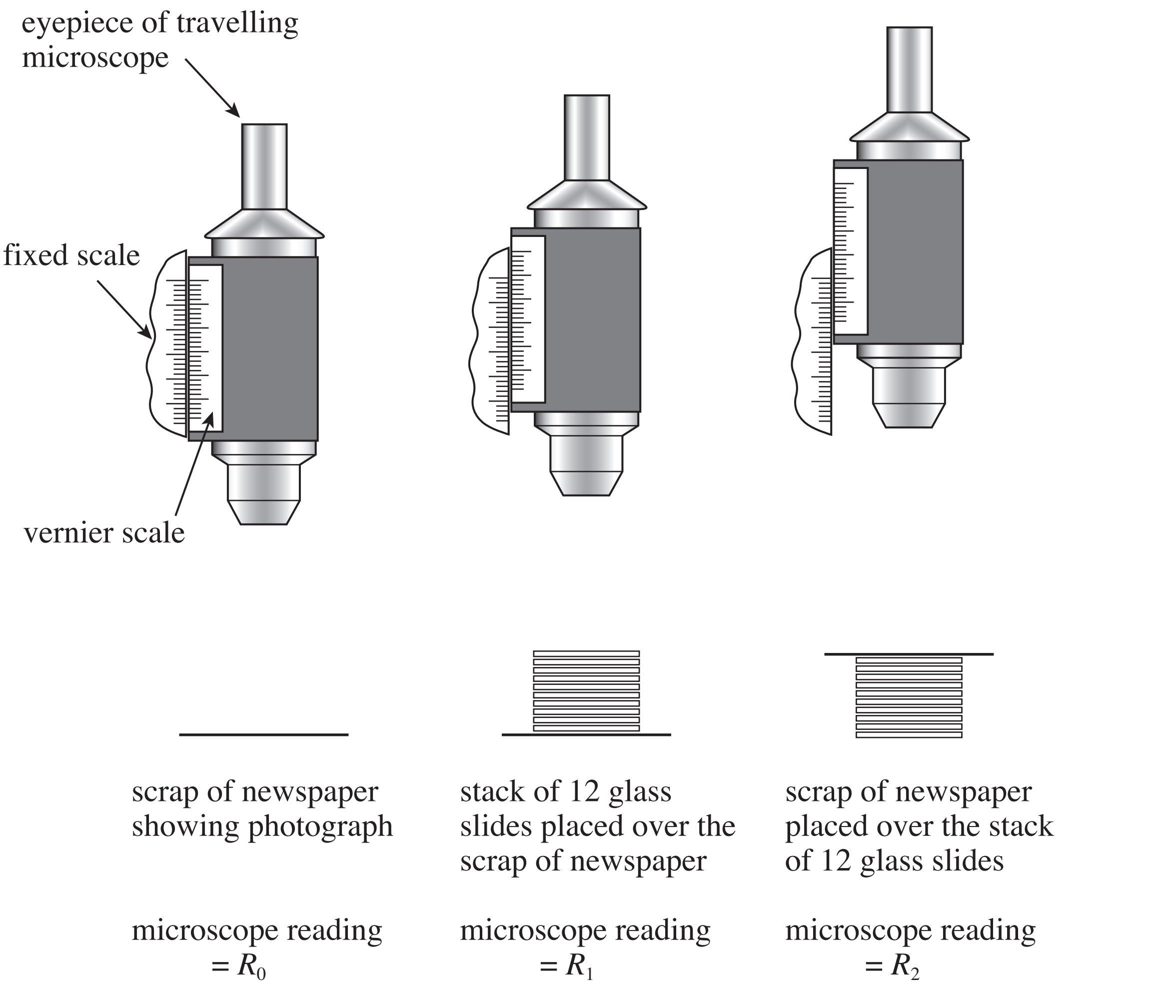
6

4 The student uses a travelling microscope to learn more about the properties of the glass slides.

The eyepiece of the microscope is arranged to move vertically up or down above a scrap of newspaper showing a photograph.
The photograph is composed of dots which are only clearly visible when viewed through the microscope. By adjusting the position of the microscope the student brings the dots into focus and then reads the position of the microscope, R_0, using the vernier scale.
The student then places a stack of 12 slides over the photograph and refocuses the microscope. She records the new reading, R_1.
Finally, she places the photograph on top of the slides, refocuses the microscope, and records the new reading R_2.

The sequence of operations is illustrated in **Figure 6**.

Figure 6



The readings made by the student are shown in the table below.

R_0 / mm	R_1 / mm	R_2 / mm
2.74	**7.31**	**17.02**

Do not write outside the box

4 (a) Assuming that the slides have identical dimensions, use the readings to determine the thickness of one glass microscope slide.

(1 mark)

4 (b) Determine n, the refractive index of the glass, given by $n = \dfrac{R_2 - R_0}{R_2 - R_1}$.

(1 mark)

4 (c) The uncertainty in each of the readings R_0, R_1 and R_2, is 0.04 mm.

4 (c) (i) State the uncertainty in $R_2 - R_0$.

4 (c) (ii) State the uncertainty in $R_2 - R_1$.

4 (c) (iii) Hence calculate the percentage uncertainty in n.

(3 marks)

5

END OF SECTION B

General Certificate of Education
Advanced Level Examination
June 2011

PHYSICS **PHA6/B6/XTN**
(SPECIFICATIONS A AND B)
Unit 6

SUPERVISOR'S REPORT

When completed by the Supervisor, this Report must be attached firmly to the attendance list, or in the case of any problem affecting a particular candidate, it should be attached to the candidate's script, before despatch to the Examiner.

Information to be provided by the centre.

Section A Part 1
Question 1 No information is required.
Question 2 No information is required.

Section A Part 2
Question 1 No information is required.

Details of problems encountered by candidate..................................... candidate number ....

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Supervisor's Signature ....

Centre Number ....

Date ....