Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

For Examiner's Use	
Examiner's Initials	
Section	Mark
Section A Task 1 Q1	
Section A Task 1 Q2	
Section A Task 2 Q1	
Section B Q1	
Section B Q2	
Section B Q3	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Physics (Specifications A and B) PHA3/B3/X

Unit 3 Investigative and Practical Skills in AS Physics
Route X Externally Marked Practical Assignment (EMPA)

Section B Written Test

For this paper you must have	**Instructions**
• your completed Section A Task 2 question paper / answer booklet. • a ruler • a pencil • a calculator.	• Use black ink or black ball-point pen. • Fill in the boxes at the top of this page. • Answer **all** questions. • You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages. • Show all your working. • Do all rough work in this book. Cross through any work you do not want to be marked.
Time allowed • 1 hour 15 minutes	**Information** • The marks for questions are shown in brackets. • The maximum mark for this paper is 24.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes, give the details below or on a separate page.

Yes ☐ No ☐

Practical Skills Verification Teacher Declaration: I confirm that the candidate has met the requirement of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.	**Yes** ☐

Signature of teacher ..... Date .....

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SECTION B

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

Time allowed is 1 hour 15 minutes.

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

1 (a) (i) Determine the gradient, G, of your graph.

.....

.....

.....

.....

G = ...

1 (a) (ii) Calculate the mass per unit length of the wire, μ, given by

$$\mu = \frac{g}{(2fG)^2},$$

where $g = 9.81\,\text{N kg}^{-1}$ and $f = 50\,\text{Hz}$.

.....

.....

.....

.....

μ = ...

(4 marks)

Question 1 continues on the next page

1 (b) Wire is manufactured in certain diameters under a system known as the *English Standard Wire Gauge*, each diameter of wire being identified by a particular SWG number.
Table 2 shows the diameter of wires with certain SWG numbers.

Table 2

SWG number	22	24	26	28	30	32	34
diameter/mm	0.711	0.559	0.457	0.376	0.315	0.274	0.234

1 (b) (i) Using your result from part (a) of Section A Task 2, identify the SWG of the wire you were given.

SWG number = ...

1 (b) (ii) State and explain the effect, if any, on your graph, if the experiment were repeated with a wire made of the same material but with a lower SWG number.

.....

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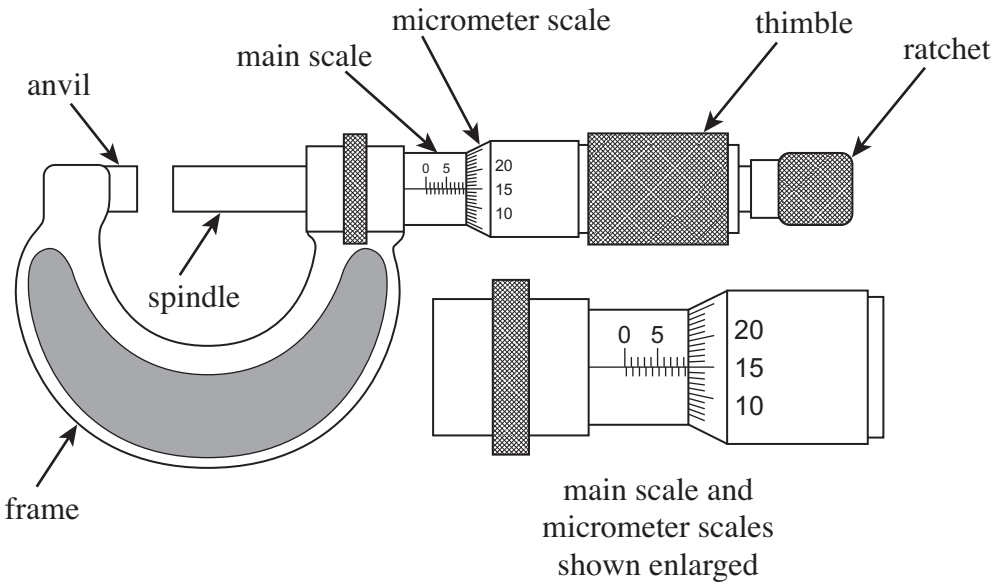
.....

(4 marks)

1 (c) In part (a) of Section A Task 2 you used a micrometer screw gauge to measure the diameter of a wire. A micrometer screw gauge is shown in **Figure 8**.

Figure 8



1 (c) (i) What is the precision of the **main scale** on the micrometer screw gauge?

.....

1 (c) (ii) Why is it important to close the gap between the anvil and the spindle of the micrometer using the ratchet and not the thimble?

.....

.....

1 (c) (iii) State a procedure to detect a possible systematic error in the micrometer readings.

.....

.....

1 (c) (iv) State any procedure you used to reduce the effect of random errors on your result for the diameter of the wire.

.....

.....

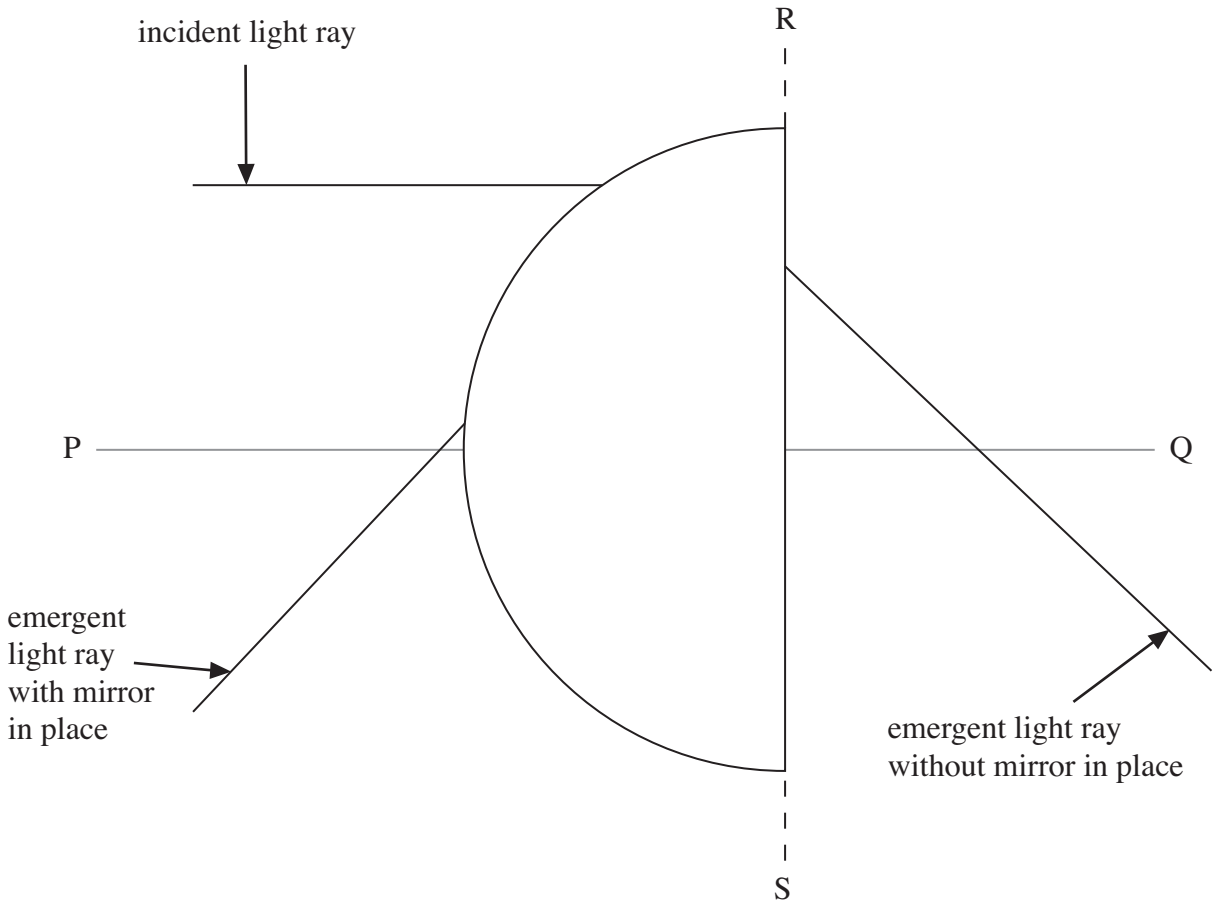
.....

(4 marks)

12

2 In Section A Task 1 you traced the paths of light rays passing through a semicircular transparent block and determined the refractive index of the block.
A student performs this experiment and produces a diagram, seen approximately to full scale in **Figure 9**, showing lines PQ and RS, the outline of the block and the paths of the incident and emergent light rays.

Figure 9



2 (a) **Figure 9** can be used to determine the refractive index of the block by a different method from that you used in Section A Task 1.

2 (a) (i) Complete **Figure 9** by showing the paths of the light rays within the block that lead to the formation of **both** emergent rays.

2 (a) (ii) Explain, by adding further detail to **Figure 9**, how you would determine another experimental value of the refractive index of the block.
Make clear the calculations you would carry out.

.....

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.....

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.....

(3 marks)

2 (b) If both methods are used with the **same ray diagram** to calculate the refractive index of the block, explain why the result obtained using the method you used in Section A Task 1 is likely to provide the more accurate result.

.....

.....

.....

.....

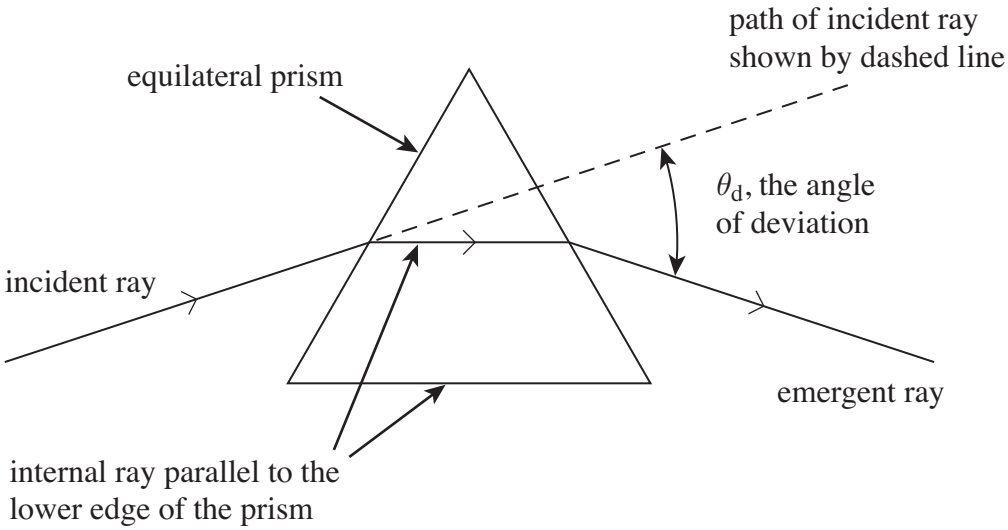
(2 marks)

5

Turn over for the next question

3 In a different experiment to that you performed in Section A Task 1, a student directs a ray of light on to an equilateral prism and adjusts the position of the prism until the internal ray is parallel to the lower edge of the prism, as shown in **Figure 10**.

Figure 10



3 (a) Outline a simple test that the student could perform **without moving the prism**, to check that the internal ray is parallel to the lower edge of the prism.
You may wish to use a sketch to illustrate your answer.

.....

.....

.....

.....

(2 marks)

3 (b) The student measures θ_d to be 40° using a protractor with a precision of 2°. Calculate the percentage uncertainty in the student's result for θ_d.

.....

percentage uncertainty in result for θ_d = ...

(1 mark)

3 (c) The student discovers that θ_d, the angle of deviation between the emergent ray and the path of the incident ray is related to n, the refractive index of the prism by

$$n = \sqrt{3} \sin\left(\frac{\theta_d}{2}\right) + \cos\left(\frac{\theta_d}{2}\right).$$

Using $\theta_d = 40°$ the student correctly calculates $n = 1.53$. Knowing that the true value of θ_d could lie anywhere between 38° and 42°, the student then calculates the smallest and largest possible values for n.

3 (c) (i) Calculate the student's result for the smallest possible value for n, which occurs when $\theta_d = 38°$.

.....

.....

smallest possible value for n = ...

3 (c) (ii) Calculate the student's result for the largest possible value for n, which occurs when $\theta_d = 42°$.

.....

.....

largest possible value for n = ...

3 (c) (iii) Calculate the percentage uncertainty in the student's result for n.

.....

.....

.....

percentage uncertainty in result for n = ...

(4 marks)

END OF QUESTIONS

7

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