Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
January 2006
Advanced Subsidiary Examination

PHYSICS (SPECIFICATION B) **PHB3**
Unit 3 Practical

ASSESSMENT and QUALIFICATIONS ALLIANCE

Tuesday 17 January 2006 1.30 pm to 3.30 pm

For this paper you must have:
- a calculator
- A4 graph paper
- a ruler
- a protractor

Time allowed: 2 hours

Instructions
- Use a blue or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions
- Answer the questions in the spaces provided. A separate sheet of graph paper is required for Question 3. Attach your graph to this book before handing it to the invigilator at the end of the examination.
- Show all your working. Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 78.
  Four of these marks are for the Quality of Written Communication
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers. Questions 1(d) and 2(d) on the paper should be answered in continuous prose. Quality of Written Communication will be assessed in these answers.

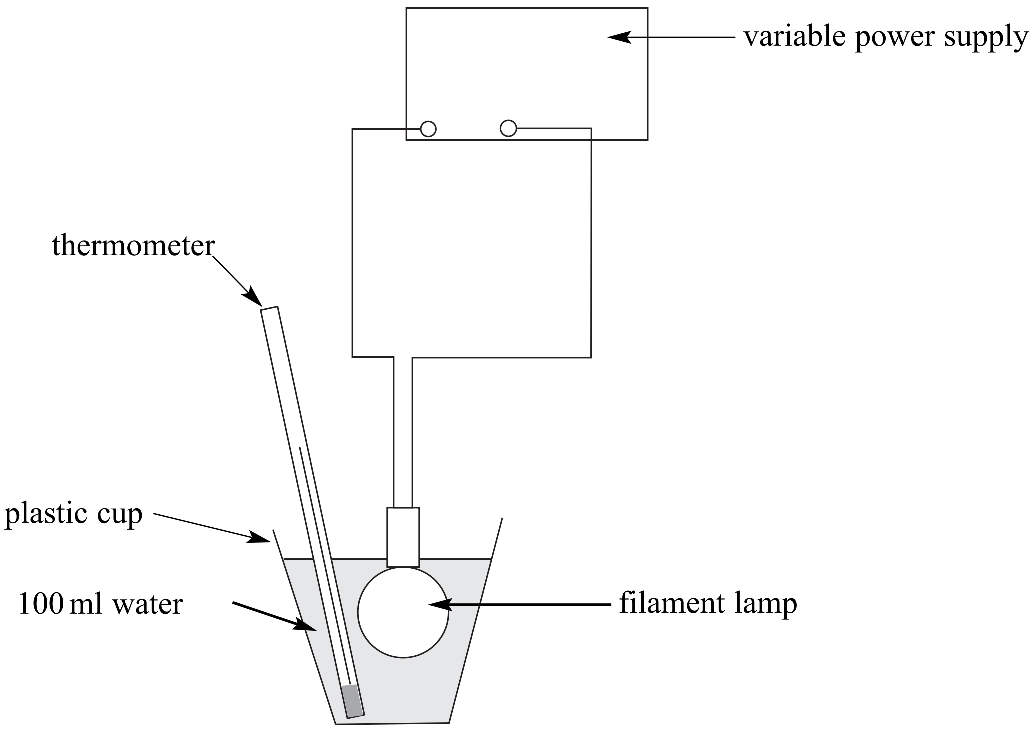
Advice
- You are allowed 30 minutes for each of Questions 1 and 2, and one hour for Question 3.
- Before commencing the first part of any question, read the question through completely.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided

1 You are going to make measurements that will allow you to determine the amount of electrical energy used by a filament lamp. You will also be able to determine how much of that energy is given out as light energy. Assume that the energy output of the lamp is just used to heat the water and to provide light energy.

Figure 1



(a) (i) Measure and record the temperature of the water.

(ii) Your variable power supply has been set to give its maximum output. **Do not adjust it**. Turn the power supply on and begin timing at the same time. Measure and record the temperature of the water after 4.0 minutes (240 s) of heating and find the temperature rise. **You are not required to repeat this measurement**.

(iii) Use the formula given below to calculate E, the energy used to heat the water.

$E = 420\,\Delta\theta$
$\Delta\theta$ = the temperature change of the water

(iv) Use your answer to part (a)(iii) and the value of the electrical power input to the lamp given on the card near your apparatus, to determine the amount of light energy emitted by the lamp during the 240 s it was turned on.

(7 marks)

(b) Predict how the total energy given out by the lamp will vary with the applied voltage. Justify your answer.

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(3 marks)

(c) (i) State the additional measurements you would need to make to check the power input to the lamp.

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(ii) Draw on the circuit in **Figure 1** any additional, correctly connected apparatus you would need to use in order to determine the power input to the lamp.

(iii) State a formula you would use in part (a)(iv) for calculating the light energy output from the lamp.

(4 marks)

Question 1 continues on the next page

Turn over

(d) Describe in detail how you would investigate how the variation of applied voltage affects the light energy output of the lamp. You should state:

- the measurements you would make
- the ranges of measurements you would use
- the quantities you would keep constant
- the method of display of the results

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

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(6 marks)

20

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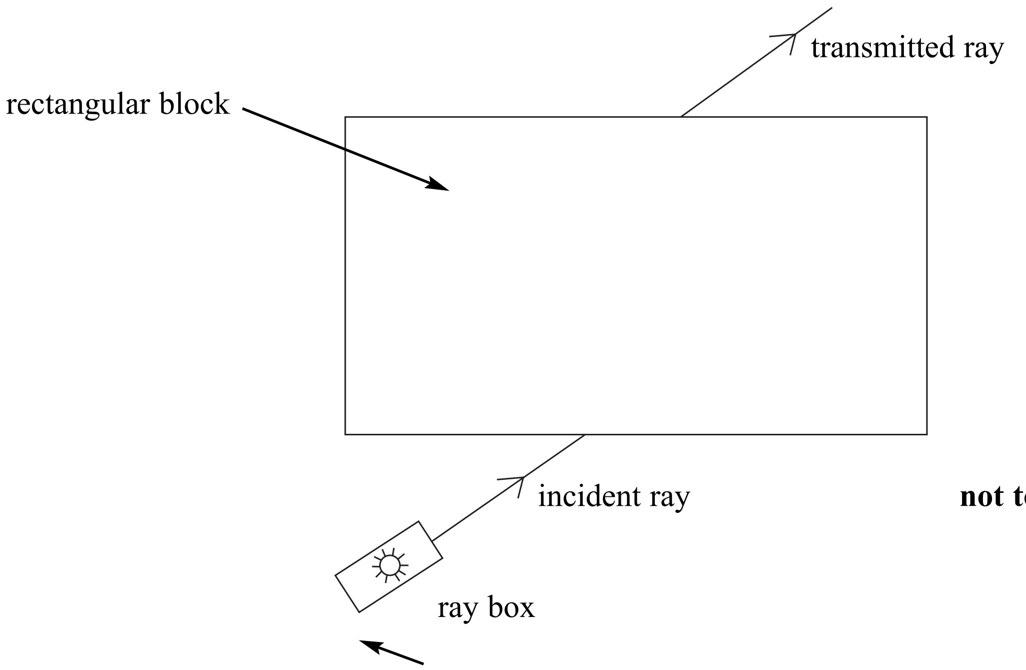
2 You are going to inspect a ray of light transmitted through a transparent rectangular block and determine n, the refractive index of the material from which the block is made. The refractive index is a measure of how much the light bends as it enters or leaves the block.

Figure 2



not to scale

(a) Switch on the ray box and direct the ray so that it goes through the block, entering and leaving through opposite faces as shown in **Figure 2**. Vary the angle the incident ray makes with the block by changing the position of the ray box. Observe the effects of changing the angle on the transmitted ray. Describe any patterns you observe in the transmitted ray as the angle is changed.

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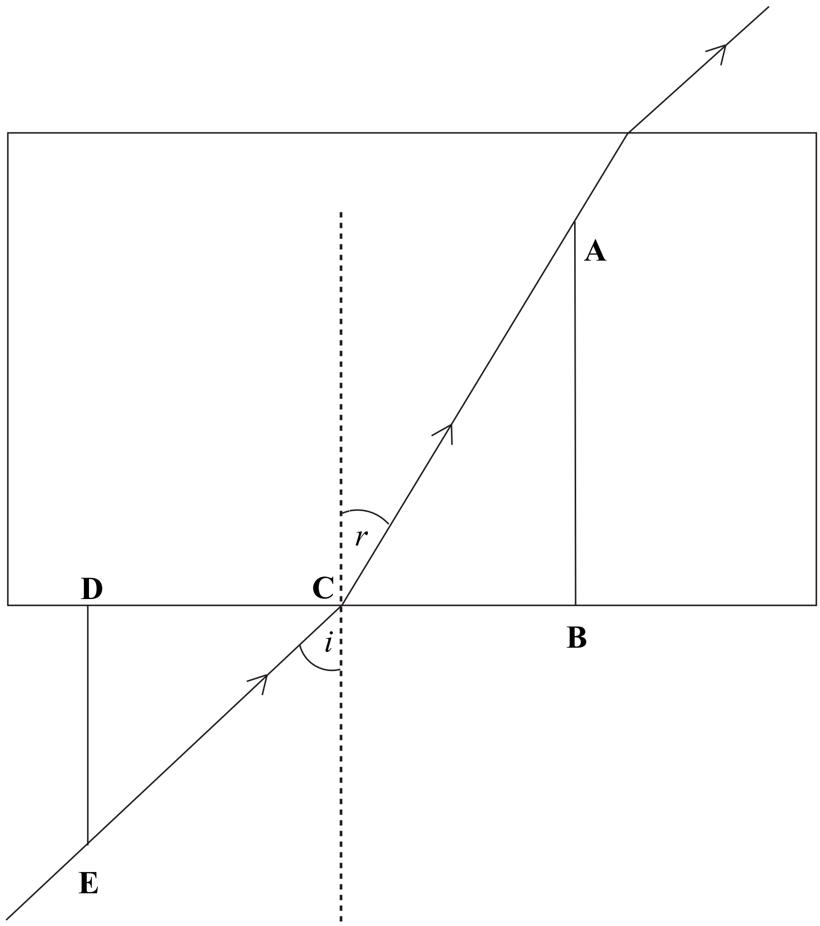
(2 marks)

Question 2 continues on the next page

Turn over

(b) An accurate ray diagram for the situation you observed in part (a) is given in **Figure 3**.

Figure 3



(i) From **Figure 3**, measure and record the distances:

EC = h =

AC = k =

DC = d =

BC = x =

Do not attempt to repeat and average these measurements.

(ii) Calculate the refractive index, n, of the material from which the block is made, using the formula:

$$n = \frac{kd}{xh}$$

(iii) State the absolute uncertainties in each of your values for h, d, x and k.

(iv) Calculate the percentage uncertainties in each of your values for h, d, x and k.

(v) Calculate the percentage uncertainty in your value for n.

(9 marks)

(c) The refractive index can also be determined by measuring the angles i and r as marked on **Figure 3**.

(i) From **Figure 3**, measure and record the angles i and r.

(ii) Calculate the refractive index of the material from which the block is made, using the formula:

$$n = \frac{\sin i}{\sin r}$$

(2 marks)

Question 2 continues on the next page

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(d) Considering your observations in part (a), discuss any difficulties you think you might have had if you had been required to obtain an accurate ray diagram experimentally and to make accurate measurements from it to determine the refractive index of the material.

Two of the 5 marks in this question are available for the quality of your written communication.

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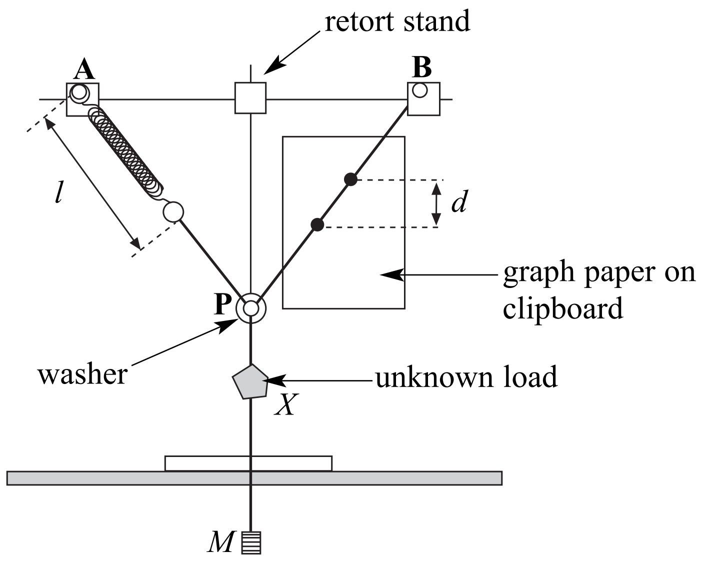
(5 marks)

18

3 You are going to investigate the extension of a spring set in a network of strings.

Figure 4



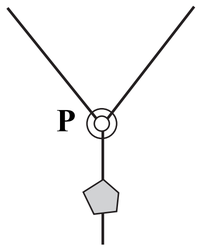
(a) Suspend a mass, M, of 0.100 kg on the end of the string. Adjust the position of the washer, **P**, so that M hangs midway between the two suspension points, **A** and **B**. Use the vertical retort stand supporting the network as a reference. Measure and record l (the complete length of the spring, in m) and d (the vertical separation, in mm, of the two ink dots on the string).

(4 marks)

Question 3 continues on the next page

(b) (i) On **Figure 5**, mark and label the forces acting on the washer **P** when it is aligned with the retort stand rod. State which **two** forces you think should have the same magnitude. Assume that there is no friction between the washer and the string.

Figure 5



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(ii) Write down an equation connecting all of the forces on the washer when it is in equilibrium.

(4 marks)

(c) You are going to vary the mass, M. For each value of M, measure and record the corresponding values of l and d. Each time you change M, adjust the position of the washer **P**, so that it aligns with the vertical retort stand behind it, before measuring l and d.

(i) In the space below, draw a table in which to record 6 sets of values of M, l and d, including the set you have already taken in part (a). The maximum value of M should be 0.600 kg.

(ii) Measure and record in the table the corresponding values of M, l and d.

(12 marks)

(d) Draw a second table to record values of M, e, and ed, where e is the total extension of the spring. The unloaded length of the spring is given on a card near your apparatus.

(4 marks)

(e) (i) On a sheet of graph paper, plot a graph of ed (on the y-axis) against M (on the x-axis). The scales on each of your axes should begin at zero.

(ii) Draw the best fit straight line for your points. *(9 marks)*

Question 3 continues on the next page

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(f) The equation of your straight line is:

$$ed = \frac{50gM}{k} + \frac{50gX}{k}$$

where k = the spring constant, measured in $\mathrm{N\,m^{-1}}$

X = the mass of the unknown load hanging below the washer

g = the Earth's gravitational field strength in $\mathrm{N\,kg^{-1}}$

The general equation of a straight line is:

$$y = mx + c$$

(i) Determine the gradient of your line.

(ii) Determine the intercept of your line with the *ed* axis

(iii) Use your data from the graph to determine a value for the mass, X.

(7 marks)

40

END OF QUESTIONS