Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2005
Advanced Subsidiary Examination

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

Wednesday 18 May 2005 Morning Session

In addition to this paper you will require:
- a calculator;
- A4 graph paper;
- a pencil and a ruler.

Time allowed: 2 hours

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. A separate sheet of graph paper is required for Question 3.
- All working must be shown. 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.
- Mark allocations are shown in brackets.
- You are expected to use a calculator where appropriate.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.
- You are allowed 30 minutes for each of Questions 1 and 2, and 1 hour for Question 3.

Advice
- Before commencing the first part of any question, read the question through completely.
- Ensure that **all** measurements taken, including repeated readings, gradients, derived quantities, etc are recorded to an appropriate number of significant figures with due regard to the accuracy of measurement.
- If an experiment does not operate correctly, you should request assistance from the Supervisor. The Supervisor will give the minimum help necessary to make the experiment operate and will report the action taken to the Examiner. If the fault is due to your inability to make the experiment operate, a deduction of marks will be made, but it will be possible for you to complete the remainder of the question and gain marks for the later parts of that question.

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**.**

Total for this question: ***19 marks***

1 You are going to investigate the variation of speed of a water wave with water depth using the apparatus shown in **Figure 1**.

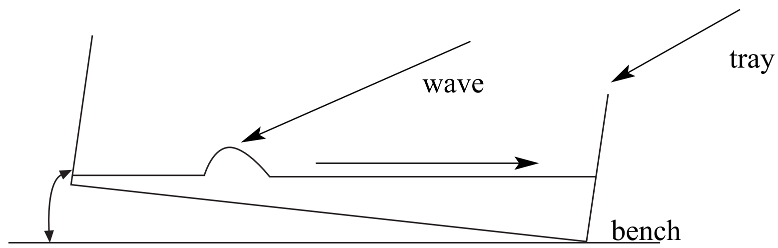

Figure 1

Pour water into the tray so that the depth of liquid is 6 mm. Use the marked rod provided to help you measure the depth.
Raise one end of the tray by about 10 mm and then allow the edge of the tray to drop back to the bench.
You should be able to see the wave pass backwards and forwards across the water surface several times.

(a) (i) Collect and record data that will allow you to calculate the speed of the water wave for depths of 6 mm and 24 mm.

(2 marks)

(ii) Use these data to calculate the speed, *c*, of the water wave at each depth *d*. Record your calculations and results in a suitable table.

(2 marks)

(b) **Without drawing a graph**, test the suggestion that the speed, c, of the water wave is related to the water depth, d, by

$$c \propto d^{\frac{1}{2}}$$

Explain your test, give the working, and state your conclusion clearly.

explanation of test	*working*

conclusion

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(3 marks)

(c) Sketch on axes of c (y-axis) against $d^{\frac{1}{2}}$ (x-axis) the graph you would expect to obtain if $c \propto d^{\frac{1}{2}}$. Label your axes carefully.

(2 marks)

(d) Describe the modifications you would make to the experiment that would enable you to obtain accurate data so that you could plot rather than sketch the graph of part (c).

Your description should include;

- any proposed modifications to the method used in part (a)
- any ways in which you would reduce the uncertainties in the measurements.

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

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(6 marks)

(e) Explain why the water wave returns to the point of origin but does not continue to cross the tray indefinitely.

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(4 marks)

19

TURN OVER FOR THE NEXT QUESTION

Total for this question: ***20 marks***

2 You are going to investigate the breaking of a thread.

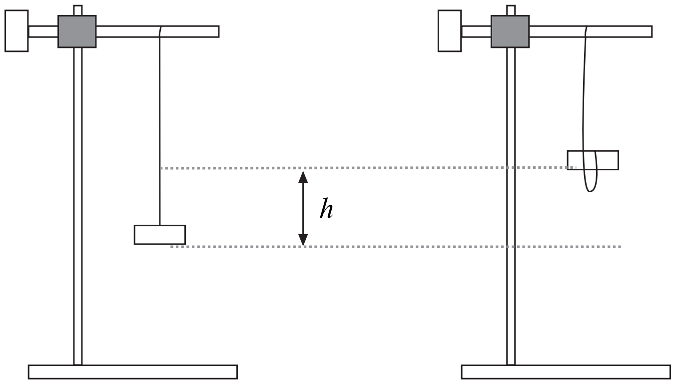

Figure 2

(a) Raise the 0.10 kg mass hanging on the end of the thread through a height, h, where $h = 4$ cm.

You will need to devise a way to measure h.

Allow the 0.10 kg mass to drop freely and observe whether the thread breaks.

Raise the mass through a measured 6 cm and again allow it to drop freely observing whether the thread breaks or not.

By increasing the drop height in 2 cm steps, determine and record x, the drop height at which the thread breaks.

(1 mark)

(b) (i) Show that the speed, v, of the mass just before the thread tightens is given by

$$v = \sqrt{(2gx)}$$

where g is the acceleration due to gravity and x is the drop height for which the thread breaks.

(2 marks)

(ii) Calculate the speed of the mass in part (a) just before the thread tightens when dropped from height x.

acceleration due to gravity, $g = 9.8 \pm 0.1\ \text{m s}^{-2}$

(2 marks)

(c) (i) State the absolute uncertainty in your measurement of x.

(1 mark)

(ii) Calculate the percentage uncertainty in your measurement of x.

(1 mark)

(iii) Calculate the percentage uncertainty in your value of v.

(2 marks)

(d) Describe the energy changes that occur in the mass-thread system when the mass is dropped but the thread does **not** break.

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

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(6 marks)

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(e) (i) Calculate the force acting on the 0.10 kg mass when it is falling freely before the thread tightens.

gravitational field strength, $g = 9.8\,\mathrm{N\,kg^{-1}}$

(1 mark)

(ii) Calculate the magnitude and state the direction of the resultant force acting on the 0.10 kg mass just before the thread breaks.

The value of the force required to break your thread is marked on a card near the apparatus.

(2 marks)

(iii) Calculate the acceleration of the 0.10 kg mass just before the thread breaks.

(2 marks)

20

Total for this question: ***39 marks***

3 You are going to investigate how the period of an oscillator that consists of a loaded hacksaw blade varies with the oscillating length of the blade.

(a) Set the mass attached to the hacksaw blade oscillating horizontally. Observe the motion for about 20 oscillations.

Figure 3 shows the system when the oscillating mass has been displaced from the equilibrium position **O** to point **A**.

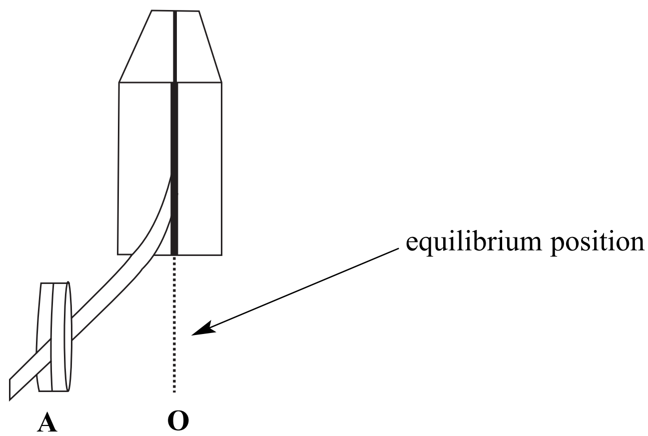

Figure 3

(i) Draw and label on the diagram the forces that act on the mass at **A** when the mass has just been released and the system is oscillating. *(3 marks)*

(ii) State clearly the point in the cycle at which the kinetic energy of the mass is a maximum.

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(1 mark)

(iii) The motion of the system is *damped*. State where the damping force is greatest and explain why this force varies with position.

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(3 marks)

(b)

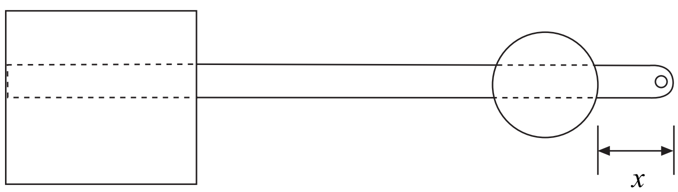

Figure 4

(i) Record the length, x, of the blade protruding beyond the 50 g masses (see **Figure 4**).

(1 mark)

(ii) Take and record measurements that will allow you to determine the period, T, of oscillation of the mass-blade system.

(3 marks)

(c) You are going to measure T for **five** further values of x up to a maximum of $x = 12$ cm. You will then calculate values of $T^{0.67}$.

(Hint: $T^{0.67}$ can be alternatively evaluated on a calculator as $\sqrt[3]{T^2}$.)

In order to vary x you will need to remove the masses and replace them in a new position on the metal strip.

(i) In the space below, draw a table for recording **all** of the measurements and derived data.

(1 mark)

(ii) Take measurements to enable you to record T for **five** further values of x between the initial value and 12 cm. Calculate and record the corresponding values of $T^{0.67}$. All your measured and derived data should be entered in your table.

(12 marks)

(d) On a separate sheet of graph paper, plot a graph with $T^{0.67}$ on the y-axis and x on the x-axis. **You should use a false origin on both axes for this graph**.
Draw the best straight line through your plotted points.

(7 marks)

(e) The equation of the straight line that you have drawn is

$$T^{0.67} = kx + C.$$

The general equation for a straight line is

$$y = mx + c.$$

(i) Determine the gradient k of your graph.

(4 marks)

(ii) State the unit of the gradient.

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(1 mark)

QUESTION 3 CONTINUES ON THE NEXT PAGE

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(iii) **Without making further measurements**, calculate the value of T for which the masses are at the free end of the metal strip as shown in **Figure 5**.

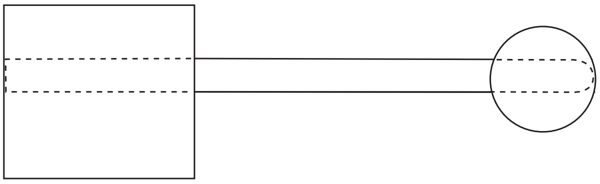

Figure 5

(3 marks)

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END OF QUESTIONS

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