Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2006
Advanced Subsidiary Examination

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

ASSESSMENT and QUALIFICATIONS ALLIANCE

Wednesday 17 May 2006 9.00 am to 11.00 am

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

Time allowed: 2 hours

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

Instructions
- Use blue or black ink or 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. 4 of these marks will be awarded 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 2(c) and 3(b) 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.

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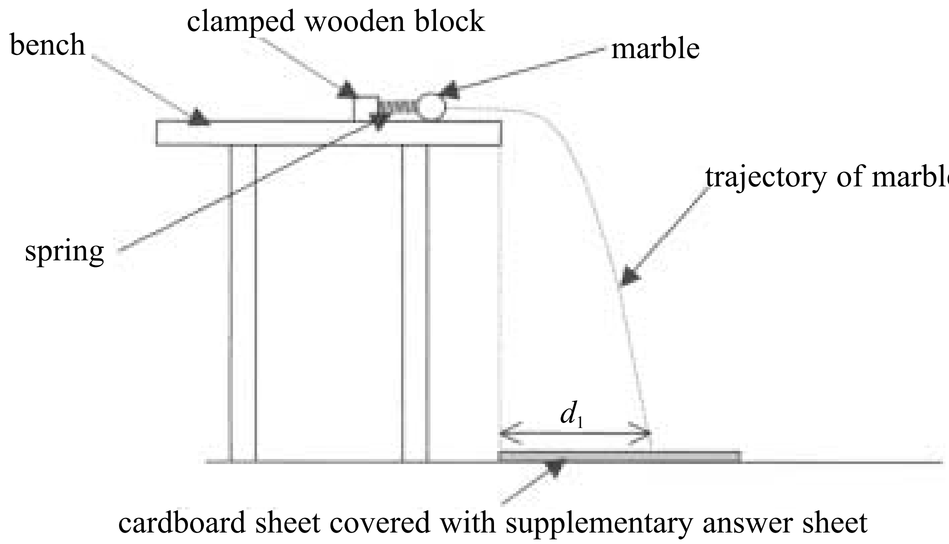
Answer **all** questions.

30 minutes are allowed for this question.

1 You are going to investigate the kinetic energy given to a marble which is fired from a compressed spring.

Figure 1



(a) (i) Compress the spring by 1.0 cm by pushing the marble against it. Release the marble so that it is projected over the edge of the bench. The marble must land on the supplementary answer sheet. Observe where the marble falls and mark the position with the marker pen. Measure and record d_1, the horizontal distance moved by the marble as it falls from the bench. The edge of the cardboard sheet is aligned with the edge of the bench.

(ii) Calculate the horizontal component of the velocity of the marble. You will need to use the value of t, the time taken for the marble to fall from the bench to the floor. The time, t, is given on the card near your apparatus.

(iii) Assume that the horizontal component of the velocity of the marble as it falls is the same as the velocity of the marble as it leaves the spring. Calculate the kinetic energy of the marble as it leaves the spring. The mass of the marble is given on the card near your apparatus.

(6 marks)

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(b) (i) Compress the spring by 3.0 cm by pushing the marble against it. Release the marble so that it is projected over the edge of the bench. Observe where the marble falls and mark the position with the marker pen. Measure and record d_2, the new horizontal distance moved by the marble as it falls from the bench.

(ii) Calculate the new horizontal component of the velocity of the marble.

(iii) Calculate the new kinetic energy of the marble as it leaves the spring.

(3 marks)

(c) Theory suggests that the kinetic energy of the marble as it leaves the spring is directly proportional to the square of the compression of the spring. By making suitable calculations, determine whether or not your measurements support this theory.

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(3 marks)

Turn over

(d) (i) State the absolute uncertainty in your measurement of d_1.

(ii) Calculate the percentage uncertainty in your measurement of d_1.

(iii) Calculate the percentage uncertainty in your value of the horizontal component of the velocity of the marble when the spring was compressed by 1.0 cm.

(iv) Calculate the percentage uncertainty in your value of the kinetic energy of the marble when the spring was compressed by 1.0 cm.

(4 marks)

(e) Without considering any other uncertainty, state and explain whether the uncertainty in your value of the kinetic energy of the marble affects your conclusion in part (c).

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(3 marks)

Attach the supplementary answer sheet to this booklet

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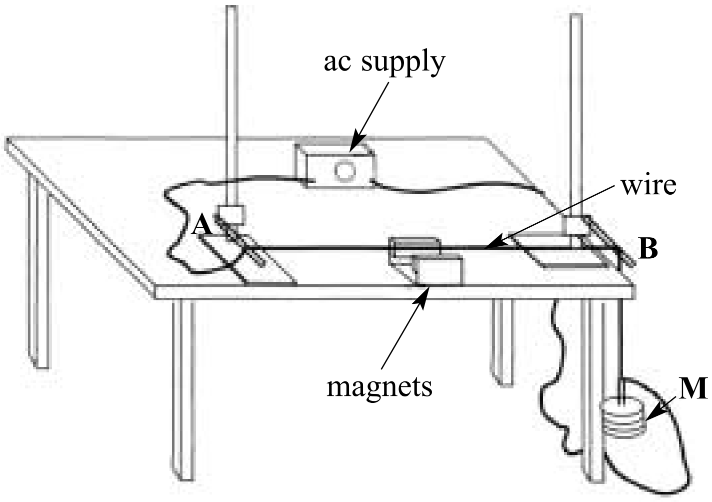
2 You are going to investigate standing waves on a stretched wire. The wire is tensioned by the load **M**. It is made to vibrate by the effect of passing an alternating electric current through the wire that is positioned between two magnets. The frequency of the alternating current is 50 Hz and the wire is made to vibrate at that frequency. For best results, the magnets should be placed on each side of the midpoint of the wire.

Figure 2



(a) Switch on the variable voltage ac supply and move stand **A** away from stand **B** until you see a large amplitude single loop standing wave on the wire. Adjust the position of stand **A** until the amplitude of oscillation is a maximum. You may find that when you stop moving the stand, the oscillation dies away. The required length, l, is the length of the wire between **A** and **B** at which you first observe the maximum amplitude oscillations of the wire.

(i) Measure and record the length, l, in metres.

(ii) State the wavelength of the standing wave on the wire.

Question 2 continues on the next page

Turn over

(iii) Sketch below **two** further possible modes of vibration for the wire, other than the fundamental. For each mode, write down the frequency of vibration of the wire.

(iv) Suggest reasons why it is difficult to determine precisely the length at which the wire vibrates with maximum amplitude.

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(7 marks)

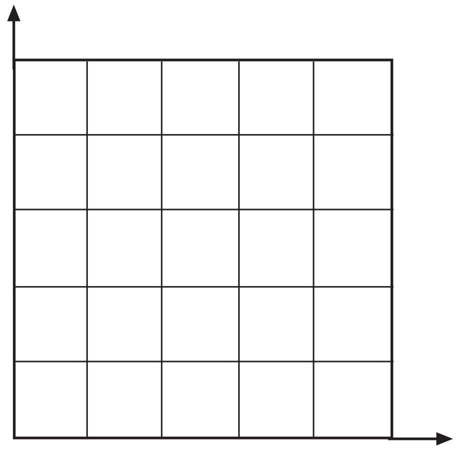
(b) The equation for the magnitude, in Hz, of the fundamental frequency of vibration for the wire is:

$$f^2 = \frac{T}{4l^2m}$$

where m = the mass per unit length of the wire, in kg m^{-1}
and l = the length of the wire in m
T = the tension in the wire = 4.0 N

(i) Calculate a value for m, using your measured value for l.

(ii) Sketch the graph you would expect of f^2 against m for wires of the same length and tension.



(4 marks)

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(c) Describe how you would investigate the relationship between the mass per unit length of a wire and the fundamental frequency. You should include the following in your account:

- the measurements you would make and the instruments you would use to perform a fair and accurate investigation,
- any improvements you would make in the apparatus and any safety precautions that may be necessary,
- the ranges of values you would use,
- details of how you would demonstrate whether or not your results supported the validity of the equation give in part (b).

Two of the 8 marks are available for the quality of your written communication.

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(8 marks)

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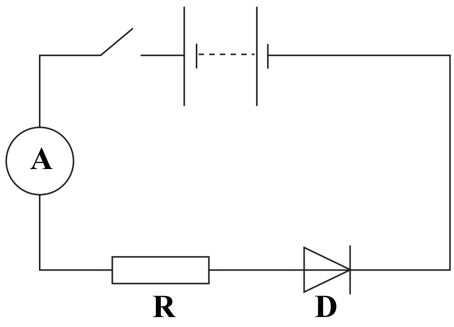
3 You are going to make measurements that will allow you to investigate the variation of the current in a circuit containing a diode. Do not reverse the connections to the battery or the diode.

Figure 3



(a) In the space below, sketch a graph to show the variation of current with applied potential difference for a diode, giving typical values on the potential difference axis.

(2 marks)

(b) Explain how it is possible to use the resistors you have available to get a range of resistances, giving numerical examples.
Two of the 6 marks are available for the quality of your written communication.

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(6 marks)

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(c) (i) Use a series combination of some or all of the four resistors labelled **R** to make a resistance of approximately 100 Ω. Place your combination of resistors in series with the diode and record the current, *I*, in amps. Also record $\frac{1}{I}$ and *R*, the value of your combination of resistors.

(ii) You are going to create five **additional**, **smaller** values of *R* and, for each value, measure the appropriate value of *I*. You should use only series combinations of resistors. Create a table in which to record all of your sets of values of *R* and *I*. Your table should also include space for values of $\frac{1}{I}$.

(iii) Measure and record in the table corresponding values of *R* and *I*. **You should not use values of *R* that are less than 10 Ω**. Also record values of $\frac{1}{I}$ in your table.

(17 marks)

Question 3 continues on the next page

Turn over

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(d) (i) On a sheet of graph paper, plot a graph of $\frac{1}{I}$ (on the y-axis) against R (on the x-axis). Include the origin on both axes.

(ii) Draw the best fit straight line for your plotted points.

(iii) Determine the gradient of your best fit line.

(11 marks)

(e) The equation describing the graph is:

$$\frac{1}{I} = \frac{k}{E}R + \frac{r}{E}$$

where E = the combined emf of the cells (given on a card near your apparatus)
r = the combined internal resistance of the cells
k = a constant

The general equation for a straight line graph is:

$$y = mx + c$$

(i) Use your value of the gradient of the graph and the data given on the card to calculate the value of the constant, k.

(ii) Use the intercept of the graph and the data given on the card to calculate the value of the combined internal resistance, r, of the cells.

(4 marks)

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END OF QUESTIONS

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There are no questions printed on this page

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