Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB3
Unit 3

Tuesday 22 January 2002 Morning Session

In addition to this paper you will require:
- a calculator;
- A4 graph paper;
- 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 to gain some

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

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

30 minutes are allowed for this question.

You are going to investigate the period of oscillation of a steel ball rolling in a watch glass. A watch glass is a small section of a hollow glass sphere which forms a shallow dish. See **Figure 1**.

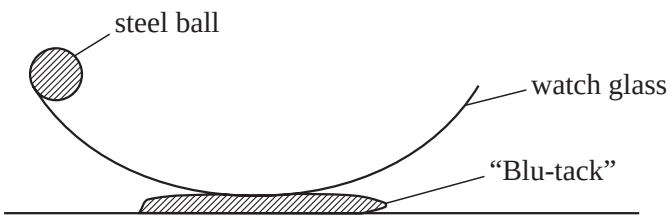


Figure 1

(a) (i) Hold the steel ball at the edge of the watch glass and release it. Observe that the ball oscillates in the watch glass. Make measurements to determine the period of the oscillation.

(3 marks)

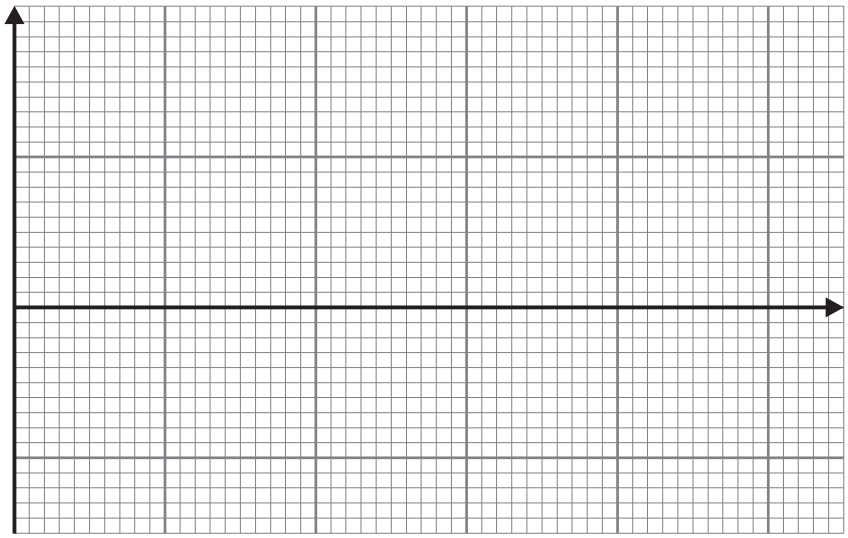
(ii) Measure the diameter of the watch glass.

(1 mark)

(iii) Set the ball oscillating in the watch glass and allow it to keep moving for at least 5 oscillations. Observe that the amplitude of the oscillations decreases and make an approximate measurement of the amplitude after 5 oscillations.

(2 marks)

(iv) Take the displacement of the ball as the horizontal distance from the centre of the watch glass. On the axes below, sketch a graph of displacement against time for the first five complete oscillations of the steel ball. You should include on your graph data that you have determined already in this question.



(4 marks)

(b) You are now going to suggest how to extend the investigation that you have started in this question. You do not have to perform the additional parts of the investigation that you will describe.

(i) The oscillations need not be started at the edge of the watch glass but could be started from any distance, *d*, from the centre of the watch glass. See **Figure 2**.

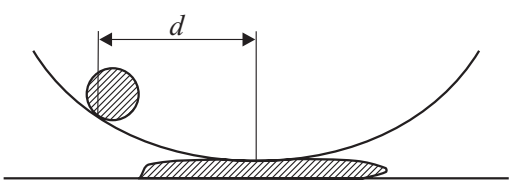


Figure 2

State and explain how you think that the average period of the oscillation would depend on *d*.

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(3 marks)

(ii) Describe how you would proceed to investigate the variation of the average period with *d* and how you would display the results of your investigation. Two of the 7 marks in this question are for the quality of your written communication.

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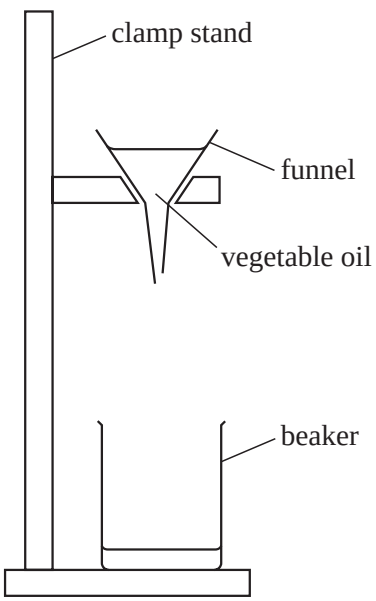
(7 marks)

20

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

30 minutes are allowed for this question.

The viscosity of a liquid is a measure of how easily it flows. Liquids with a low viscosity flow easily. You are going to make measurements relating to the viscosity of vegetable oil. You will also begin to investigate how the viscosity varies with temperature.



(a) You are provided with two 100 ml samples of vegetable oil at different temperatures. You are to measure the time it takes for the oil to flow through a funnel.

(i) Measure the temperature of the oil in the beaker marked **A**.

(1 mark)

(ii) Pour the oil quickly but carefully into the funnel. Measure the time taken from the moment that you have finished pouring to the moment the oil stops draining **continuously** from the funnel. It is not necessary to repeat this measurement.

(2 marks)

(iii) Repeat your measurements for the oil in the beaker marked **B**.

(2 marks)

(b) (i) Estimate the absolute uncertainty in your first timing.

(1 mark)

(ii) Calculate the percentage uncertainty in your first timing.

(1 mark)

(iii) State one **systematic** and one **random** error in your timings. For the systematic error, describe an improvement to the measurement technique that would reduce the error. Two of the 7 marks in this question are for the quality of your written communication.

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(7 marks)

(c) 100 ml of the oil was measured out for you using the measuring cylinder provided.

(i) Calculate the percentage uncertainty in the measurement of the volume of the oil.

(1 mark)

(ii) The viscosity of the oil is related to volume flow rate, $\frac{V}{t}$, where:

V = the volume of the oil

and t = time taken for the oil to drain.

Calculate the volume flow rate for each of your sets of results. Calculate the percentage uncertainty for the value of $\frac{V}{t}$ for your first set of results.

(4 marks)

(d) Without doing any further calculations, state how you think viscosity is related to temperature.

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(1 mark)

20

TURN OVER FOR THE NEXT QUESTION

3 **Total for this question: *38 marks***

One hour is allowed for this question.

You are to use two methods to determine the emf, E, of a cell. You will also determine the internal resistance, r, of the cell.

(a) Connect the voltmeter to the terminals, **A** and **B**, of the cell as shown in **Figure 3**.

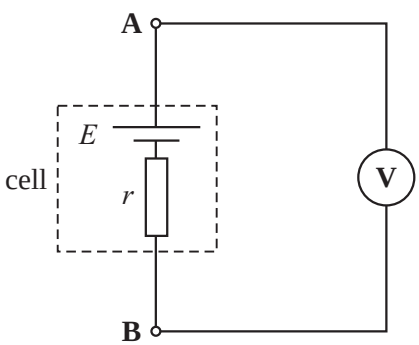

Figure 3

(i) Measure the voltage between the terminals **A** and **B**.

(2 marks)

(ii) State a reason why there is uncertainty in this reading.

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(1 mark)

(iii) State what is meant by the emf of the cell.

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(2 marks)

(iv) State a reason why a high resistance voltmeter is necessary to give an accurate value of the emf of the cell.

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(1 mark)

(b) In the circuit shown in **Figure 4**, the resistance wire has a length L and a resistance per unit length of w. When the switch **S** is closed, the current, I, can be read from the ammeter.

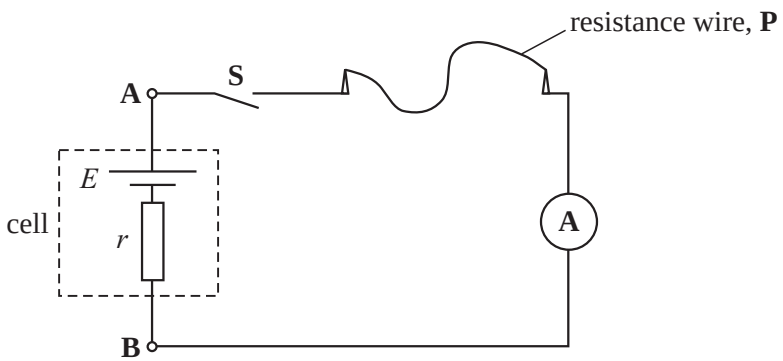

Figure 4

(i) Write down an equation for I, in terms of w, L, E and r.

(2 marks)

(ii) Assemble the circuit shown in **Figure 4**. You are going to take readings of I (in A) for **five** different values of L (in m). You will then calculate values of $\frac{1}{I}$.

QUESTION 3 CONTINUES ON THE NEXT PAGE

(iii) In the space below, draw a table for recording all of the measurements you will make.

Include space for values of $\frac{1}{I}$. *(1 mark)*

(iv) By adjusting the length L of the resistance wire connected between the crocodile clips, measure and record **five** different values of L and I. Close the switch **S** only when taking readings. Calculate and record the corresponding values of $\frac{1}{I}$.

(11 marks)

(c) You are now to plot a graph from which you will calculate values of E and r.

On a separate sheet of graph paper, plot a graph of $\frac{1}{I}$ (along the y-axis) against L. The values of L should start at zero. Draw the best straight line through your plotted points.

(7 marks)

(d) The equation of the straight line you have drawn is:

$$\frac{1}{I} = \left(\frac{w}{E}\right) L + \frac{r}{E}$$

This equation may be compared to the general equation for a straight line:

$$y = mx + c$$

(i) Determine the gradient of the graph.

(3 marks)

(ii) The value of w is given on the card. Calculate a value for the emf, E, of the cell.

(3 marks)

(iii) Read from the graph the intercept of the line with the $\frac{1}{I}$ axis.

(2 marks)

(iv) Calculate a value for r, the internal resistance of the cell.

(3 marks)

38

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE