Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature				

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General Certificate of Education
June 2004
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB3
Unit 3

Wednesday 19 May 2004 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: ***20 marks***

30 minutes are allowed for this question.

1 You are going to measure the emf of a cell and consider how a decreasing terminal p.d. will affect its usefulness.

(a) Connect the high resistance voltmeter across the cell as shown in **Figure 1**.

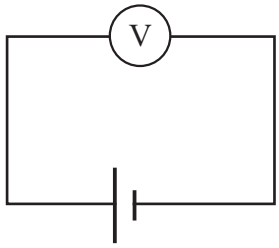

Figure 1

(i) Write down the voltage shown on the voltmeter to the number of significant figures that it shows. This is a measurement of the emf, *E*, of the cell.

(1 mark)

(ii) State the absolute uncertainty in this value for *E*.

(1 mark)

(iii) Calculate the percentage uncertainty in this value for *E*.

(1 mark)

(b) Connect the circuit shown in **Figure 2**. Use this circuit to obtain values for the current, *I*, and the potential difference, *V*, for each of the resistors **A** and **B**.
Record your readings in the table of **Figure 3**.
Do not repeat readings for these quantities. *(2 marks)*

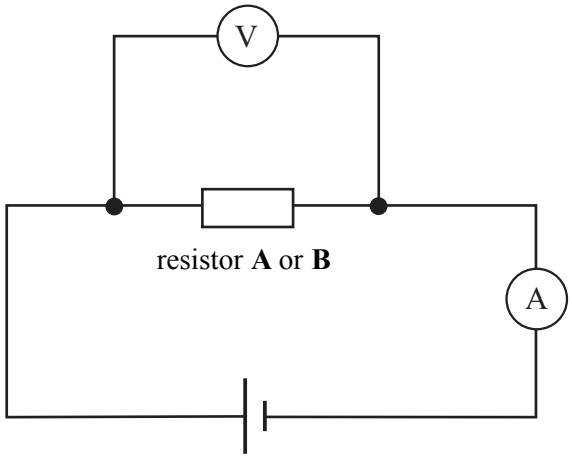

Figure 2

resistor	**A**	**B**
I/A		
V/V		

Figure 3

(c) (i) Complete the scales on the grid of **Figure 4**. *(1 mark)*

(ii) Plot your readings on this grid. *(1 mark)*

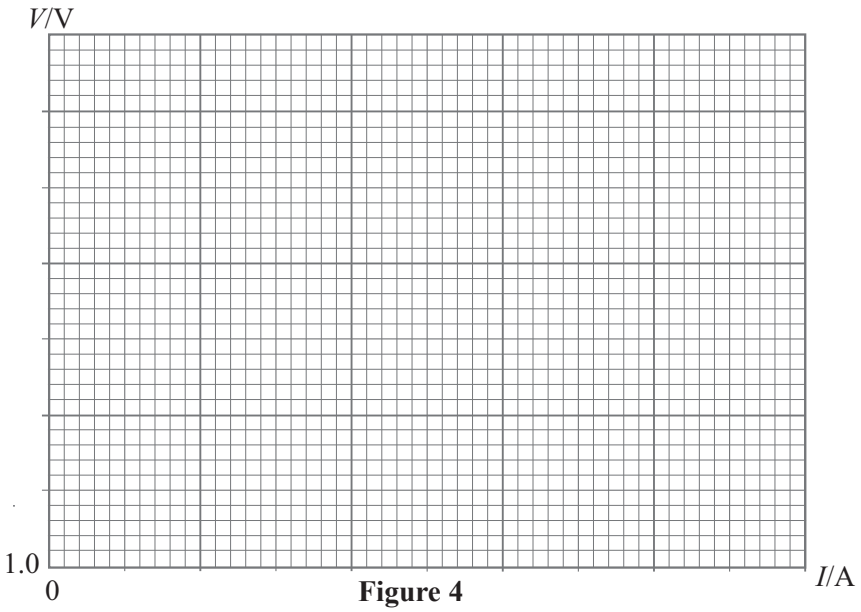

Figure 4

(iii) Draw a straight line through your plotted points. *(1 mark)*

QUESTION 1 CONTINUES ON THE NEXT PAGE

(d) When a resistor is connected across the cell, the current, I, through the resistor and the potential difference, V, across the resistor are related to E by the equation

$$V = -Ir + E,$$

where r is the internal resistance of the cell.

Compare this equation to the equation of a straight line, $y = mx + c$, to find a second value for E.

(2 marks)

(e) (i) Explain which of your two values for E is likely to be the more reliable.

(2 marks)

(ii) Consider both measurements of E and quote a final value for E with an appropriate absolute uncertainty. Explain your reasoning.

(2 marks)

(f) **Figure 5** is a datalogged plot of the terminal potential difference against time for a cell permanently connected to a resistor.

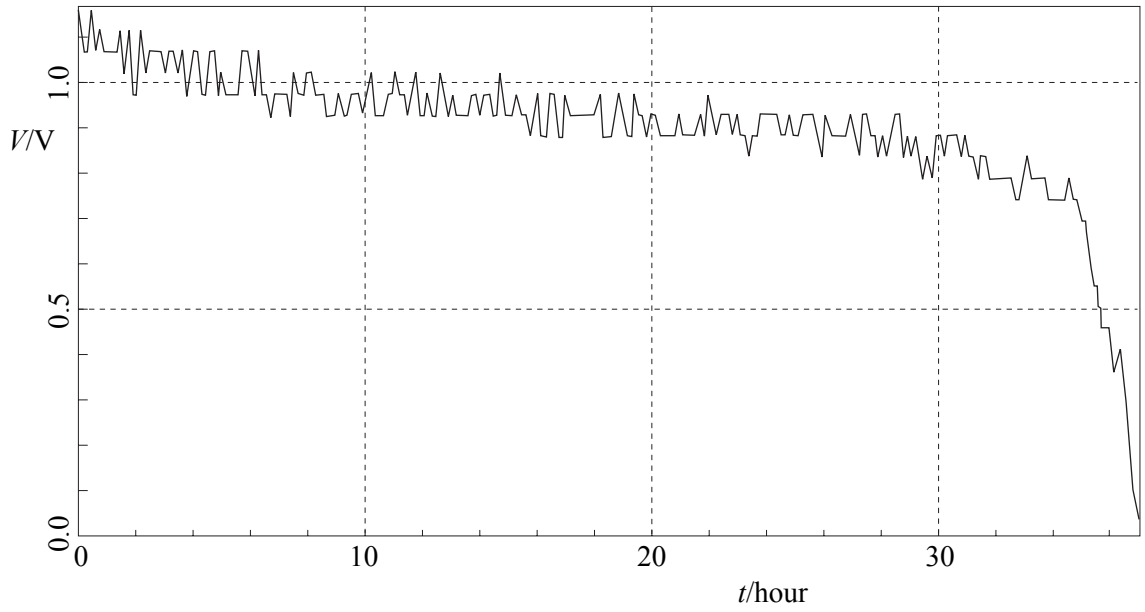

Figure 5

Explain:

(i) why the plot, shown in **Figure 5**, is not smooth;

(ii) why a datalogger has been used rather than manual readings taken;

(iii) the implications of using a cell to provide current over the time shown in the plot.

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

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(6 marks)

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

30 minutes are allowed for this question.

2 You are going to investigate the effect that a pair of coupled pendulums have on each other and then go on to suggest how the experiment may be further developed.

(a) **Figure 6** shows a pair of pendulums **P** and **Q** hanging from a sagging string attached to a pair of supports at the same level. **P** is a table tennis ball, **Q** a metal weight.

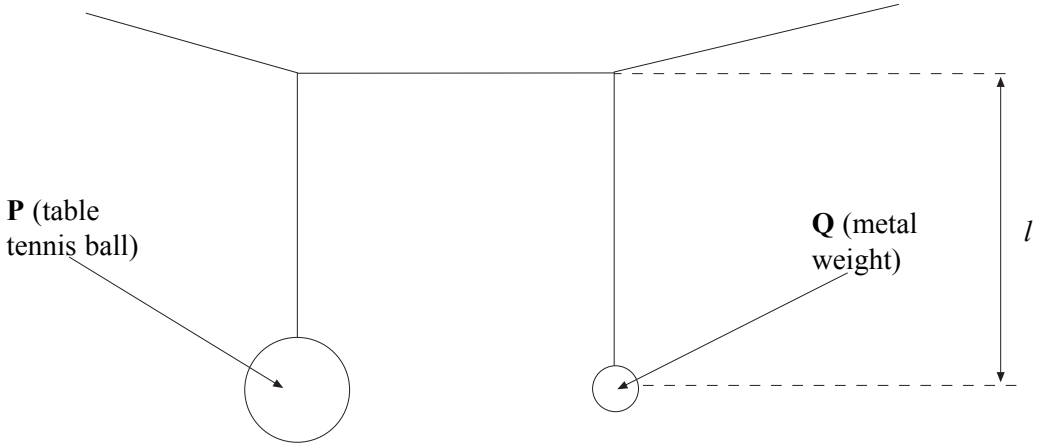

Figure 6

(i) Displace pendulum **Q** by 20-30 mm in a plane at right angles to that of the strings (i.e. towards you as seen in **Figure 6**). Observe the subsequent motion of both pendulums and describe what you see happening.

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(3 marks)

(ii) Explain why the damping of the two pendulums is different.

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(1 mark)

(b) Measure and record the period, T, of pendulum **Q**.

(2 marks)

(c) Measure and record the length, l, of this pendulum in m from the point of suspension to the centre of mass of the metal weight.

(1 mark)

(d) The gravitational field strength, g, is given by the equation

$$g = \frac{4\pi^2}{T^2} l$$

(i) Calculate a value for g, using your measured values of l and T.

(2 marks)

(ii) The accepted value for g is $9.8\,\text{m}\,\text{s}^{-2}$. Calculate the percentage difference between the accepted and measured values for g. Show your working.

(3 marks)

QUESTION 2 CONTINUES ON THE NEXT PAGE

(e) You are now going to consider in more detail the effect that two coupled pendulums have on each other. When pendulum **Q** is displaced as in part (a) it causes **P** to oscillate. The amplitude of the oscillation of **P** depends upon its length compared with that of **Q**.

Describe how you would investigate the relationship between the amplitude of the oscillation of pendulum **P** and its length when it is forced to oscillate by pendulum **Q**. Pendulum **Q** should be kept the same length throughout the investigation.

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

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(8 marks)

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

One hour is allowed for this question.

3 You are to investigate how the efficiency of dragging a loaded slider along a ramp varies with the angle, θ, of the ramp.

(a) Using the newtonmeter determine the size of the force, F, required to move the loaded slider at a steady speed along the long sheet of wood when it is lying flat.

(3 marks)

(b) Set up the apparatus as shown in **Figure 7**.

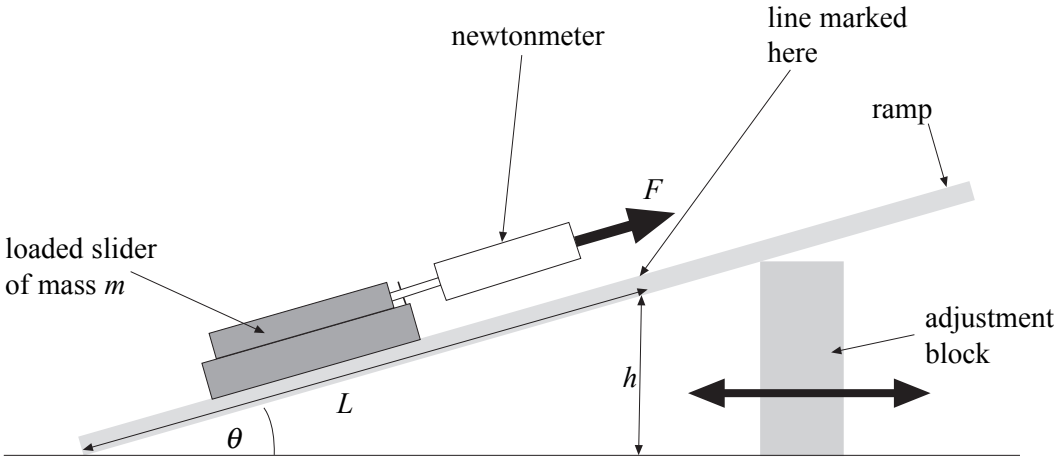

Figure 7

(i) On **Figure 7** mark and label the **three** forces that in addition to the pulling force, F, act on the loaded slider when it is in equilibrium.

(3 marks)

(ii) The loaded slider is in equilibrium as it moves at a steady speed. By considering the forces parallel and at right angles to the ramp, write down **two** equations relating the forces that you have labelled in part (i).

(2 marks)

QUESTION 3 CONTINUES ON THE NEXT PAGE

(c) You are now going to drag the loaded slider at a steady speed from the bottom of the ramp. You will do this until the rear end of the loaded slider reaches the line marked on the ramp. Slide or rotate the adjustment block to obtain a number of different heights. For each height, h, you will measure and record the value of h and the corresponding value of F.
Make sure that the newtonmeter is pulled parallel to the ramp.

(i) In the space below, draw a table in which to record 5 sets of values of h and F.

(2 marks)

(ii) Measure and record in the table corresponding values of F and h. The maximum value of h should be 0.20 m. *(10 marks)*

(d) The efficiency of the ramp is given by the relationship

$$\text{efficiency} = \frac{\text{gain in gravitational potential energy}}{\text{work done by pulling force}}$$

$$= \frac{mgh}{FL} = \frac{G}{W}$$

The mass, m, is the value marked on the loaded slider. L is the distance in m between the end of the ramp and the line marked on the ramp shown in **Figure 7**.

$$g = 9.8\,\text{N kg}^{-1}$$

Draw a second table and record corresponding values for G and W.

(5 marks)

(e) (i) On a sheet of graph paper plot a graph of G against W. *(6 marks)*

(ii) Draw the line of best fit for your plotted points. *(2 marks)*

QUESTION 3 CONTINUES ON THE NEXT PAGE

(iii) Explain the factors that determined the choice of your line of best fit.

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(2 marks)

(f) State and explain what your graph suggests about the efficiency of the ramp.

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(3 marks)

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END OF QUESTIONS