Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

Leave blank

General Certificate of Education
June 2003
Advanced Subsidiary Examination

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

Thursday 15 May 2003 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			

LEAVE MARGIN BLANK

Answer **all** questions in the spaces provided.

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

30 minutes are allowed for this question.

You are going to investigate the motion of a small wooden cylinder rolling down a sloping track. Four lines have been drawn on the track with labels A, B, C and D, as shown in **Figure 1**.

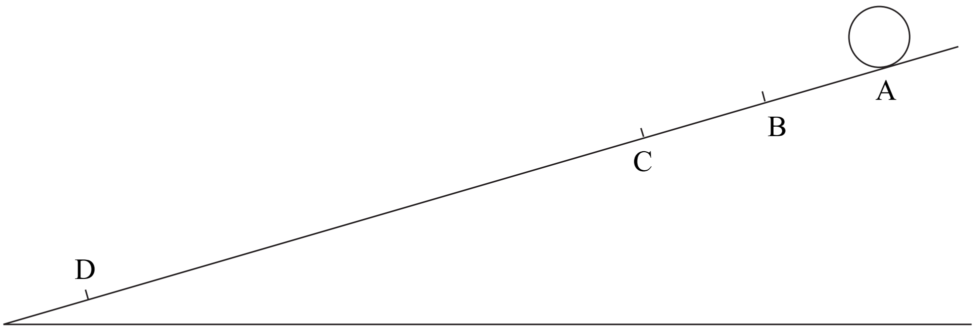


Figure 1

(a) Allow the cylinder to roll from rest positions A, B and C in turn and time how long it takes to reach line D. You should also measure the distance d travelled by the cylinder in each case and record all of your results in the following table.

Motion	Distance d/m	Roll-time in seconds 1st	2nd	3rd	Average time t/s
A to D					
B to D					
C to D					

(3 marks)

(b) (i) Using the values from your table, **calculate** the absolute uncertainty in t for the motion C to D.

(2 marks)

(ii) Suggest, giving a reason, the absolute uncertainty in your measurement of the distance C to D.

(2 marks)

(iii) Calculate the average speed of the cylinder as it rolls from rest between C and D.

(1 mark)

(iv) Use your answers from part (i) and part (ii) to calculate the percentage uncertainty in your answer to part (iii).

(4 marks)

QUESTION 1 CONTINUES ON THE NEXT PAGE

Turn over ▸

LEAVE MARGIN BLANK

(c) For a **light** cylinder rolling down a **shallow** slope, theory suggests that, for d less than a few metres, t^2 is proportional to d.

(i) Use your values for t and d to test this relationship, and then say whether or not it is verified by your experiment.

(3 marks)

(ii) Describe and explain how the velocity and the acceleration of a light cylinder rolling from rest down a **much longer** slope would vary with time.

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

....

....

....

....

....

....

....

....

....

....

....

(5 marks)

20

LEAVE MARGIN BLANK

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

30 minutes are allowed for this question.

This question is about the properties of a simple electric cell made from rods of carbon and copper in salt solution, as shown in **Figure 2a**.

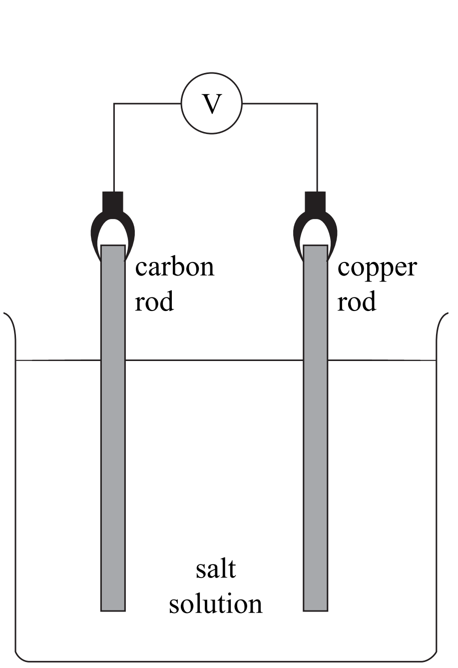


Figure 2a

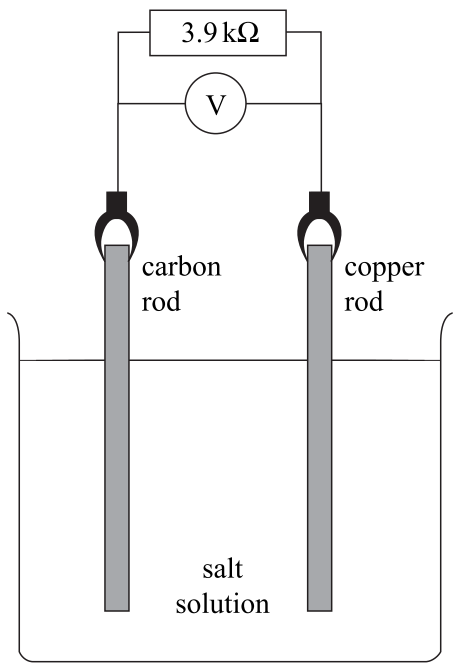


Figure 2b

(a) (i) Put the rods into the solution and measure E, the emf of the cell. Take care that the rods do not touch when taking the reading.

(2 marks)

(ii) Remove the rods from the solution and wipe them using the paper towel. Connect the 3.9 kΩ resistor in parallel with the voltmeter to act as a load, as shown in **Figure 2b**. Put the rods back into the solution. Record the terminal pd, V, as soon as they are in place.

Do not leave the rods in the solution as *V* will decrease.

(2 marks)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Turn over

LEAVE MARGIN BLANK

(b) The internal resistance r of the cell is given by

$$r = \frac{R(E - V)}{V}$$

where R is the load resistance.

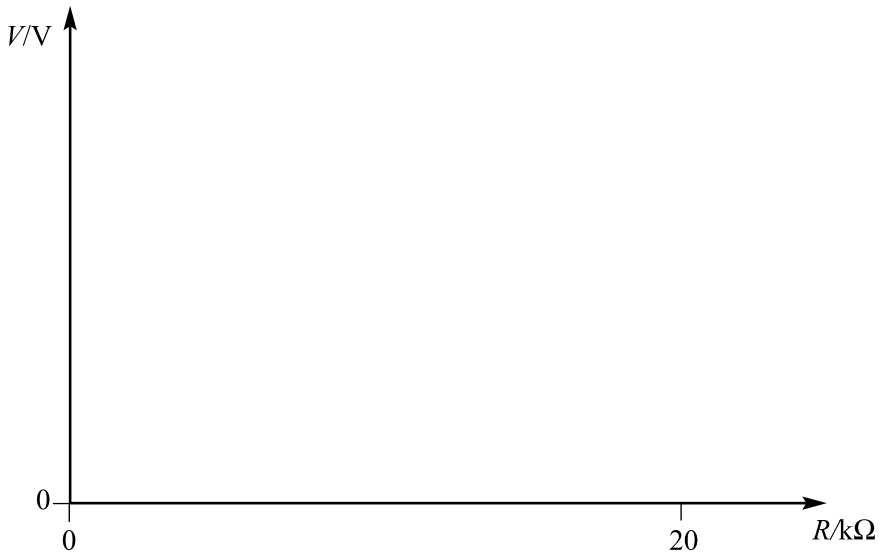
Use your values for E and V to calculate r.

(2 marks)

(c) (i) Repeat the procedures in part (a)(ii) using the 1.0 kΩ resistor as the load. Record this value for V.

(1 mark)

(ii) On the axes below sketch a graph of V against R, including a suitable scale for V.



(3 marks)

LEAVE MARGIN BLANK

(d) Temperature is one variable that is thought to affect the internal resistance of the cell.

(i) Suggest **one** other variable which you think might affect the internal resistance of this cell.

....

(1 mark)

(ii) State and explain how you would expect the variable that you suggested in part (d)(i) to affect the internal resistance of the cell.

....

....

....

....

(2 marks)

(e) Describe how you would investigate the variation of internal resistance with temperature for this cell.

Two of the 7 marks in this question are available for the quality of your written communication.

....

....

....

....

....

....

....

....

....

....

....

....

(7 marks)

20

Turn over

LEAVE MARGIN BLANK

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

One hour is allowed for this question.

You are going to investigate the twisting oscillations of a half-metre rule supported by two strings. The apparatus has been assembled for you as shown in **Figure 3**.

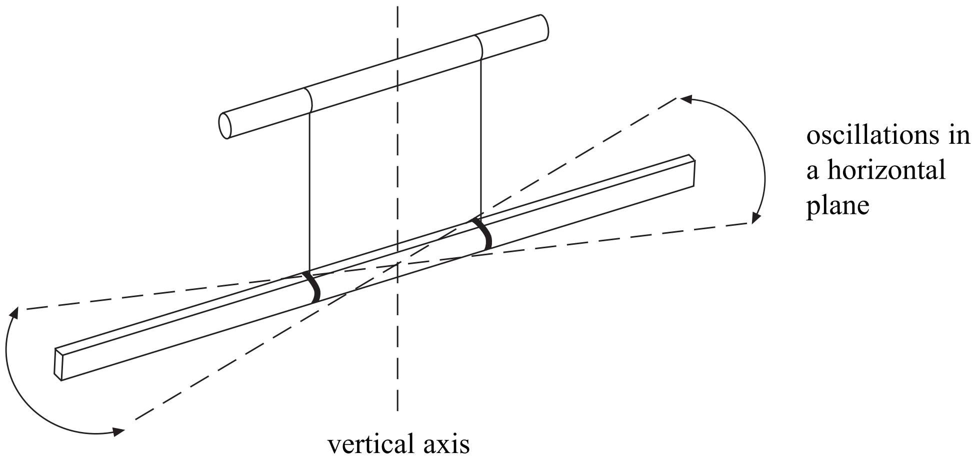


Figure 3

(a) (i) Set the beam twisting with **small amplitude oscillations** about the vertical axis through its centre. Measure its period of oscillation T_0.

If you are unsure about the motion of the beam consult the supervisor. You will not be penalised for doing so.

(2 marks)

(ii) Suggest **two** possible sources of uncertainty in your value for T_0.

....

....

....

....

(2 marks)

LEAVE MARGIN BLANK

(b) You are now going to measure the period of oscillation T, in s, for five different values of the distance d as shown in **Figure 4**. You will then calculate the values of T^2 and d^2 from these measurements.

On page 10 draw a table in which to record your observations and the corresponding values of d, T, d^2 and T^2.

(c) Using the rubber bands provided, attach the two 100 g masses 10 mm from each end of the rule as shown in **Figure 4**.

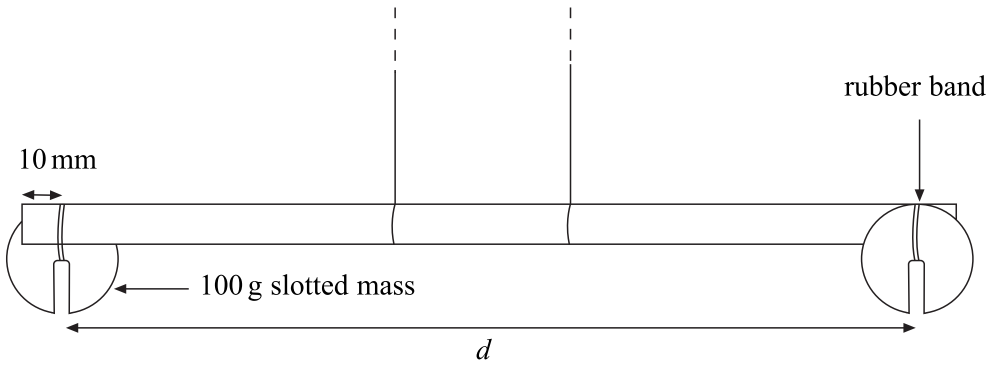


Figure 4

(i) Measure and record in your table the distance d, in m, and the corresponding period T of small twisting oscillations for this loaded rule.

(ii) Measure and record **four** further measurements of T for values of d in the range 0.160 m to 0.480 m.

Ensure that the 100 g masses are always equal distances from the ends of the rule.

(16 marks)

QUESTION 3 CONTINUES ON PAGE 11

LEAVE MARGIN BLANK

(d) Plot a graph of T^2 (along the y-axis) against d^2 (along the x-axis). The values on both axes should start at zero. Draw the best straight line through your plotted points.

(7 marks)

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

$$T^2 = (0.10K)d^2 + 0.042Km$$

where m is the effective mass of the suspended rule in kg
and K is a constant for the system.

This equation may be compared to the general equation of a straight line

$$y = mx + c$$

(i) Determine the gradient of the graph.

(3 marks)

(ii) Calculate a value for K.

(2 marks)

(iii) Read from the graph the intercept of the line with the T^2 axis.

(3 marks)

(iv) Calculate a value for m, the effective mass of the rule.

(3 marks)

END OF QUESTIONS

38

General Certificate of Education
June 2003
Advanced Subsidiary Examination

PHYSICS (SPECIFICATION B) **PHB3/TN**

Instructions to Supervisors

CONFIDENTIAL

OPEN ON RECEIPT

The examination will be held on Thursday 15 May 2003 Morning Session

It is the responsibility of the Examinations Officer to ensure that these Instructions to Supervisors are given immediately to the Supervisor of the practical examination.

These Instructions are strictly confidential and must be kept in safe custody by the Examinations Officer or by the Supervisor. They should be given to the Invigilator for the duration of the actual examination and afterwards returned to the Examinations Officer. The Invigilator must ensure that when the Instructions are not in use, they are returned and kept in safe custody. Additional copies of these Instructions cannot be supplied by AQA.

Please note that these Instructions have the relevant questions from the paper, PHB3, printed after each set of apparatus and materials in the document, so that the Supervisor can consider any appropriate modifications. No copies of the relevant question paper should be given to the Supervisor at any time leading up to the examination.

INSTRUCTIONS TO THE SUPERVISOR OF THE PRACTICAL EXAMINATION.

General

1 The instructions and details of materials contained in this document are for the use of the Supervisor **and are strictly confidential**. In no circumstances should information concerning apparatus or materials be given before the examination to a candidate or other unauthorised person.

2 In a centre with a large number of candidates it may be necessary for two or more examination sessions to be organised. Candidates waiting for their session must be fully invigilated in a separate room throughout the period from the time of the first session until they enter the examination room. Candidates completing their session before the published starting time must similarly be invigilated. Requests for such arrangements, giving full details of invigilation arrangements and times, must be made in writing to AQA, Devas Street, Manchester, M15 6EX.

3 A suitable laboratory, or laboratories, must be reserved for the examination and kept locked throughout the period of preparation. Unauthorised persons not involved in the preparation for the examination must not be allowed to enter. Candidates must not be admitted until the specified time for commencement of the examination.

4 The Supervisor, in order to ensure that the apparatus and materials are suitable for the performance of the experiments, now has been granted access to the question paper as part of these Instructions. All the relevant questions are printed so that minor modifications can be carefully considered.

5 The examination paper contains three compulsory questions. Candidates are allowed 30 minutes on each of Questions 1 and 2, and 1 hour on Question 3.

6 Centres may provide sufficient sets of apparatus for half their candidates to work on Questions 1 and 2, while the other half work on Question 3. Under strict supervision, the groups of candidates change over after 1 hour. It will be necessary to allow a short period of time whilst the change over takes place. During this time the apparatus should be returned to its original state, ready for use by the next group of candidates. A similar short delay for the same purpose will be needed in centres running two or more sessions.

Whatever arrangement is adopted, enough apparatus and materials must be prepared to ensure that in the case of failure of a set of apparatus, a substitute is available so that the candidate does not lose time.

7 AQA will provide the question paper/answer books and A4 graph paper for use in Question 3. All other materials required must be provided by the centre.

8 The apparatus and materials for each candidate must be arranged neatly, and ready to use, on the laboratory bench. No attempt should be made to connect together any parts or to wire up any electrical circuits except when specifically stated in these Instructions.

9 Clear instruction must be given by the Supervisor to all candidates at the beginning of the examination concerning the organisation of the examination in the laboratory and the amount of time allowed for each question. Candidates must also be instructed that all readings must be entered in the question paper/answer book provided and all working must be shown. **Scrap paper must not be used.**

10 If a candidate is unable to perform any experiment, or is performing an experiment incorrectly, the Supervisor is expected to give the minimum help required to enable the candidate to proceed. In this instance, a note bearing the candidate's name and number must be attached to the candidate's script reporting to the Examiner the extent of the help given. **No help should be given with the analysis of the experimental data**.

It is not the wish of the Examiner that a candidate should waste time because of, for example, an incorrect electrical connection. The Examiner wishes to test the candidate's ability to perform an experiment and carry out the subsequent analysis.

Any failure in the apparatus should also be reported to the Examiner.

11 The Supervisor is required to report details concerning the experiment, apparatus or materials to the Examiner on the *Supervisor's Report* located at the end of this document. **The Supervisor's Report must be attached to the topmost script before despatch to the Examiner**.

Details must be given on the *Supervisor's Report* if the apparatus or materials provided differ from that detailed in this document. Where specific information or data about apparatus or materials is requested in these Instructions, it is important that it is given accurately. In some cases it may represent the only means available to the Examiner of assessing the accuracy of a candidate's work.

Centres may make copies of this *Supervisor's Report* for attachment to individual scripts if necessary. If all the information cannot easily be included on the *Supervisor's Report*, separate sheets of paper, bearing the candidates' names and numbers can be attached to the relevant candidates' scripts.

12 Note that candidates will require a separate sheet of A4 graph paper for Question 3. The graph paper for each candidate should be secured to their question paper/answer book using a treasury tag before despatch to the examiner.

13 The examination room must be cleared of candidates immediately after the examination.

In case of difficulty the Supervisor should telephone the Senior Subject Officer for A Level Physics, David Baker, at AQA (Manchester Office) telephone number 0161 953 1180 or email dbaker@aqa.org.uk

Turn over ▶

Question 1

Candidates will be required to measure the time taken for a light cylinder to roll a measured distance down a sloping track.

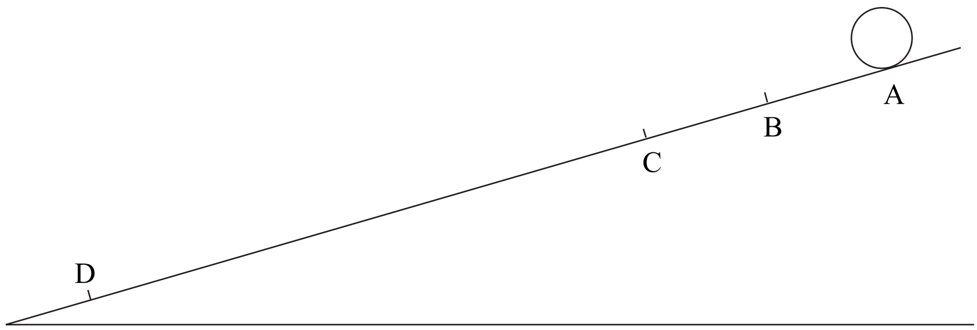


Figure 1

Apparatus and materials – The following items should be supplied to each candidate:

(a) a ramp of at least 1 metre in length (a dynamics trolley track is ideal but a suitable length of shelving or similar wood will do just as well),

lines A, B, C and D should be clearly drawn across the ramp (see **Figure 1**) so that AD = 700 mm, AC = 550 mm and AB = 400 mm,

the angle of the slope should be adjusted so that the cylinder rolls from rest between A and D in approximately 2 seconds;

(b) a small wooden cylinder (this can be made from a 6 cm length of 1 cm diameter dowel, however its size is not critical);

(c) a stopclock or stopwatch reading to 0.1 or 0.01s;

(d) a metre rule.

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

30 minutes are allowed for this question.

You are going to investigate the motion of a small wooden cylinder rolling down a sloping track. Four lines have been drawn on the track with labels A, B, C and D, as shown in **Figure 1**.

(a) Allow the cylinder to roll from rest positions A, B and C in turn and time how long it takes to reach line D. You should also measure the distance *d* travelled by the cylinder in each case and record all of your results in the following table.

Motion	Distance d/m	Roll-time in seconds			Average time t/s
		1st	2nd	3rd	
A to D					
B to D					
C to D					

(3 marks)

(b) (i) Using the values from your table, **calculate** the absolute uncertainty in t for the motion C to D. *(2 marks)*

(ii) Suggest, giving a reason, the absolute uncertainty in your measurement of the distance C to D. *(2 marks)*

(iii) Calculate the average speed of the cylinder as it rolls from rest between C and D. *(1 mark)*

(iv) Use your answers from part (i) and part (ii) to calculate the percentage uncertainty in your answer to part (iii). *(4 marks)*

(c) For a **light** cylinder rolling down a **shallow** slope, theory suggests that, for d less than a few metres, t^2 is proportional to d.

(i) Use your values for t and d to test this relationship, and then say whether or not it is verified by your experiment. *(3 marks)*

(ii) Describe and explain how the velocity and the acceleration of a light cylinder rolling from rest down a **much longer** slope would vary with time.

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

Turn over ▶

Question 2

Candidates will be required to measure the emf and terminal pd of a simple cell comprising rods of copper and carbon in salt (sodium chloride) solution.

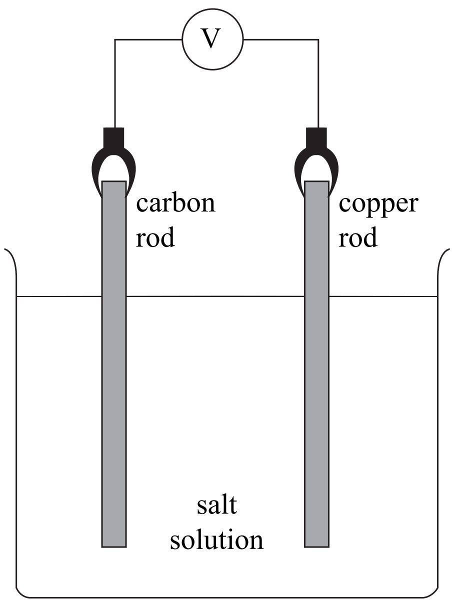


Figure 2a

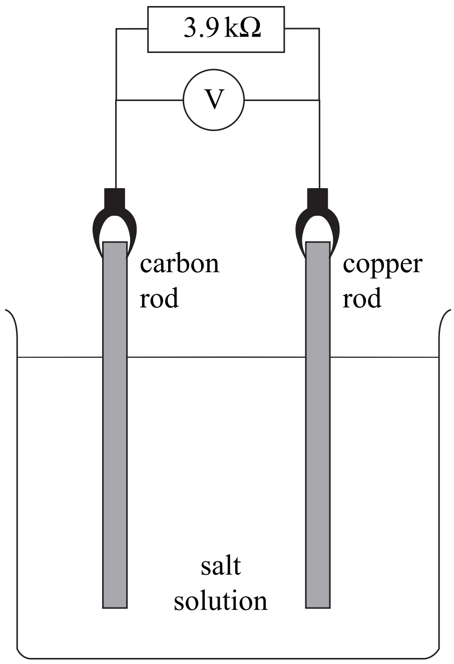


Figure 2b

Apparatus and materials – The following items should be supplied for each candidate:

(a) 250 ml beaker about 2/3 full of sodium chloride solution (5 g of NaCl per 100 cm^3 of water);

(b) carbon rod (100 mm × 5 mm, from Timstar (ref. ELO 6886) or Griffin and George (ref. EKW-724-500D) is suitable);

(c) 10 cm length of stiff **bare** copper wire;

(d) digital voltmeter reading to 0.01 V;

the voltmeter should be connected to the carbon and copper rods with leads and crocodile clips so that a positive reading is given when they are placed in the salt solution as shown in **Figure 2a**;

the apparatus should be assembled like this **with the rods out of the solution** and resting on a paper towel at the start of the examination;

(e) 1.0 kΩ and 3.9 kΩ resistors, clearly labelled as such and with suitable connectors (eg mounted in component holders) for use in the arrangement shown in **Figure 2b**;

(f) paper towel.

NOTE The emf of the cell is not critical but a measurable reduction in the terminal pd when it is on load is needed.

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

30 minutes are allowed for this question.

This question is about the properties of a simple electric cell made from rods of carbon and copper in salt solution, as shown in **Figure 2a**.

(a) (i) Put the rods into the solution and measure E, the emf of the cell. Take care that the rods do not touch when taking the reading. *(2 marks)*

(ii) Remove the rods from the solution and wipe them using the paper towel. Connect the 3.9 kΩ resistor in parallel with the voltmeter to act as a load, as shown in **Figure 2b**. Put the rods back into the solution. Record the terminal pd, V, as soon as they are in place.

Do not leave the rods in the solution as *V* will decrease.

(2 marks)

(b) The internal resistance r of the cell is given by

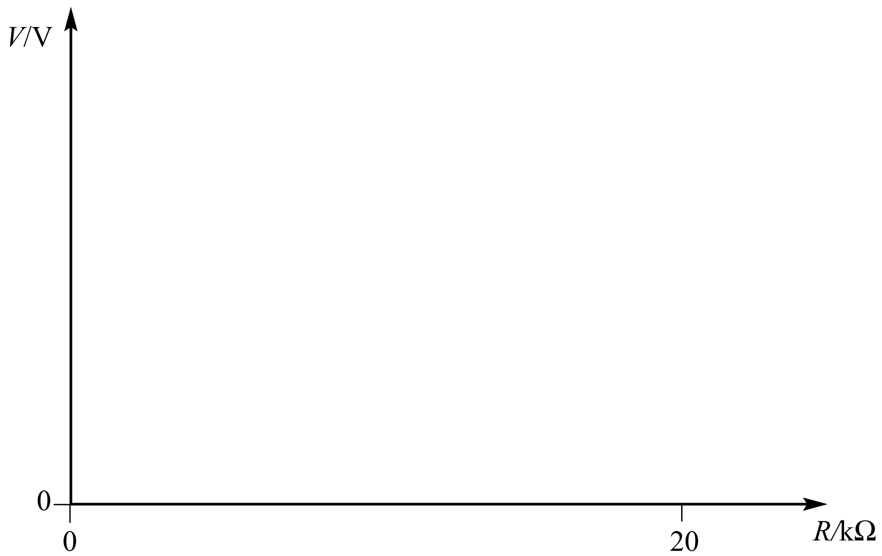
$$r = \frac{R(E - V)}{V}$$

where R is the load resistance.

Use your values for E and V to calculate r. *(2 marks)*

(c) (i) Repeat the procedures in part (a)(ii) using the 1.0 kΩ resistor as the load. Record this value for V. *(1 mark)*

(ii) On the axes below sketch a graph of V against R, including a suitable scale for V.



(3 marks)

Turn over ▶

(d) Temperature is one variable that is thought to affect the internal resistance of the cell.

(i) Suggest **one** other variable which you think might affect the internal resistance of this cell. *(1 mark)*

(ii) State and explain how you would expect the variable that you suggested in part (d)(i) to affect the internal resistance of the cell. *(2 marks)*

(e) Describe how you would investigate the variation of internal resistance with temperature for this cell.

Two of the 7 marks in this question are available for the quality of your written communication. *(7 marks)*

Question 3

Candidates will be required to measure the effective mass of a half-metre rule in the form of a loaded bifilar pendulum.

Apparatus and materials - The following items should be supplied for each candidate:

(a) a bifilar pendulum, pre-assembled using a half-metre rule suspended with its scale in the vertical plane, as shown in **Figure 3**. The suspension threads should be attached at the 20 cm and 30 cm marks with the rule horizontal and approximately 20 cm below the suspension bar. Tight loops of thread around the bar and the rule, both secured with a clear adhesive tape proved to be satisfactory in tests. The suspension bar could be a short retort stand rod, a length of dowel or something similar. The suspension bar should be clamped to a stand at a convenient working height.

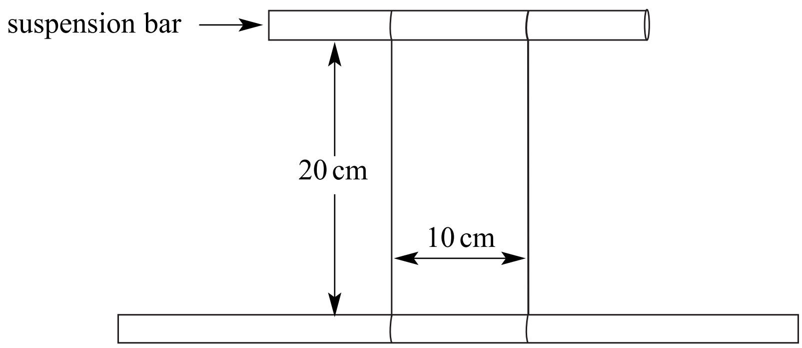


Figure 3

(b) two 100 g slotted masses with rubber bands to attach them to the rule;

(c) a stopclock or stopwatch reading to 0.1 or 0.01 s;

(d) retort stand, boss and clamp.

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

One hour is allowed for this question.

You are going to investigate the twisting oscillations of a half-metre rule supported by two strings. The apparatus has been assembled for you as shown in **Figure 3**.

(a) (i) Set the beam twisting with **small amplitude oscillations** about the vertical axis through its centre. Measure its period of oscillation T_0.

If you are unsure about the motion of the beam consult the supervisor. You will not be penalised for doing so. *(2 marks)*

(ii) Suggest **two** possible sources of uncertainty in your value for T_0. *(2 marks)*

(b) You are now going to measure the period of oscillation T, in s, for five different values of the distance d as shown in **Figure 4**. You will then calculate the values of T^2 and d^2 from these measurements.

Draw a table in which to record your observations and the corresponding values of d, T, d^2 and T^2.

(c) Using the rubber bands provided, attach the two 100 g masses 10 mm from each end of the rule as shown in **Figure 4**.

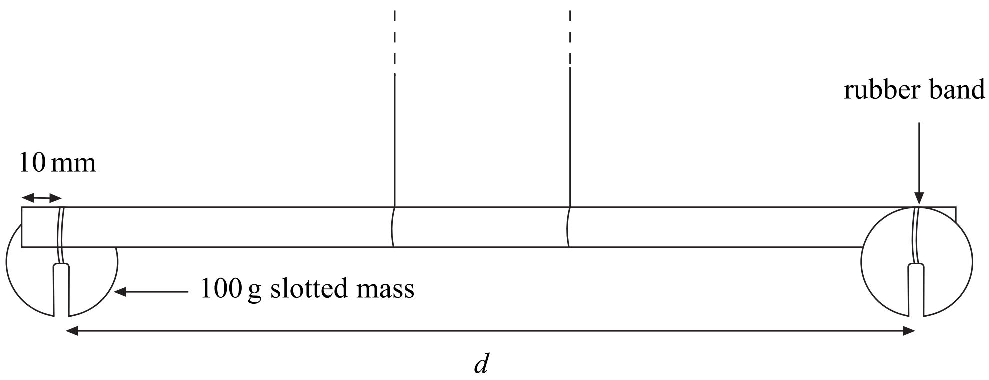


Figure 4

(i) Measure and record in your table the distance d, in m, and the corresponding period T of small twisting oscillations for this loaded rule.

(ii) Measure and record **four** further measurements of T for values of d in the range 0.160 m to 0.480 m.

Ensure that the 100 g masses are always equal distances from the ends of the rule. *(16 marks)*

(d) Plot a graph of T^2 (along the y-axis) against d^2 (along the x-axis). The values on both axes should start at zero. Draw the best straight line through your plotted points.

(7 marks)

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

$$T^2 = (0.10K)d^2 + 0.042Km$$

where m is the effective mass of the suspended rule in kg
and K is a constant for the system.

This equation may be compared to the general equation of a straight line

$$y = mx + c$$

(i) Determine the gradient of the graph.

(3 marks)

(ii) Calculate a value for K.

(2 marks)

(iii) Read from the graph the intercept of the line with the T^2 axis.

(3 marks)

(iv) Calculate a value for m, the effective mass of the rule.

(3 marks)

END OF QUESTIONS

General Certificate of Education
June 2003
Advanced Subsidiary Examination

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

SUPERVISOR'S REPORT

Your attention is drawn to paragraph 11 on page 3.

Questions 1 and 2.
No specific information is required about the experiments detailed in these Instructions.

Question 3.
A measurement of T_0 and a sample set of readings for d and T in range $0.160\,\text{m} < d < 0.480\,\text{m}$.

When completed by the Supervisor, this Report must be attached firmly to the topmost script, before despatch to the Examiner.

Comments:

Supervisor's Signature ....

Centre Number..

Date ....

Centres may make copies of this Supervisor's Report for attachment to individual scripts where necessary.

THERE ARE NO INSTRUCTIONS PRINTED ON THIS PAGE