General Certificate of Education
January 2003
Advanced Level Examination

PHYSICS (SPECIFICATION A) **PHAP/TN**

Instructions to Supervisors for the Practical Examination (Units 5-9)

CONFIDENTIAL

OPEN ON RECEIPT

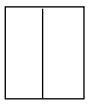
The examination will be held on Monday 3 February 2003 9.00am - 10.45am

- **These *Instructions* are provided to enable centres to make appropriate arrangements for the examination. Copies of the *Instructions* are to be kept at the centre under lock and key when not in use; they are not to be removed from the centre. The question paper packets must not be opened prior to the examination.**
- **These instructions explain how to set up the equipment for Question 2.**
- **Question 2 is printed on pages 4 to 6 of this instruction booklet.**
- **Centres are at liberty to make any reasonable minor modifications to the apparatus which may be required for the successful working of the experiment but a note of all such modifications must be forwarded to the Examiner with the scripts. However, any such modifications must permit the experiment to be carried out in the specified manner.**

Candidates are required to investigate how the period of a ruler, supported in a vertical plane by a pivot near the top, is affected when masses are attached at a point close to its lower end.

Apparatus required by each candidate:

- ❒ wooden metre ruler, free of warping and otherwise in generally good condition with small diameter hole drilled in median section at the 10 cm graduation: the mass of the ruler should be determined before the examination
- ❒ four 20 g and one 100 g slotted disc masses
- ❒ elastic band with which to attach slotted masses to the ruler as shown in **Figure 3** of the question.
- ❒ digital stopwatch capable of reading to 0.1 s or better.
- ❒ plane mirror for use in constructing tangent at a point on curving graph
- ❒ fiducial mark to assist candidates in determining period of oscillation of the pivoted ruler: this should be a piece of A4 card, marked 'fiducial mark' with line ruled down the centre, parallel to the longest edges, e.g. see right



- ❒ prism to provide support for ruler
- ❒ rectangular block of wood, dimensions $100 \times 70 \times 40$ mm: the prism is to be placed on this to raise it (100 mm) above the level of the bench.
- ❒ retort stand rod with boss attached fitted with a clamp, the jaws of which are set to restrict the movement of one end of the ruler when it is balanced, as shown in **Figure 1** and **Figure 2** of the question.
- ❒ additional retort stand fitted with boss to hold a small screwdriver or stout nail to act as horizontal pivot: the position of the pivot should be between 10 cm and 20 cm above the level of the bench

The apparatus should not be assembled beforehand with the exception of the attachment of the pivot to the second retort stand.
Supervisors should check whether steps should be taken to stabilise the retort stand when the ruler is oscillating.

Examiners will require the following information:

(i) the mass of the metre ruler to ± 0.5 g.

(ii) the period of the ruler when pivoted as shown in **Figure 3** of the question when **no additional masses** have been attached to the lower end.

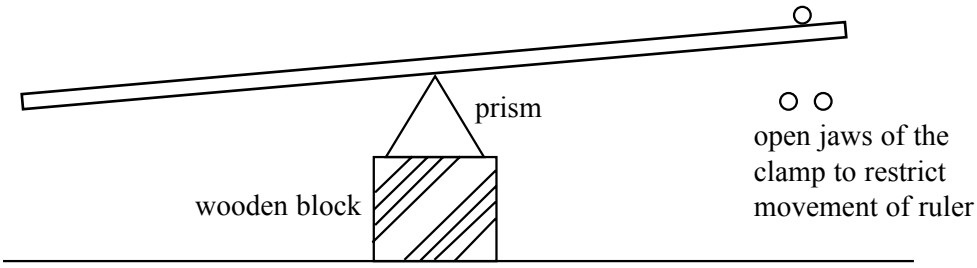


Figure 1

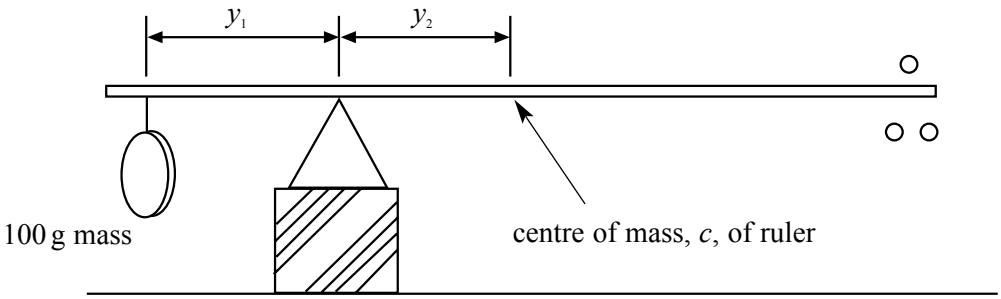


Figure 2

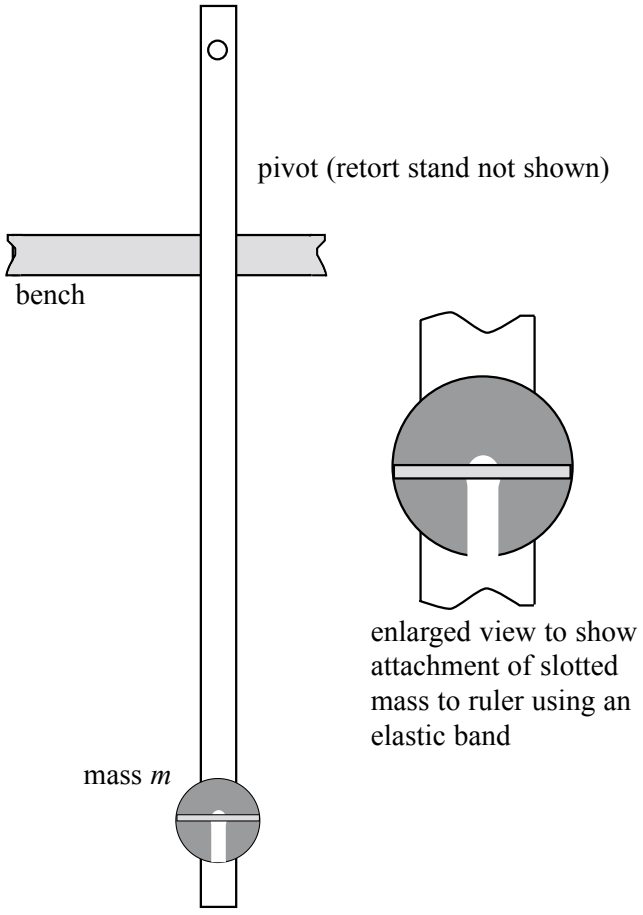


Figure 3

2 This question is divided into parts (a) to (e).

In this experiment you will find the mass of a metre ruler. You will then investigate how the period of the ruler, supported in a vertical plane by a pivot near one end, is affected when masses are attached at a point close to the other end.
No description of the experiment is required.

(a) Arrange the metre ruler, prism and wooden block as shown in **Figure 1**.
Use the open jaws of the clamp to restrict the movement of one end of the ruler.

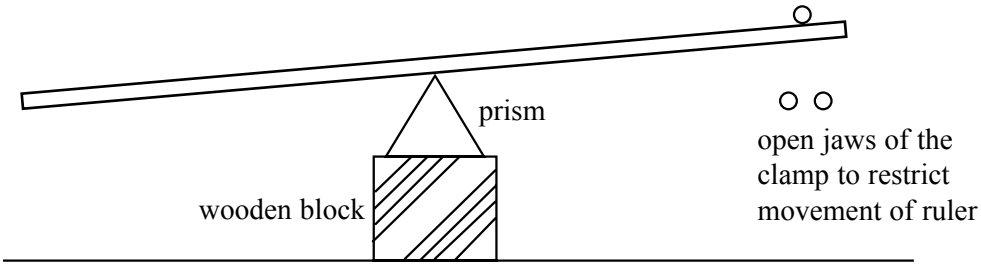


Figure 1

(i) Adjust the position of the ruler until it is balanced on the prism. Locate and record the position of the centre of mass of the ruler.

(ii) Position a 100 g mass at a point close the left-hand end of the ruler. Adjust the position of the prism until the ruler is once again balanced as shown in **Figure 2**.

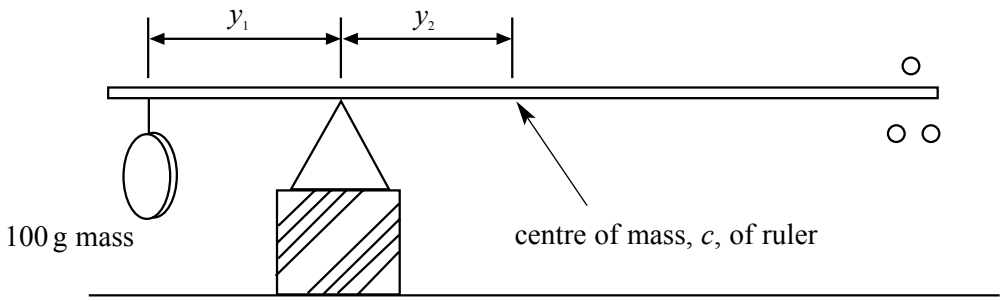


Figure 2

(i) Measure and record y_1 and y_2.

(ii) Use your readings to determine the mass, M, of the metre ruler.

(b) Suspend the metre ruler from the horizontal pivot that is clamped near the top of the retort stand, the pivot passing through the hole at the 10 cm graduation of the ruler. Arrange the apparatus so that the ruler hangs in a vertical plane that is parallel to the edge of the bench. The lower end of the ruler should be about 10cm above the floor.

Attach a mass, *m*, of value 20 g to the ruler with an elastic band, the centre of the mass being at the 90 cm graduation mark, as shown in **Figure 3**.

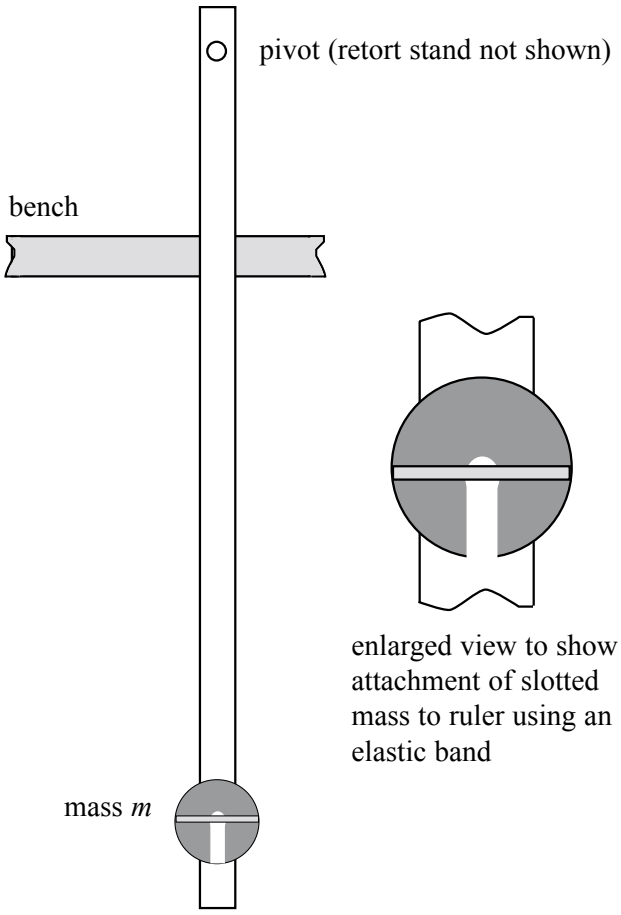


Figure 3

(7 marks)

Determine the time period, T, of the loaded ruler for small amplitudes oscillations in a vertical plane. The piece of card marked fiducial mark should be placed on the floor to assist you in making this measurement.

Repeat the procedure to find new values of T for **four** further values of m up to a **maximum** of 100 g.
When m consists of two masses, they should be fixed either side of the ruler.
Record all your measurements and observations below.

(c) Using the grid on page 11 plot a graph of your results with T on the vertical axis and m on the horizontal axis.

(6 marks)

(d) (i) Measure and record the gradient, G, of your graph at the point where

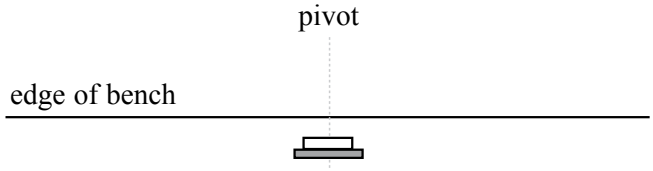
$m = \frac{M}{2}$, i.e. m is equal to half the mass of the ruler.

(ii) Read and record from your graph the period T' at the point where $m = \frac{M}{2}$.

(iii) Evaluate $\frac{2MG}{T'}$.

(3 marks)

(e) (i) The diagram below shows a view of the apparatus from directly above. Complete the diagram, to show where you positioned the fiducial mark when measuring the period of the loaded ruler.



Explain why you positioned the fiducial mark as shown.

(ii) Describe, with the aid of a sketch, the procedure you employed to determine the gradient, G, of the graph.

(iii) The overall percentage error in determining the period, T, of the loaded ruler can be reduced by measuring the time, nT, for n oscillations, n being an integer. It can be shown that the error in T is inversely proportional to n. Students A and B perform the experiment using slightly different methods. For each determination of T, student A makes timing for 50 oscillations of the ruler while student B makes two timings, each being for 25 oscillations of the ruler.
Discuss briefly the advantages of the methods proposed by each student.

(6 marks)

END OF QUESTIONS