

General Certificate of Education  
June 2005  
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 Wednesday 25 May 2005 Morning Session

- 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 3 to 4 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 will investigate the oscillation of a metre ruler and a half-metre ruler on cylindrical surfaces of different diameters.

**Apparatus required for each candidate:**

- wooden metre ruler and wooden half-metre ruler, in good condition, and free from warping
- 20 cm to 25 cm lengths of plastic cylindrical drainpipe of three different diameters (see below)
- G-clamp
- stopwatch capable of reading to 0.1 s or better
- suitable fiducial mark, arrangement to be at the discretion of the centre
- set square
- micrometer screw gauge: mechanical type (see note below)

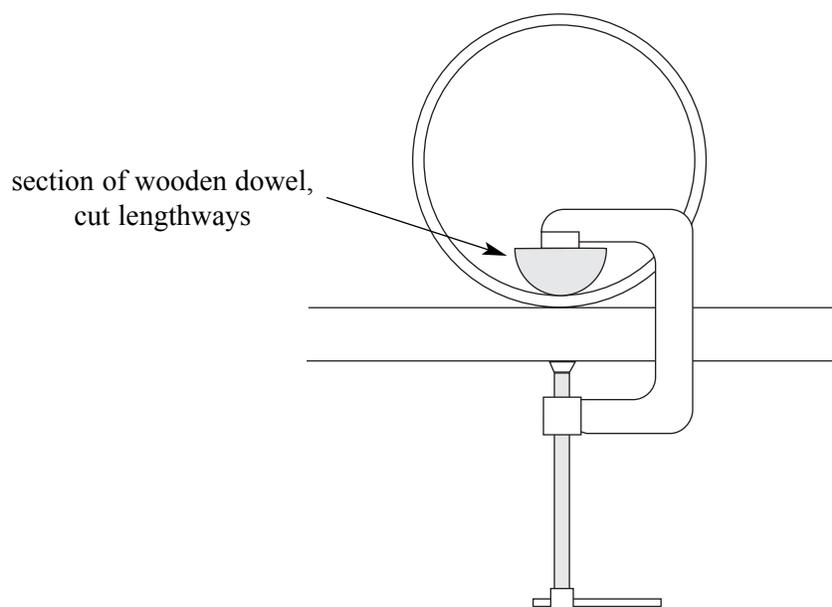
Drainpipes in the following metric sizes are preferable.

- 1 Underground drain or soil pipe, 100 mm in diameter
- 2 Down pipe, e.g. from guttering 68 mm in diameter
- 3 Waste water pipe, 50 mm or 56 mm in diameter

All are available at builders' merchants and DIY stores.

Clamp the largest diameter pipe to the bench with the G-clamp, the axis of the pipe to be perpendicular to the edge of the bench. To avoid distortion of the pipe occurring as the G-clamp is tightened, insert a short length of wooden dowel cut lengthways, with the cut surface uppermost, between the clamp and the inside surface of the pipe.

A length of 30 mm of dowel of 20 mm diameter (shown shaded in the diagram below) will be suitable.



Candidates will use the micrometer screw gauge to determine the thickness of the half-metre ruler and of the meter ruler. If supplies of micrometer are limited the centre may allow more than one candidate to use the same micrometer but the supervisor must control the exchange so that the instrument is reset before being handed to the next candidate. In such cases, candidates can be told that the measurements made in part (a) (ii) of the question can be made after (or during) part (b). The remaining apparatus should be placed on the bench.

**Examiners require no information for this question.**

- 2 In this experiment you will investigate the oscillation of a metre ruler and a half-metre ruler on cylindrical surfaces of different diameters.

**No description of the experiment is required.**

You are provided with three lengths of plastic cylindrical drainpipe of different diameters. The drainpipe of largest diameter has been clamped to the bench in such a way that the pipe retains its circular cross-section when the G-clamp is tightened.

- (a) (i) Make suitable measurements to determine the external diameter,  $d$ , of each drainpipe.
- (ii) Use the micrometer screw gauge to measure the thickness of the half-metre ruler and the thickness of the metre ruler.  
Record the thickness,  $t$ , of each ruler. (2 marks)
- (b) Balance the half-metre ruler with its graduated face uppermost on the largest diameter drainpipe.

**The ruler should be perpendicular to the axis of the drainpipe.**

Depress then release one end of the ruler so that the ruler performs small amplitude oscillations in a vertical plane on the curved surface of the drainpipe.

Make suitable measurements to determine the period,  $T$ , of these oscillations.

Repeat the procedure with the metre ruler balanced on the drainpipe.

Use each ruler, in turn, on each of the smaller diameter drainpipes, until you have a total of **six** values of  $T$ .

**Ensure that when you tighten the G-clamp the drainpipe retains its circular cross-section.**

Record all your measurements and observations. (3 marks)

- (c) Plot a graph with  $T^2$  on the vertical axis and  $\frac{l^2}{d-t}$  on the horizontal axis.

Tabulate below the data you will plot on your graph. (8 marks)

- (d) (i) Measure and record the gradient,  $G$ , of your graph.

(ii) Evaluate  $\frac{\pi^2}{G}$ . (3 marks)

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- (e) (i) Make a labelled sketch of the apparatus to show the positioning of the fiducial mark used.

Explain why you chose this position for the fiducial mark.

- (ii) The amplitude of the oscillations decreases due to the effects of air damping on the ruler: this presents a difficulty in making accurate measurements of  $T$ .  
Explain the nature of this difficulty and suggest how this might be overcome.
- (iii) For a uniform ruler of length  $l$  and thickness  $t$ , performing simple harmonic motion of period  $T$ , on a cylindrical tube of constant diameter  $d$ , theory suggests that

$$T^2 \propto \frac{l^2}{d-t}.$$

Hence explain how the period will change if the ruler is **not** kept perpendicular to the axis of the drainpipe when oscillating. (6 marks)

**END OF QUESTION**