

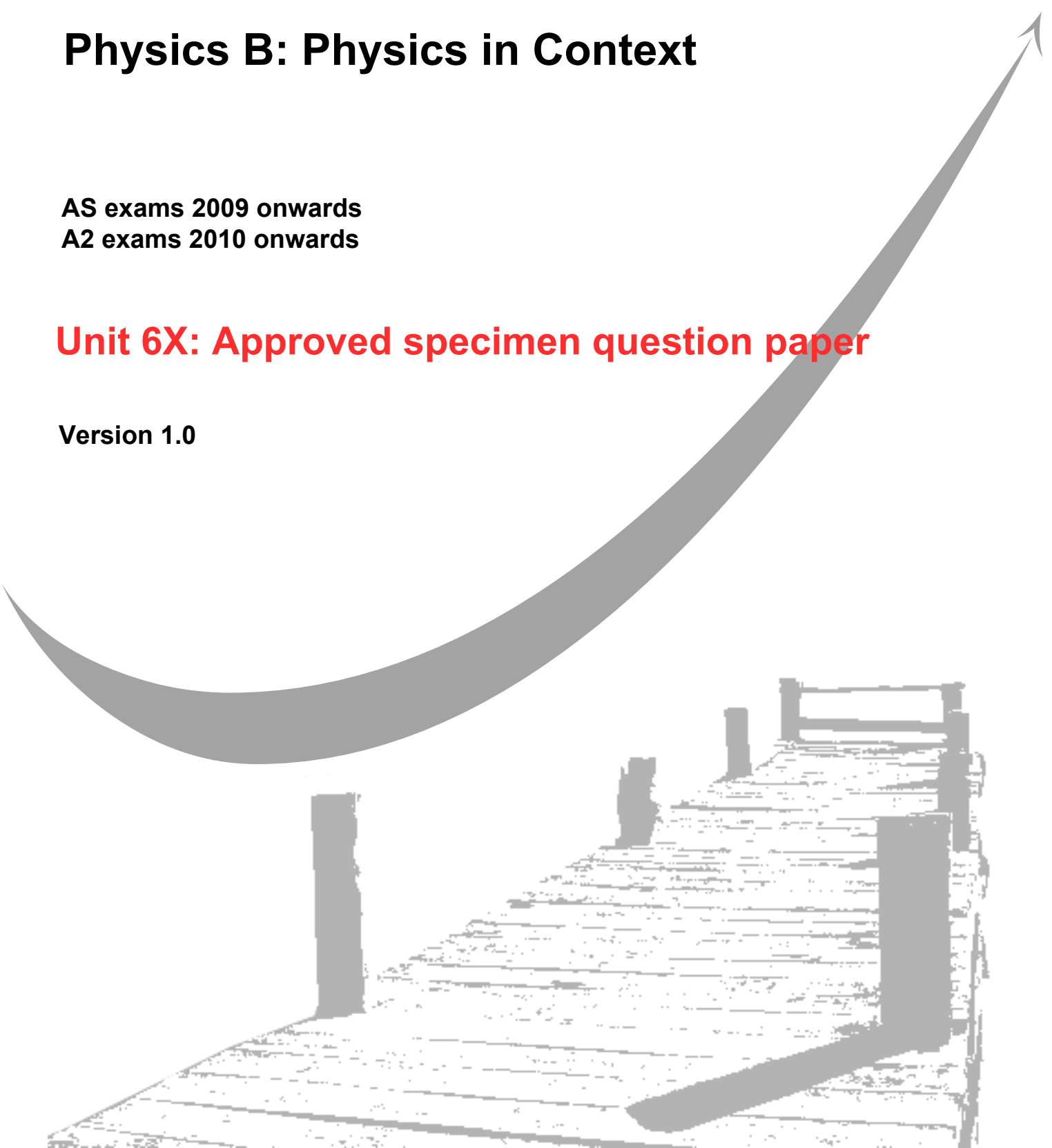
GCE
AS and A Level

Physics B: Physics in Context

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 6X: Approved specimen question paper

Version 1.0



General Certificate of Education
2010
Advanced Examination



version 1.0

PHYSICS
Investigative and Practical Skills in A2 Physics

Route X Externally Marked Practical Assignment PHB6X

Instructions to Supervisors

SPECIMEN PAPER

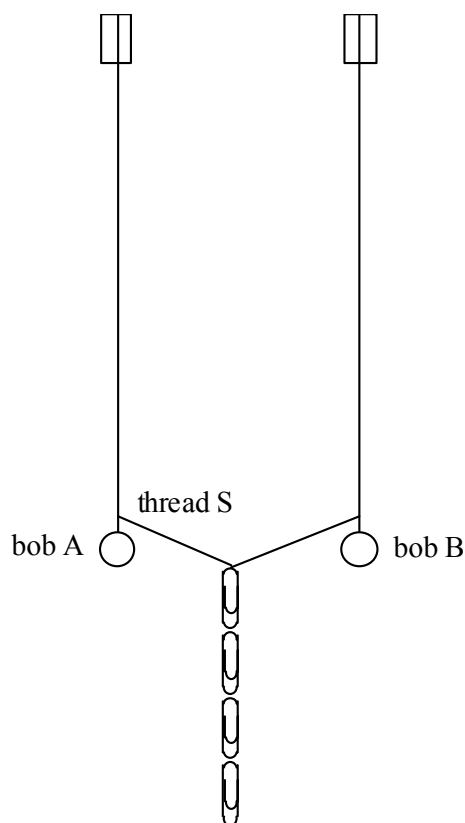
Section A Task 1

Candidates are to observe and describe the motion of two coupled pendulums.

Apparatus required for each candidate:

- two 200 g masses or large pendulum bobs, fastened at the ends of strong threads of length about 80 cm
- additional thread, length about 45 cm
- large paperclips, e.g. ‘Giant paperclips’, typical length about 5 cm; four of these to be assembled into a chain to be suspended from the coupling thread (see diagram below)
- two retort stands, each fitted with a boss and clamp
- two small blocks of wood and G-clamp to secure fixed end of wire
- small rectangular wooden blocks to provide well-defined points of suspension
- stopwatch capable of reading to 0.1 s or better

The apparatus to be set up by the Supervisor, is shown in the diagram.



Construct two pendulums of length 70 cm. The pendulums should hang clear of the bench with the bobs in the same horizontal plane. Attach the coupling thread to each pendulum just above the bob with a chain of four paperclips suspended at the mid point.

Holding bob B in its rest position displace bob A by pulling it to one side so that it remains in the same vertical plane as bob B. Release both bobs simultaneously so that, initially, A is set in oscillatory motion with B at rest. Measure the time for energy transfer from A to B then back to A again. The time for this transfer should be approximately 60 s; if significantly different (i.e. by more than 10%), adjust the number of clips suspended from the chain. Provide four additional paperclips which candidates will need when completing part (c) of the question.

Examiners require the time for complete energy transfer from bob A to bob B and back again, as in part (a) of the question.

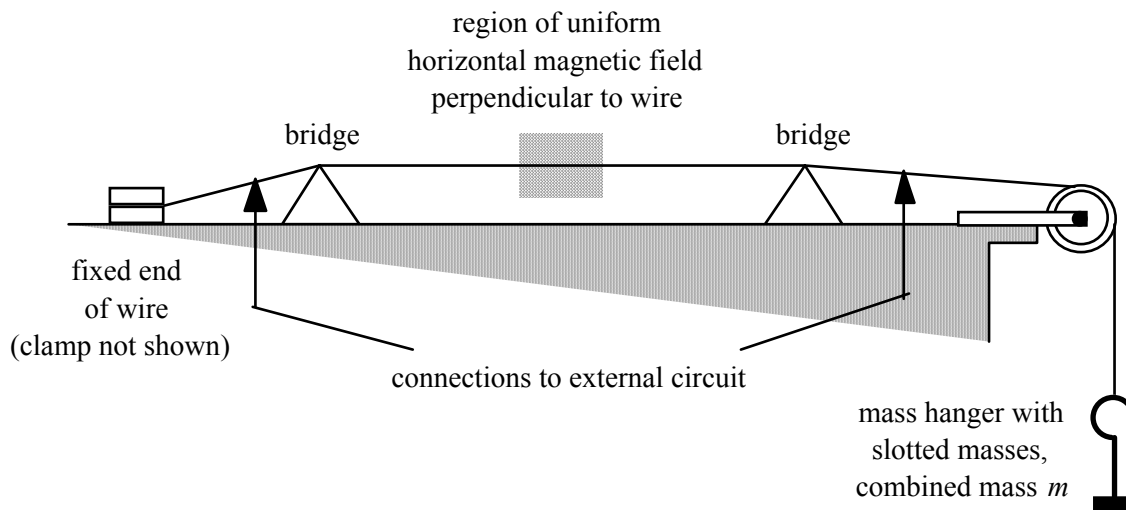
Section A Task 2

Candidates are to investigate transverse stationary waves on a wire undergoing forced vibration at fundamental frequency.

Apparatus required for each candidate:

- 50 Hz continuously variable a.c. voltage supply to provide sinusoidal current of about 0.5 A, fitted with suitable connecting wires to attach to the ends of the constantan wire (equivalent arrangement using a stepped voltage supply with potentiometer may be used as a substitute).
- about 1.5 m 28 s.w.g. constantan wire with a small loop tied at one end to attach hanger for slotted masses
- two Magnadur (slab) magnets, $50 \times 19 \times 6$ mm (Philip Harris Q66550/4) and mild steel yoke (to hold slab magnets) as per Westminster Electromagnetism kit, to provide horizontal uniform magnetic field (check that the opposing faces of the magnets are of opposite polarity)
- micrometer screw gauge capable of reading to 0.01 mm (see note on page #)
- metre ruler and set square
- two bridges, e.g. glass bridges to define vibrating section of wire: candidates should be able to vary this distance between 0.20 m and 0.80 m
- two small blocks of wood and G-clamp to secure fixed end of wire
- pulley, supported in a suitable fashion to enable the slotted masses to hang freely as shown in the diagram
- mass hanger of mass 50 g or 100 g and slotted masses of values 1×50 g and 3×100 g (to provide maximum mass of 450 g)

The apparatus is shown in the diagram.



There is **no insistence** that the fixed end should be at the left-hand end of the arrangement as presented to the candidate. Note that each set will need to be set up parallel with, and close to, the edge of the bench, with the pulley overhanging the end of the bench. Ensure that the sections of the wire between bridge and fixed end, and between bridge and pulley, are not too steeply inclined, to enable ease of movement of the bridges.

Prior to the examination, the output of the power supply should be adjusted so that when the length of the vibrating section is about 0.5 m, the wire oscillates in fundamental mode with amplitude between 1 cm and 2 cm at the mid-point. The variable voltage control should then be taped over.

If the number of micrometer screw gauges available is limited the supervisor may ask the candidates to share instruments but must ensure that when transfer takes place, the screw gauge is reset. There is **no insistence** that the measurement with the micrometer (part (a) of question 1 in Section A) should be made by the candidates at the beginning of the experiment.

Examiners require no further information for this question.

Surname					Other Names				
Centre Number					Candidate Number				
Candidate Signature									

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Route X Externally Marked Practical Assignment PHB6X

Section A Task 1

SPECIMEN PAPER

For this paper you must have:

- a calculator
- a ruler

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **both** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The maximum mark for this task is 10.
- The marks for the questions are shown in brackets.

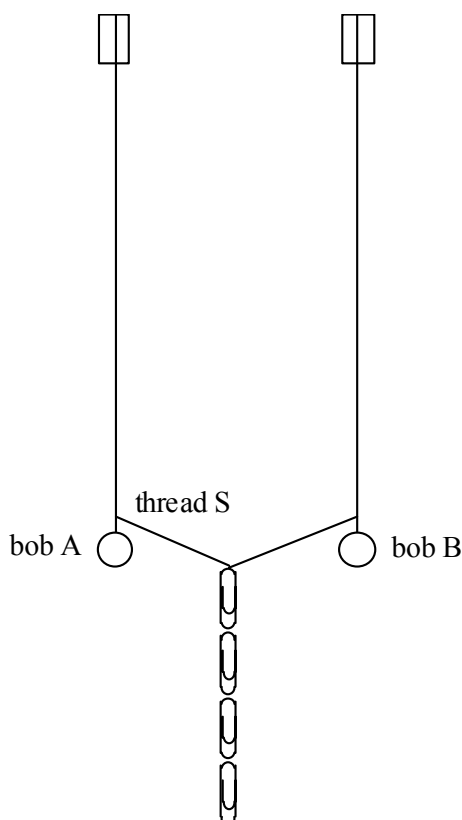
For Examiner's Use			
Sec A	Mark		Mark
1			
Total (Sec A)			
Total (Sec B)			
TOTAL			
Examiner's Initials			

SECTION A TASK 1

- Follow the instructions given below.
- Provide the information required in the spaces provided.
- No description of the experiment is required.

- 1 In this experiment you are to investigate forced oscillation of the coupled pendulum system, shown in **Figure 1**.

Figure 1



The pendulums have the same length and the bobs, A and B, lie in the same horizontal plane. S is a thread of negligible mass, fastened to the strings of the pendulums just above each bob. Several paper clips, chained together, are attached at the centre of S.

Holding bob B at its rest position, displace bob A by pulling it to one side so that it remains in the same vertical plane as bob B.

Release both bobs simultaneously so that, initially, A is set in oscillatory motion with B at rest.

Observe the subsequent behaviour of the system.

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- (i) Describe the motion of the system from the point at which bob A is first set in motion, explaining the relative phase of the pendulums and how the amplitudes of A and B vary.

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- (ii) Measure and record the time, T , for the general pattern of behaviour exhibited by the system to repeat itself.

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- (iii) Explain one difficulty you encountered that affected the precision with which T could be determined.

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(5 marks)

- (b) Show that the tension, F , in the thread S, is directly proportional to n , the number of paperclips suspended from the thread. You may assume that the weight of the suspended paperclips does not significantly affect the horizontal separation of A and B. You may wish to use a diagram to illustrate your answer.

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(2 marks)

- (c) A student suggests that T is inversely proportional to n .
- (i) Use the additional paperclips that you are provided with to investigate whether the student's suggestion is correct.
Do not suspend fewer than the number of paperclips attached during part (a) of the experiment.

Record your measurements below.

(ii) Discuss whether the results of your investigation confirm the student's suggestion.

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(3 marks)

END OF SECTION A TASK 1

Surname					Other Names				
Centre Number					Candidate Number				
Candidate Signature									

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Section A Task 2

SPECIMEN PAPER

For this paper you must have:

- a calculator
- a ruler

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The maximum mark for this task is 16.
- The marks for the questions are shown in brackets.

For Examiner's Use			
Sec A	Mark		Mark
1			
Total (Sec A)			
Total (Sec B)			
TOTAL			
Examiner's Initials			

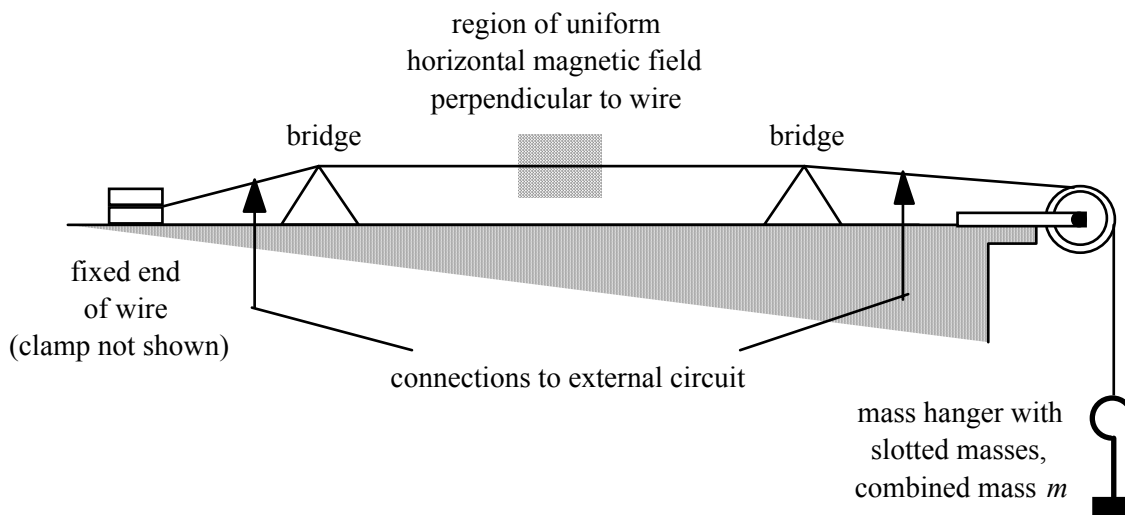
SECTION A TASK 2

- Follow the instructions given below.
- Provide the information required in the spaces provided.
- No description of the experiment is required.

In this experiment you are required to investigate transverse stationary waves on a wire undergoing forced vibration at the fundamental frequency.

You are provided with the arrangement shown in **Figure 1**.

Figure 1



- (a) Use the micrometer screw gauge to make suitable measurements to determine the diameter, d , of the wire.
Record your measurements and result below.

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$d =$

(2 marks)

- (b) Place sufficient slotted masses on the hanger so the total mass, m , supported by the wire is equal to 100 g.

Adjust the separation of the bridges so that the length of the wire, x , between them is approximately 0.20 m then turn on the a.c. power supply.

With the horizontal magnetic field at the centre of the vibrating section of the wire, increase x until the wire is seen to vibrate at the **fundamental frequency**.

Record below your measurements of m and x then repeat the procedure for **five larger** values of m .

Note that

- the independent variable should be recorded in the **left-hand** column of your table.

When you have completed your measurements, turn off the a.c. power supply.

(5 marks)

DO NOT CONTINUE BEYOND THIS POINT UNLESS INSTRUCTED TO DO SO

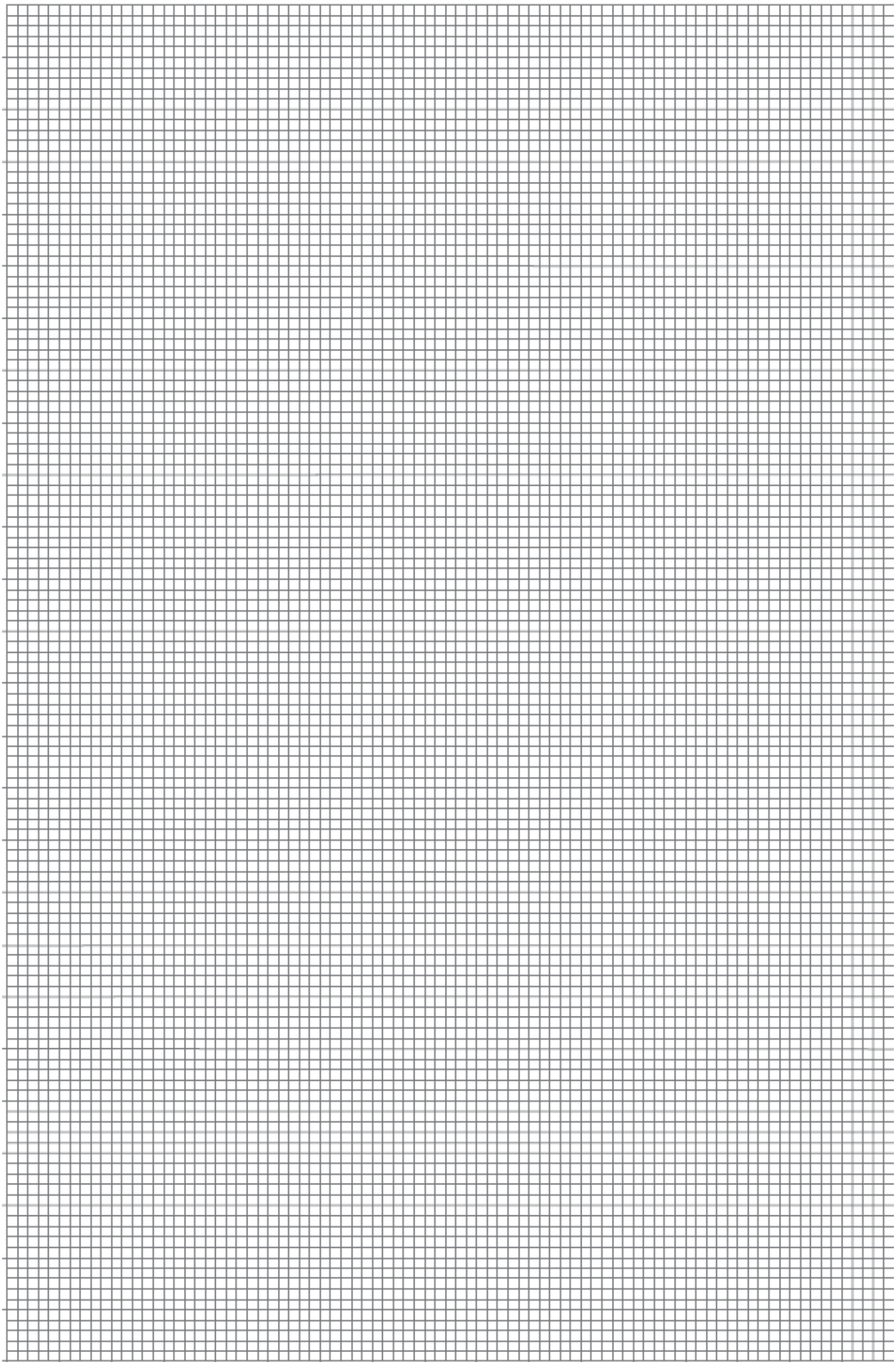
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- (c) It is suggested that x^2 is directly proportional to m .

Use your experimental data to plot, on the grid opposite, a suitable graph to test this suggestion.

Tabulate below the data that you intend to plot.

(9 marks)

END OF SECTION A TASK 2



Surname					Other Names				
Centre Number					Candidate Number				
Candidate Signature									

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Section B

SPECIMEN PAPER

Time allowed: 1 ¼ hours

For this paper you must have:

- a calculator
- a ruler

For Examiner's Use			
Sec B	Mark		Mark
1			
2			
3			
4			
Total (Sec A)			
Total (Sec B)			
TOTAL			
Examiner's Initials			

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The maximum mark for this paper is 29.
- The marks for the questions are shown in brackets.

SECTION B

- Answer all the questions in the spaces provided.
- Time allowed 1 hour 15 minutes.
- You need to refer to the work you did in completing Section A when answering this section.

1 (a) State and explain whether your graph confirms that x^2 is directly proportional to m .

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(2 marks)

(b) Determine the gradient, G , of your graph.

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(4 marks)

(c) The density, ρ , of the wire used in the experiment = $8.90 \times 10^3 \text{ kg m}^{-3}$.

Evaluate $G\rho d^2$.

$G\rho d^2 = \dots\dots\dots$

(3 marks)

2 (a) Explain **two** procedures that you used to reduce the uncertainty in determining the value of d .

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(4 marks)

(b) By considering the factors that cause the wire to oscillate, state and explain any modification that you could make that would make it easier to detect when the wire is vibrating in its fundamental mode of oscillation.

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(2 marks)

3 Wire is manufactured in certain diameters that are identified by SWG (standard wire gauge) numbers.

diameter/mm	0.711	0.559	0.457	0.376	0.315	0.274	0.234	0.193
SWG number	22	24	26	28	30	32	34	36

(a) With reference to the table above, identify the SWG number of the wire you were provided with.

SWG number =

(1 mark)

(b) It can be shown that the mass per unit length, μ , of the wire is related to x according to

$$\mu \propto \frac{1}{x^2}.$$

State and explain the effect, if any, on your graph, if the experiment were repeated with a wire made of the same material but with a higher SWG number.

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(3 marks)

4 By using a variable frequency a.c. supply, a student intends to adjust the frequency, f , of the a.c. signal to investigate the harmonics of the vibrating wire.

(a) State **three** factors that the student must control when carrying out an investigation to see how n , the number of loops seen when the wire is resonating in different modes of vibration, depends on f .

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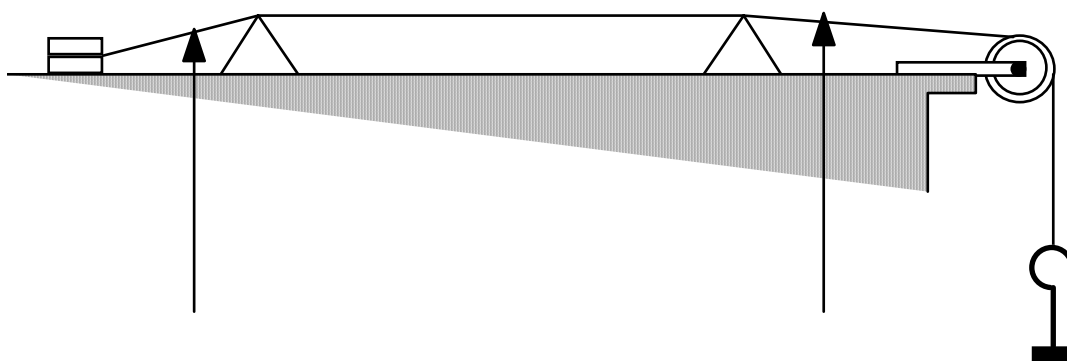
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(3 marks)

A teacher suggests to the student that it would be a good idea to check that the variable frequency a.c. supply is accurately calibrated.

(b) (i) Complete **Figure 2** to show how an appropriate measuring instrument could be used to confirm that the value of f is reliable.

Figure 2



(2 marks)

- (ii) Explain any procedure that the student should employ when using the measuring instruments to reduce uncertainty in the measurements of f .

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(2 marks)

- (c) A student suspects that f may be related to n by an expression of the form

$$f \propto n^k$$

where k is an integer.

Suggest how the student could process the data to determine k .

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(3 marks)