



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Advanced Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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**PHYSICS**

**9702/51**

Paper 5 Planning, Analysis and Evaluation

**May/June 2010**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

**For Examiner's Use**

**1**

**2**

**Total**

This document consists of **8** printed pages.



- 1 A hammer is often used to force a nail into wood. The faster the hammer moves, the deeper the nail moves into the wood.

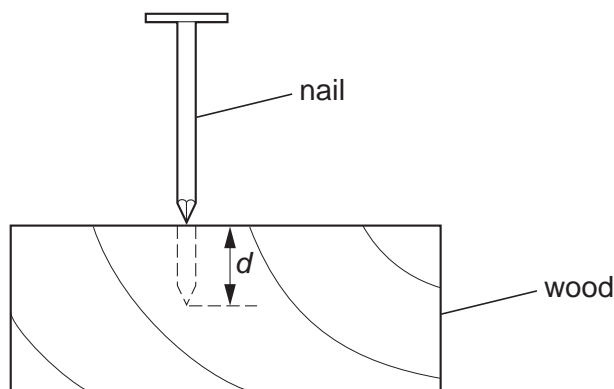
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This can be represented in a laboratory by a mass falling vertically onto a nail.

It is suggested that the depth  $d$  of the nail in the wood (see Fig. 1.1) is related to the velocity  $v$  of the mass at the instant it hits the nail by the equation

$$d = kv^n$$

where  $k$  and  $n$  are constants.



**Fig. 1.1**

Design a laboratory experiment to investigate the relationship between  $v$  and  $d$  so as to determine a value for  $n$ . You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to

- (a) the procedure to be followed,
- (b) the measurements to be taken,
- (c) the control of variables,
- (d) the analysis of the data,
- (e) the safety precautions to be taken.

[15]

**Diagram**

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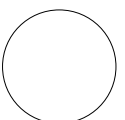
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This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

For Examiner's Use	Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail



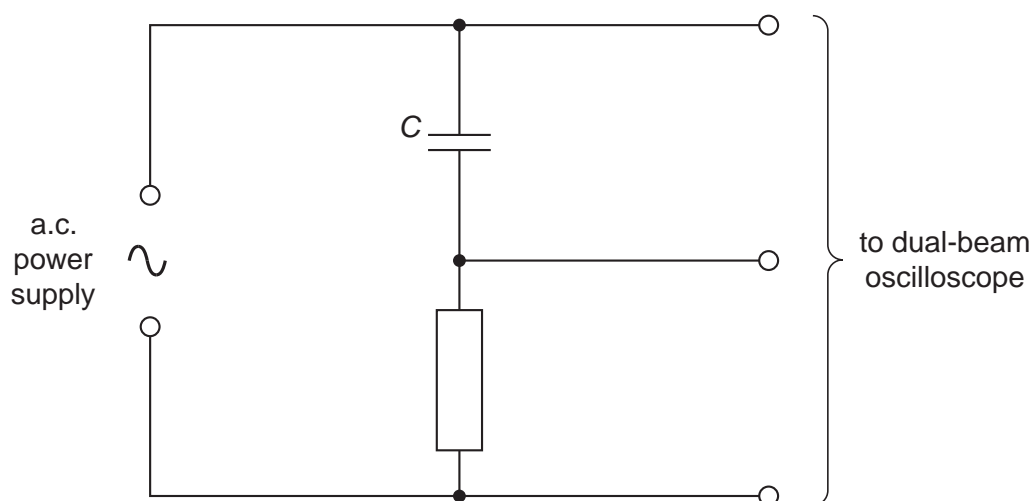
- 2 The reactance  $X_c$  of a capacitor is defined as

$$X_c = \frac{V_0}{I_0}$$

where  $V_0$  is the peak voltage across the capacitor and  $I_0$  is the peak current through the capacitor.

An experiment is carried out to investigate how the reactance of a capacitor varies with the frequency  $f$  of the a.c. supply to the capacitor.

The equipment is set up as shown in Fig. 2.1.



**Fig. 2.1**

The dual-beam oscilloscope is used to determine values of  $V_0$  and  $I_0$ .

**Question 2 continues on the next page.**

It is suggested that  $X_c$  and  $f$  are related by the equation

$$X_c = \frac{1}{2\pi fC}$$

where  $C$  is the capacitance of the capacitor.

- (a) A graph is plotted with  $X_c$  on the  $y$ -axis and  $\frac{1}{f}$  on the  $x$ -axis. Express the gradient in terms of  $C$ .

gradient = ..... [1]

- (b) Values of  $f$ ,  $V_0$  and  $I_0$  are given in Fig. 2.2.

$f/\text{Hz}$	$V_0/\text{V}$	$I_0/10^{-3}\text{A}$	$\frac{1}{f}/10^{-3}\text{s}$	$X_c/\Omega$
220	$5.0 \pm 0.2$	$15 \pm 0.2$		
250	$5.0 \pm 0.2$	$17 \pm 0.2$		
300	$5.0 \pm 0.2$	$21 \pm 0.2$		
350	$5.0 \pm 0.2$	$24 \pm 0.2$		
400	$5.0 \pm 0.2$	$28 \pm 0.2$		
450	$5.0 \pm 0.2$	$31 \pm 0.2$		

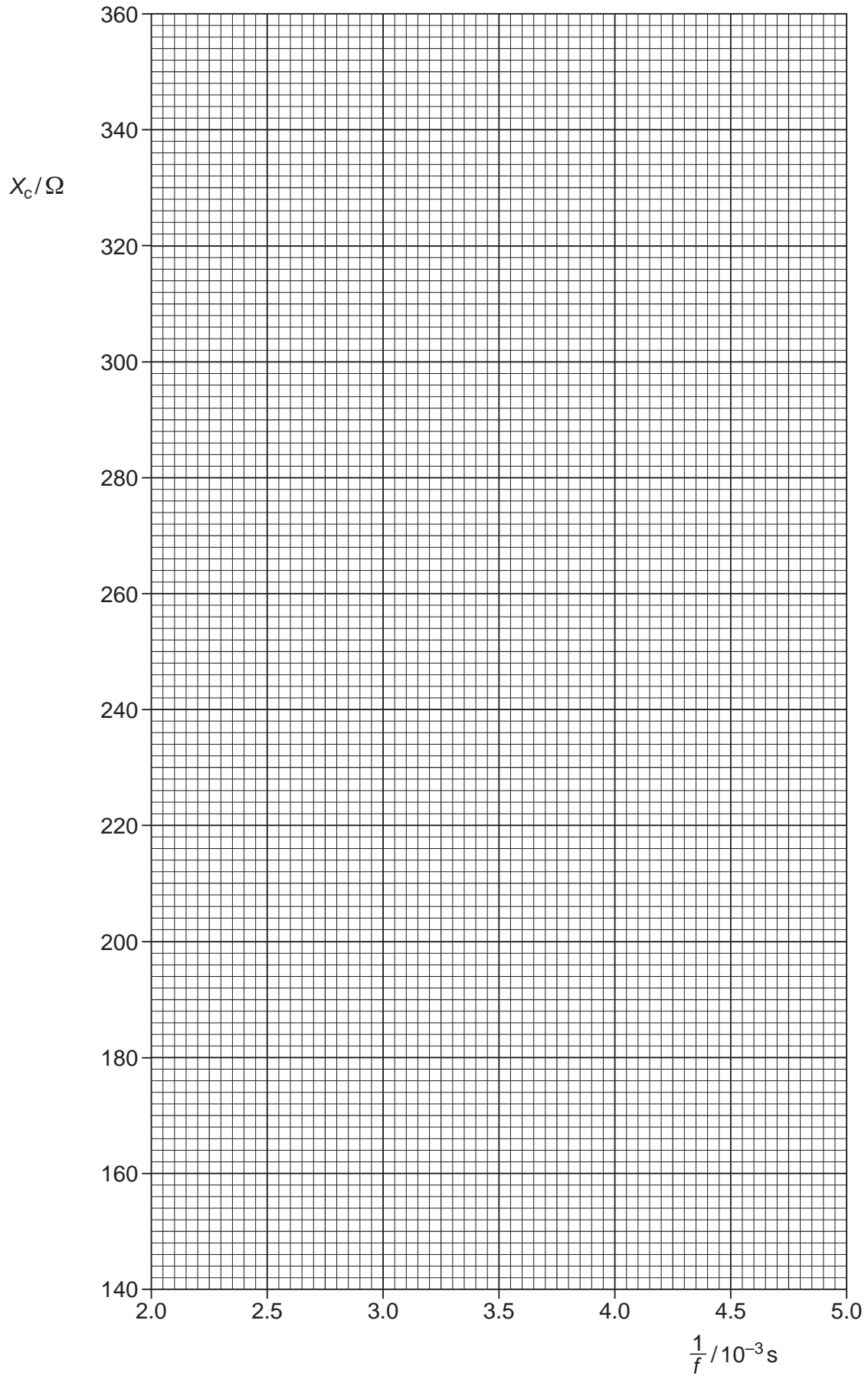
**Fig. 2.2**

Calculate and record values of  $\frac{1}{f}$  and  $X_c$  in Fig. 2.2. Include the absolute uncertainties in  $X_c$ . [3]

- (c) (i) Plot a graph of  $X_c/\Omega$  against  $\frac{1}{f}/10^{-3}\text{s}$ . Include error bars for  $X_c$ . [2]
- (ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2]
- (iii) Determine the gradient of the line of best fit. Include the uncertainty in your answer.

gradient = ..... [2]

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- (d) Using your answer to (c)(iii), determine the value of  $C$ . Include the absolute uncertainty in your value and an appropriate unit.

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$C = \dots\dots\dots$  [3]

- (e) The time constant  $\tau$  is defined as  $\tau = CR$  where  $R$  is the total resistance of the circuit.

- (i)  $C$  is placed in a circuit with total resistance  $220\text{ k}\Omega$ . Determine the value of  $\tau$ .

$\tau = \dots\dots\dots$  s [1]

- (ii) The percentage uncertainty in the total resistance of the circuit is  $\pm 10\%$ . Determine the percentage uncertainty in  $\tau$ .

percentage uncertainty =  $\dots\dots\dots$  % [1]

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