

# Cambridge International AS & A Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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NUMBER

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## PHYSICS

**9702/52**

## Paper 5 Planning, Analysis and Evaluation

May/June 2023

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

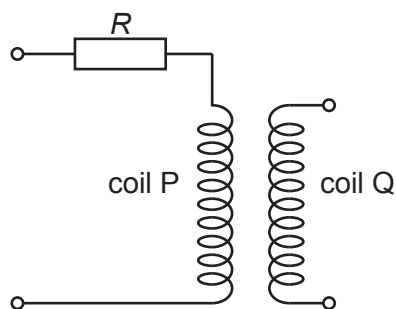
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has 8 pages.

- 1 Two coils, P and Q, are placed close to each other, as shown in Fig. 1.1.



**Fig. 1.1**

A resistor of resistance  $R$  is connected in series with coil P.

A changing magnetic flux of frequency  $f$  in coil P causes an electromotive force (e.m.f.)  $E$  to be induced across the terminals of coil Q.

It is suggested that  $E$  is related to  $R$  by the relationship

$$E = 2\pi f M \left( \frac{V}{R + k} \right)$$

where  $V$  is the potential difference across the resistor and coil P, and  $k$  and  $M$  are constants.

Plan a laboratory experiment to test the relationship between  $E$  and  $R$ .

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for  $k$  and  $M$ .

In your plan you should include:

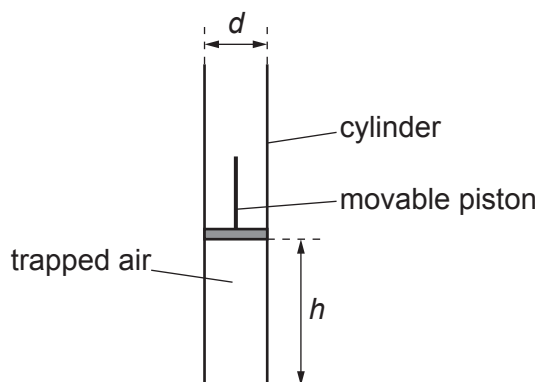
- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

### Diagram

[illegible]



- 2 A student investigates how the volume of a gas varies with its temperature. Air is trapped in a transparent cylinder of diameter  $d$  with a movable piston as shown in Fig. 2.1.



**Fig. 2.1**

The distance between the base of the cylinder and the bottom of the piston is  $h$ .

The trapped air is heated by placing the cylinder in water of temperature  $\theta$ . The increase in temperature of the trapped air causes the piston to move. When the piston stops moving, the value of  $h$  is measured.

For each value of  $h$ , the volume  $V$  of the trapped air is calculated.

The experiment is repeated for different values of  $\theta$ .

It is suggested that  $V$  and  $\theta$  are related by the equation

$$pV = Yk(\theta + Z)$$

where  $k$  is the Boltzmann constant,  $p$  is the atmospheric pressure, and  $Y$  and  $Z$  are constants.

- (a) A graph is plotted of  $V$  on the  $y$ -axis against  $\theta$  on the  $x$ -axis.

Determine expressions for the gradient and  $y$ -intercept.

gradient = .....

$y$ -intercept = .....

[1]

(b) Values of  $\theta$  and  $h$  are given in Table 2.1.

**Table 2.1**

$\theta/^\circ\text{C}$	$h/\text{mm}$	$V/10^{-5}\text{m}^3$
23	$62.4 \pm 0.1$	
35	$65.2 \pm 0.1$	
48	$68.1 \pm 0.1$	
62	$70.9 \pm 0.1$	
73	$73.3 \pm 0.1$	
88	$76.1 \pm 0.1$	

The value of  $d$  is  $(27.9 \pm 0.1)\text{mm}$ .

The volume  $V$  is calculated using the relationship

$$V = \frac{\pi d^2 h}{4}.$$

Calculate and record values of  $V/10^{-5}\text{m}^3$  in Table 2.1.

Include the absolute uncertainties in  $V$ .

[2]

(c) (i) Plot a graph of  $V/10^{-5}\text{m}^3$  against  $\theta/^\circ\text{C}$ . Include error bars for  $V$ .

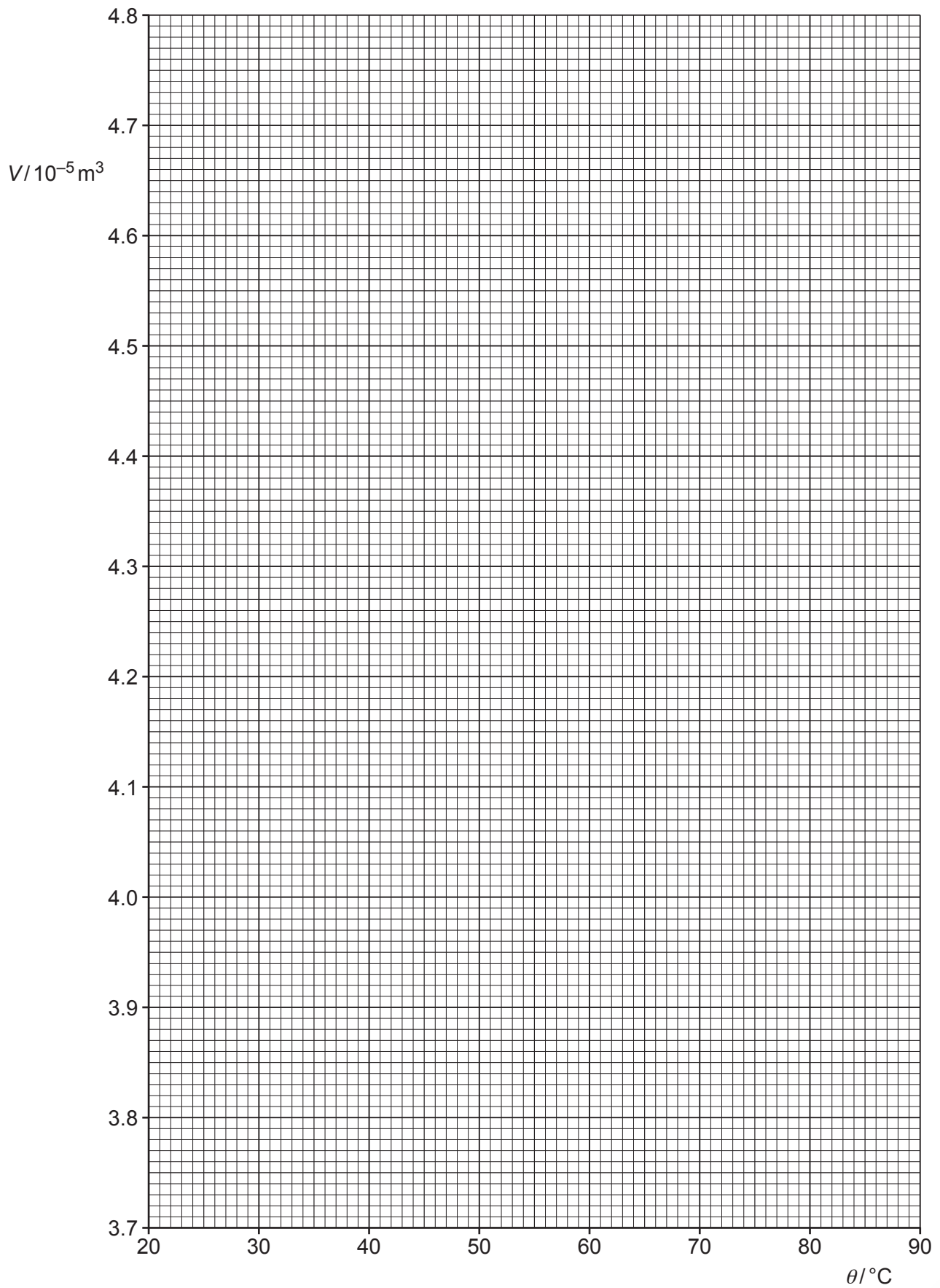
[2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines.

[2]

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ..... [2]



- (iv) Determine the  $y$ -intercept of the line of best fit. Include the absolute uncertainty in your answer.

$y$ -intercept = ..... [2]

- (d) (i) Using your answers to (a), (c)(iii) and (c)(iv), determine the values of  $Y$  and  $Z$ . Include appropriate units.

Data:  $p = (1.01 \pm 0.01) \times 10^5 \text{ Pa}$   
 $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

$Y = \dots\dots\dots$

$Z = \dots\dots\dots$  [2]

- (ii) Determine the percentage uncertainty in  $Y$ .

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

- (e) The experiment is repeated. Determine the temperature  $\theta$  that gives a value of  $h$  of 60.0 mm.

$\theta = \dots\dots\dots$  °C [1]

[Total: 15]

