

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



**PHYSICS** **9702/32**  
 Paper 3 Advanced Practical Skills 2 **May/June 2021**  
**2 hours**

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

**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 will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

**INFORMATION**

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

| For Examiner's Use |  |
|--------------------|--|
| 1                  |  |
| 2                  |  |
| <b>Total</b>       |  |

This document has **12** pages. Any blank pages are indicated.

You may not need to use all of the materials provided.

- 1 In this experiment, you will investigate the patterns produced by overlaid grids.
- (a) Grid A is the grid of parallel, equally spaced lines shown in Fig. 1.1.

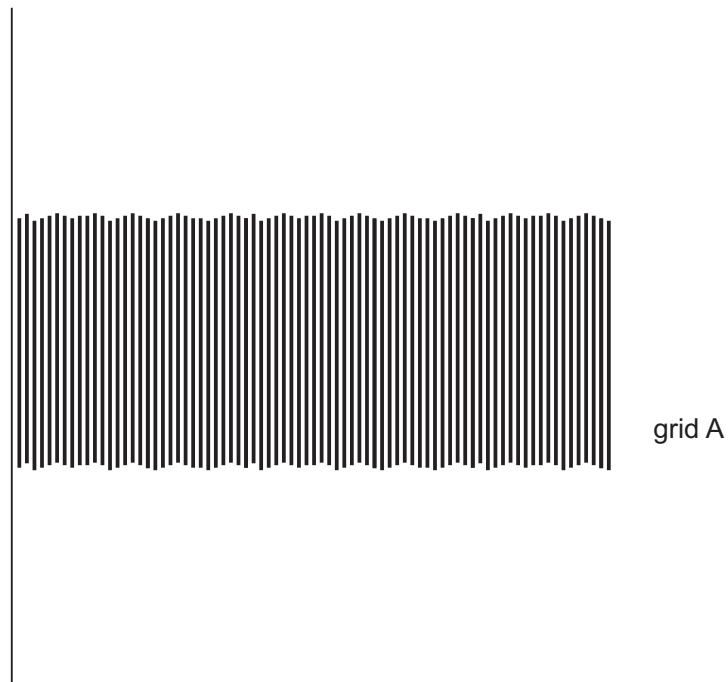


Fig. 1.1

Take measurements to determine the average spacing  $s_A$  between the centres of the lines on grid A.

$s_A = \dots\dots\dots$  mm [2]

(b) You have been provided with a second grid (labelled grid B) printed on a transparent sheet.

- Place grid B on top of grid A in Fig. 1.1.
- Turn grid B so that there is a small angle  $G$  between the grids. A pattern of fringes will be produced, as shown in the example in Fig. 1.2.

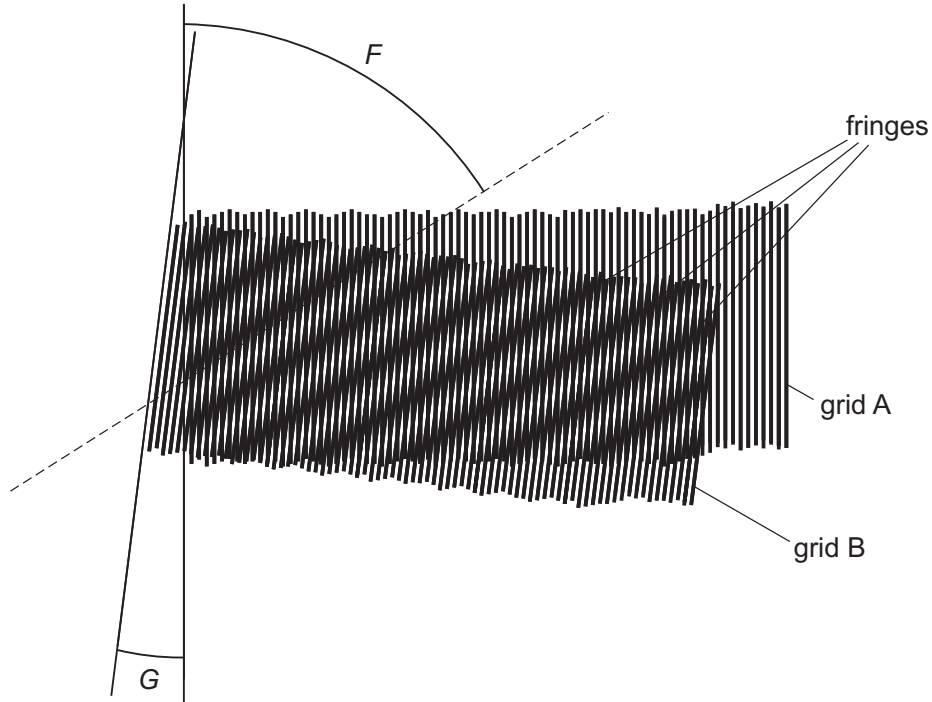


Fig. 1.2

- Do not take measurements from Fig. 1.2.

Measure and record your value of  $G$  from Fig. 1.1.

$$G = \text{.....}^\circ$$

- The fringes make an angle  $F$  with grid A, as shown in Fig. 1.2.

Measure and record your value of  $F$  from Fig. 1.1.

$$F = \text{.....}^\circ$$

[1]

(c) Rotate grid B and repeat (b) until you have six sets of values of  $G$  and  $F$ .

Use values of  $G$  in the range  $0^\circ$  to  $20^\circ$ .

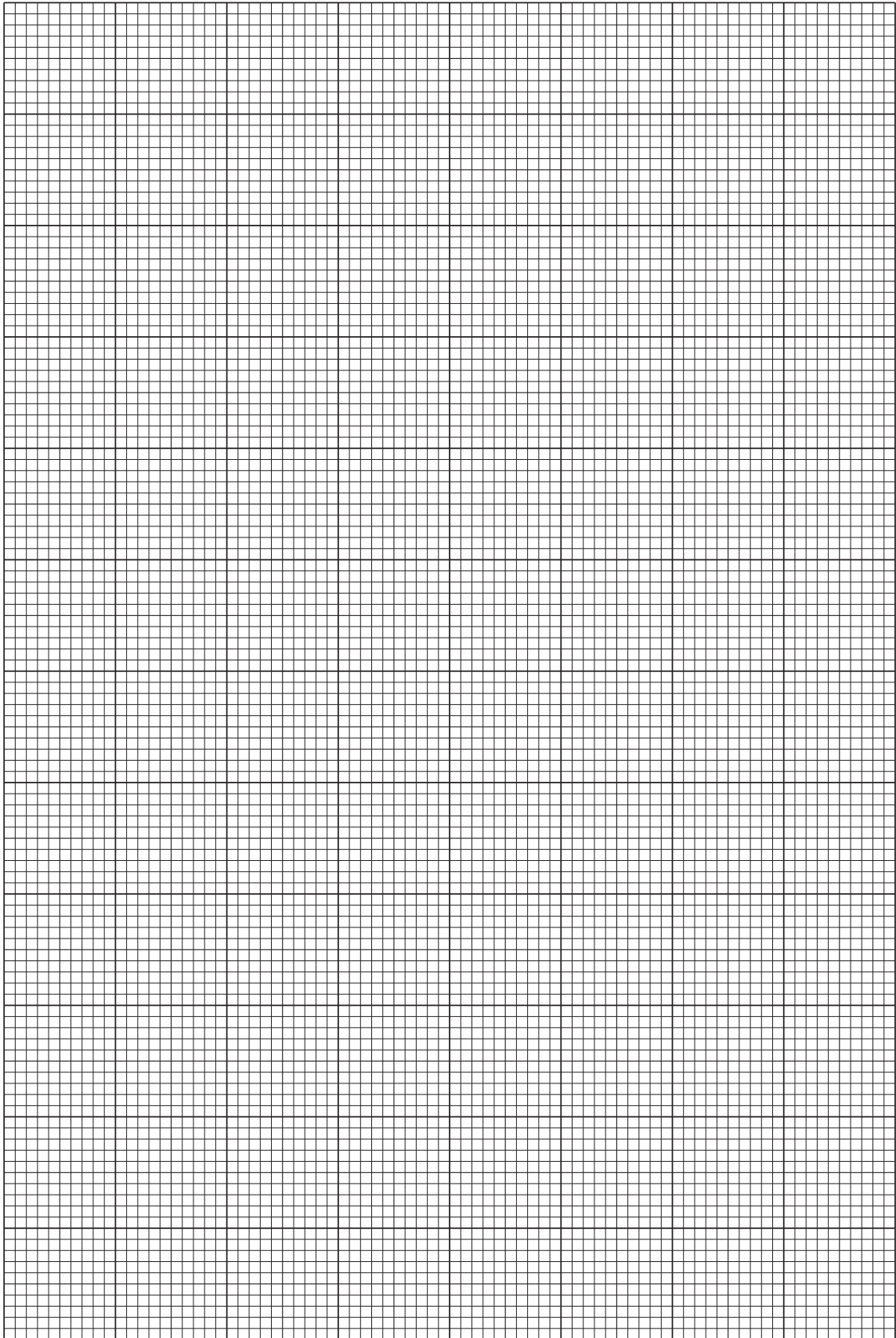
Record your results in a table. Include values of  $\sin F$  and  $\sin(F - G)$  in your table.

- [8]
- (d) (i) Plot a graph of  $\sin(F - G)$  on the  $y$ -axis against  $\sin F$  on the  $x$ -axis. [3]
- (ii) Draw the straight line of best fit. [1]
- (iii) Determine the gradient and  $y$ -intercept of this line.

gradient = .....

$y$ -intercept = .....

[2]



- (e) It is suggested that the quantities  $F$  and  $G$  are related by the equation

$$\sin(F-G) = p \sin F + q$$

where  $p$  and  $q$  are constants.

Use your answers in (d)(iii) to determine the values of  $p$  and  $q$ .

$$p = \dots\dots\dots$$

$$q = \dots\dots\dots$$

[2]

- (f) The constant  $p$  is related to the spacing of the lines of grids A and B by

$$p = \frac{s_B}{s_A}$$

where  $s_B$  is the line spacing of grid B.

Use your values of  $p$  and  $s_A$  to calculate  $s_B$ .

$$s_B = \dots\dots\dots \text{mm} [1]$$

[Total: 20]

You may not need to use all of the materials provided.

2 In this experiment, you will investigate the oscillations of a mass on a spring.

(a) (i) • Set up the apparatus as shown in Fig. 2.1 using the 50 g mass hanger.

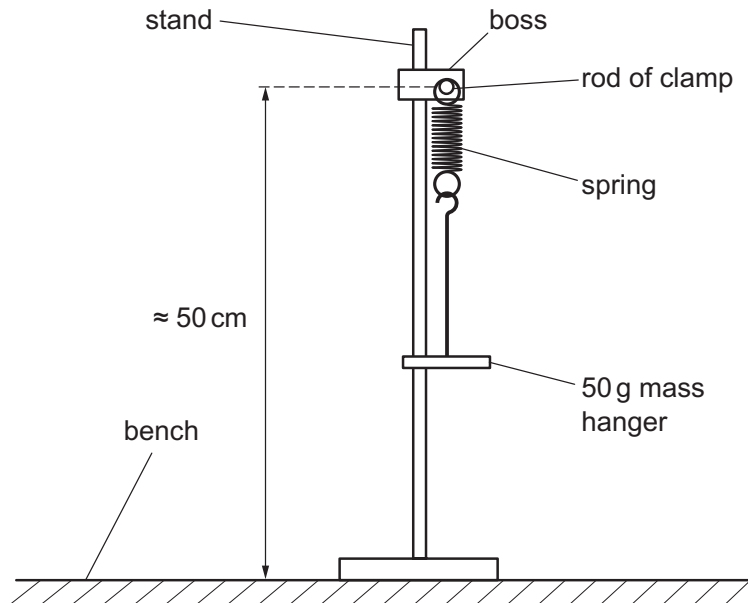


Fig. 2.1

- Pull the mass hanger down by approximately 1 cm. Release it so that it oscillates vertically, with no swinging motion.
- Take measurements to find the period  $T_V$  of these oscillations.

$$T_V = \dots\dots\dots [2]$$

- (ii) • Ensure that the mass hanger has stopped moving.
- Push the mass hanger approximately 1 cm away from you. Release it so that it swings towards and away from you, with as little vertical oscillation as possible.
  - Take measurements to find the period  $T_S$  of these oscillations.

$$T_S = \dots\dots\dots [1]$$

(b) Repeat (a) with a total mass of 150g suspended from the spring.

$$T_V = \dots\dots\dots$$

$$T_S = \dots\dots\dots [2]$$

(c) It is suggested that the quantity  $T_S^2 - T_V^2$  is independent of the mass suspended from the spring.

(i) Using your data, calculate two values of  $T_S^2 - T_V^2$ .

$$\text{first value of } T_S^2 - T_V^2 = \dots\dots\dots$$

$$\text{second value of } T_S^2 - T_V^2 = \dots\dots\dots [1]$$

(ii) Justify the number of significant figures you have given for your values of  $T_S^2 - T_V^2$ .

.....  
 .....  
 ..... [1]

(iii) Explain whether your results in (c)(i) support the suggestion.

.....

.....

.....

..... [1]

- (d) (i) • Remove the masses from the spring and the spring from the rod.  
 • Measure and record the length  $x_1$  of the spring, as shown in Fig. 2.2.

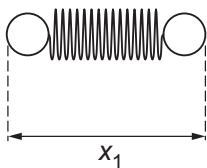


Fig. 2.2

$x_1 = \dots\dots\dots$  cm [1]

- (ii) Estimate the percentage uncertainty in your value of  $x_1$ . Show your working.

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

- (iii) Measure and record the length  $x_2$  of the mass hanger, as shown in Fig. 2.3.

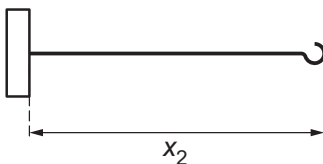


Fig. 2.3

$x_2 = \dots\dots\dots$  cm [1]

- (iv) Using your first value of  $T_S^2 - T_V^2$ , calculate  $g$  using

$$g = \frac{4\pi^2(x_1 + x_2)}{T_S^2 - T_V^2}$$

$g = \dots\dots\dots$  [1]

(e) (i) Describe four sources of uncertainty or limitations of the procedure for this experiment.

- 1. ....  
.....
- 2. ....  
.....
- 3. ....  
.....
- 4. ....  
.....

[4]

(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

- 1. ....  
.....
- 2. ....  
.....
- 3. ....  
.....
- 4. ....  
.....

[4]

[Total: 20]

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