Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2010

Physics
(Specifications A and B)

PHA3/B3/X

Unit 3 Investigative and Practical Skills in AS Physics
Route X Externally Marked Practical Assignment (EMPA)

Section B

For this paper you must have:
- a calculator
- a pencil
- a ruler
- your completed Section A Task 2 question paper/ answer booklet.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for Section B is 26.

Section B

Answer **all** the questions in the spaces provided.

The time allowed is 1 hour 15 minutes.

You will need to refer to the work you did in Section A Task 2 when answering these questions.

1 You are provided with a small plane mirror which you may use to assist you in answering part (a) of this question.

1 (a) (i) Determine the gradient, G_1, of your graph, at $x = 750\,\text{mm}$.

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$G_1 =$ .....

1 (a) (ii) Determine the gradient, G_2, of your graph, at $x = 650\,\text{mm}$.

$G_2 =$ .....

(3 marks)

1 (b) Evaluate $\frac{G_1}{G_2}$.

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$\frac{G_1}{G_2} =$ .....

(2 marks)

1 (c) Explain the procedure you used to determine the gradients, G_1 and G_2.

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(1 mark)

6

2 (a) Describe how you ensured that the wooden metre ruler was vertical whilst you made your measurements of h and h_0.
You may wish to use a sketch to illustrate your answer.

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(2 marks)

2 (b) Explain how you used the pin and the mirror when measuring the vertical height of the free end of the plastic ruler above the floor.
Identify the error that the procedure you have explained is intended to overcome.
You may wish to use a sketch to illustrate your answer.

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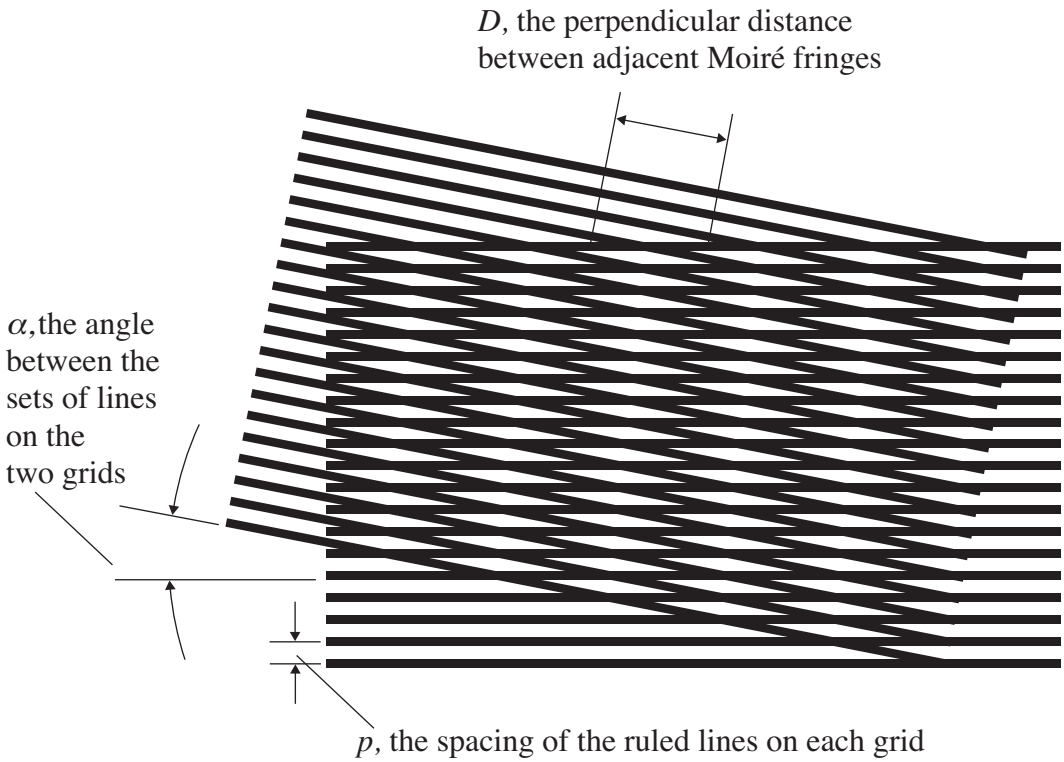
(3 marks)

5

3 In an experiment in Section A, you saw how two grids of parallel ruled lines can be used to produce Moiré fringe patterns, as shown in **Figure 7**.

Figure 7



A student obtains two diffraction gratings thought to be identical with a line spacing of about 3×10^{-6} m. The student finds that when these are placed together and viewed against a white background a Moiré fringe pattern is observed when one grating is rotated slightly.
For small angles, the distance between the Moiré interference fringes, D, is given by the approximate equation, $D \simeq \frac{57p}{\alpha}$, where α is in degrees.
By assuming that $p = 3.0 \times 10^{-6}$ m, the student uses this equation in a spreadsheet to find D for values of α up to 16°.
The student's results are shown below.

α/°	D/mm
2	0.0855
4	0.0428
6	0.0285
8	0.0214
10	0.0171
12	0.0143
14	0.0122
16	0.0107

The student intends to view the Moiré fringes through a microscope to check the spreadsheet results for D by measuring D using the microscope directly.
The vernier scale on the microscope can measure to the nearest 0.01 mm.

3 (a) Explain using suitable calculations why this microscope is not suitable to check the results of the spreadsheet calculation.

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(4 marks)

3 (b) The equation for D can be rearranged to give $p \simeq \frac{\alpha D}{57}$.

The student suggests that if a better microscope can be provided and α can be set to produce values of D greater than 0.10 mm, the value of p can be found experimentally. Discuss whether the student's suggestion is sensible.

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(2 marks)

3 (c) The theoretical separation of the Moiré fringes when $\alpha = 2°$, shows $D = 0.0859$ mm. Calculate the percentage difference between this value and the student's spreadsheet result for D when $\alpha = 2°$.

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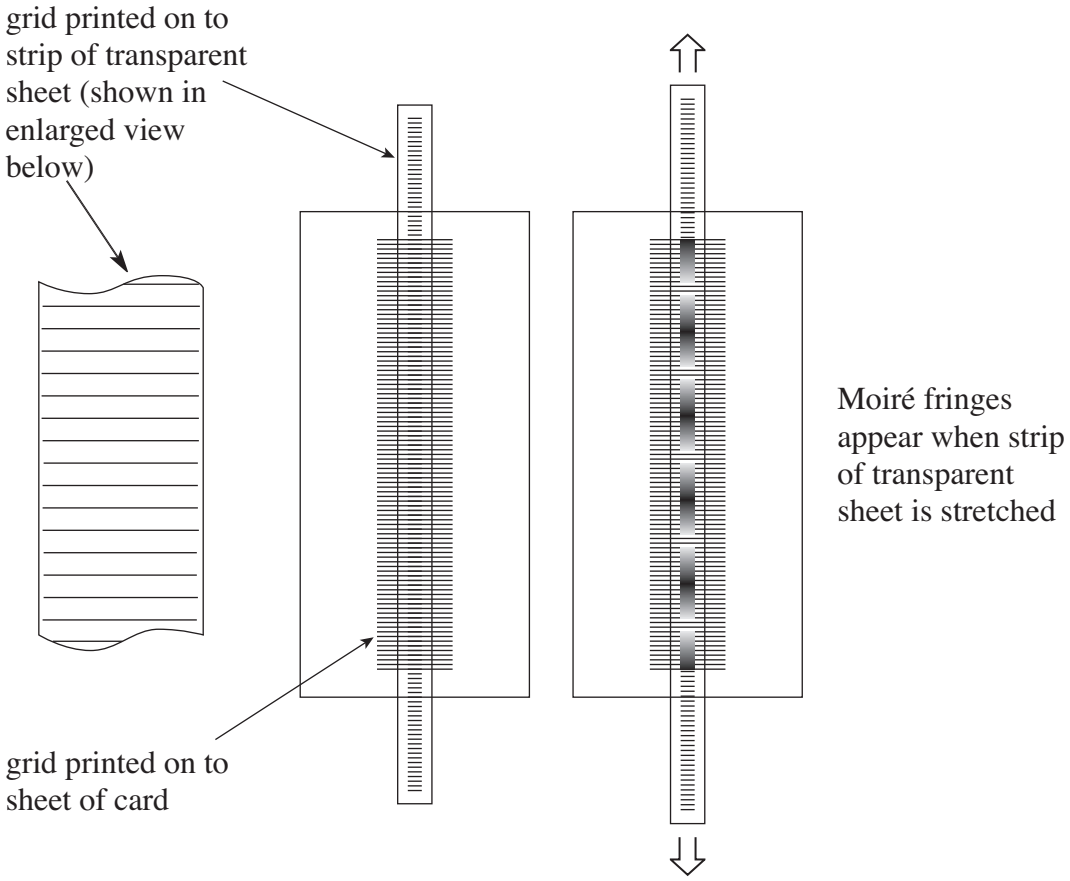
(2 marks)

8

4 In the experiment in Section A Task 1 you observed Moiré fringes using a transparent sheet on which gridlines were printed. This question is about an experiment to measure the stiffness of a narrow strip of the transparent sheet.

In **Figure 8**, which is not to scale, the strip of the transparent sheet is suspended vertically in front of a sheet of card; the lines printed in the strip are parallel to those on the card.
A grid, of identical spacing to that on the transparent sheet, is printed on the card.
The strip is stretched and when viewed against the grid on the card, Moiré fringes are seen.

Figure 8



It can be shown that Δl, the extension of the strip of transparent sheet, is given by

$$\Delta l = \frac{p \times l}{2d},$$

where p = distance between centres of adjacent lines on the grid printed on the card,
d = the distance between the centres of adjacent dark Moiré fringes,
l = length of the strip before being stretched.

The stiffness, k, of the strip is given by

$$k = \frac{F}{\Delta l},$$

where F = the force applied at each end to stretch the strip of transparent sheet.

4 (a) Explain how the stiffness of the strip of transparent sheet can be determined experimentally.
You may assume that the value of p is known.
In your answer

- state what measurements should be taken, explaining how each will be made
- describe procedures to reduce uncertainty in each of these measurements
- explain how the measurements can be used to calculate the stiffness of the strip of transparent sheet.

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(6 marks)

4 (b) In Section A Task 2 you used a plastic metre ruler.
Explain why it is not sensible to measure the stiffness of the plastic ruler using the method suggested in part (a).

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(1 mark)

7

END OF QUESTIONS

There are no questions printed on this page

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