Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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 A Task 1

For this paper you must have:
- a calculator
- a pencil
- a ruler.

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.
- **Figure 4** is printed on a perforated sheet. You may wish to detach this sheet before starting Question 2(a).

Information
- The marks for questions are shown in brackets.
- The maximum mark for Section A Task 1 is 14.

Do not write outside the box

Section A Task 1

Follow the instructions given below.

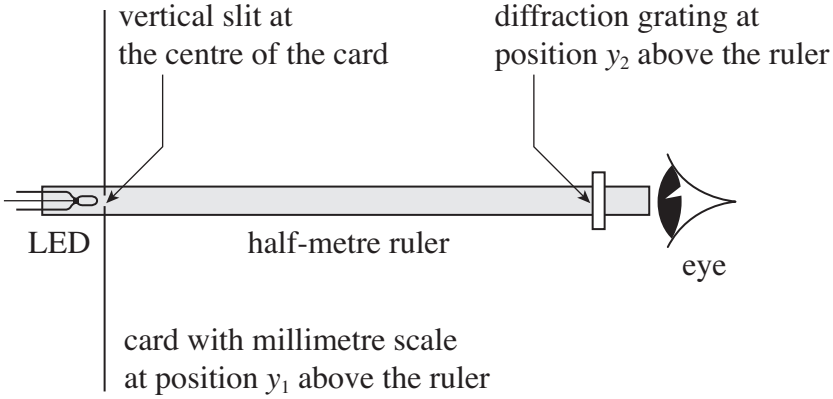
Answer **all** the questions in the spaces provided.

No description of the experiment is required.

You are to use a diffraction grating to observe the diffracted images of a vertical single slit illuminated by light from an LED.

1 The slit is in the centre of a card. A horizontal scale on the card shows the distances from the centre of the slit.
The slit is vertically above a half-metre ruler, with the card at right angles to the ruler.

Figure 1



1 (a) (i) Read and record the reading, y_1, on the half-metre ruler, directly below the slit, as shown in **Figure 1**.

y_1 = ...

A diffraction grating has been positioned so that it is vertically above the ruler and at right-angles to it. The grating lines are vertical, with the centre of the grating at the same height as the centre of the slit.
Do not move the stand to which the grating has been clamped or change the position of the grating in it.

1 (a) (ii) Read and record the reading, y_2, on the half-metre ruler, vertically below the face of the grating that is closest to the slit, as shown in **Figure 1**.

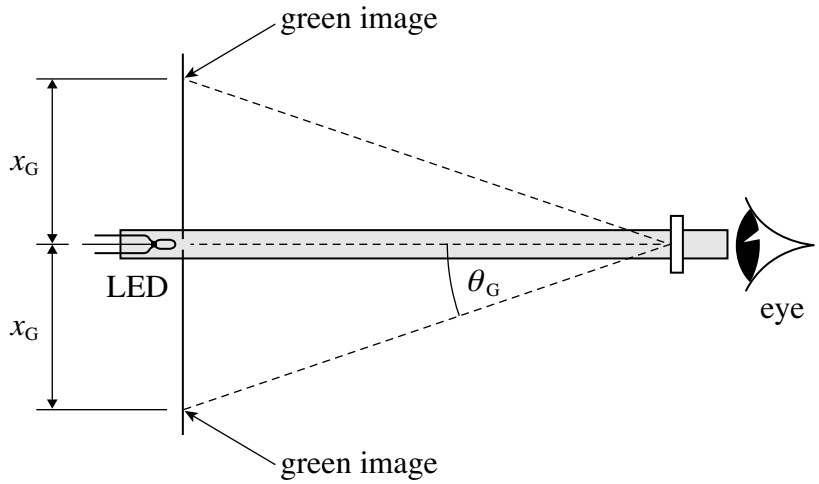
y_2 = ...

(1 mark)

Do not write outside the box

1 (b) The LED will emit green or red light depending on the setting of switch S.
Set the switch to the position marked G and adjust the output voltage of the power supply until the current in the LED is 20 mA.
View the slit through the grating with your eye close to the grating and observe the diffracted images of the slit. You will see three images of green light, which are the central (undeviated) image of the slit and the first-order diffracted images to the left and right.
Ignore any yellow or orange light produced by the LED.
If you are colour-blind you should assume that the green images are those closest to the slit.
A plan view of the apparatus when green light is emitted from the LED is shown in **Figure 2**.

Figure 2



1 (b) (i) Make readings to determine the mean distance, x_G, between the centre of the first-order green diffracted images and the centre of the slit. You should do this by looking at the scale on the card with one eye, whilst looking through the grating at the slit with the other eye.

.....

.....

.....

x_G = ...

Do not write outside the box

1 (b) (ii) Without changing the position of the grating or slit, set the switch S to the position marked R and adjust the output voltage of the power supply until the current in the LED is 20 mA. Make readings to determine the mean distance, x_R, between the centre of the first-order red diffracted images and the centre of the slit.

.....

.....

.....

x_R = ...

(2 marks)

1 (c) The angle of diffraction, θ, is given by $\tan \theta = \dfrac{x}{y_2 - y_1}$

1 (c) (i) Use your measurements to determine θ_G and θ_R, the angles of diffraction for the first-order images for green light and red light, respectively.

.....

.....

θ_G = ...

.....

.....

θ_R = ...

1 (c) (ii) Evaluate $\dfrac{\sin \theta_R}{\sin \theta_G}$.

.....

$\dfrac{\sin \theta_R}{\sin \theta_G}$ = ...

(3 marks)

Do not write outside the box

1 (d) Explain how you could determine the spacing of the lines on the diffraction grating you used. In your answer

- state what additional information you would need to determine the spacing of the lines on the diffraction grating
- explain how you would use your measurements to calculate the spacing of the lines on the diffraction grating
- describe **one** procedure or modification that would reduce the uncertainty in your result.

.....

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(4 marks)

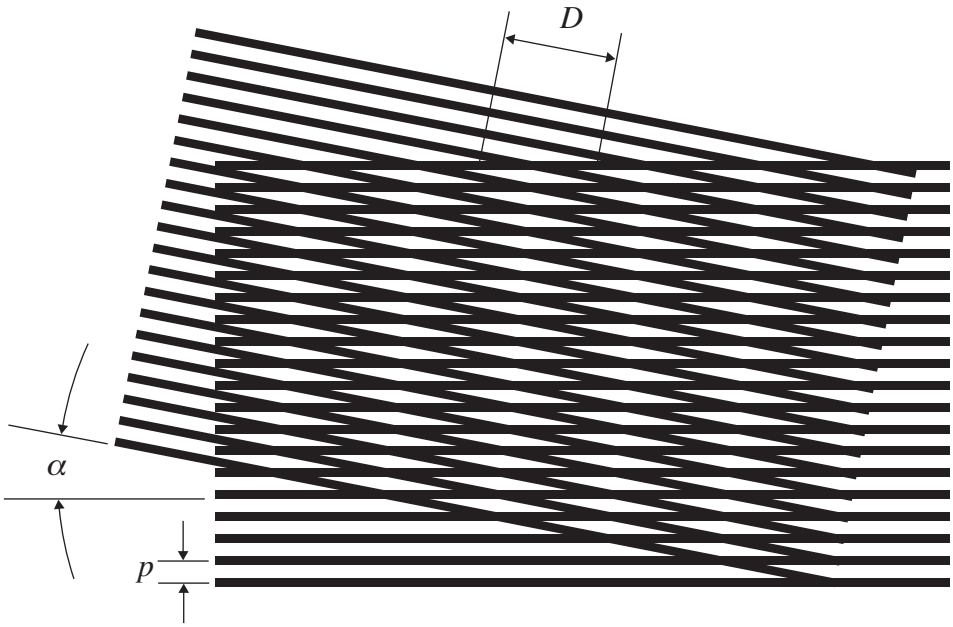
10

Turn over for the next question

Do not write outside the box

2 You are to make measurements of an optical pattern produced when two grids of parallel, ruled lines are overlaid, as shown in **Figure 3**.
The alternate lighter and darker regions in the pattern are called Moiré fringes.
The perpendicular distance, D, between adjacent Moiré fringes depends on the angle, α, between the sets of lines on the two grids and on p, the spacing between the centres of the adjacent lines on the grid.

Figure 3



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Note that Figure 4, for use with this question, is printed on page 9.
You may wish to detach this perforated sheet before starting Question 2(a).

2 (a) (i) Make suitable measurements to determine p, the spacing of the ruled lines on the grid shown in **Figure 4**.

.....

.....

p = ...

2 (a) (ii) Place the transparent copy over **Figure 4** so that the two sets of grid lines are parallel, then rotate the transparent copy until the grid lines on it are parallel to the line AB on **Figure 4**. Make suitable measurements to determine D, the perpendicular distance between adjacent Moiré fringes.

.....

.....

D = ...

2 (a) (iii) Evaluate $\frac{D}{p}$.

.....

.....

$\frac{D}{p}$ = ...

(3 marks)

2 (b) Justify the number of significant figures you gave with your result for $\frac{D}{p}$.

.....

.....

(1 mark)

4

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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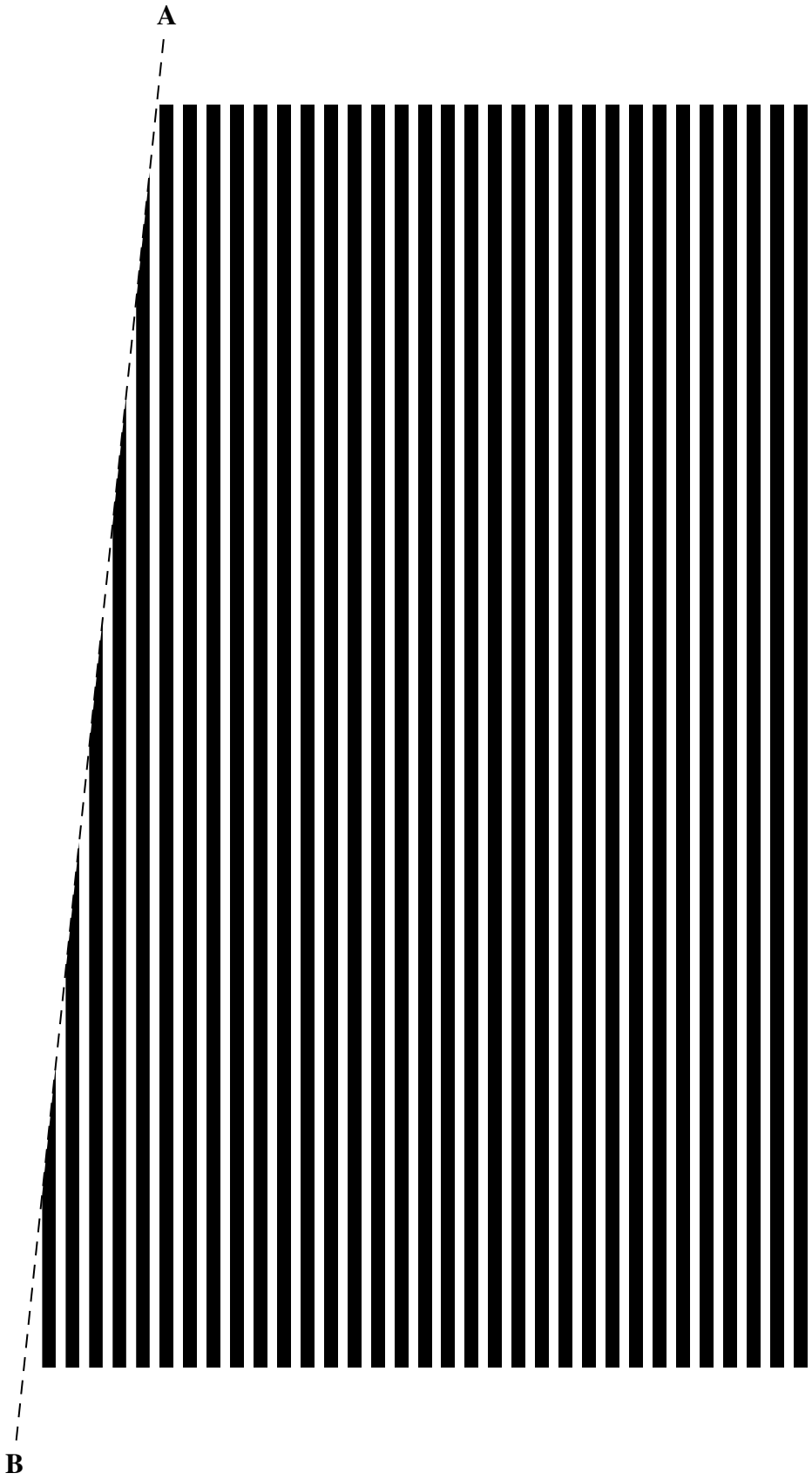
Figure 4



END OF QUESTIONS

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