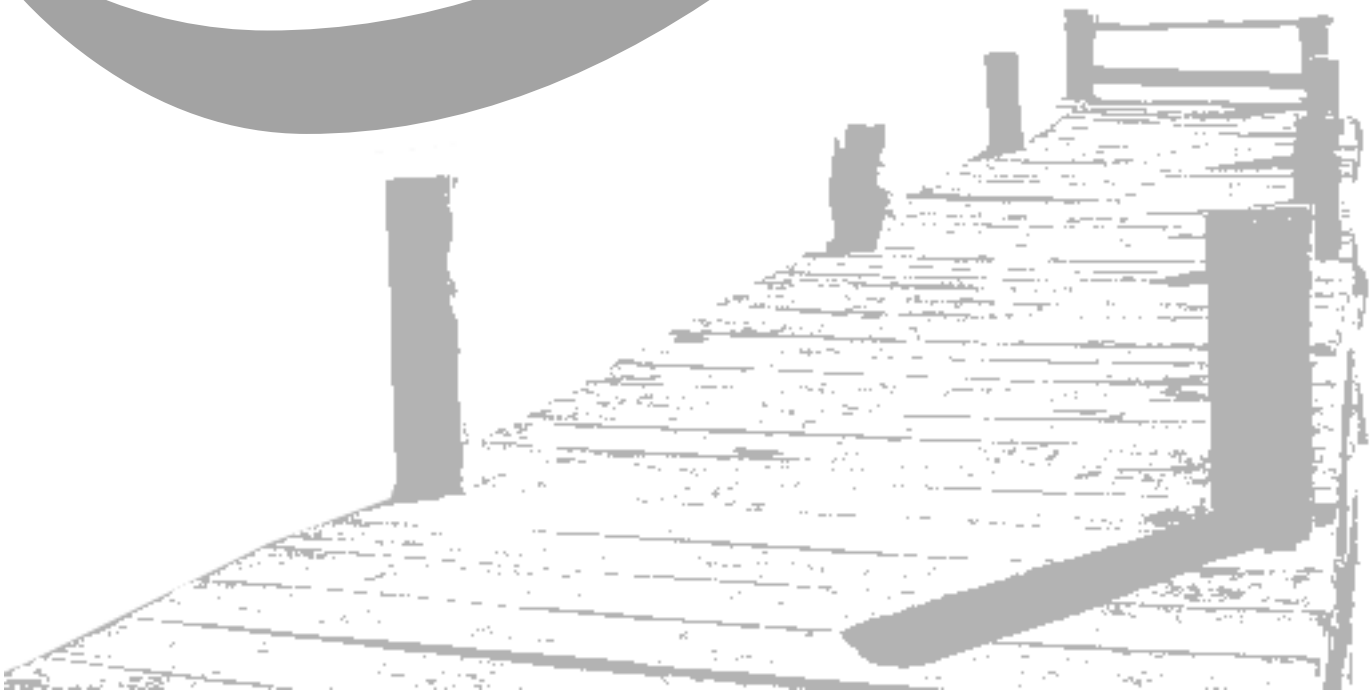
GCE
AS and A Level

Physics A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 3X: Approved specimen question paper

Version 1.0



General Certificate of Education
2009
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

version 1.0

PHYSICS
Investigative and Practical Skills in AS Physics

Route X Externally Marked Practical Assignment PHA3X

Instructions to Supervisors

SPECIMEN PAPER

For Section A Task 1

Candidates to compare the refractive index of a transparent triangular prism with that of a transparent rectangular block.

Apparatus required for each candidate:

- ❑ suitable white light source, e.g. ray box fitted with cylindrical convex and slit to produce narrow parallel beam of white light
- ❑ power supply for ray box and connecting leads
- ❑ 90-60-30 prism (acrylic plastic or glass) e.g. Griffin & George XFL-441-L, of sides 127 × 114 × 63.5 mm
- ❑ rectangular block (acrylic plastic or glass) e.g. Griffin & George XFL-401-Q, of sides 114 × 73 mm
- ❑ plane mirror
- ❑ 1 or 2 sheets of plain paper, e.g. A4 or A3 photocopier paper
- ❑ protractor
- ❑ 30 mm plastic ruler

The experiment may be conducted under conditions of subdued lighting but total black-out will not be necessary.
Place the apparatus on the bench. No assembly is required beforehand.

Examiners require the following information:

(i) The refractive index of the 90°-60°-30° prism ± 0.05.
(ii) The refractive index of the rectangular block ± 0.05.

For Section A Task 2

Candidates are to investigate the deviation of a light ray as it passes through a semicircular transparent block.

Apparatus required for each candidate:

- ❑ semicircular block (acrylic plastic or glass) e.g. Griffin & George XFL-521-R, diameter 98 mm
- ❑ suitable white light source, e.g. ray box fitted with cylindrical convex lens and slit to produce narrow parallel beam of white light
- ❑ power supply for ray box and connecting leads
- ❑ 1 or 2 (full scale) A3 photocopies of diagram provided as a loose insert with these instructions
- ❑ set-square
- ❑ 30 mm plastic ruler

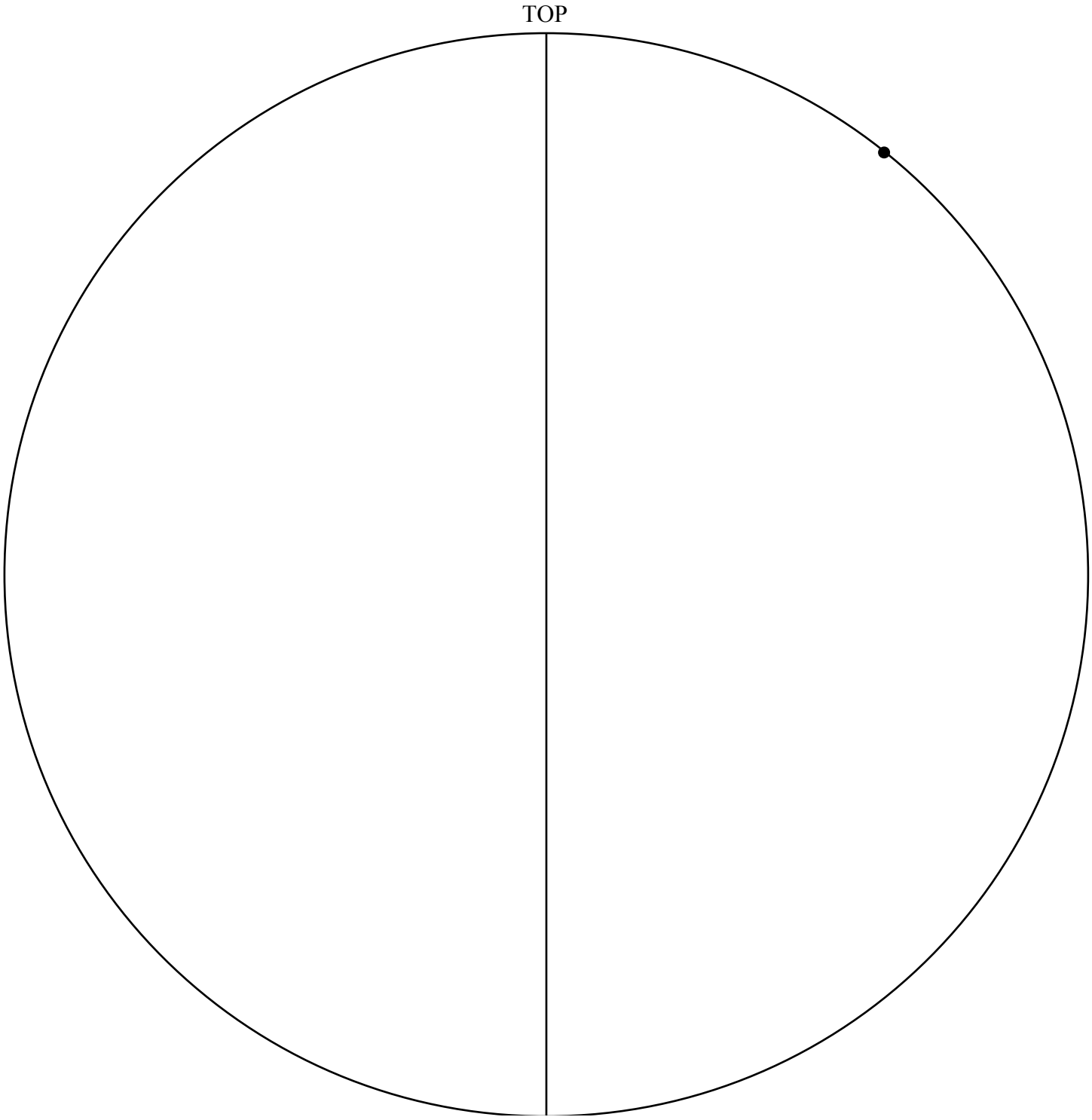
The experiment may be conducted under conditions of subdued lighting but total black-out will not be necessary.
Place the apparatus on the bench. No assembly is required beforehand.

Before the examination, supervisors should make full-scale photocopies onto A3 paper of the diagram provided as a loose insert with these instructions. Candidates should be provided with 1 or 2 copies of this at the start of the examination. Spare copies should be made: candidates are instructed to ask for additional sheets should this prove necessary.

Note that the examiners do not require the A3 sheets candidates will use: Centres should dispose of these after the examination and not forward them with the scripts.

Examiners require no information for Section A, Task 2.

Loose insert to be supplied with the instructions for **Section A, Task 2**.



Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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Section A Task 1

SPECIMEN PAPER

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

For Examiner's Use			
Sec A	Mark		Mark
1			
Total (Sec A)			
Total (Sec B)			
TOTAL			
Examiner's Initials			

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this task is 10.
- The marks for the questions are shown in brackets.

SECTION A TASK 1

- Follow the instructions given below.
- Provide the information required in the spaces provided.
- No description of the experiment is required.

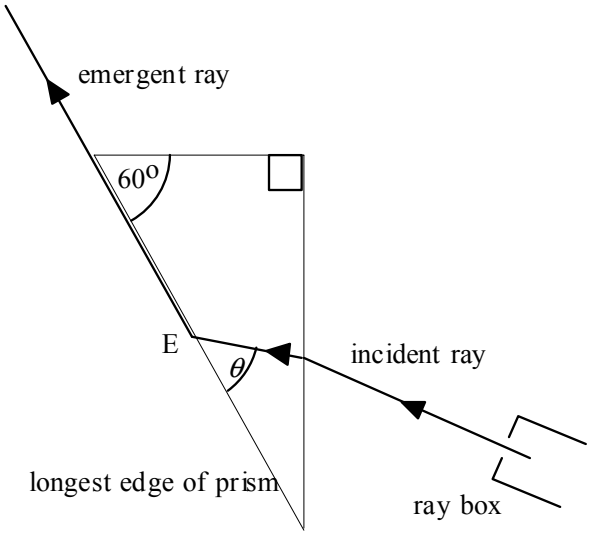
In these experiments you are required to compare the refractive index of a transparent triangular prism with that of a transparent rectangular block.

You are provided with large sheets of paper on which to trace out the paths of light rays through these blocks.

1 (a) Place the transparent triangular prism with one of its largest faces in contact with a sheet of paper.
Draw the outline of the block on the paper.

Use the ray box in the manner indicated in **Figure 1** to locate and then mark on the page, the path of a ray that emerges from the prism at point E and then passes close to the longest edge of the prism.

Figure 1



(i) Measure and record the angle θ.

θ = ……..

(ii) Evaluate $\frac{1}{\cos\theta}$, which gives the refractive index of the prism.

$\frac{1}{\cos\theta}$ = ……..

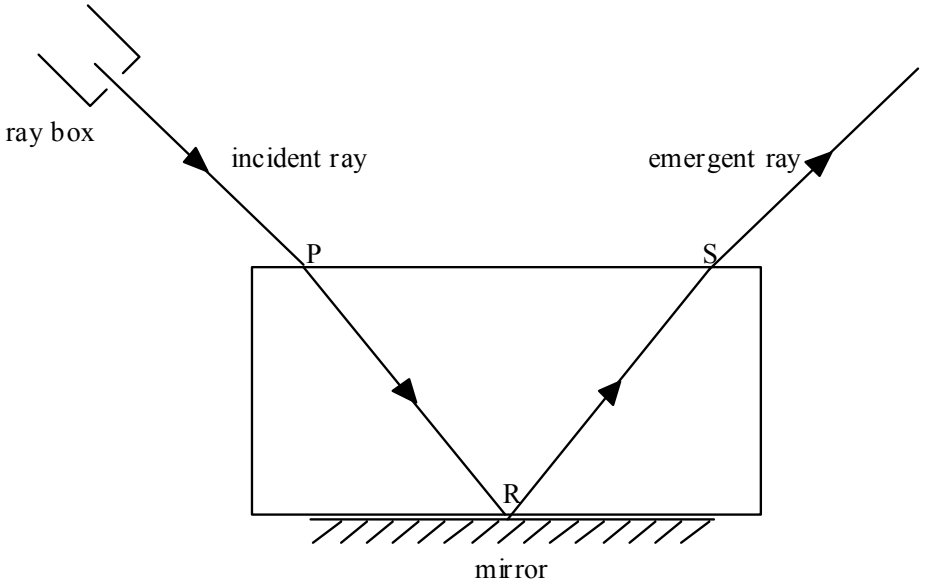
(3 marks)

(b) Place the transparent rectangular block with one of its largest faces in contact with a new sheet of paper.
Draw the outline of the block on the paper.

Place the plane mirror with the reflective surface in contact with one of the longer edges of the block.

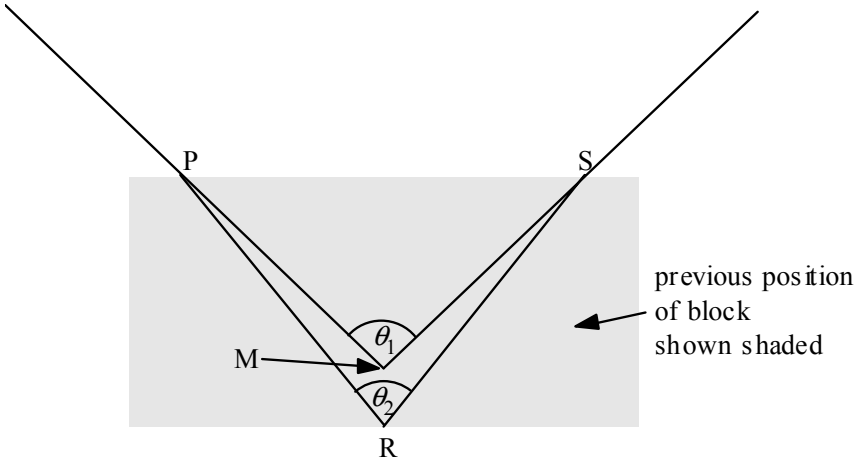
Use the ray box in the manner indicated in **Figure 2** to locate and then mark on the page, the path of a ray that travels in to and then out of the same face of the block, at points P and S respectively, having been reflected at point R on the mirror.

Figure 2



Remove the block then extend the paths of the incident and emergent rays and locate the point M where these rays would meet, as shown in **Figure 3**.

Figure 3



(i) Measure and record the angle θ_1.

$\theta_1 =$ ……..

(ii) Measure and record the angle θ_2.

$\theta_2 =$ ……..

(iii) Evaluate $\dfrac{\sin\left(\frac{\theta_1}{2}\right)}{\sin\left(\frac{\theta_2}{2}\right)}$, which gives the refractive index of the material of the block.

$\dfrac{\sin\left(\frac{\theta_1}{2}\right)}{\sin\left(\frac{\theta_2}{2}\right)} =$ ……..

(iv) Explain how you located the position of point R.
You may wish to use a sketch to illustrate your answer.

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(4 marks)

(c) Discuss whether your results for the refractive index of the triangular prism and for the rectangular block suggest that these blocks have the same optical properties.

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(3 marks)

END OF SECTION A TASK 1

Surname		Other Names	
Centre Number						Candidate Number				
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Route X Externally Marked Practical Assignment PHA3X

Section A Task 2

SPECIMEN PAPER

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

For Examiner's Use			
Sec A	Mark		Mark
1			
Total (Sec A)			
Total (Sec B)			
TOTAL			
Examiner's Initials			

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this task is 20.
- The marks for the questions are shown in brackets.

SECTION A TASK 2

- Follow the instructions given below.
- Provide the information required in the spaces provided.
- No description of the experiment is required.

In this experiment you are required to investigate the deviation of a light ray passing through a semicircular transparent block.

You are provided with a large sheet of paper showing a diagram of a circle.

A diameter of the circle has been marked on the diagram.

1 (a) (i) Measure and record the diameter, D, of the circle.

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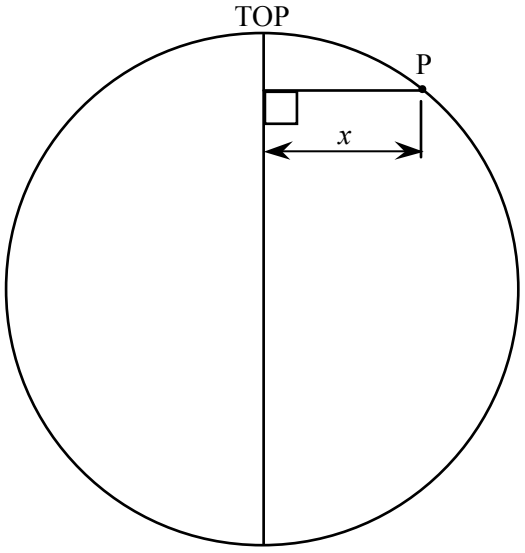
D = ……..

(ii) With the point marked TOP furthest from you, measure and record the perpendicular distance, x, between the point P on the circle and the marked diameter, as shown in **Figure 1**.

Figure 1

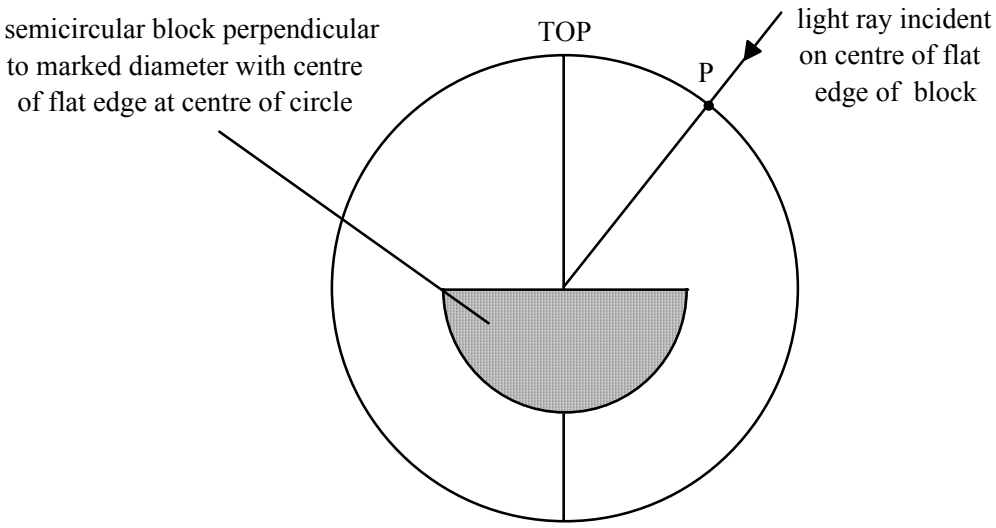


x = ……

(2 marks)

(b) Position the semicircular block as shown in **Figure 2** so the centre of the flat edge of the block is perpendicular to the marked diameter. Adjust the position of the block until the centre of the flat edge of the block is at the centre of the circle.

Figure 2

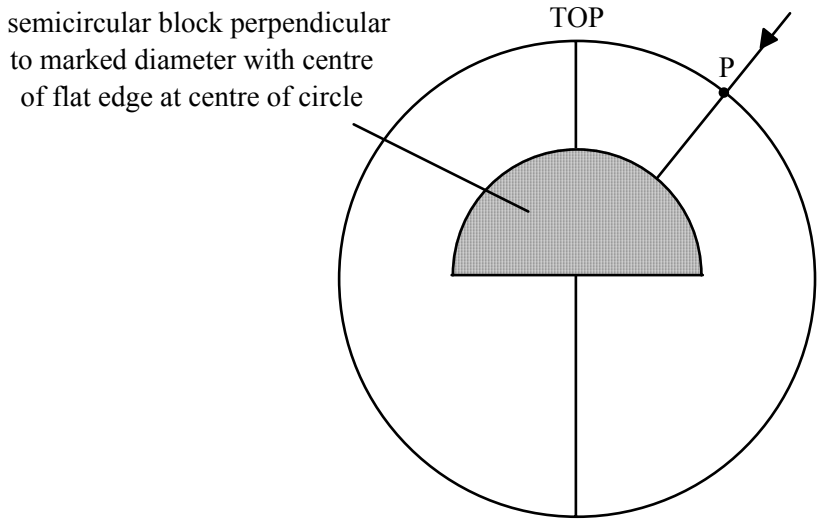


Position the ray box so that a ray of light passes through point P and is then incident on the centre of the flat edge of the block.
Mark on the diagram the path of the ray emerging from the curved edge of the block. Extend this line to reach the circle.
Measure and record the perpendicular distance, *y*, between the point where the emergent ray reaches the circle and the marked diameter.

y = ……

Rotate the block to the position shown in **Figure 3**. Note that the centre of the flat edge of the block should still be perpendicular to the marked diameter and the centre of the flat edge of the block should remain at the centre of the circle.

Figure 3



Mark on the diagram the path of the ray emerging from the flat edge of the block.
Extend this line to reach the circle.
Measure and record the perpendicular distance, z, between the point where the emergent ray reaches the circle and the marked diameter.

z = …….

Replace the block as in **Figure 2** and reposition the ray box so that the ray of light now enters the circle **between** point P and the point marked TOP on the marked diameter.
Ensure that the ray is once again incident on the centre of the flat edge of the block.
Repeating the procedure as before, measure and record additional values of y and z corresponding to **four smaller** values of x.
You may ask the supervisor for additional sheets of paper, if required.

Record all your measurements and observations below.
Note that

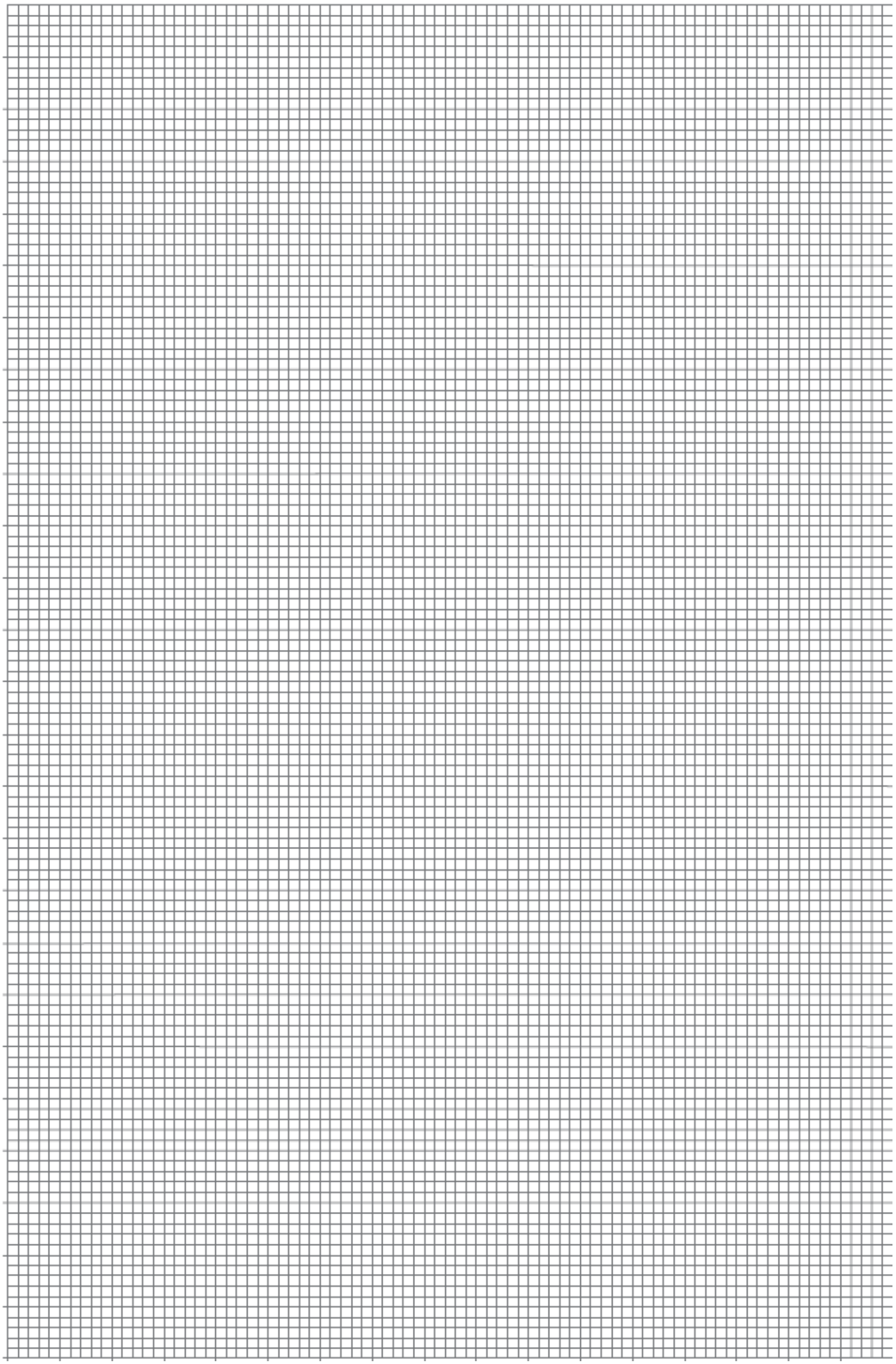
- the independent variable should be recorded in the **left-hand** column of your table.

(9 marks)

(c) Plot, on the grid opposite, a graph with z on the vertical axis and y on the horizontal axis.

(9 marks)

END OF SECTION A TASK 2



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Centre Number						Candidate Number				
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Section B

SPECIMEN PAPER

Time allowed: 1 ¼ hours

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

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 25.
- The marks for the questions are shown in brackets.

For Examiner's Use			
Sec B	Mark		Mark
1			
2			
3			
4			
5			
Total (Sec A)			
Total (Sec B)			
TOTAL			
Examiner's Initials			

SECTION B

- Answer all the questions in the spaces provided.
- Time allowed 1 hour 15 minutes.
- You need to refer to the work you did in completing Section A when answering this section.

1 Determine the gradient, G, of your graph.

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G = …….

(4 marks)

2 (a) Write down the reading of x which will have the **greatest** percentage uncertainty.

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(b) Calculate the percentage uncertainty in this reading of x.

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(3 marks)

3 Explain the procedure you used to position the semicircular block as in **Figure 2** in Section A.

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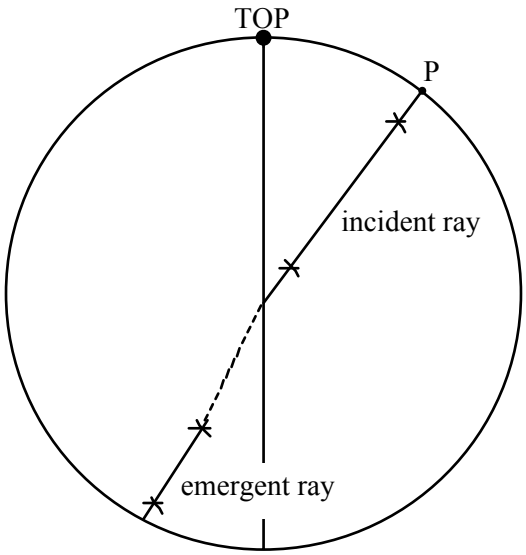
(3 marks)

4 A student, performing the experiment, arranges the block, as in **Figure 2** in Section A, so that light passes in through the flat edge and traces the paths of the incident and emergent rays to and from the block. When the block is removed, the student draws a line (shown dotted in **Figure 4**) to join the incident and emergent rays.

Figure 4



Assuming that the block was of constant radius, state **two** possible mistakes the student could have made.

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(2 marks)

5 It can be shown that the gradient, G, depends on the optical properties of the transparent block. A student carries out the experiment that you have just performed using semicircular blocks made of glass with different optical properties.
The student produces the table of results shown below.

Type of glass	G
Light barium crown	2.37
Crown	2.39
Light flint	2.50
Dense barium crown	2.59
Dense flint	2.62
Flint	3.05

In arriving at the results for *Flint* glass, the student performs eight repeat experiments. The results of these tests are shown below.

Experiment	G	Experiment	G
1	2.34	5	3.65
2	3.84	6	2.92
3	3.37	7	2.53
4	2.75	8	3.01

(a) Following these experiments, the student records a mean value of G for *Flint* glass and gives the uncertainty as ± 0.01.

(i) Explain why this is not a valid assessment of the uncertainty in the mean value of G.

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(ii) Calculate the mean value of G and give a more realistic figure for the uncertainty.

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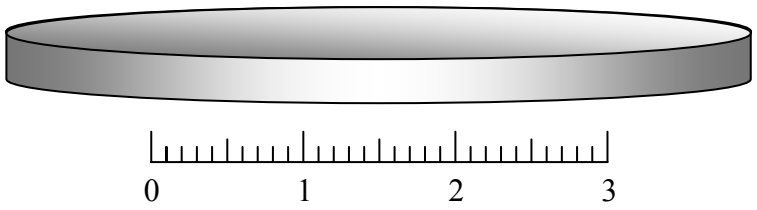
(4 marks)

A teacher suggests that for different types of glass listed in the first table, there may be a link between *G* and the density of the glass.
Thin cylindrical disc samples of each type of glass are available. The teacher asks some students to devise an experiment to test whether such a link exists.
A typical cylinder is shown in **Figure 5**; the centimetre scale is included to give an impression of the dimensions of the cylinder.

Figure 5



centimetre scale

(b) Explain what the students should do.
Give details of

- the measurements to be made and how this will be done,
- the procedures taken to reduce uncertainty in each of the measurements,
- how the measurements will be used to test whether a link exists between *G* and the density of the glass.

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(9 marks)