

Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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5	
6	
7	
TOTAL	



General Certificate of Education  
Advanced Subsidiary Examination  
June 2010

# Physics A

# PHYA2

## Unit 2 Mechanics, Materials and Waves

Wednesday 9 June 2010 9.00 am to 10.15 am

**For this paper you must have:**

- a ruler
- a calculator
- a Data and Formulae 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.
- 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 this paper is 70.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Book* is provided as a loose insert.
- You will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

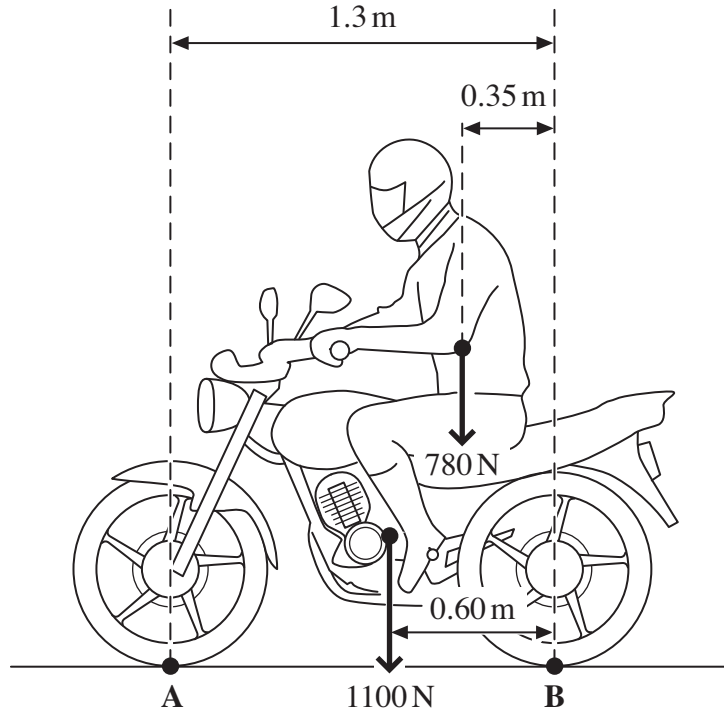


JUN10PHYA201

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

- 1** **Figure 1** shows a motorcycle and rider. The motorcycle is in contact with the road at **A** and **B**.

**Figure 1**



The motorcycle has a weight of 1100 N and the rider's weight is 780 N.

- 1 (a)** State the Principle of Moments.

.....  
 .....  
 .....

(2 marks)

- 1 (b)** Calculate the moment of the rider's weight about **B**. Give an appropriate unit.

answer = .....

(2 marks)



- 1 (c)** By taking the moments about **B**, calculate the vertical force that the road exerts on the front tyre at **A**. State your answer to an appropriate number of significant figures.

answer = ..... N  
(4 marks)

- 1 (d)** Calculate the vertical force that the road exerts on the rear tyre at **B**.

answer = ..... N  
(1 mark)

- 1 (e)** The maximum power of the motorcycle is 7.5 kW and it has a maximum speed of  $26 \text{ m s}^{-1}$ , when travelling on a level road.

Calculate the total horizontal resistive force for this speed.

answer = ..... N  
(2 marks)



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ANSWER IN THE SPACES PROVIDED**



2 Galileo used an inclined plane, similar to the one shown in **Figure 2**, to investigate the motion of falling objects.

2 (a) Explain why using an inclined plane rather than free fall would produce data which is valid when investigating the motion of a falling object.

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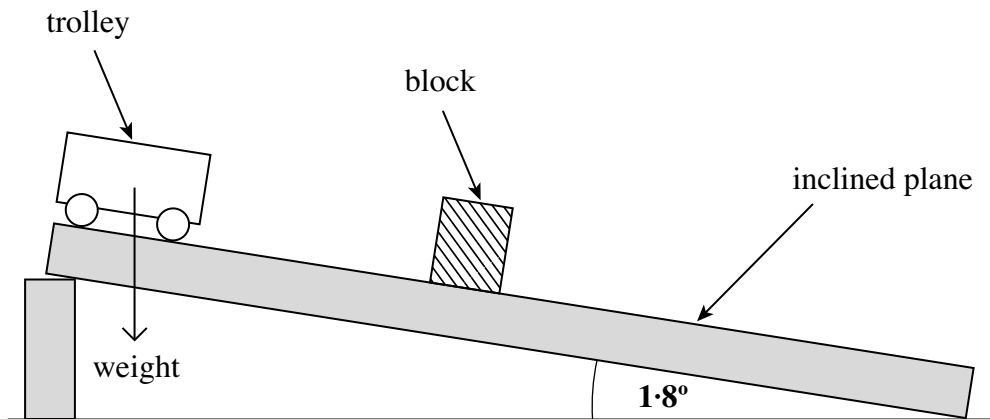
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(2 marks)

2 (b) In a demonstration of Galileo's investigation, the number of swings of a pendulum was used to time a trolley after it was released from rest. A block was positioned to mark the distance that the trolley had travelled after a chosen whole number of swings. See **Figure 2**.

**Figure 2**



The mass of the trolley in **Figure 2** is 0.20 kg and the slope is at an angle of  $1.8^\circ$  to the horizontal.

2 (b) (i) Show that the component of the weight acting along the slope is about 0.06 N.

(2 marks)

**Question 2 continues on the next page**

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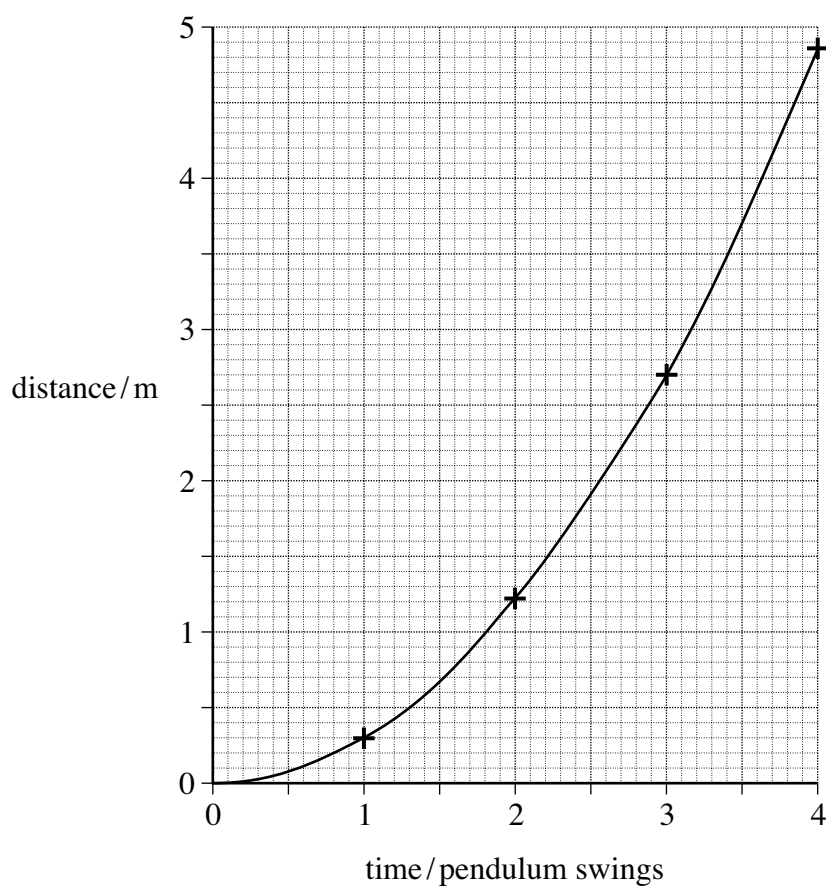


2 (b) (ii) Calculate the initial acceleration down the slope.

answer = .....  $\text{m s}^{-2}$   
(2 marks)

2 (c) In this experiment, the following data was obtained. A graph of the data is shown below it.

time / pendulum swings	distance travelled / m
1	0.29
2	1.22
3	2.70
4	4.85



**2 (c)** From the graph on **page 6**, state what you would conclude about the motion of the trolley?  
Give a reason for your answer.

.....  
.....  
.....  
.....

(2 marks)

**2 (d)** Each complete pendulum swing had a period of 1.4 s. Use the graph on **page 6** to find the speed of the trolley after it had travelled 3.0 m.

answer = ..... m s<sup>-1</sup>  
(3 marks)

11

**Turn over for the next question**

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3 (a) Define the amplitude of a wave.

.....  
 .....  
 (1 mark)

3 (b) (i) Other than electromagnetic radiation, give **one** example of a wave that is transverse.

.....  
 (1 mark)

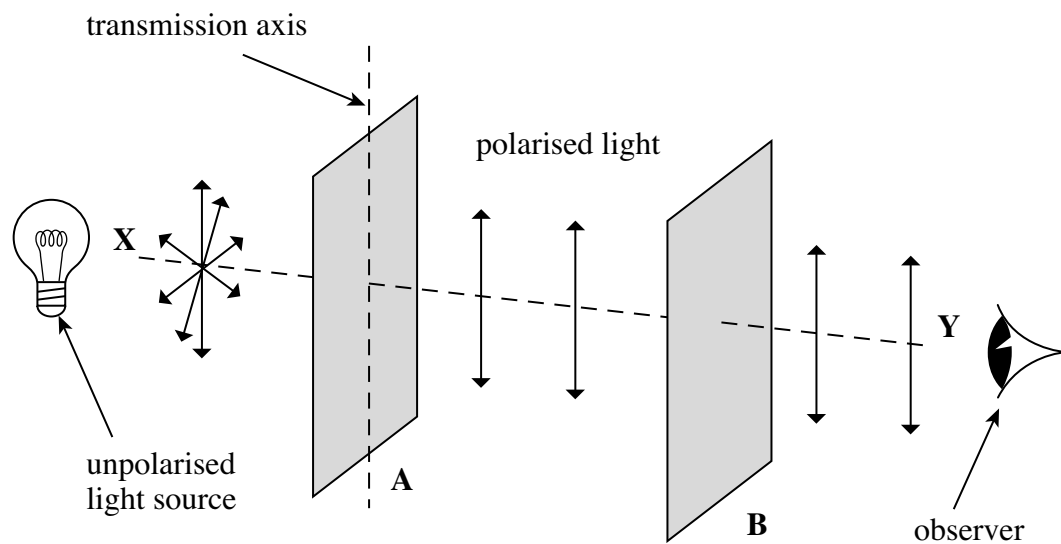
3 (b) (ii) State **one** difference between a transverse wave and a longitudinal wave.

.....  
 .....  
 (1 mark)

3 (c) **Figure 3** shows two identical polarising filters, **A** and **B**, and an unpolarised light source. The arrows indicate the plane in which the electric field of the wave oscillates.

3 (c) (i) If polarised light is reaching the observer, draw the direction of the transmission axis on filter **B** in **Figure 3**.

**Figure 3**

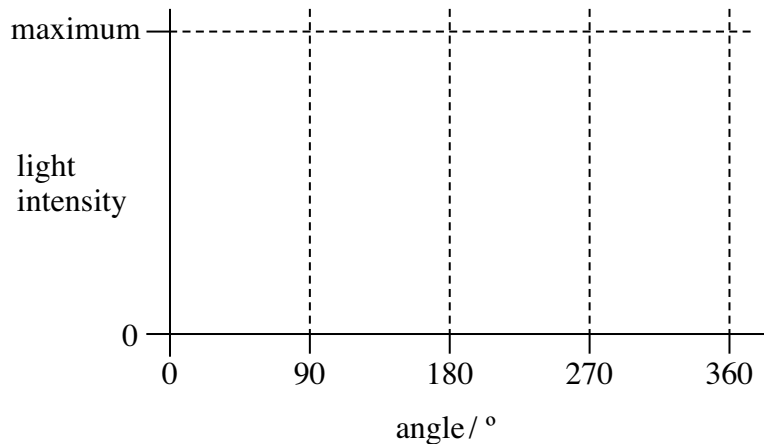


(1 mark)





3 (c) (ii) The polarising filter **B** is rotated clockwise through  $360^\circ$  about line **XY** from the position shown in **Figure 3**. On the axes below, sketch how the light intensity reaching the observer varies as this is done.



(2 marks)

3 (d) State **one** application, other than in education, of a polarising filter and give a reason for its use.

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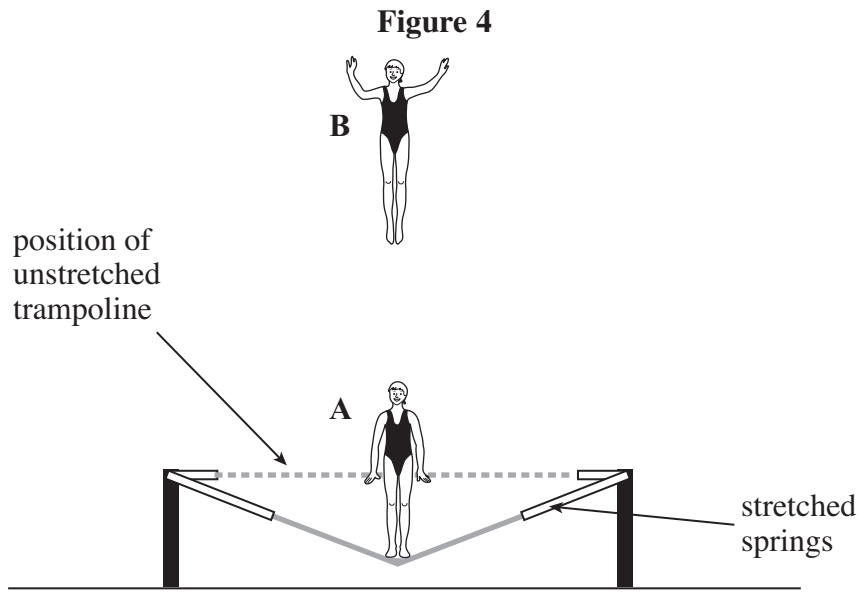
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(2 marks)

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4 **Figure 4** shows a gymnast trampolining.



In travelling from her lowest position at **A** to her highest position at **B**, her centre of mass rises 4.2 m vertically. Her mass is 55 kg.

4 (a) Calculate the increase in her gravitational potential energy when she ascends from position **A** to position **B**.

answer = ..... J  
(2 marks)



**4 (b)** The gymnast descends from position **B** and regains contact with the trampoline when it is in its unstretched position. At this position, her centre of mass is 3.2 m below its position at **B**.

**4 (b) (i)** Calculate her kinetic energy at the instant she touches the unstretched trampoline.

answer = ..... J  
(1 mark)

**4 (b) (ii)** Calculate her vertical speed at the same instant.

answer = .....  $\text{m s}^{-1}$   
(2 marks)

**4 (c)** Draw an arrow on **Figure 4** to show the force exerted on the gymnast by the trampoline when she is in position **A**.

(1 mark)

**4 (d)** As she accelerates upwards again from position **A**, she is in contact with the trampoline for a further 0.26 s. Calculate the average acceleration she would experience while she is in contact with the trampoline, if she is to reach the same height as before.

answer = .....  $\text{m s}^{-2}$   
(2 marks)

**Question 4 continues on the next page**

**Turn over ►**



4 (e) On her next jump the gymnast decides to reach a height above position **B**. Describe and explain, in terms of energy and work, the transformations that occur as she ascends from her lowest position **A** until she reaches her new position above **B**.

The quality of your written communication will be assessed in this question.

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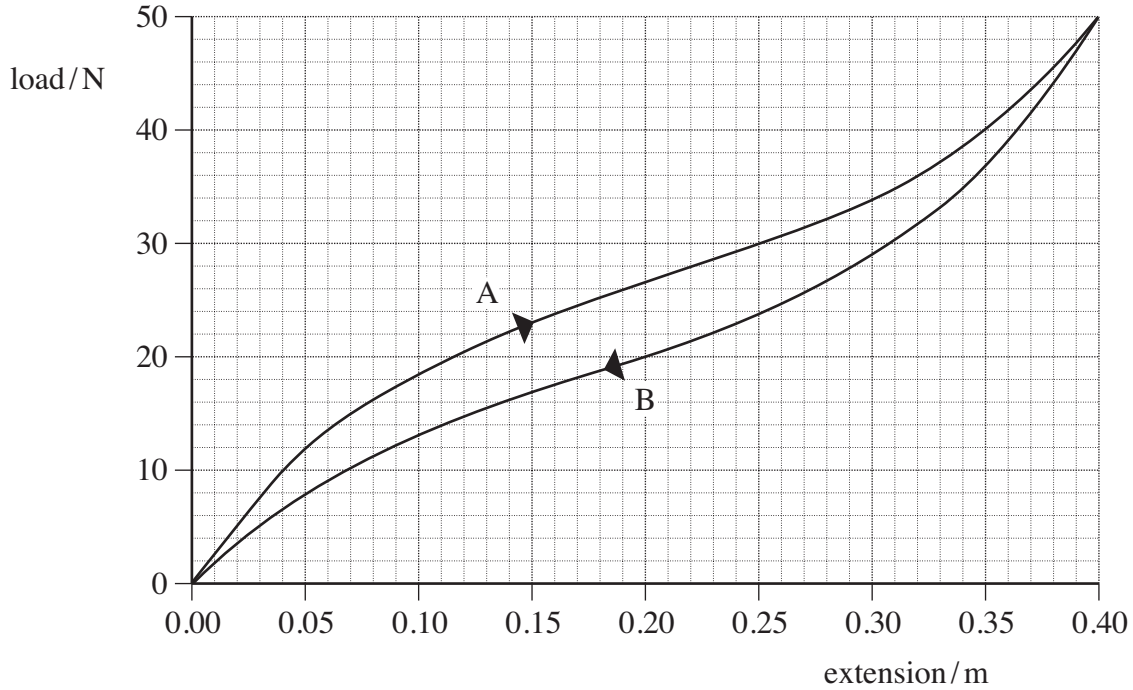
(6 marks)

<b>14</b>



5 A rubber cord is used to provide mechanical resistance when performing fitness exercises. A scientist decided to test the properties of the cord to find out how effective it was for this purpose. The graph of load against extension is shown in **Figure 5** for a 0.50 m length of the cord.

**Figure 5**



Curve **A** shows loading and curve **B** shows unloading of the cord.

5 (a) State which feature of this graph confirms that the rubber cord is elastic.

.....  
(1 mark)

5 (b) Explaining your method, use the graph (curve **A**) to estimate the work done in producing an extension of 0.30 m.

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answer = ..... J  
(3 marks)

**Question 5 continues on the next page**

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**5 (c)** Assuming that line **A** is linear up to an extension of 0.040 m, calculate the Young modulus of the rubber for small strains.

The cross-sectional area of the cord =  $5.0 \times 10^{-6} \text{ m}^2$   
The unstretched length of the cord = 0.50 m

answer = ..... Pa  
(3 marks)

**5 (d)** The scientist compared this cord with a steel spring that reached the same extension for the same maximum load without exceeding its *limit of proportionality*.

**5 (d) (i)** On **Figure 5**, draw the load-extension line for this spring up to a load of 50 N and label it **C**.  
(1 mark)

**5 (d) (ii)** With reference to the spring, explain what is meant by limit of proportionality.

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.....  
(1 mark)

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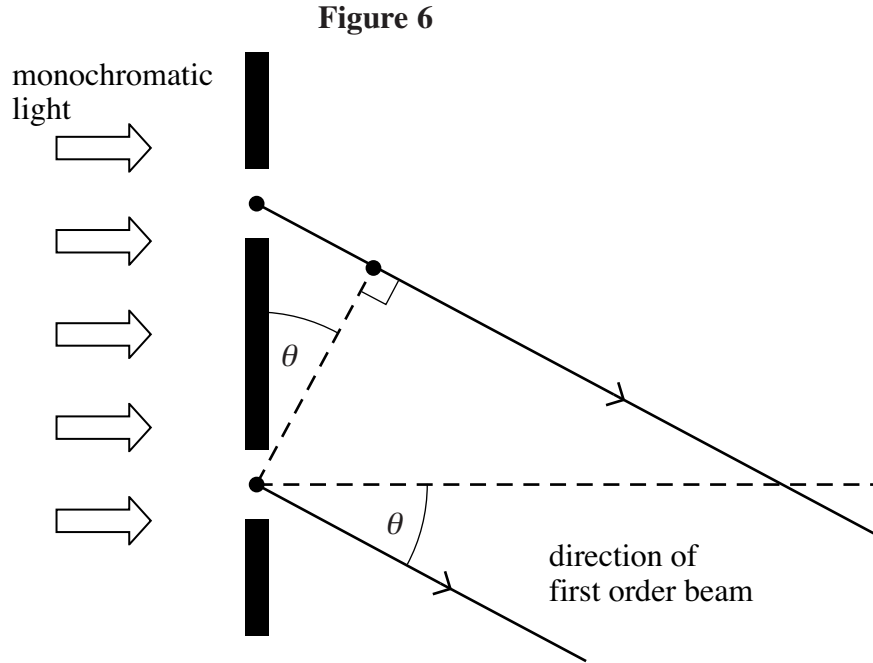


6 For a plane transmission diffraction grating, the diffraction grating equation for the first order beam is:

$$\lambda = d \sin \theta$$

6 (a) **Figure 6** shows two of the slits in the grating. Label **Figure 6** with the distances  $d$  and  $\lambda$ .

(2 marks)



6 (b) State and explain what happens to the value of angle  $\theta$  for the first order beam if the wavelength of the monochromatic light decreases.

.....

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(2 marks)

Question 6 continues on the next page

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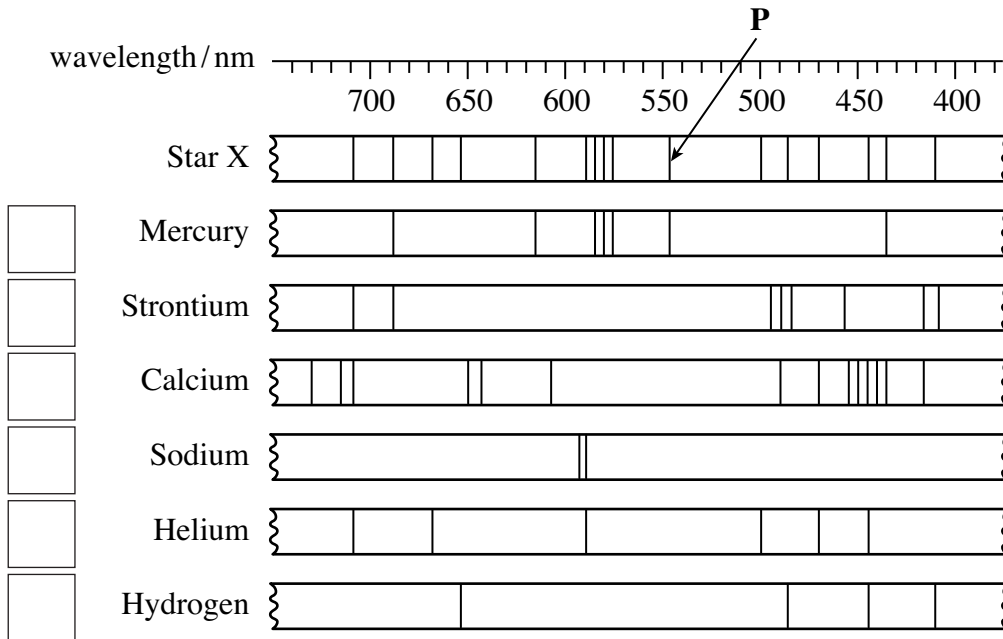


6 (c) A diffraction grating was used with a spectrometer to obtain the line spectrum of star X shown in **Figure 7**. Below this are some line spectra for six elements that have been obtained in the laboratory.

Place ticks in the boxes next to the **three** elements that are present in the atmosphere of star X.

(2 marks)

**Figure 7**



6 (d) The diffraction grating used to obtain the spectrum of star X had 300 slits per mm.

6 (d) (i) Calculate the distance between the centres of two adjacent slits on this grating.

answer = ..... m  
(1 mark)

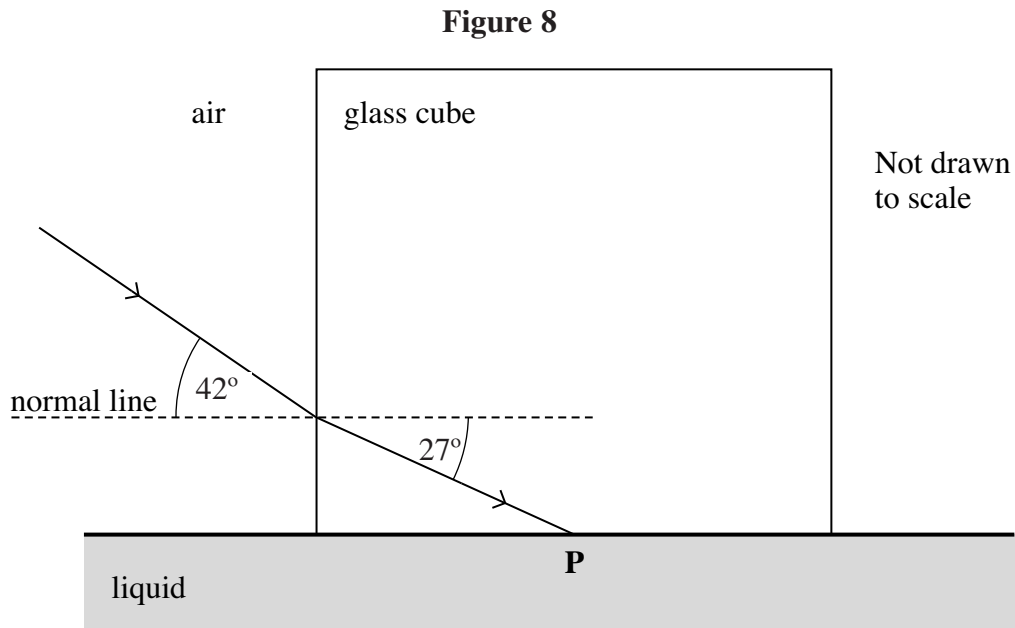
6 (d) (ii) Calculate the first order angle of diffraction of line P in **Figure 7**.

answer = ..... degrees  
(2 marks)





- 7 A glass cube is held in contact with a liquid and a light ray is directed at a vertical face of the cube. The angle of incidence at the vertical face is then decreased to  $42^\circ$  as shown in **Figure 8**. At this point the angle of refraction is  $27^\circ$  and the ray is totally internally reflected at **P** for the first time.



- 7 (a) Complete **Figure 8** to show the path of the ray beyond **P** until it returns to air. (3 marks)

- 7 (b) Show that the refractive index of the glass is about 1.5.

(2 marks)

- 7 (c) Calculate the critical angle for the glass-liquid boundary.

answer = ..... degrees  
(1 mark)

**Question 7 continues on the next page**

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7 (d) Calculate the refractive index of the liquid.

answer = .....  
(2 marks)

**END OF QUESTIONS**

8



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