Surname	
Other Names	
Candidate Signature	

AQA

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
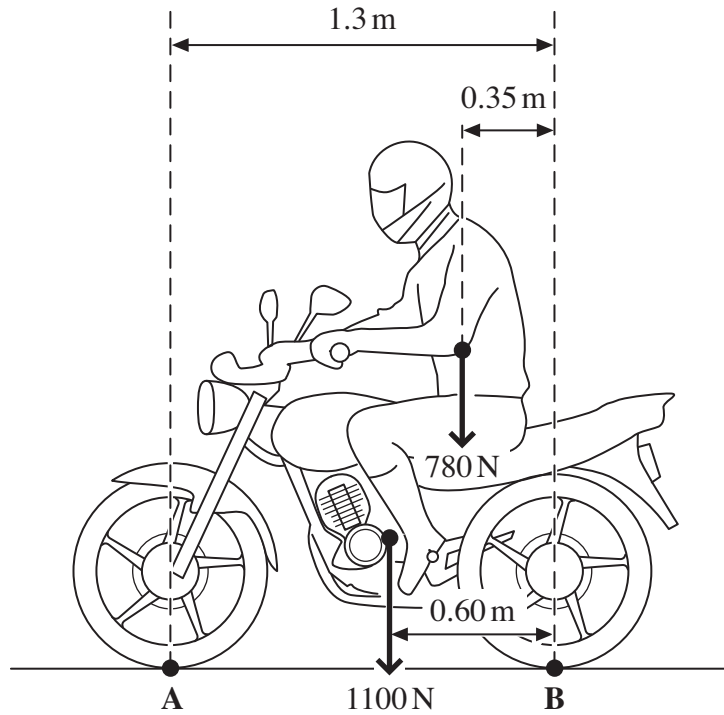 – use specialist vocabulary where appropriate.

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 m s^{-1}, when travelling on a level road.

Calculate the total horizontal resistive force for this speed.

answer = ... N

(2 marks)

11

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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.
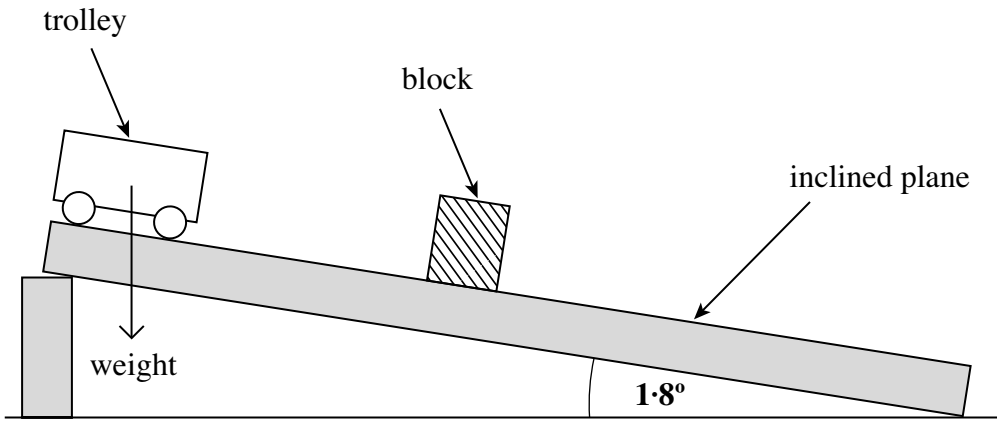
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(2 marks)

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

trolley

block

inclined plane

weight

1·8º

The mass of the trolley in **Figure 2** is 0.20 kg and the slope is at an angle of 1·8º 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 = ... 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
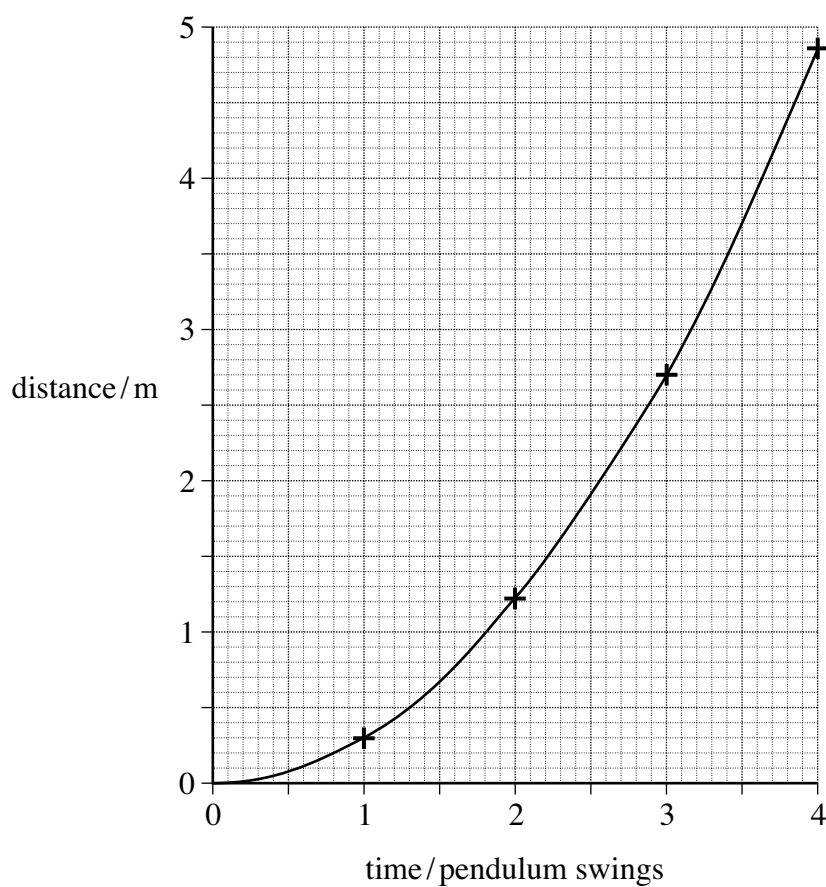
2 (c) From the graph on **page 6**, state what you would conclude about the motion of the trolley?
Give a reason for your answer.

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(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 = ... $m s^{-1}$

(3 marks)

$\boxed{11}$

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**.
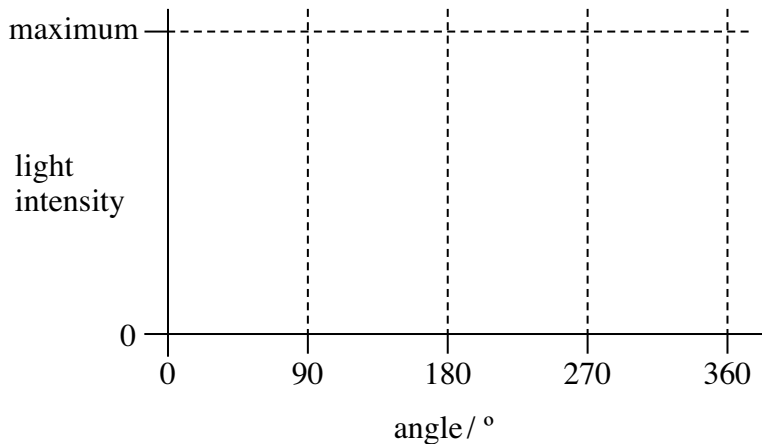
Figure 3
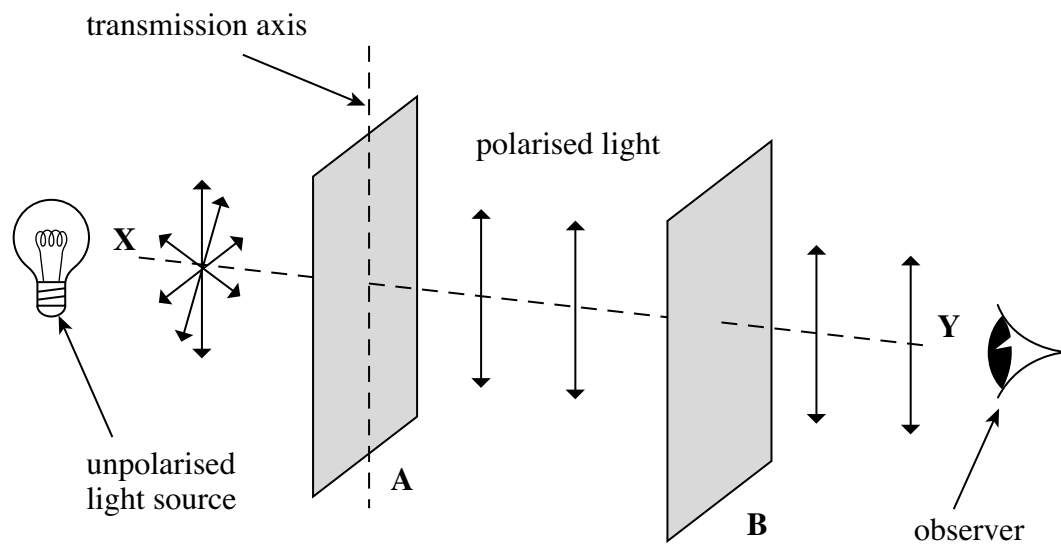
(1 mark)

3 (c) (ii) The polarising filter **B** is rotated clockwise through 360º 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.

maximum ┼--------┬--------┬--------┬--------┼

light
intensity

0 ┼────┴────┴────┴────┴────
     0   90   180   270   360

angle / º

(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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(2 marks)

Turn over for the next question

8

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

Figure 4

B

position of
unstretched
trampoline

A

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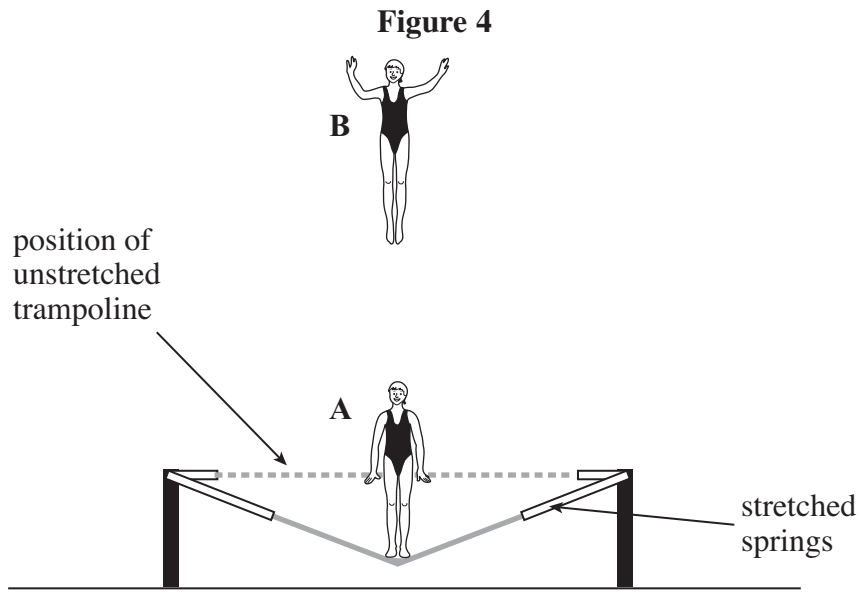
In travelling from her lowest position at **A** to her highest position at **B**, her centre of
mass rises 4.2 m vertically. Her mass is 55 kg.

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 = ... 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 = ... 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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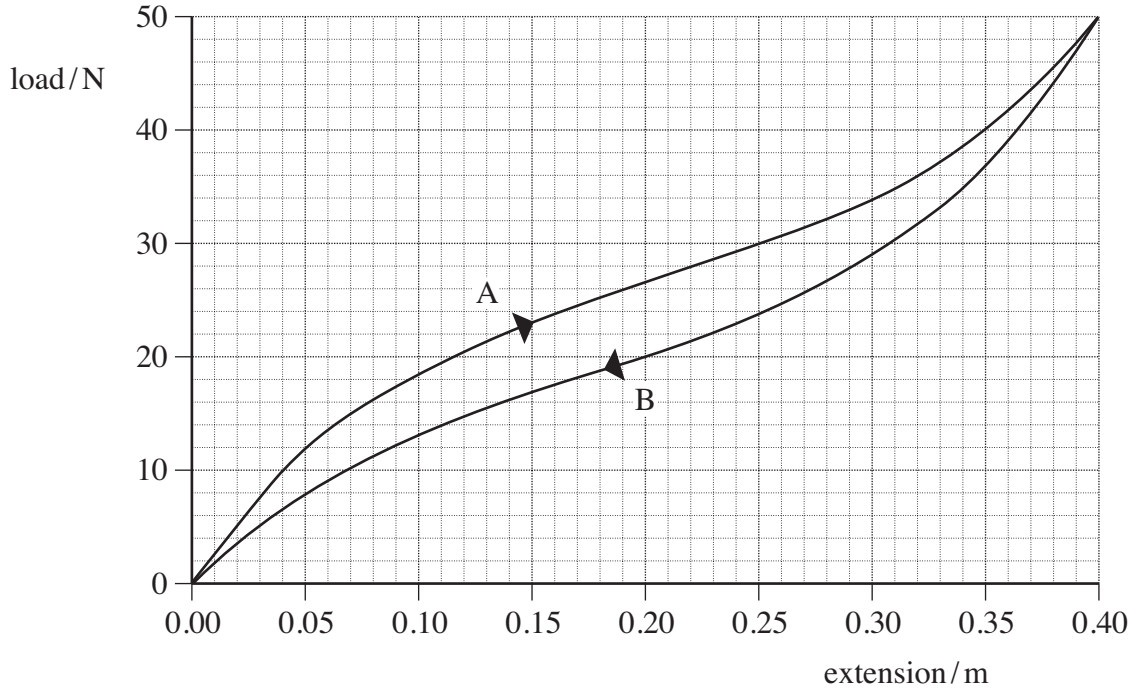
(6 marks)

14

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

Turn over ▶

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 x 10^{-6} 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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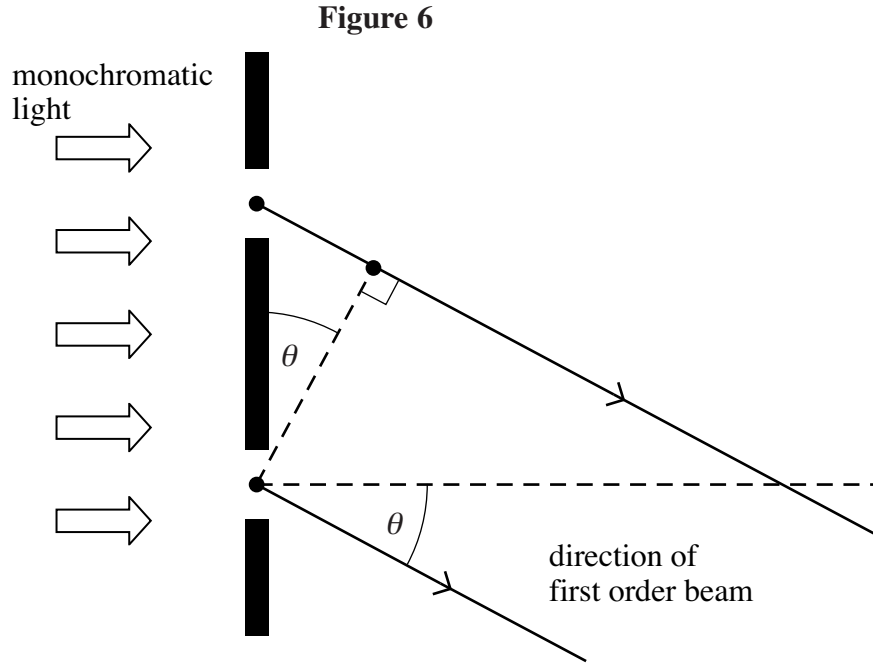
(1 mark)

9

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 *λ*.

(2 marks)

Figure 6

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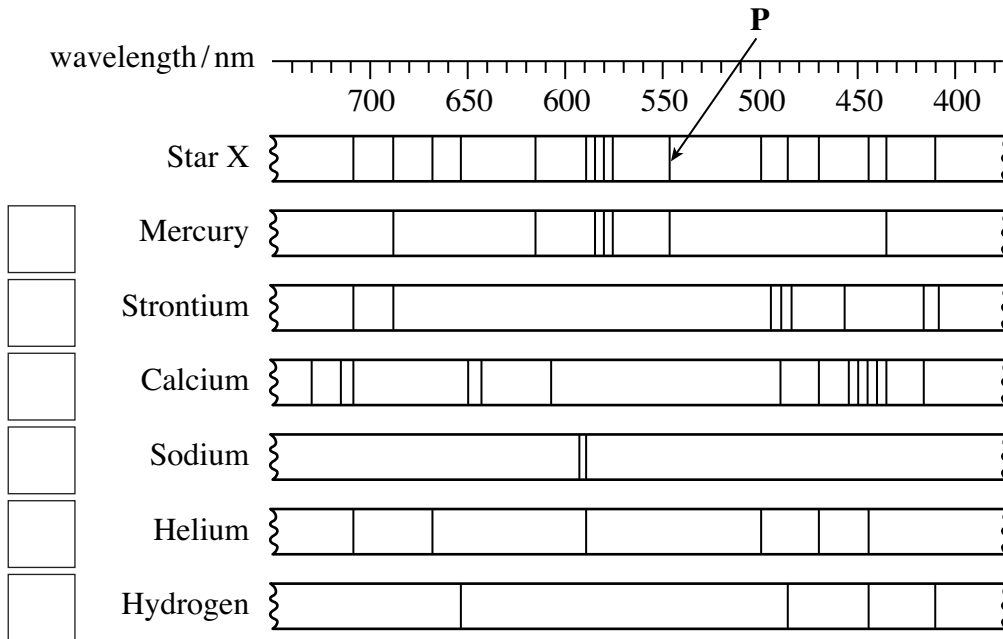
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6 (c)   A diffraction grating was used with a spectrometer to obtain the line spectrum of star X shown in **Figure 7**. Below this are some line spectra for six elements that have been obtained in the laboratory.

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)

9

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° as shown in **Figure 8**. At this point the angle of refraction is 27° and the ray is totally internally reflected at **P** for the first time.
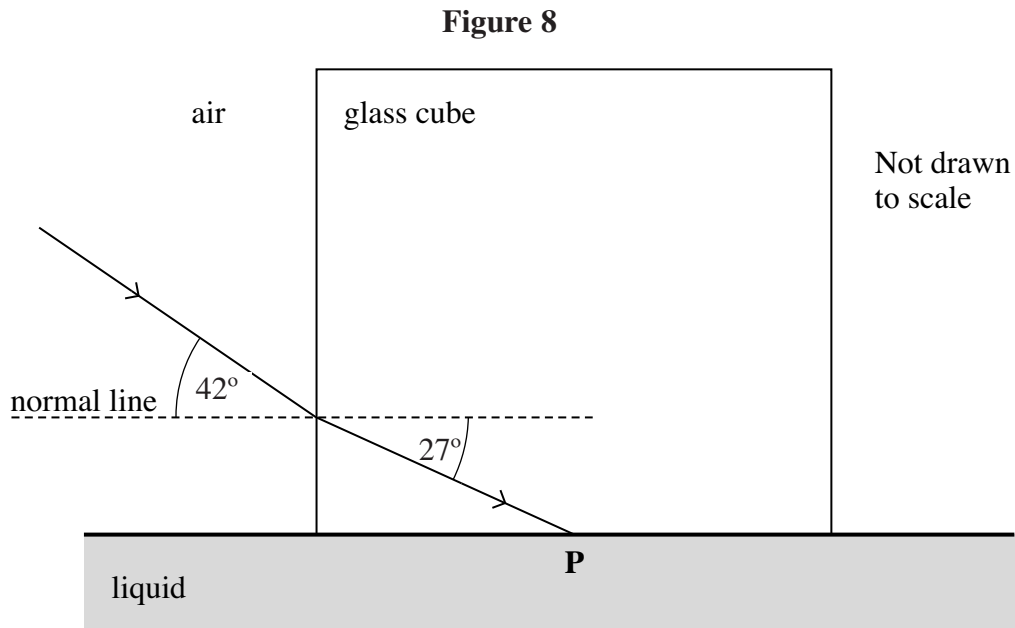
Figure 8

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

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

answer = ...

(2 marks)

END OF QUESTIONS

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