Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

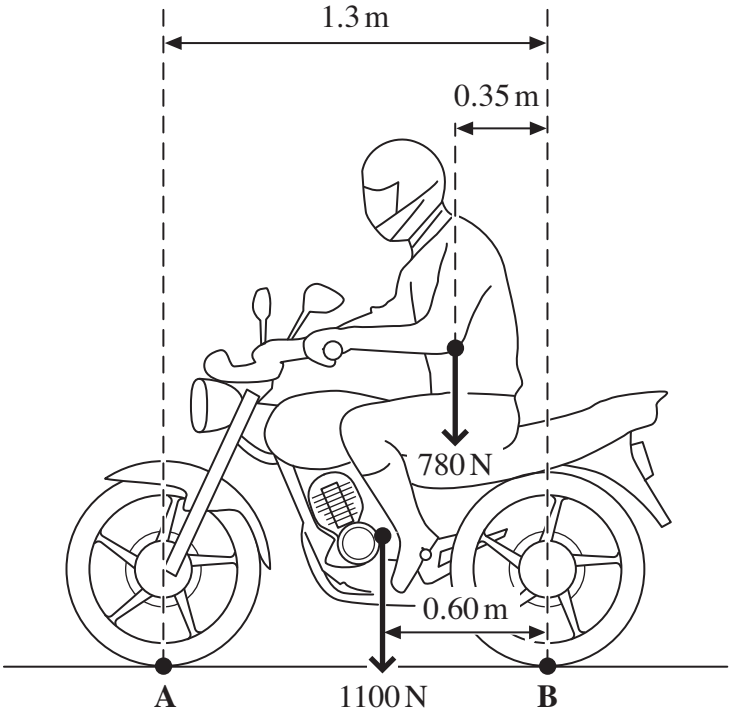
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work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

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

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
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.

.....

.....

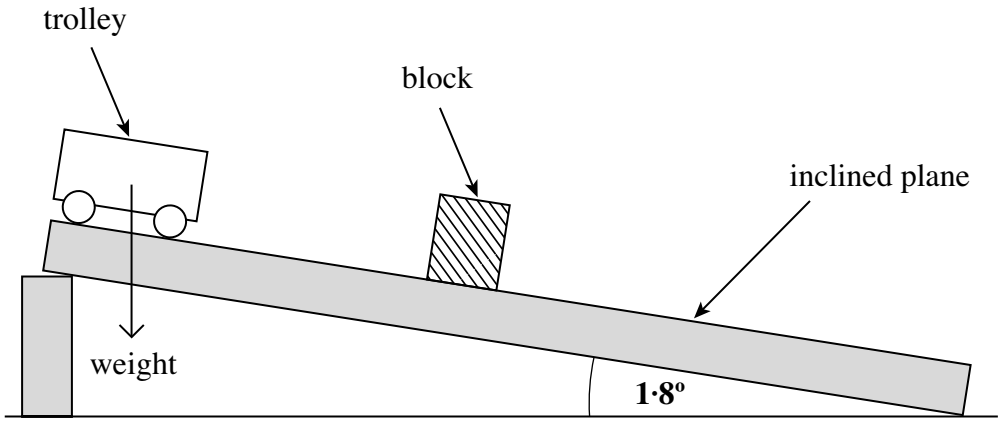
.....

.....

(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° 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

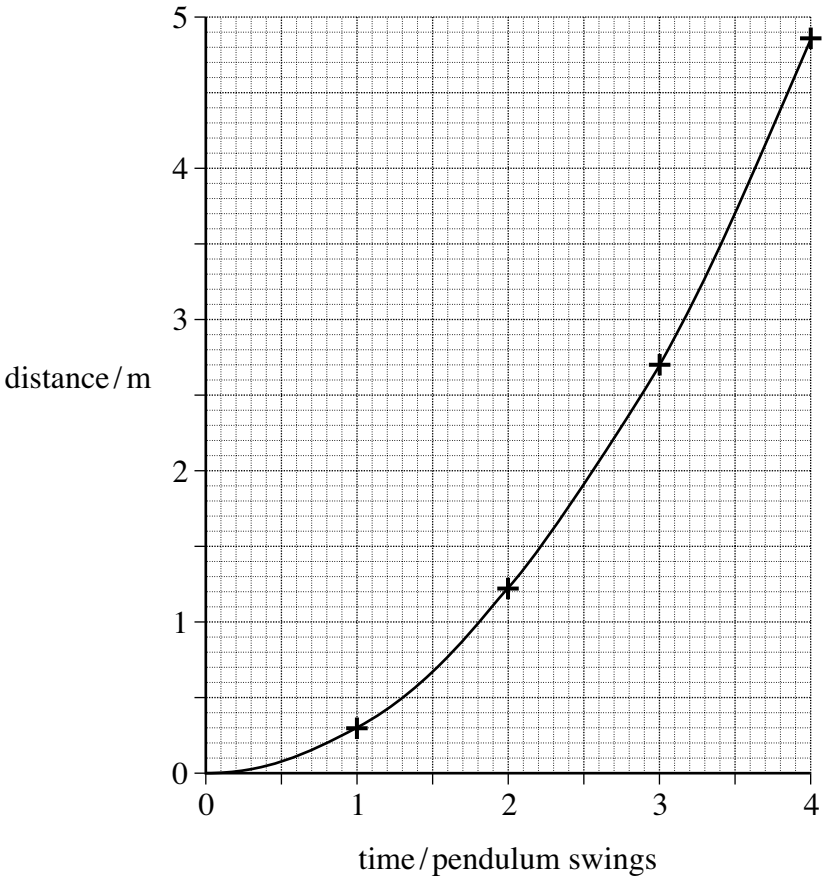
2 (b) (ii) Calculate the initial acceleration down the slope.

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.

.....

.....

.....

.....

(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)

11

Turn over for the next question

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.

.....

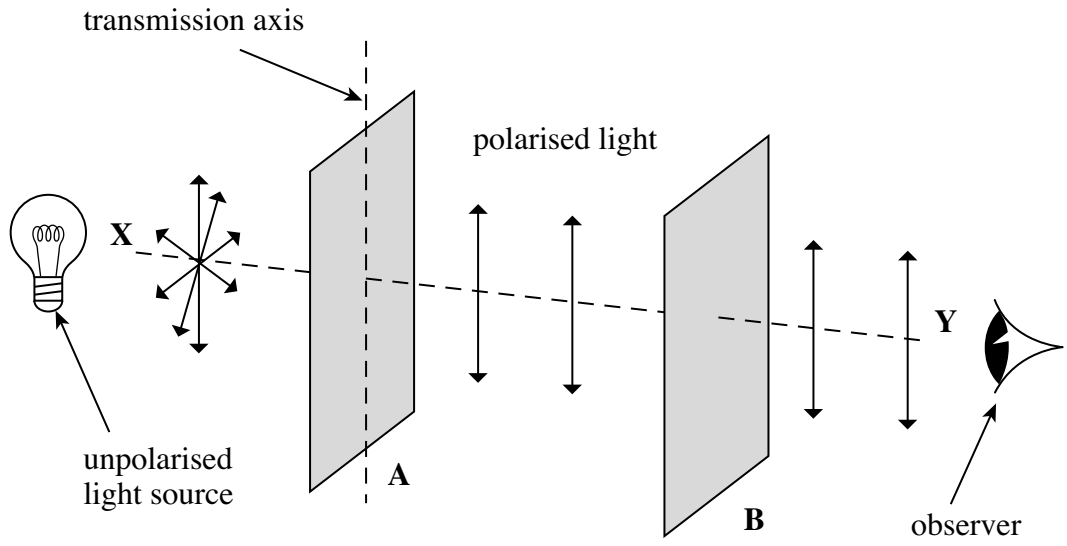
.....

(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.

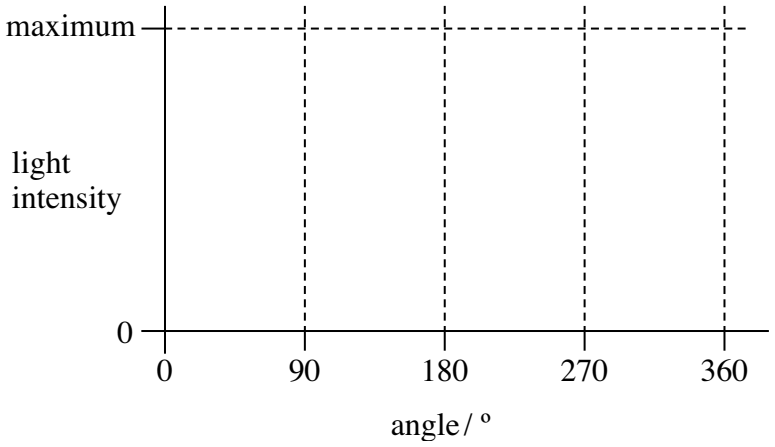
3 (c) (i) If polarised light is reaching the observer, draw the direction of the transmission axis on filter **B** in **Figure 3**.

Figure 3



(1 mark)

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

.....

.....

.....

.....

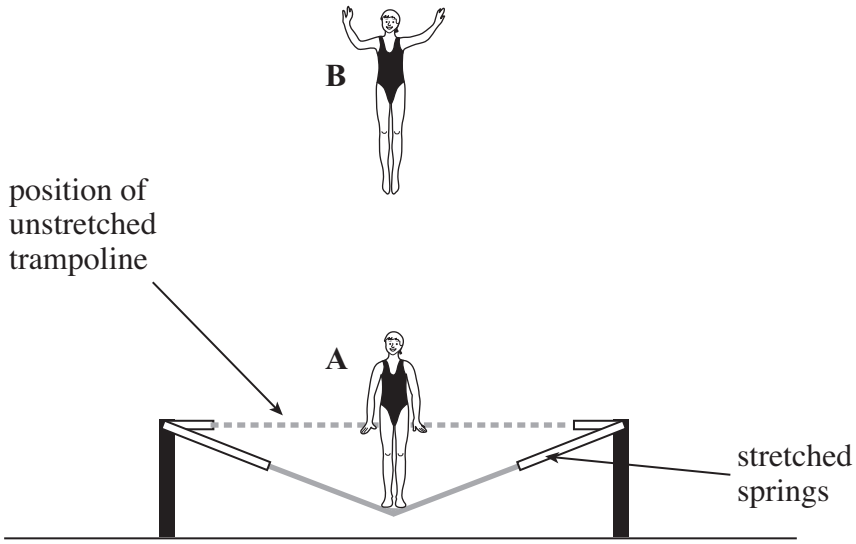
(2 marks)

Turn over for the next question

8

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

Figure 4



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

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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

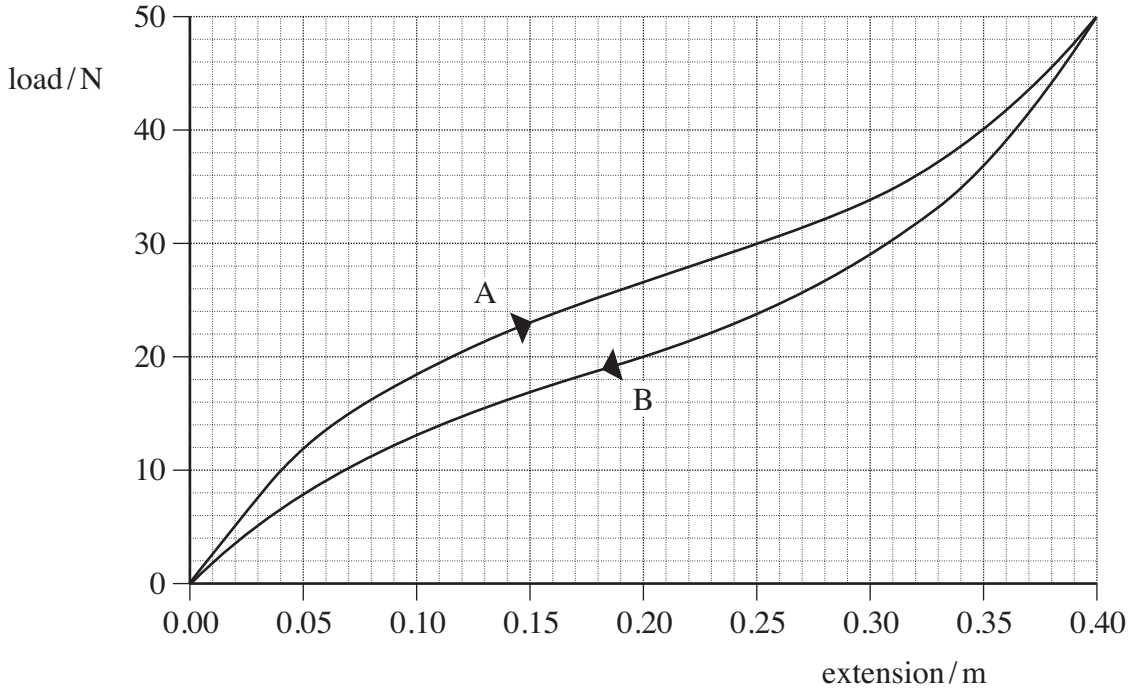
.....

(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.

.....

.....

.....

.....

.....

.....

answer = ... J

(3 marks)

Question 5 continues on the next page

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 = $5.0 \times 10^{-6}\,m^2$
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.

.....

.....
(1 mark)

9

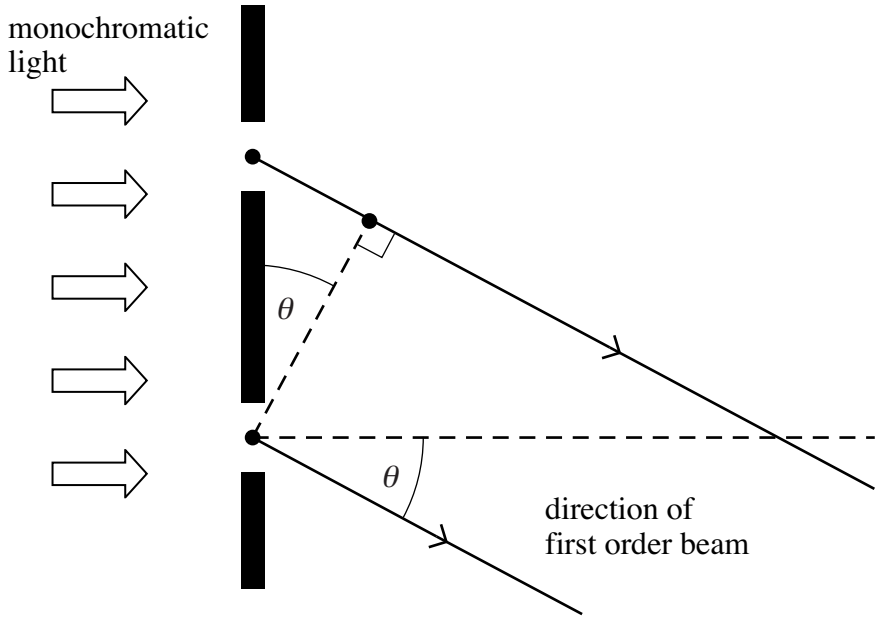
6 For a plane transmission diffraction grating, the diffraction grating equation for the first order beam is:

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

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.

.....

.....

.....

.....

(2 marks)

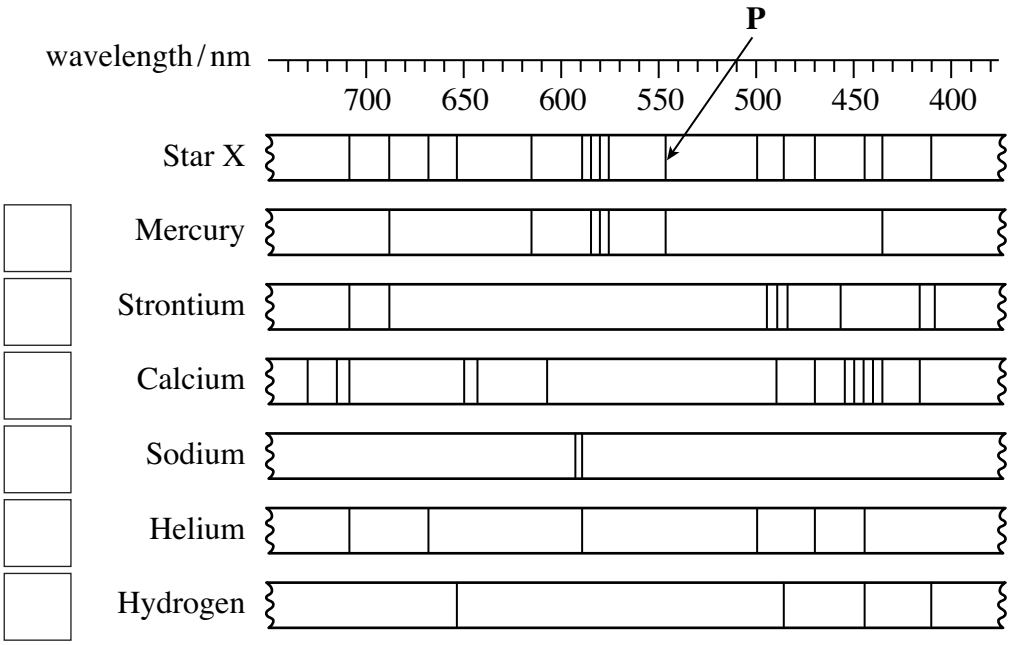
Question 6 continues on the next page

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**.

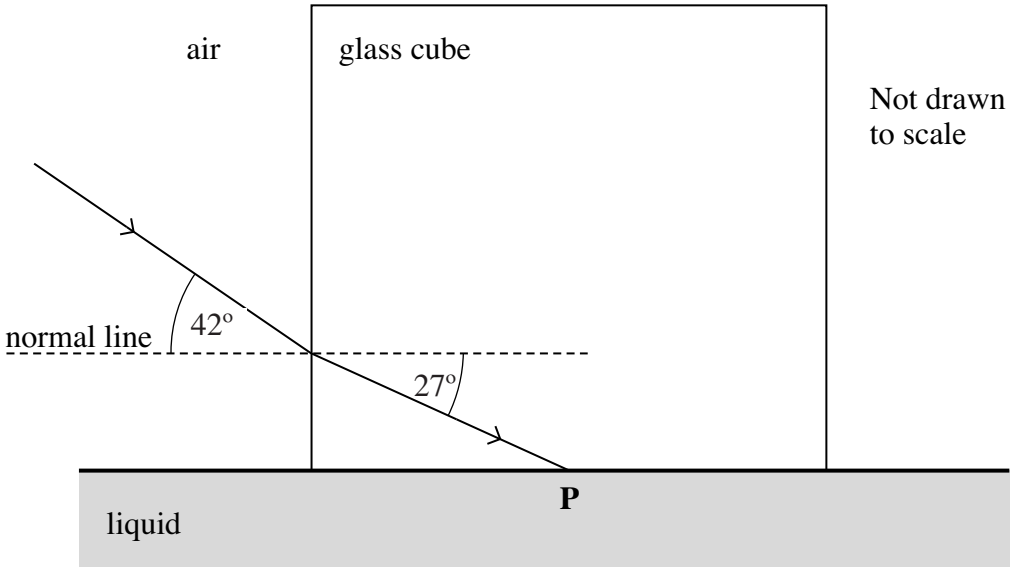
answer = ... degrees

(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

8

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED