

Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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TOTAL	



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Physics A

PHYA2

Unit 2 Mechanics, Materials and Waves

Monday 6 June 2011 1.30 pm to 2.45 pm

For this paper you must have:

- a pencil and 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 Booklet* 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.

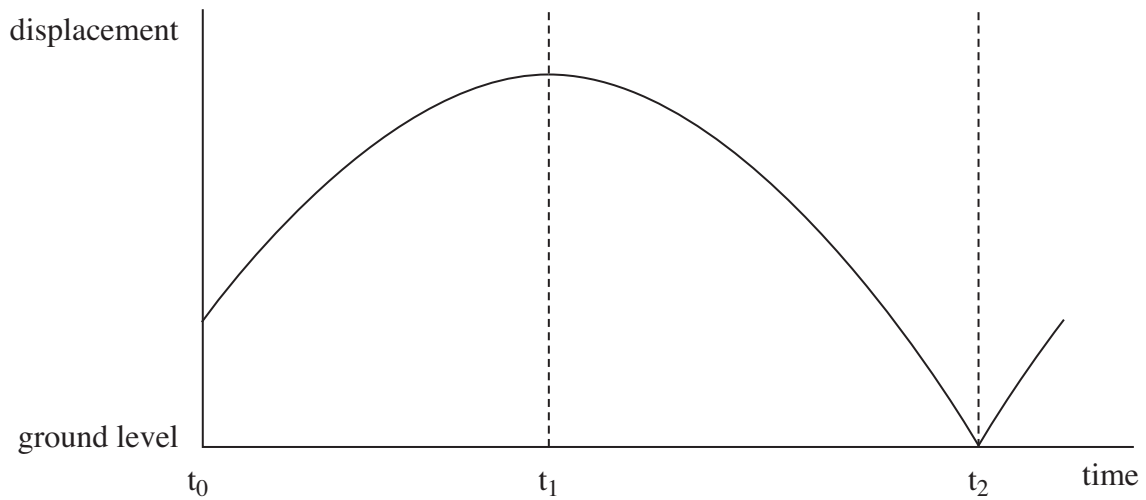


J U N 1 1 P H Y A 2 0 1

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

- 1** A boy throws a ball vertically upwards and lets it fall to the ground. **Figure 1** shows how displacement relative to the ground varies with time for the ball.

Figure 1

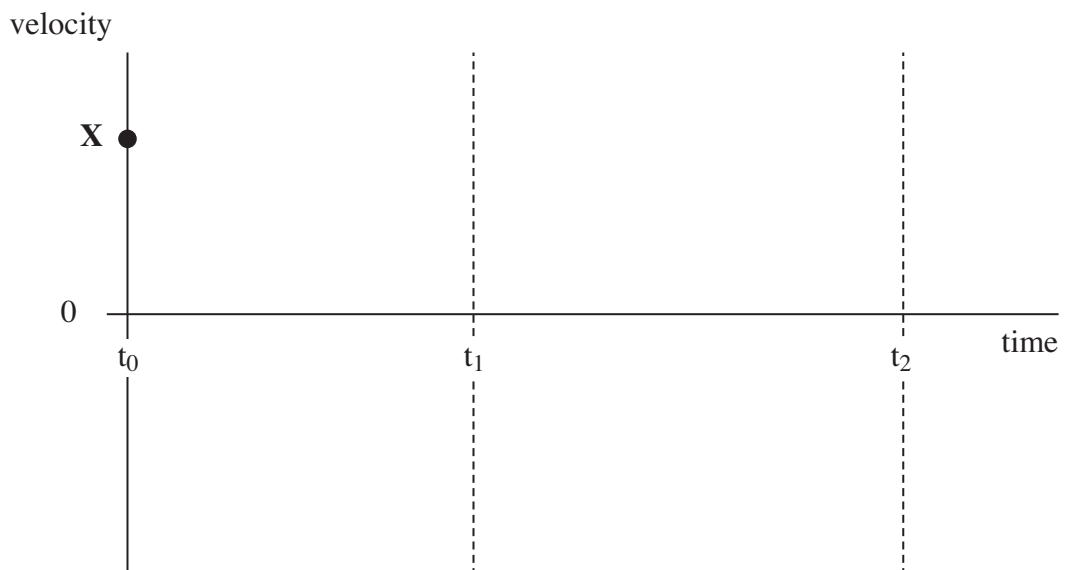


- 1 (a) (i)** State which feature of a displacement-time graph represents the velocity.

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(1 mark)

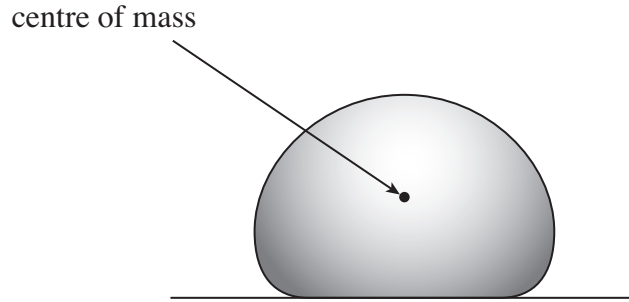
- 1 (a) (ii)** On the axes below, draw the shape of the velocity-time graph for the ball between t_0 and t_2 . The starting point is labelled **X**.

(3 marks)



1 (b) **Figure 2** shows the ball deforming as it contacts the ground, just at the point where it is stationary for an instant and has reached maximum deformation.

Figure 2



1 (b) (i) Explain how Newton’s third law of motion applies to **Figure 2**.

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(2 marks)

1 (b) (ii) Explain why there is a resultant upward force on the ball in **Figure 2**.

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(2 marks)

8

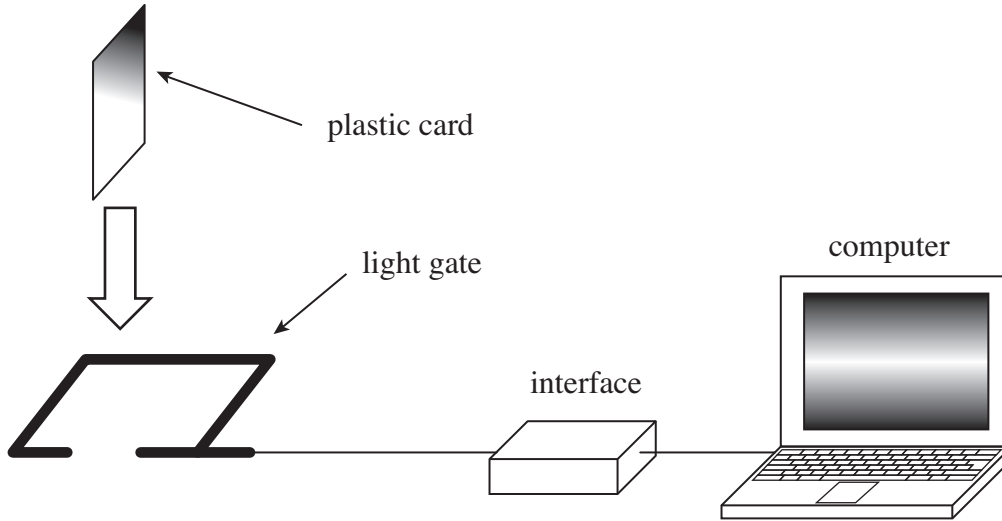
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- 2 A student measures the acceleration due to gravity, g , using the apparatus shown in **Figure 3**. A plastic card of known length is released from rest at a height of 0.50 m above a light gate. A computer calculates the velocity of the card at this point, using the time for the card to pass through the light gate.

Figure 3



- 2 (a) The computer calculated a value of 3.10 ms^{-1} for the velocity of the card as it travelled through the light gate. Calculate a value for the acceleration due to gravity, g , from these data.

answer = ms^{-2}
(2 marks)

- 2 (b) The student doubles the mass of the card and finds a value for g that is similar to the original value. Use the relationship between *weight*, *mass* and g to explain this result.

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(1 mark)



2 (c) State and explain **one** reason why the card would give more reliable results than a table tennis ball for this experiment.

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(2 marks)

5

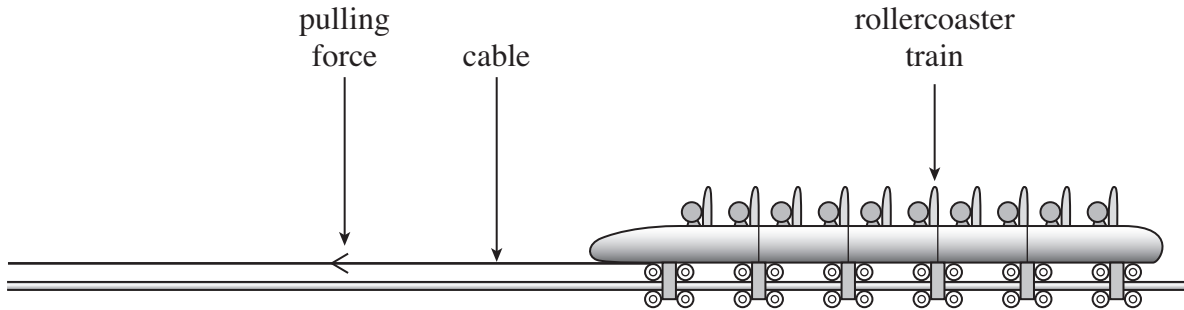
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- 3 **Figure 4** shows a rollercoaster train that is being accelerated when it is pulled horizontally by a cable.

Figure 4



- 3 (a) The train accelerates from rest to a speed of 58 ms^{-1} in 3.5 s. The mass of the fully loaded train is 5800 kg.
- 3 (a) (i) Calculate the average acceleration of the train.

answer = ms^{-2}
(2 marks)

- 3 (a) (ii) Calculate the average tension in the cable as the train is accelerated, stating an appropriate unit.

answer =
(3 marks)



3 (a) (iii) Calculate the distance the train moves while accelerating from rest to 58 ms^{-1} .

answer = m
(2 marks)

3 (a) (iv) The efficiency of the rollercoaster acceleration system is 20%.
Calculate the average power input to this system during the acceleration.

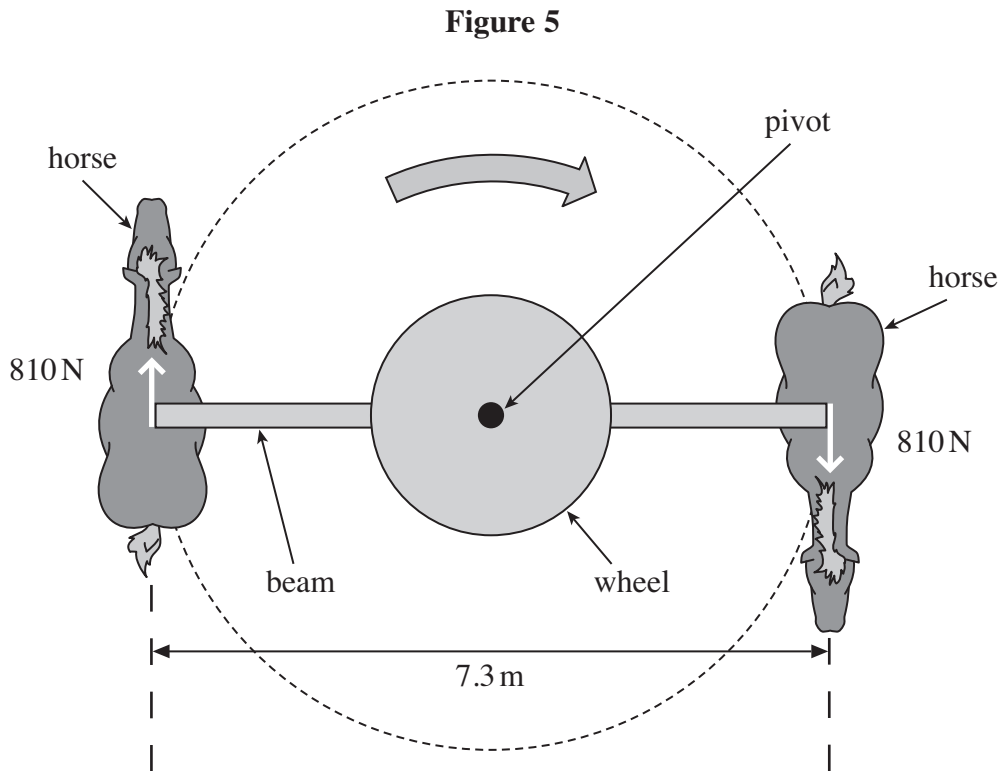
answer = W
(3 marks)

3 (b) After reaching its top speed the driving force is removed and the rollercoaster train begins to ascend a steep track. By considering energy transfers, calculate the height that the train would reach if there were no energy losses due to friction.

answer = m
(3 marks)



4 Horses were once used to power machinery in factories, mines and mills. **Figure 5** shows two horses attached to a beam which turns a wheel. This wheel drives machinery.



4 (a) Each horse exerts a force of 810 N and the length of the beam is 7.3 m.

4 (a) (i) Define the moment of a couple.

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.....
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(2 marks)

4 (a) (ii) Calculate the moment of the couple exerted by the horses, stating an appropriate unit.

answer =
(2 marks)



4 (b) The horses move at a constant speed of 0.91 ms^{-1} . Calculate the combined power output of the two horses. Give your answer to an appropriate number of significant figures.

answer = W
(3 marks)

4 (c) During the Industrial Revolution in the 19th Century, James Watt became well known for developing and improving steam engines to replace horses. He defined the unit of power called '*horsepower*' by studying a system similar to the one shown in **Figure 5**.

Suggest why Watt decided to use *horsepower* as a unit of power.

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(1 mark)

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5 (a) The speed of light is given by

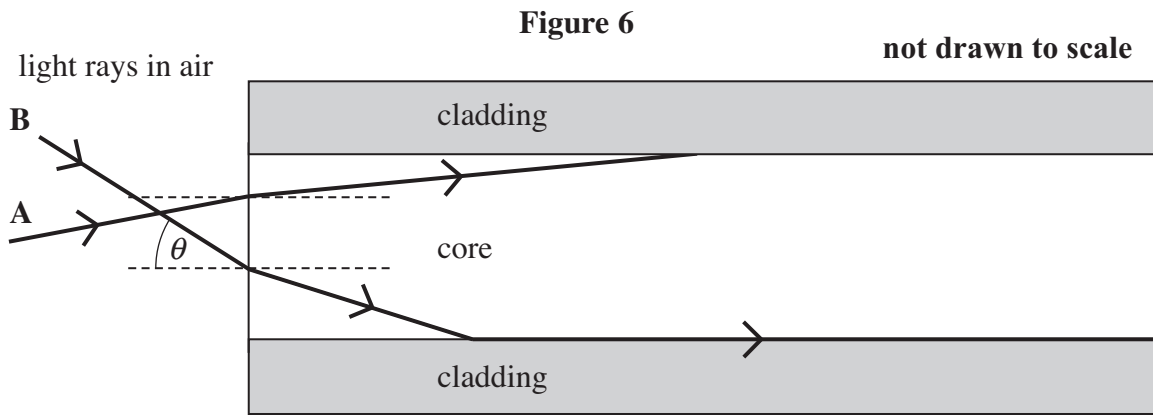
$$c = f \lambda$$

State how each of these quantities will change, if at all, when light travels from air to glass.

- c
- f
- λ

(3 marks)

Figure 6 shows a side view of a step index optical fibre.



5 (b) Ray A enters the end of the fibre and then undergoes total internal reflection. On Figure 6 complete the path of this ray along the fibre.

(2 marks)

5 (c) (i) The speed of light in the core is $2.04 \times 10^8 \text{ ms}^{-1}$. Show that the refractive index of the core is 1.47.

(2 marks)

5 (c) (ii) Show that the critical angle at the boundary between the core and the cladding is about 80° .

refractive index of the cladding = 1.45

(2 marks)

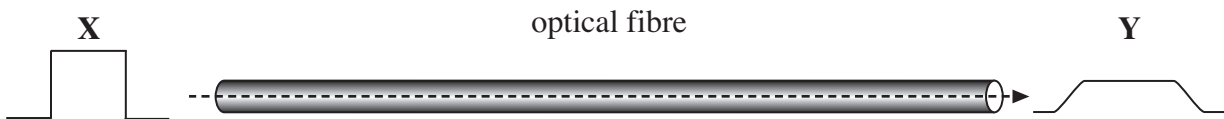


5 (d) Ray **B** enters the end of the fibre and refracts along the core-cladding boundary. Calculate the angle of incidence, θ , of this ray at the point of entry to the fibre.

answer = degrees
(3 marks)

5 (e) **Figure 7** shows a pulse of monochromatic light (labelled **X**) that is transmitted a significant distance along the fibre. The shape of the pulse after travelling along the fibre is labelled **Y**. Explain why the pulse at **Y** has a lower amplitude and is longer than it is at **X**.

Figure 7



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(2 marks)

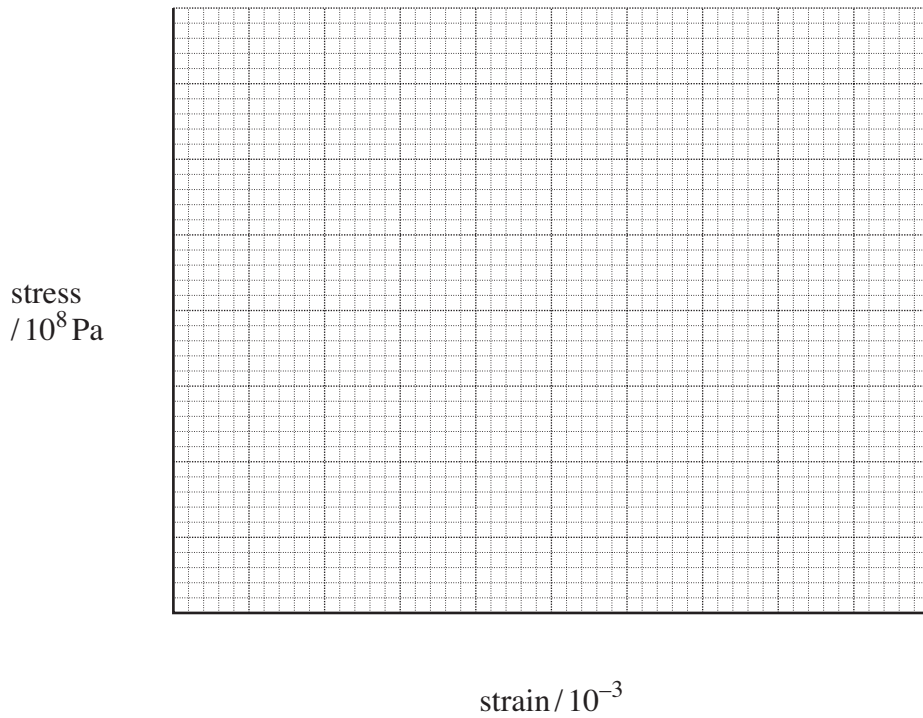
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6 The table below shows the results of an experiment where a force was applied to a sample of metal.

6 (a) On the axes below, plot a graph of stress against strain using the data in the table. (3 marks)

strain / 10^{-3}	0	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
stress / 10^8 Pa	0	0.90	2.15	3.15	3.35	3.20	3.30	3.50	3.60	3.60	3.50



6 (b) Use your graph to find the Young modulus of the metal.

answer = Pa
(2 marks)



- 6 (c)** A 3.0 m length of steel rod is going to be used in the construction of a bridge. The tension in the rod will be 10 kN and the rod must extend by no more than 1.0 mm. Calculate the minimum cross-sectional area required for the rod.

Young modulus of steel = 1.90×10^{11} Pa

answer = m²
(3 marks)

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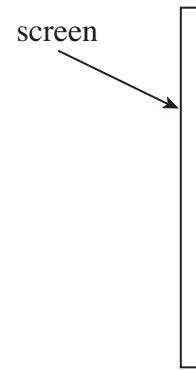
7 (b) In 1802 Thomas Young used candle light to observe the interference pattern from two narrow slits acting as *coherent light sources*.

Explain what is meant by coherent light sources.

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(2 marks)

7 (c) Sketch and label on the diagram below the arrangement that Young would have used to obtain his interference pattern.



(2 marks)

7 (d) State **two** differences in the appearance of the pattern obtained with a laser and that produced by a white light source such as a candle.

Difference 1

Difference 2

(2 marks)

7 (e) Explain how the wave theory of light accounts for the areas on the screen where the intensity is a minimum.

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(2 marks)

END OF QUESTIONS



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