

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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



General Certificate of Education  
Advanced Level Examination  
June 2010

## Physics

(Specifications A and B)

## PHA6/B6/X

Unit 6 Investigative and Practical Skills in A2 Physics  
Route X Externally Marked Practical Assignment (EMPA)

### Section B

**For this paper you must have:**

- a calculator
- a pencil
- a ruler
- a small plane mirror
- your completed Section A Task 2 question paper/ answer 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.
- Show all your working.
- 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 Section B is 24.



JUN10PHA6B6X01

WMP/Jun10/PHA6/B6/X

## PHA6/B6/X

**Section B**

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

The time allowed is 1 hour 15 minutes.

You will need to refer to the work you did in Section A Task 2 when answering these questions.

- 1** In part (a) and part (b) of Section A Task 2 you obtained measurements to determine the mean length,  $c$ , of one paper clip, and  $d$ , the diameter of the wire from which the paper clips have been formed.

It can be shown that  $L$ , the length of the paper clip chain used in part (c) of Section A Task 2, when laid out flat, is given by

$$L = nc - 2d(n - 1),$$

where  $n$  = number of paper clips in the chain.

- 1 (a)** Evaluate  $L$ .

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.....

$$L = \dots\dots\dots$$

(2 marks)

- 1 (b)** A student suggests that because  $d$  is much less than  $c$ , the length of the chain can be safely estimated by calculating  $nc$ .  
The student calculates the percentage difference between the calculated value of  $nc$  and the true value of  $L$ , for different values of  $n$ .  
The student's results are shown in **Table 1**.

**Table 1**

$n$	percentage difference
1	0.00
2	2.17
4	3.28
8	3.85
16	4.14
32	4.28
64	4.35

1 (b) (i) Explain why the percentage difference increases as  $n$  increases.

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1 (b) (ii) The student suggests that the percentage difference tends towards a constant value when  $n$  becomes very large. Explain with reference to the data in **Table 1**, why the student's suggestion might be correct.

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1 (b) (iii) A different student decides that calculating  $nc$  is an acceptable method of estimating  $L$ , providing that the percentage difference is less than 4%. Suggest how the student could use the data in **Table 1** to determine the **largest** value of  $n$  that meets this condition and explain what the student should do so this value of  $n$  is determined accurately. You should illustrate your answer with a sketch.

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(5 marks)

Turn over ►

- 2 A student performs the experiment using apparatus identical to that which you used. The student records the position of **every junction** between paper clips in the chain, starting at the centre of the chain where the 12<sup>th</sup> and 13<sup>th</sup> paper clips are joined, and finishing where the 24<sup>th</sup> paper clip meets the horizontal support at the right-hand end of the chain.

Using all the data measured, the student uses a computer to produce the graph, shown in **Figure 4**.

- 2 (a) Use **Figure 4** to determine the gradient,  $G$ , at the junction **between the 18<sup>th</sup> and 19<sup>th</sup> paper clips**. You are provided with a small plane mirror which you may use to assist you in answering the question.

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$$G = \text{.....}$$

(2 marks)

- 2 (b) The student calculates the length of the chain,  $L$ , and measures the horizontal distance,  $s$ , between the ends of the paper clip chain. The student's results are  $L = 1.17$  m and  $s = 0.756$  m.

Using your result for  $G$  and the student's values for  $L$  and  $s$ , evaluate

- 2 (b) (i)  $p$ , where  $p = \frac{L}{4G}$ ,

.....  
.....

- 2 (b) (ii)  $q$ , where  $q = \frac{s}{2p}$ .

.....  
.....

(1 mark)

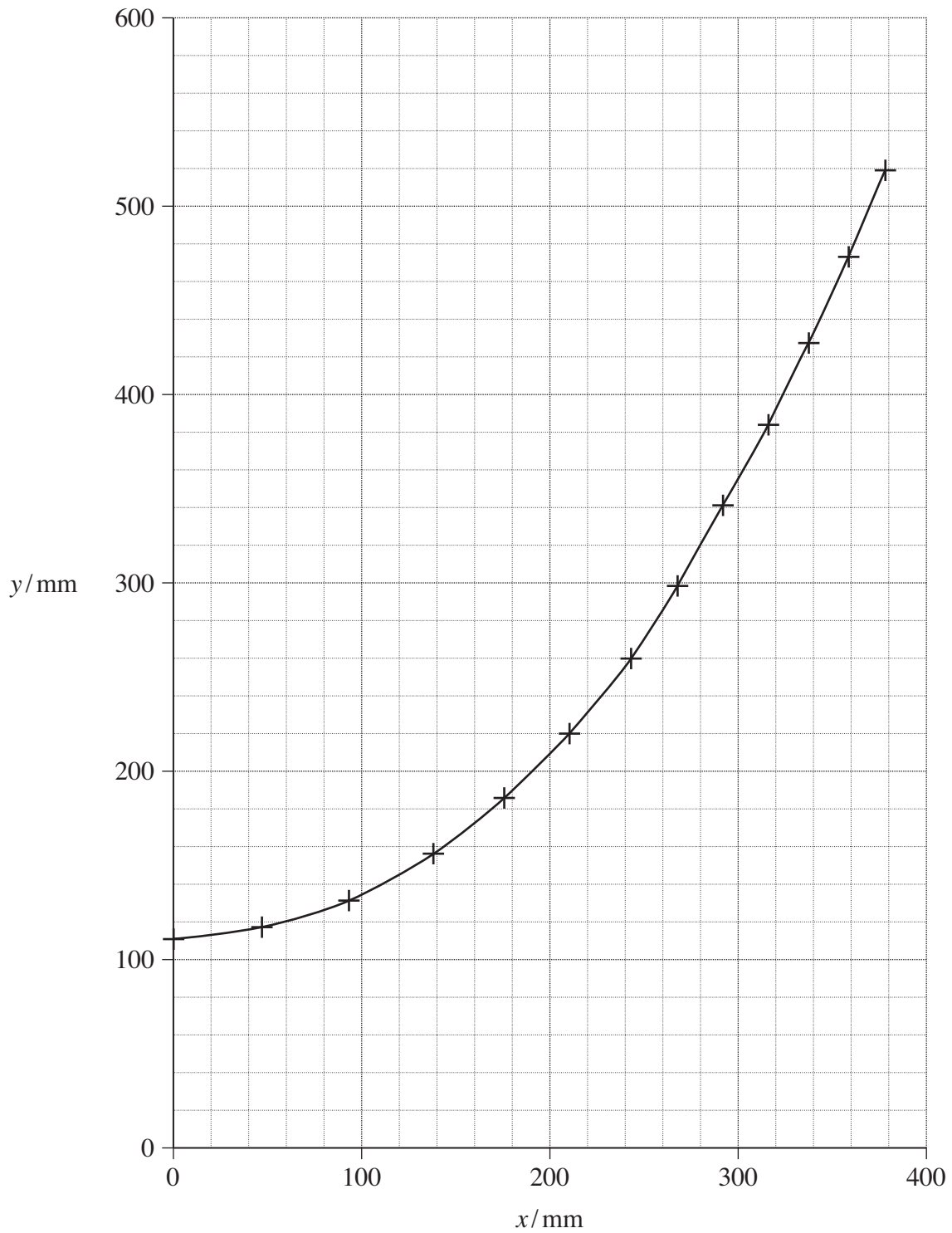
- 2 (c) The sag,  $r$ , is the vertical distance between the point of suspension and the bottom of the chain.

Evaluate  $r$ , where  $r = \frac{p}{2}(e^q + e^{-q} - 2)$ .

.....  
.....

(2 marks)

Figure 4



Turn over for the next question

Turn over ►

- 3 In Section A Task 1 you measured the period,  $T$ , of an oscillating chain of paper clips.
- 3 (i) Make a sketch to show how you used a fiducial mark (reference point) to reduce the uncertainty in your values of  $T$ .

- 3 (ii) Explain why you positioned the fiducial mark in the position shown in the sketch.

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(2 marks)

- 4 In Section A Task 1 you investigated the motion of coupled pendulums, measuring the time,  $\tau$ , for the amplitude of either pendulum to increase from zero to a maximum and then fall to zero again. A student performs this experiment and measures four values of  $\tau$  with three, five and then seven paper clips suspended from the thread. The student's results are shown in **Table 2**.

**Table 2**

$n$	$\tau_1/s$	$\tau_2/s$	$\tau_3/s$	$\tau_4/s$	mean $\tau/s$	uncertainty/s	percentage uncertainty
3	112.8	111.2	115.8	114.3			
5	67.3	69.9	64.2	66.2			
7	44.8	49.1	48.7	47.9			

- 4 (a) Complete the relevant column of **Table 2** to show the mean value of  $\tau$  for  $n = 3$ ,  $n = 5$  and  $n = 7$ .
- (1 mark)
- 4 (b) (i) Calculate the uncertainty in the mean values of  $\tau$  for  $n = 3$ ,  $n = 5$  and  $n = 7$ ; show the results of these calculations in the relevant column of **Table 2**.
- 4 (b) (ii) Use your results to calculate the percentage uncertainty in the mean values of  $\tau$  for  $n = 3$ ,  $n = 5$  and  $n = 7$ ; show the results of these calculations in the relevant column of **Table 2**.

(2 marks)

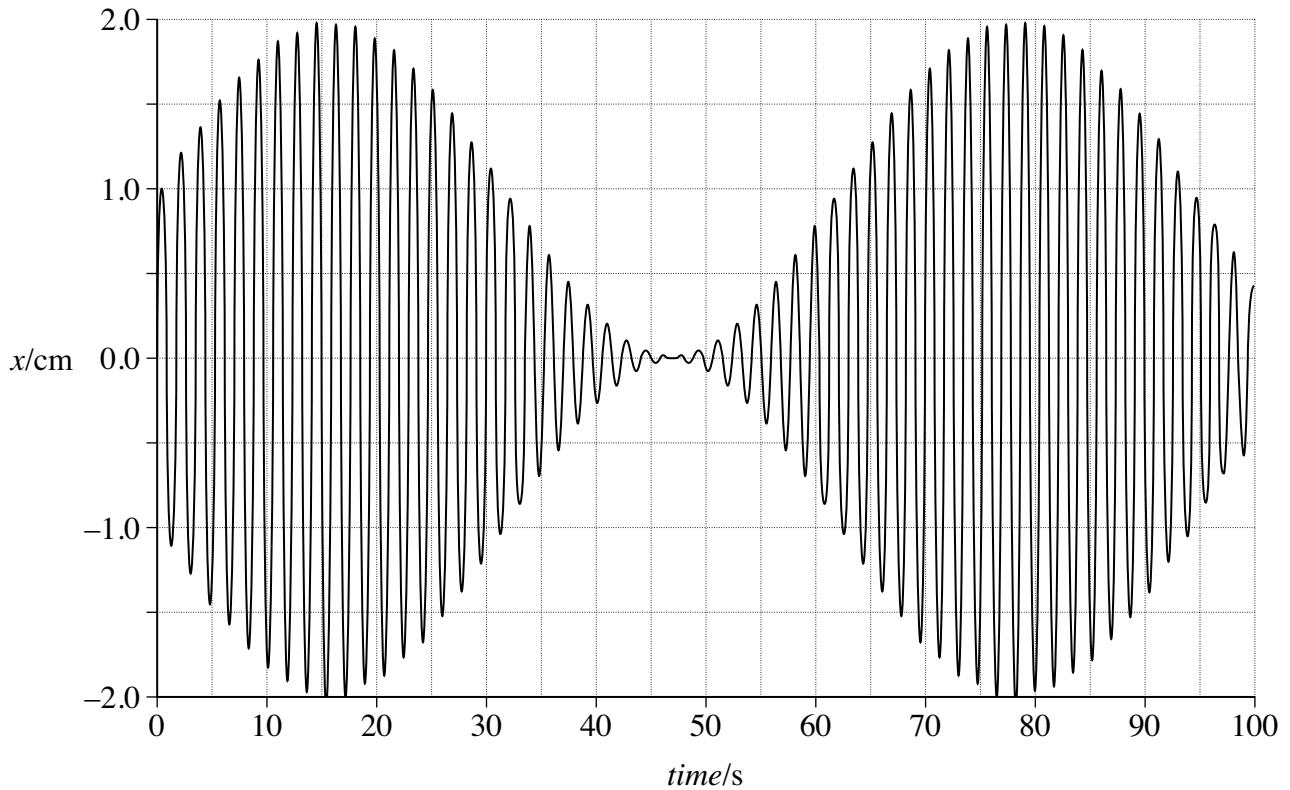
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**Question 4 continues on the next page**

**Turn over** ►

- 4 (c) A student uses a motion sensor connected to a data logger to investigate the motion of one of the coupled pendulums. Data about the displacement,  $x$ , of the pendulum bob is recorded over an interval of 100 seconds and then displayed graphically, as shown in **Figure 5**.

**Figure 5**



- 4 (c) (i) Use **Figure 5** to estimate  $\tau$  for these coupled pendulums.

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 .....

$\tau =$  .....

- 4 (c) (ii) Determine the period of the pendulum's motion represented in **Figure 5**.

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 .....

period = .....

(3 marks)



4 (d) State and explain **two** advantages of using a data logging technique to produce the data in an experiment such as this, compared with the method which you were required to use in Section A Task 1.

*advantage 1*

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*advantage 2*

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(4 marks)

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**END OF QUESTIONS**

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