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.

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 = ...

(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)

7

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^{th} and 13^{th} paper clips are joined, and finishing where the 24^{th} 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^{th} and 19^{th} paper clips**. You are provided with a small plane mirror which you may use to assist you in answering the question.

.....

.....

G = ...

(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 $p = \dfrac{L}{4G}$,

.....

.....

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

.....

.....

(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 $r = \dfrac{p}{2}(e^{q} + e^{-q} - 2)$.

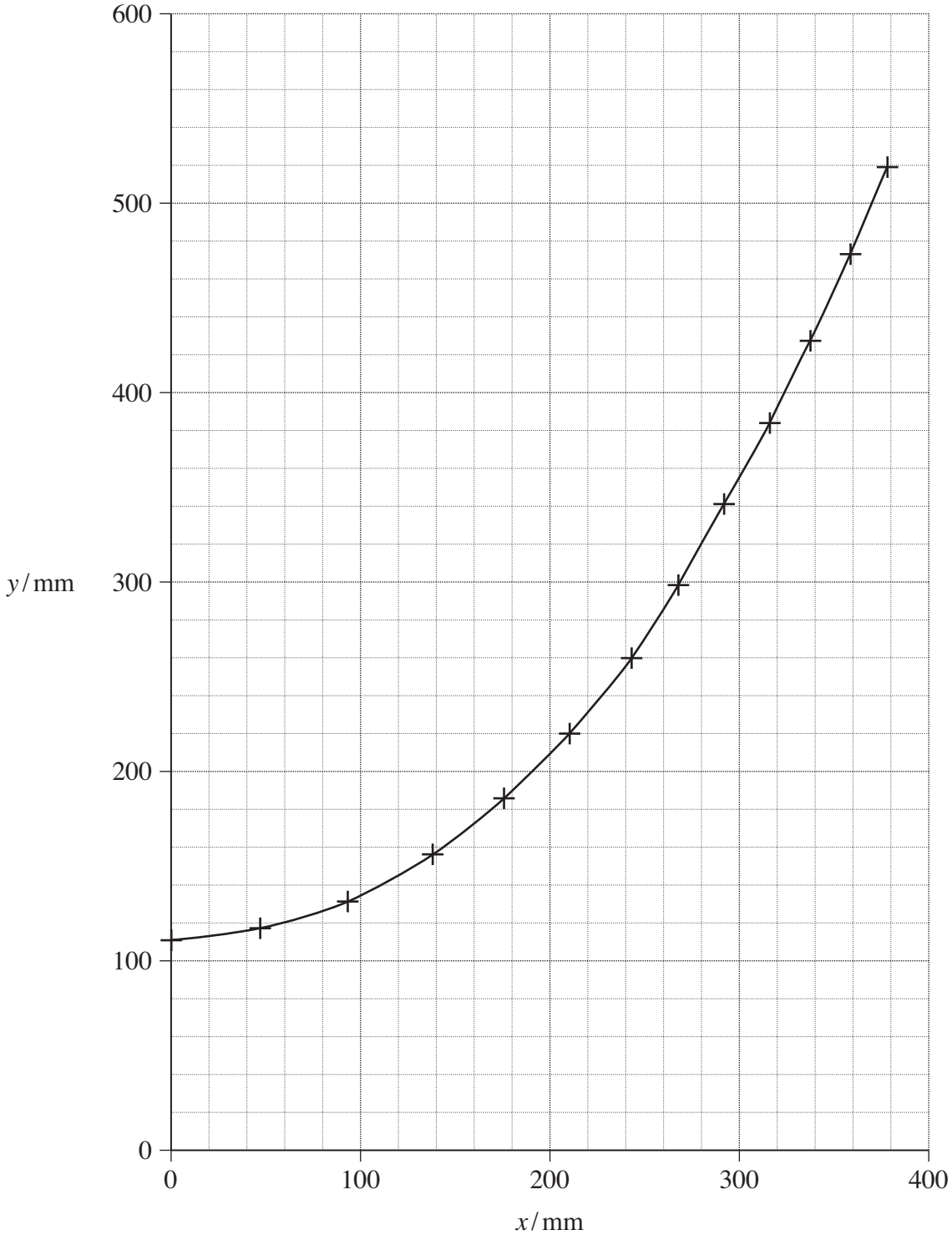
.....

.....

(2 marks)

5

Figure 4



Turn over for the next question

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)

2

4 In Section A Task 1 you investigated the motion of coupled pendulums, measuring the time, τ, 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 τ with three, five and then seven paper clips suspended from the thread.
The student's results are shown in **Table 2**.

Table 2

n	τ_1 / s	τ_2 / s	τ_3 / s	τ_4 / s	mean τ / 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 τ for $n = 3$, $n = 5$ and $n = 7$.

(1 mark)

4 (b) (i) Calculate the uncertainty in the mean values of τ 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 τ for $n = 3$, $n = 5$ and $n = 7$; show the results of these calculations in the relevant column of **Table 2**.

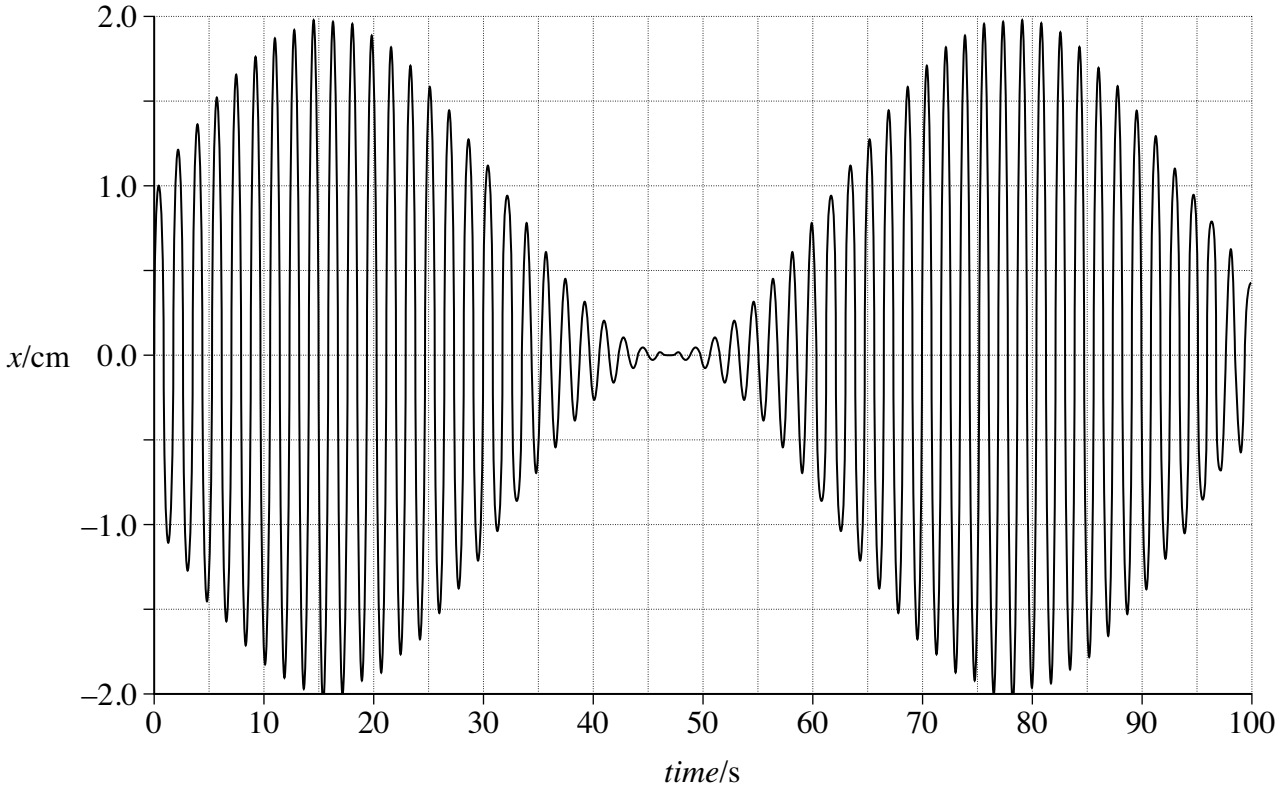
(2 marks)

Use this space for any working.

Question 4 continues on the next page

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 τ for these coupled pendulums.

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.....

τ = ...

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

.....

.....

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)

10

END OF QUESTIONS

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