Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

AQA

General Certificate of Education
Advanced Level Examination
June 2015

Physics PHA6/B6/XPM1

(Specifications A and B)

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

Section A Task 1

For this paper you must have:
- a calculator
- a pencil
- a ruler.

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 A Task 1 is 16.

Section A Task 1

Follow the instructions given below.

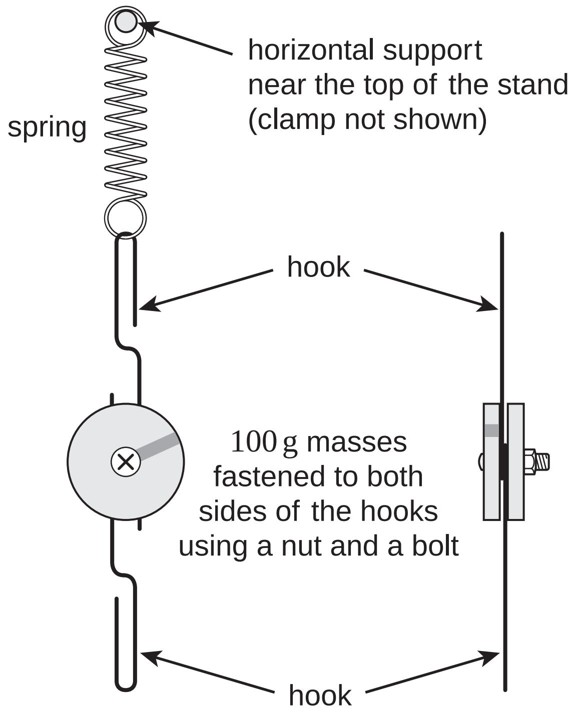
Give the information required in the spaces provided.

No description of the experiments are required.

1 You are to investigate vertical oscillations of a mass–spring system.

1 (a) (i) You are provided with two $100\ \mathrm{g}$ masses that have been fastened together using a nut and bolt.
Use one of the hooks attached to the masses to suspend the masses from the spring hanging from the horizontal support near the top of the stand, as shown in **Figure 1**.

Figure 1

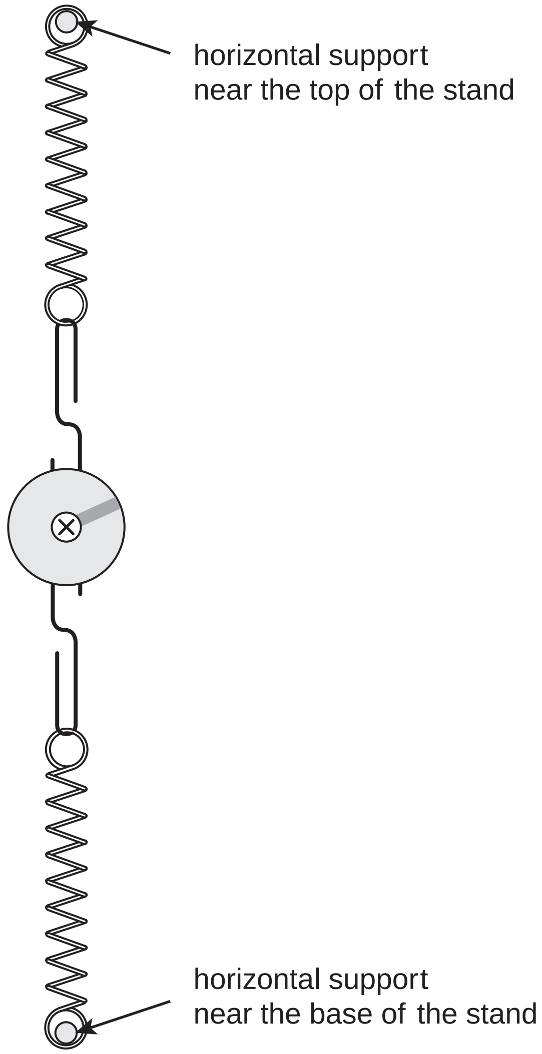


Pull the masses a short distance vertically downwards then release them so they perform small-amplitude oscillations in a vertical plane.
Make suitable measurements to determine the period T_1 of these oscillations.
A fiducial mark has been provided to assist you in making this measurement.

T_1 = ...

1 (a) (ii) Connect the spring that is hanging from the horizontal support near the base of the stand to the lower hook on the masses, as shown in **Figure 2**.

Figure 2



Displace then release the masses as before.
Make suitable measurements to determine the period T_2 of these oscillations.

[1 mark]

T_2 = ...

Question 1 continues on the next page

Turn over ▶

1 (b) A student predicts that the stiffness k of the system will double, when the lower spring is attached.

1 (b) (i) State the assumption that the student is making about the springs used in the experiment.

[1 mark]

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1 (b) (ii) Explain whether your results from part (a) support the student's prediction.

You may wish to use the equation

$$T = 2\pi\sqrt{\frac{m}{k}}$$

which gives the period T of a mass–spring system in terms of the mass m and the stiffness k of the system of springs.

[4 marks]

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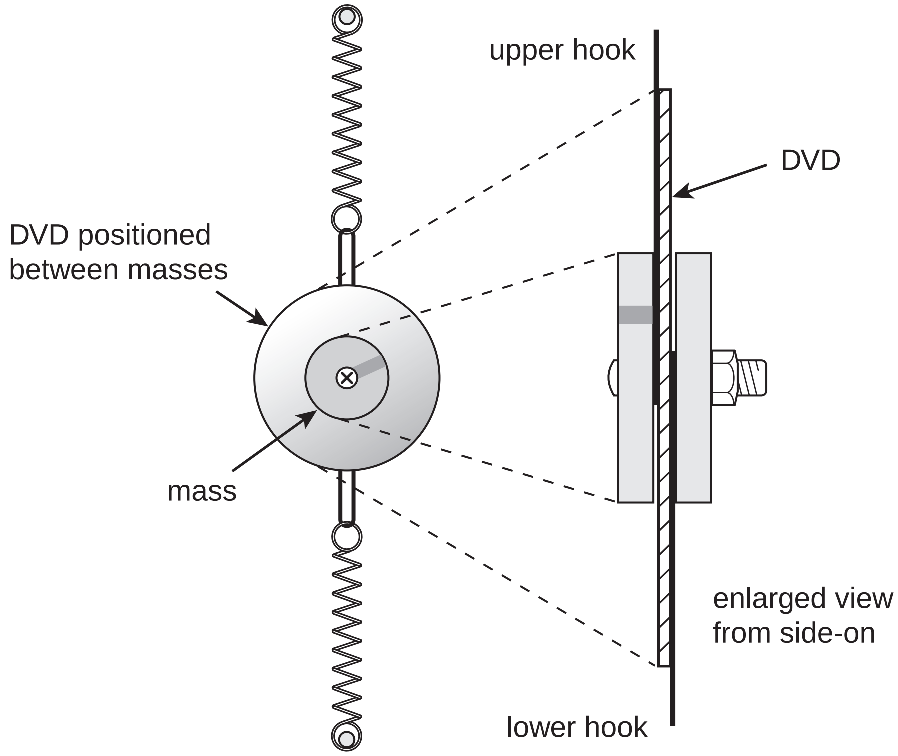
1 (c) A student adapts the experiment to determine the mass of a DVD. After removing the nut and one of the masses, she reassembles the arrangement with the DVD positioned between the two 100 g masses as shown in **Figure 3**.

Figure 3



Using this new arrangement, the student finds that her result for T_1 increases by 3.1 % and the result for T_2 increases by 3.3 %.

1 (c) (i) Using the equation for the period of a mass–spring system, the student deduces that the mass of the DVD is about 13 g.
Show how the student arrives at this result.

[3 marks]

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Question 1 continues on the next page

1 (c) (ii) The student's result is checked using an electronic balance and the correct mass of the DVD is found to be 14.4 g.
Suggest why the student's result is different to that obtained using the balance.

[1 mark]

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10

Turn over for the next question

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2 You are to investigate the period of an oscillating system as the distribution of the mass of the system is changed.

2 (a) (i) You are provided with a wooden beam of length 1 m with holes at points 1 cm, 50 cm, 70 cm and 99 cm from one end.
A horizontal pivot has been passed through the hole 1 cm from the end of the beam.
This hole is labelled 'PIVOT 1'.
Do not adjust the height of this pivot.

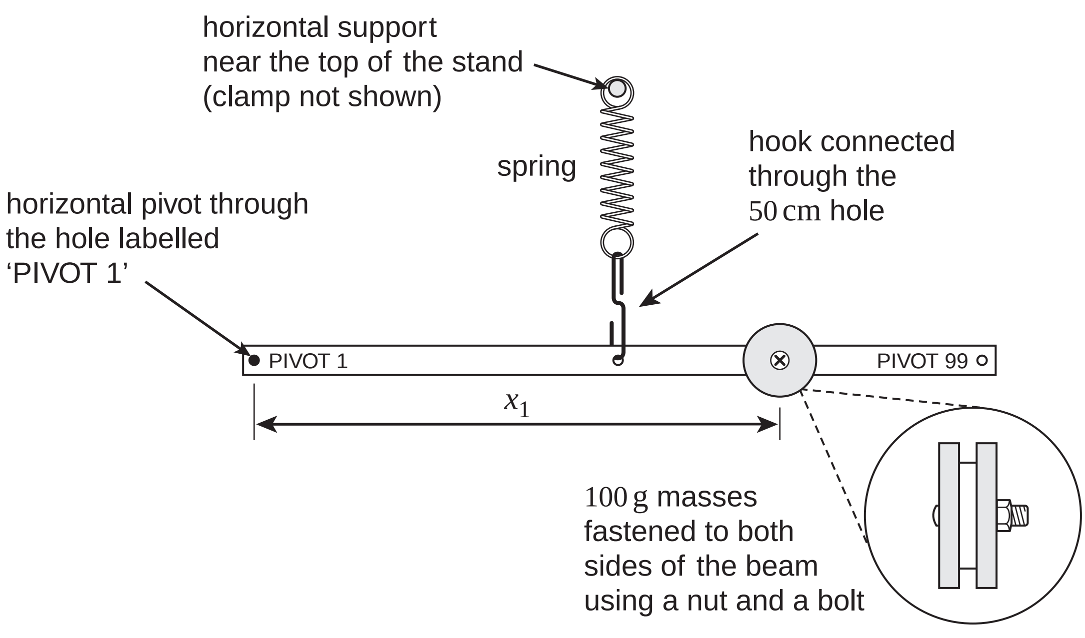
Detach the lower spring from the mass–spring system you used in Question 1.
You will not use this spring for this question.

Remove the nut from the threaded bolt and take off one of the masses and both of the hooks. Pass the bolt through the 70 cm hole and replace the second mass on the bolt before securing with the nut.

Use one of the hooks to attach the spring to the beam at the 50 cm hole.
Adjust the height of the horizontal support from which the spring is suspended until the beam is parallel to the surface of the bench with its largest faces vertical.

The spring should be vertical as shown in **Figure 4**.

Figure 4

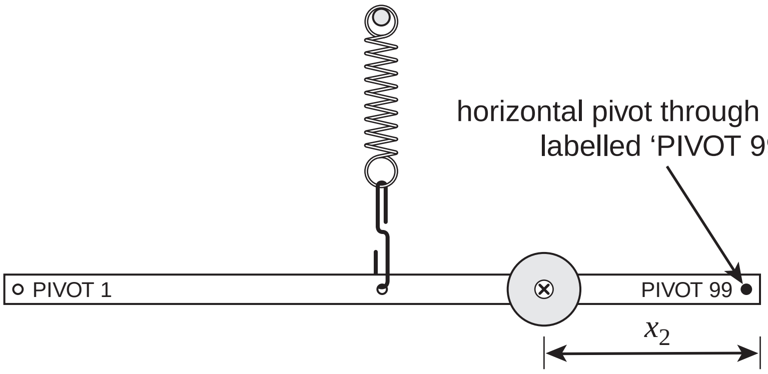


Press down the free end of the beam a short distance then release it so that the beam performs small-amplitude oscillations in a vertical plane.
Make suitable measurements to determine the period T_3 of these oscillations.

T_3 = ...

2 (a) (ii) Without adjusting the height of the pivot, rearrange the apparatus so that the beam is pivoted through the hole labelled ‘PIVOT 99’.
Ensure that the spring is vertical as shown in **Figure 5**.

Figure 5



Adjust the apparatus as before, so that the beam is once again parallel to the surface of the bench.
Press down the free end of the beam a short distance then release it so that the beam performs small-amplitude oscillations in a vertical plane.

Make suitable measurements to determine the period T_4 of these oscillations.

T_4 = ...

2 (a) (iii) It can be shown that

$$\frac{T_3^2 - T_4^2}{T_1^2(x_1^2 - x_2^2)} = k,$$

where k is a constant.
T_1 is the period that you determined in Question 1(a)(i).
x_1 and x_2 are the horizontal distances between the pivot and the centre of the masses fixed to the beam, as defined, respectively, in **Figure 4** and in **Figure 5**.

Evaluate k.

[2 marks]

k = ...

2 (b) Describe and explain **two** procedures you used to reduce the uncertainty in your T_3 and T_4 measurements.

[4 marks]

procedure 1 ....

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procedure 2 ....

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6

END OF QUESTIONS

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