Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

For Teacher's Use	
Section	Mark
PSA	
Stage 1	
Section A	
Section B	
TOTAL (max 50)	

General Certificate of Education
Advanced Level Examination
June 2015

Physics (Specification A & B) PHY6T/Q15/test

Unit 6T A2 Investigative Skills Assignment (ISA) Q

For submission by 15 May 2015

For this paper you must have:	**Time allowed**
• your documentation from Stage 1 • a ruler with millimetre measurement • a calculator.	• 1 hour
Instructions:	**Information**
• 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 space 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. • Show all working.	• The marks for questions are shown in brackets. • The maximum mark for this paper and Stage 1 is 41.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes give the details below or on a separate page.

Yes ☐ No ☐

Teacher Declaration:
I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

Signature of teacher ..... Date .....

USEFUL FORMULAE

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

$$T = \frac{1}{f}$$

Do not write outside the box

Section A

Answer **all** questions in the spaces provided.
You should refer to your documentation from Stage 1 as necessary.
The formulae on page 2 may be useful when answering questions in this section.

1 (a) State the independent variable in the Stage 1 experiment.

[1 mark]

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1 (b) Describe how you ensured that the ruler was horizontal and that the springs were vertical.

[2 marks]

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1 (c) (i) Describe a problem in obtaining an accurate value for the period for low values of m.

[1 mark]

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Question 1 continues on the next page

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1 (c) (ii) State and explain **three** techniques to improve the accuracy of the measurement of the period for low values of m using the same apparatus.

[3 marks]

1 .....

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2 .....

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3 .....

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1 (d) State and explain what your graph suggests about the relationship between T^2 and m.

[2 marks]

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1 (e) (i) Explain why the springs will not have zero extension when the 100 g masses and the holder are removed.

[1 mark]

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1 (e) (ii) State the effect this has on your graph.

[1 mark]

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1 (f) Explain how you could use your graph to find the stiffness k of each spring.

[2 marks]

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13

Turn over for the next question

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Section B

Answer **all** questions in the spaces provided.
The formulae on page 2 may be useful when answering questions in this section.

2 A student performs an experiment similar to the one you did in Stage 1 but uses a constant mass m and six different pairs of springs. The springs are chosen so that each pair has a different effective stiffness k.
For each pair of springs, the student measures the time t for the ruler to make 10 oscillations and calculates the time T for one oscillation. The student then plots a graph of log k against log T. Four of the results are shown calculated in **Table 1** and plotted on the graph in **Figure 1**.

Table 1

k/N m^{-1}	t_1/s	t_2/s	t_3/s	t_{mean}/s	T/s	log(k/N m^{-1})	log(T/s)
49.0	8.60	8.50	8.43	8.51	0.851	1.690	–0.0701
73.5	6.94	6.81	6.91	6.89	0.689	1.866	–0.1618
98.0	5.97	5.90	6.00	5.96	0.596	1.991	–0.2248
123	5.47	5.31	5.38	5.39	0.539	2.090	–0.2684
147	4.94	4.92	4.87				
172	4.53	4.57	4.43				

2 (a) Complete **Table 1**.

[1 mark]

2 (b) Plot the final two points on the graph in **Figure 1** on page 7 and draw a best fit straight line.

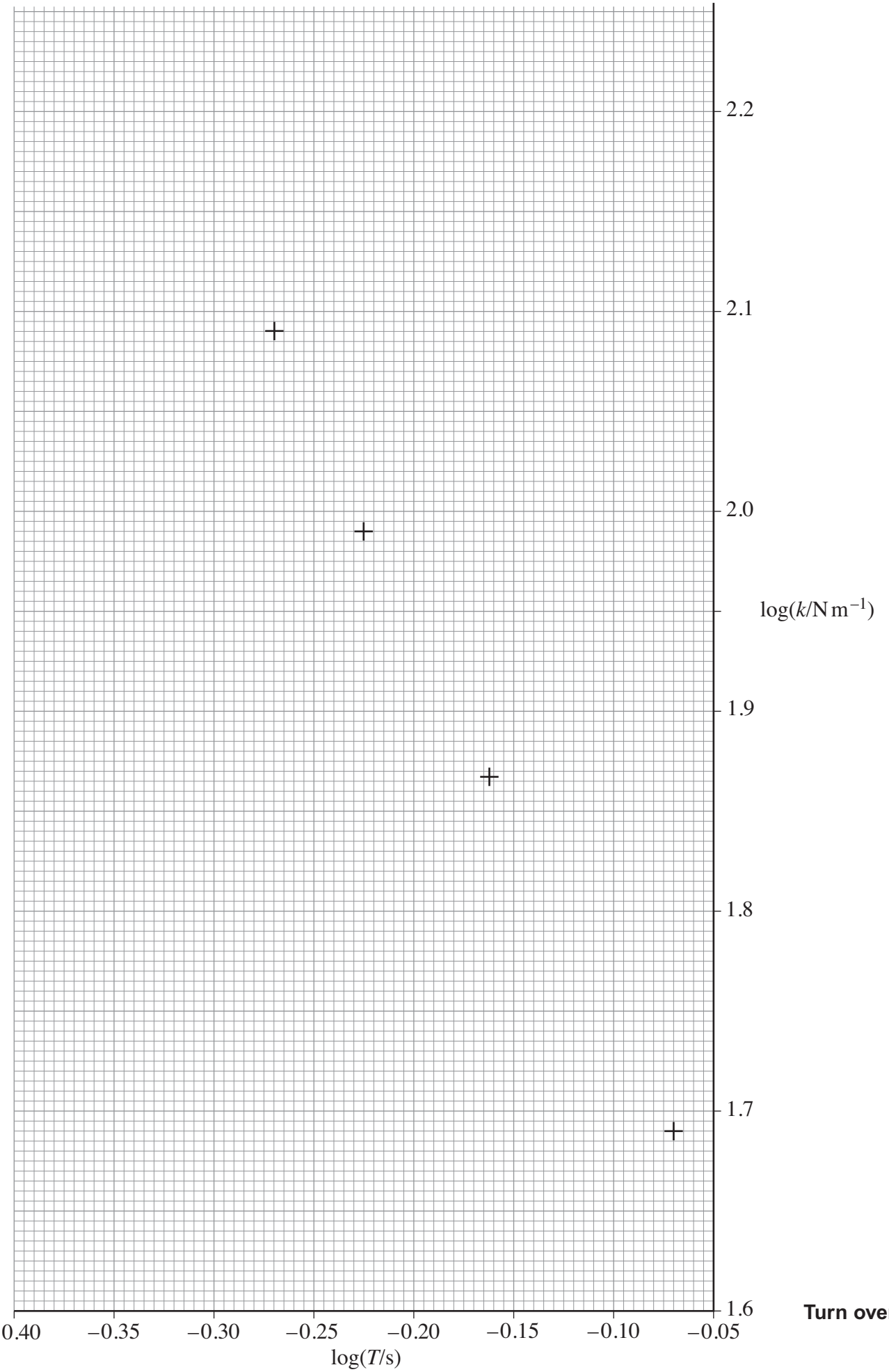
[2 marks]

2 (c) Determine the gradient of your line.

[3 marks]

gradient = ...

Figure 1



2 (d) The time T for one oscillation is given by $T = 2\pi\sqrt{\frac{m}{k}}$.

Show whether the gradient of your graph is consistent with that predicted by this equation.

[4 marks]

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Question 2 continues on the next page

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2 (e) For the smallest value of k in **Table 1**, determine the percentage uncertainty in the corresponding mean value of t.

[1 mark]

percentage uncertainty = ... %

2 (f) State the type of error in t and explain how the uncertainty arises.

[1 mark]

type of error .....

explanation .....

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.....

2 (g) (i) The uncertainty in k is 0.5%.
Determine the percentage uncertainty in m using your answer to Question 2(e).

[2 marks]

percentage uncertainty = ... %

Question 2 continues on the next page

Do not write outside the box

2 (g) (ii) Calculate the uncertainty in the value of m when $m = 900$ g.

[1 mark]

uncertainty = ...

15

Do not write outside the box

3 (a) When designing bridges, engineers need to make sure that the natural frequency of oscillation of the bridge is not close to the frequencies likely to be encountered as forced vibrations caused by winds or other periodic forces.
Considering your experiment in Stage 1 and that described in Question 2, state and explain **two** physical factors that will affect the natural frequency of oscillation of a suspension bridge.

[2 marks]

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Question 3 continues on the next page

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3 (b) A designer is to investigate the effect of increasing the number of supports on the natural frequency of oscillation of a bridge. She decides to model the bridge using a ruler supported by springs.
Describe a suitable experiment to carry out this investigation. Include a diagram of the apparatus you would use.

[4 marks]

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END OF QUESTIONS