| 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 Examiner's Use | |
|---|---|
| Examiner's Initials | |
| Section | Mark |
| Section A Task 1 Q1 | |
| Section A Task 1 Q2 | |
| Section A Task 2 Q1 | |
| Section B Q1 | |
| Section B Q2 | |
| Section B Q3 | |
| TOTAL | |

General Certificate of Education
Advanced Level Examination
June 2013

# 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 Written Test

**For this paper you must have:**
- your completed Section A Task 2 question paper / answer booklet.
- a ruler
- a pencil
- a calculator.

**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 space 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.

**Time allowed**
- 1 hour 15 minutes

**Information**
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 23.

**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 ☐

**Practical Skills Verification**
Teacher Declaration: I confirm that the candidate has met the requirement of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.

**Yes** ☐

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

**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

## Section B

Answer **all** the questions in the spaces provided. Time allowed 1 hour 15 minutes.
You will need to refer to the work you did in Section A Task 2 when answering these questions.

**1 (a)** Determine the gradient, $G$, of your graph of $\log\left(\frac{1}{T^2} - \frac{1}{T_0^2}\right)$ against $\log d$.

..........................................................................................................

..........................................................................................................

..........................................................................................................

$G$ = ..............................................................

*(4 marks)*

**1 (b)** It is suggested that the period is related to the distance by the expression

$$\frac{1}{T^2} - \frac{1}{T_0^2} = kd^n,$$

where $k$ is a constant and $n$ is an integer.

**1 (b) (i)** Deduce the value of $n$.

$n$ = ..............................................................

**1 (b) (ii)** Deduce the unit for $k$.

..........................................................................................................

..........................................................................................................

..........................................................................................................

**1 (b) (iii)** State and explain how you could use your graph to deduce the numerical value of $k$.

..........................................................................................................

..........................................................................................................

..........................................................................................................

..........................................................................................................

..........................................................................................................

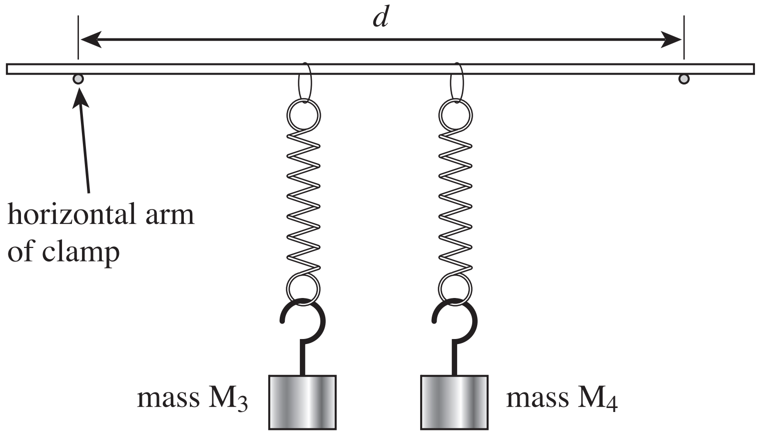
..........................................................................................................

*(4 marks)*

8

**2** In Section A Task 1 you observed the energy transfer between masses $M_3$ and $M_4$ suspended by springs from a horizontal metre ruler using the apparatus shown in **Figure 7**.

**Figure 7**




With the same apparatus, a student investigates how $d$, the horizontal distance between the arms of the clamps on which the metre ruler is supported, affects $\tau$, the time of energy transfer between $M_3$ and $M_4$.

The student measured the times for $n$ energy transfers between the masses, as shown in **Table 2.**

**Table 2**

| $d$/cm | $n$ | $n\tau$/s | $n\tau$/s | $\tau$/s |
|---|---|---|---|---|
| 86.0 | 6 | 212 | 209 | |
| 78.0 | 5 | 236 | 240 | |
| 70.0 | 6 | 408 | * | |
| 65.0 | 4 | 347 | * | |

* only one set of readings of $n\tau$ was completed for these values of $d$

**2 (a) (i)** Complete **Table 2** to show the values for $\tau$ that the student obtained.

**2 (a) (ii)** Justify the number of significant figures you have given for the values of $\tau$.

......................................................................................................................................

......................................................................................................................................

*(2 marks)*

**2 (b)** The student claimed that these results showed that $\tau$ was directly proportional to $\frac{1}{d^2}$.

Analyse the data in **Table 2** to show whether the student's claim is correct.

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

*(2 marks)*

**2 (c)** Suggest **three** valid control variables for the experiment.

1 .......................................................................................................................................

2 .......................................................................................................................................

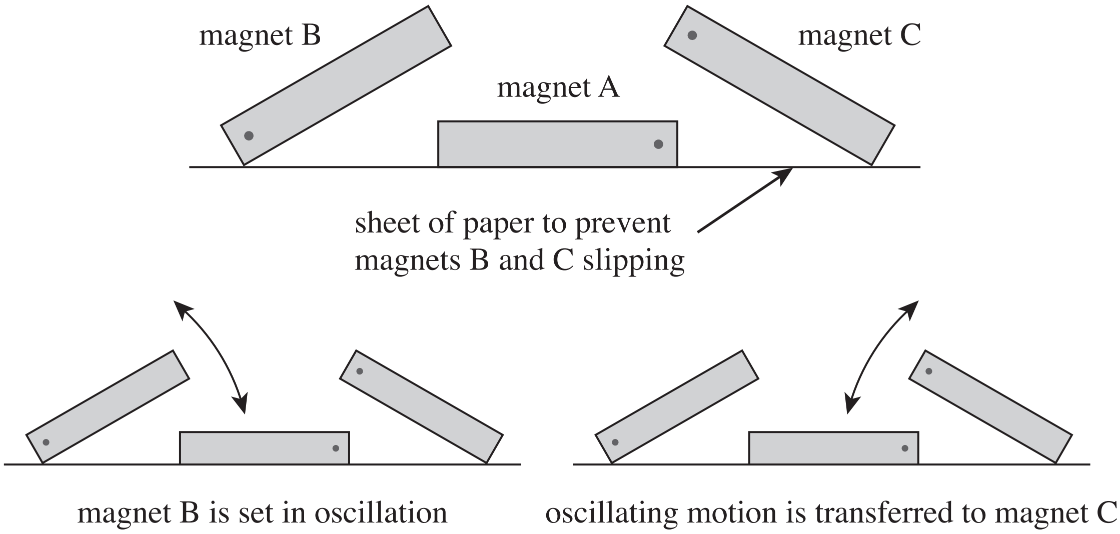
3 .......................................................................................................................................

*(1 mark)*

**THE QUESTION IS CONTINUED ON THE NEXT PAGE**

**2 (d)** In a different experiment to illustrate energy transfer between oscillators, three bar magnets are arranged as shown in **Figure 8**.

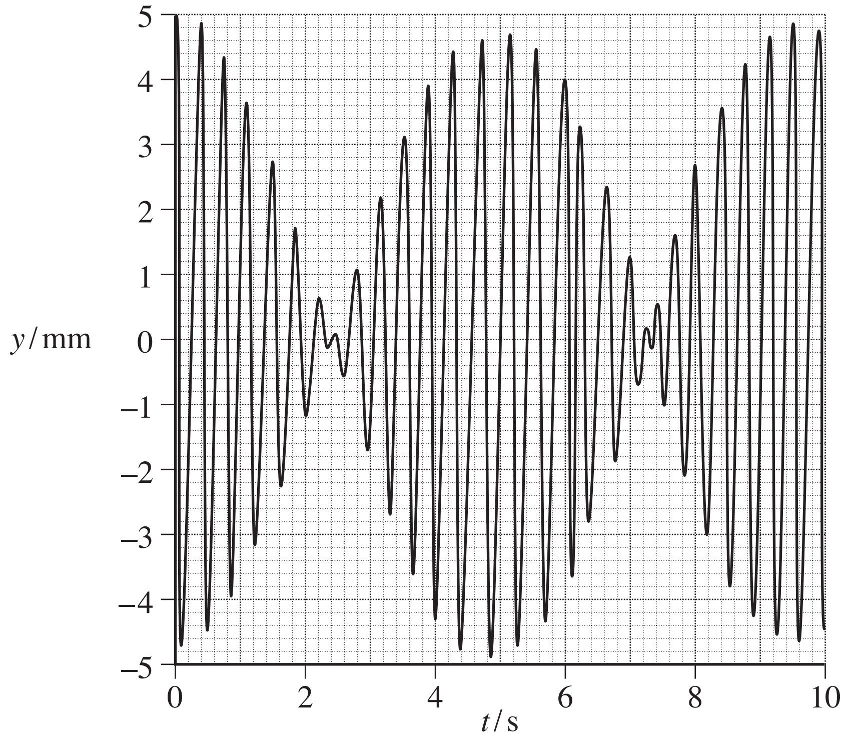
**Figure 8**




Magnets B and C are balanced on one edge using the repulsion produced by magnet A, the paper below providing friction to prevent B and C slipping.
When B is set oscillating about the point of contact with the paper, the oscillating motion is transferred within a few cycles to C, and then back again, as in your experiment with masses $M_3$ and $M_4$.

A student uses a motion sensor and a data logger to record the motion of magnet B; the data are then exported to a computer and analysed using a spreadsheet.
**Figure 9** is based on 25 000 measurements that are transferred to the data logger in 10 seconds and shows how the displacement, *y*, of the moving end of magnet B, varies with time, *t*.

**Figure 9**

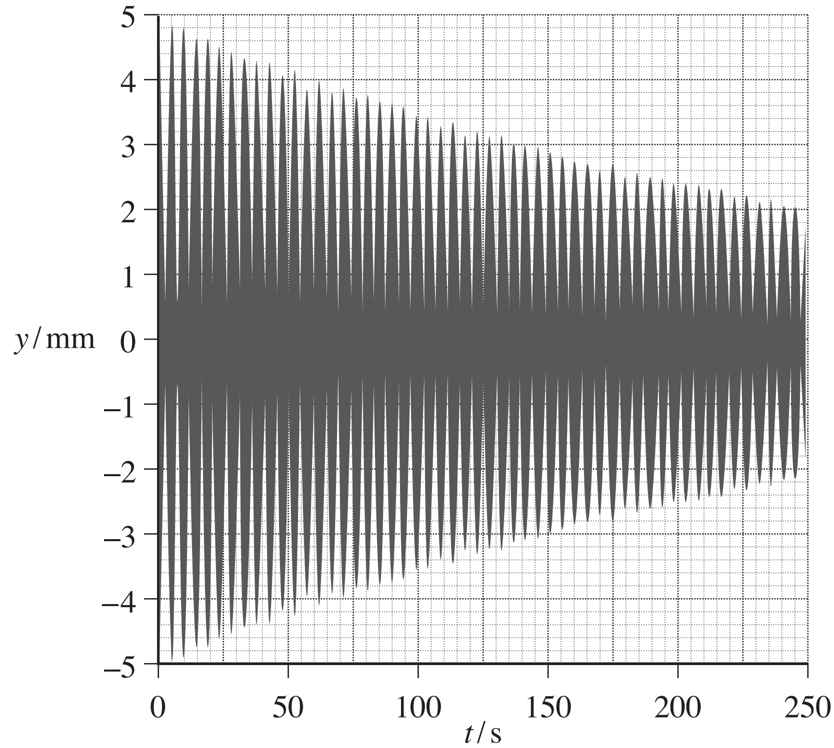


**2 (d) (i)** What was the *sample rate* of the data logger when the data displayed in **Figure 9** was being recorded?

sample rate = ..........................................................................................................

The sample rate is then changed so that 25 000 measurements are transferred to the data logger in 250 seconds. These results are displayed in **Figure 10**.

**Figure 10**




**2 (d) (ii)** If $\tau$ = the time for energy transfer from magnet B to magnet C and back again to B, and $T$ = the period of oscillations of magnet B, use **Figure 9** and **Figure 10** to determine $\frac{\tau}{T}$.
You may assume that in both **Figure 9** and **10**, $y$ has just reached a maximum value at $t = 0$.

..........................................................................................................

..........................................................................................................

..........................................................................................................

..........................................................................................................

$\frac{\tau}{T}$ = ..........................................................................................

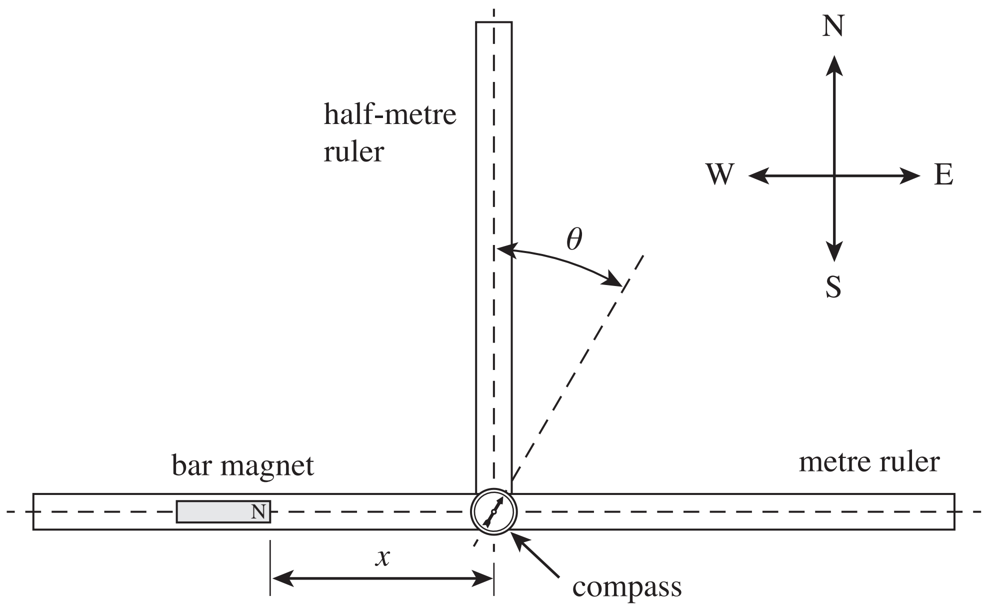
*(4 marks)*

9

Do not write outside the box

**3** In Section A Task 1 you used a compass to investigate how the magnetic flux density varies between two bar magnets. One magnet was positioned on a metre ruler, aligned east-west, and the other on a half-metre ruler, aligned north-south.
A student, performing this experiment, sees that when the magnet on the half-metre ruler is removed the compass needle rotates through an angle $\theta$, as shown in **Figure 11**.
The student notices that when the remaining magnet is moved along the metre ruler so that the distance $x$ defined in **Figure 11,** is reduced, $\theta$ increases.

**Figure 11**



A teacher explains that $B$, the magnetic flux density due to the bar magnet at the plotting compass, is given by $B = B_0 \tan \theta$.
$B_0$ is the horizontal component of the ambient magnetic flux density (ie due to the surroundings) and is known to be $1.8 \times 10^{-5}$ T.

**3** **(a)** Describe how the student could investigate how $B$ varies with $x$, the distance along the metre ruler from the end of the magnet to the centre of the compass.
Your answer should:

- explain how the student should make the necessary measurements to determine $B$ and $x$; you may wish to add detail to **Figure 11** to illustrate this part of your answer
- explain any relevant procedure that will reduce **systematic error** in the results for $B$
- explain how the measurements will be used to determine how $B$ varies with $x$.

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

*(3 marks)*

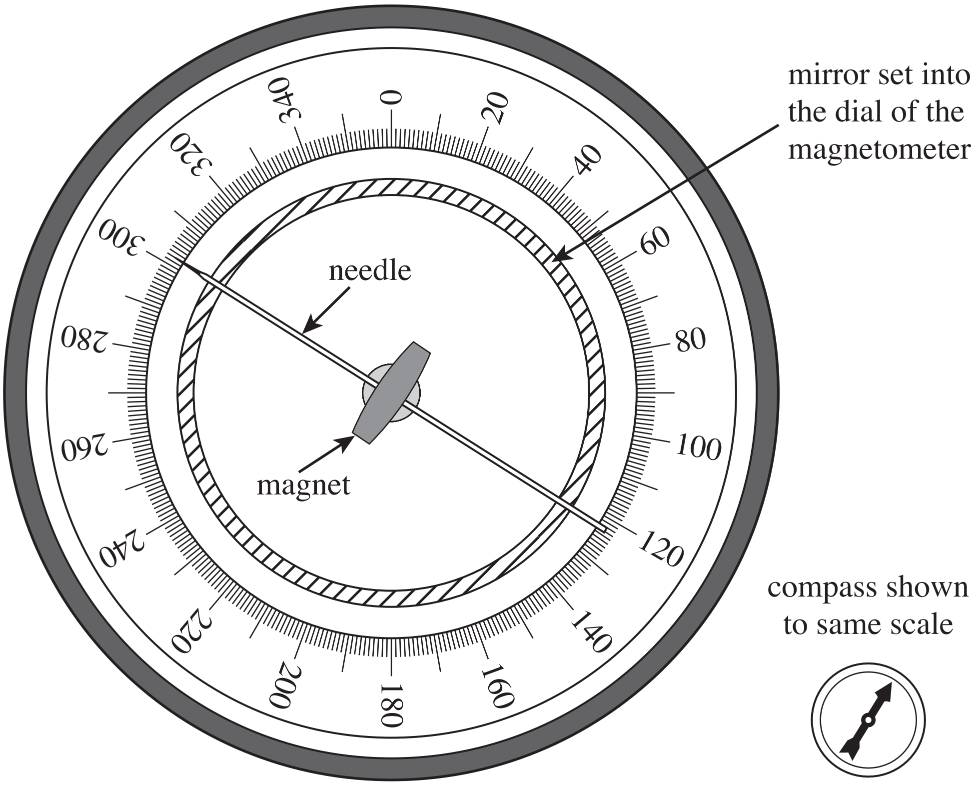
**THE QUESTION IS CONTINUED ON THE NEXT PAGE**

Do not write outside the box

**3** **(b)** The teacher shows the student an instrument called a deflection magnetometer and suggests that this could be used in place of the compass to reduce uncertainty in the measurement of $\theta$.

A deflection magnetometer, as seen from above, is shown in **Figure 12** and consists of a magnet pivoted at the centre of a rotary scale. A long pointer is mounted at right angles to the magnet and a mirror is set into the dial. A plotting compass is shown to the same scale so a comparison can be made with the size of the magnetometer.

**Figure 12**




State and explain two features of the design of the magnetometer that help to reduce uncertainty in the measurement of $\theta$.

first feature:

.............................................................................................................................

.............................................................................................................................

.............................................................................................................................

second feature:

.............................................................................................................................

.............................................................................................................................

.............................................................................................................................

*(3 marks)*

6

**END OF QUESTIONS**

**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**