Centre Number						Candidate Number				
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Other Names										
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Question	Mark
1	
2	
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 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 15.

Section A Task 1

Follow the instructions given below.

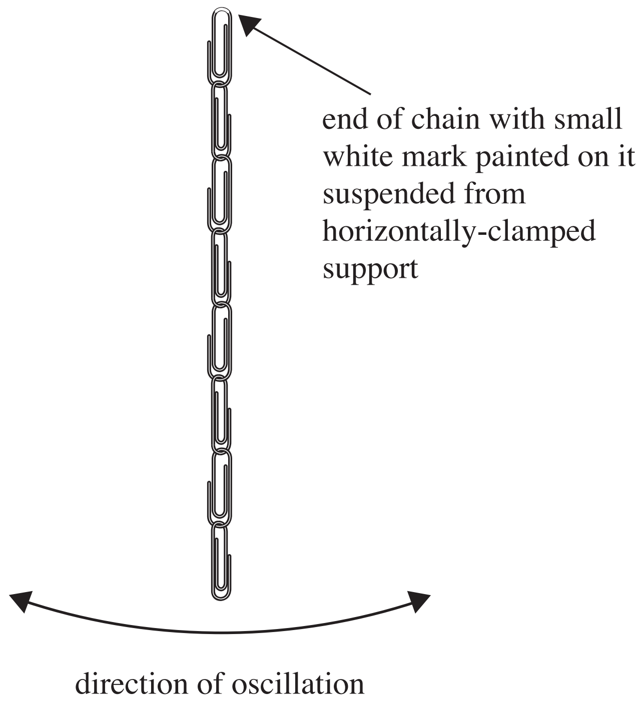
Answer **all** the questions in the spaces provided.

No description of the experiment is required.

1 You are to investigate the small-amplitude oscillations of a chain, suspended from one end, in a vertical plane.

1 (a) You are provided with three short chains, each consisting of eight paper clips joined together. One end of each chain has a small white mark painted on it to show the end from which it should be suspended. Suspend one chain from the horizontally-clamped support so that the chain hangs freely in a vertical plane. The white mark should be at the point of suspension of this chain.
Displace the lower end then release the chain so that it performs small-amplitude oscillations in a vertical plane, as shown in **Figure 1**.

Figure 1



1 (a) (i) Make and record suitable measurements to calculate the period, T_1, of the oscillations of this chain. You should use a fiducial mark to assist in making these measurements.

....

....

T_1 = ...

1 (a) (ii) Connect one of the other chains to the lower end of the suspended chain, thereby doubling the number of inter-connected paper clips.
The white mark on the lower chain should be at the point of suspension to the upper chain. Repeating the procedure as before, make and record suitable measurements to calculate the period, T_2, of the oscillations of this chain.

....

....

....

T_2 = ...

1 (a) (iii) Connect the remaining chain to the lower end of the suspended chain, thereby suspending all the paper clips in a single chain.
The white mark on the lower chain should be at the point of suspension to the upper chain. Repeating the procedure as before, make and record suitable measurements to calculate the period, T_3, of the oscillations of this chain.

....

....

T_3 = ...

(3 marks)

Question 1 continues on the next page

1 (b) It is suggested that n, the number of suspended paper clips is related to T, the period of the paper clip chain by an expression of the form $n \propto T^x$ where x is an integer.
With the aid of the grid provided or otherwise, use the results that you obtained in part (a) to determine the value of x.

x = ...

(4 marks)

1 (c) A student claims that T can be calculated in the same manner as the period of a simple pendulum of length equal to that of the chain.
Show that the student's claim is false.

....

....

....

....

....

....

....

....

....

(2 marks)

9

Turn over for the next question

2 You are provided with two identical pendulums coupled to each other by thread from which four paper clips have been suspended.

2 (a) Displace the bob of the left-hand pendulum about 5 cm leftwards, keeping the string in the vertical plane defined by the rest position of the pendulums.
Release the bob and observe the subsequent motion of both pendulums; you will see that the amplitude of the left-hand pendulum gradually decreases and the amplitude of the right-hand pendulum increases.
After a certain time has elapsed, the left-hand pendulum briefly comes to rest and the right-hand pendulum swings with maximum amplitude, then the transfer of energy between the pendulums reverses until the right-hand pendulum is once again at rest and the left-hand pendulum swings with maximum amplitude.

Make suitable measurements to calculate the time, τ, for the amplitude of either pendulum to increase from zero to a maximum and then fall to zero again.
Labels, on which you may write, have been placed on the edge of the bench to assist you in making these measurements.

....

....

τ = ...

(1 mark)

2 (b) It is suggested that τ may be inversely proportional to the number of paper clips suspended from the thread.

2 (b) (i) Make measurements to calculate τ with five paper clips suspended from the thread.

....

....

τ = ...

2 (b) (ii) Make additional measurements to calculate τ with six paper clips suspended from the thread.

....

....

τ = ...

2 (b) (iii) Explain whether your results from parts (a) and (b) show that τ is inversely proportional to the number of paper clips suspended from the thread.

....

....

....

....

....

....

(4 marks)

2 (c) Explain **one** difficulty that might be encountered if you were to make measurements to determine τ with **less than** four paper clips suspended from the thread.

....

....

....

(1 mark)

6

END OF QUESTIONS

Centre Number						Candidate Number				
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General Certificate of Education
Advanced Level Examination
June 2011

Physics (Specifications A and B) PHA6/B6/XPM1

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

Section A Part 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 Part 1 is 15.

Section A Part 1

Follow the instructions given below.

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

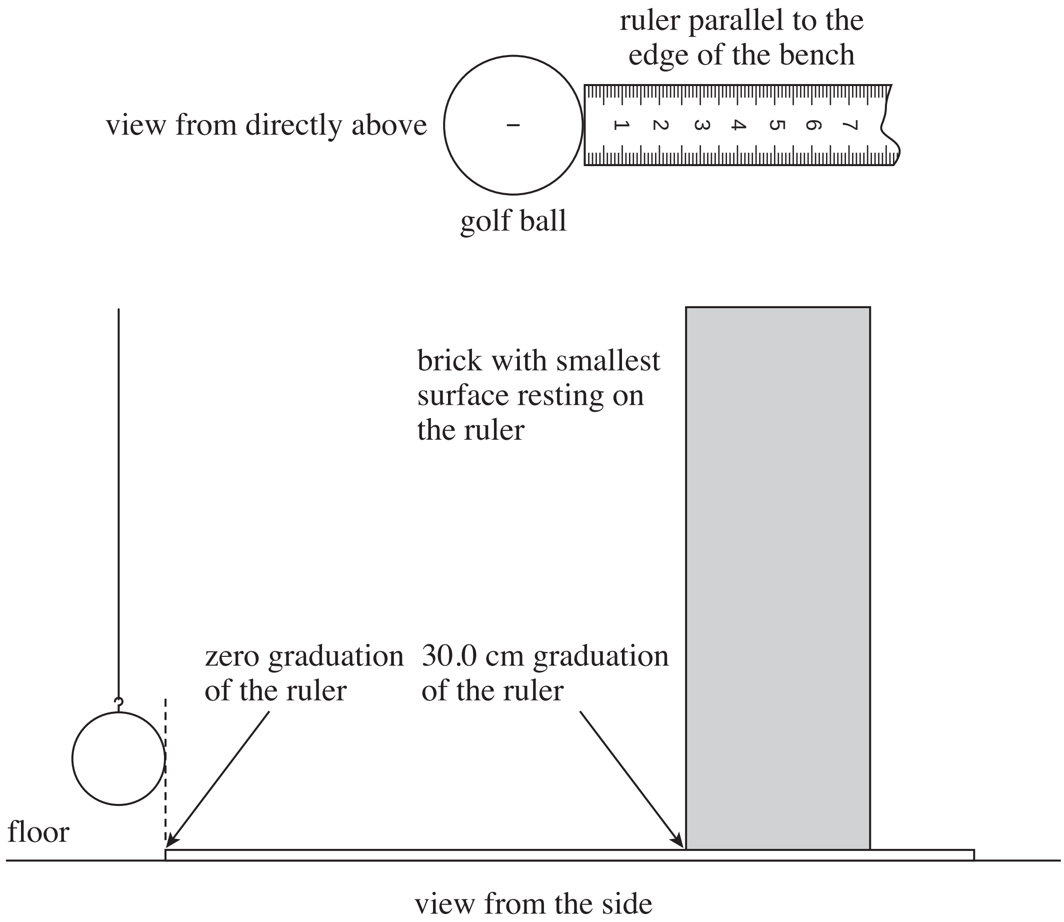
No descriptions of the experiments are required.

1 You are to investigate how the amplitude of a simple pendulum diminishes as its energy becomes absorbed by the surrounding air.

A golf ball is suspended from a string to form a simple pendulum.
Do not adjust the length of the pendulum or the height above the floor of the clamped end of the thread.
Put the ruler on the floor with the graduated face uppermost.
Place the brick on the ruler so the smallest surface of the brick is in contact with the ruler and a smooth vertical face of the brick faces the golf ball.
This nearest face of the brick should be 30.0 cm from the golf ball, as shown in **Figure 1**.

The axis of the ruler should be parallel to the edge of the bench and the zero graduation directly below the edge of the golf ball closest to the brick.

Figure 1



1 (a) Keeping the string straight, pull the golf ball to one side, so it touches the brick. Release the golf ball so that it performs simple harmonic motion in a vertical plane, directly above the ruler.

1 (a) (i) Record in the table below, A_n, the amplitude of the oscillation of the golf ball after n oscillations have been completed; use the values $n = 10, 20$ and 30 indicated in the table.
The table has been partly completed for you.

Use the additional columns in the table as required, to record repeated measurements.

	A_n the amplitude of the pendulum after n oscillations					
n	**A_n / cm**	**A_n / cm**				**mean A_n / cm**
0	30.0	30.0				30.0
10						
20						
30						

1 (a) (ii) Determine the mean value of A_n after 10, 20 and 30 oscillations of the pendulum. Record these data in the right-hand column of the table.

1 (a) (iii) Use your data to calculate ΔA_{10}, the uncertainty in A_{10}, the amplitude after 10 oscillations.

....

....

....

....

....

ΔA_{10} = ...

(2 marks)

Question 1 continues on the next page

1 (b) Textbooks suggest that under certain conditions the amplitude of a simple pendulum subject to air damping should decrease exponentially.

A teacher says that if the suggestion is correct, then

$$\frac{A_n}{A_{n+10}} = \text{constant.}$$

Perform suitable calculations with your data from part (a) to test the teacher's idea. State and explain your conclusion.

....

....

....

....

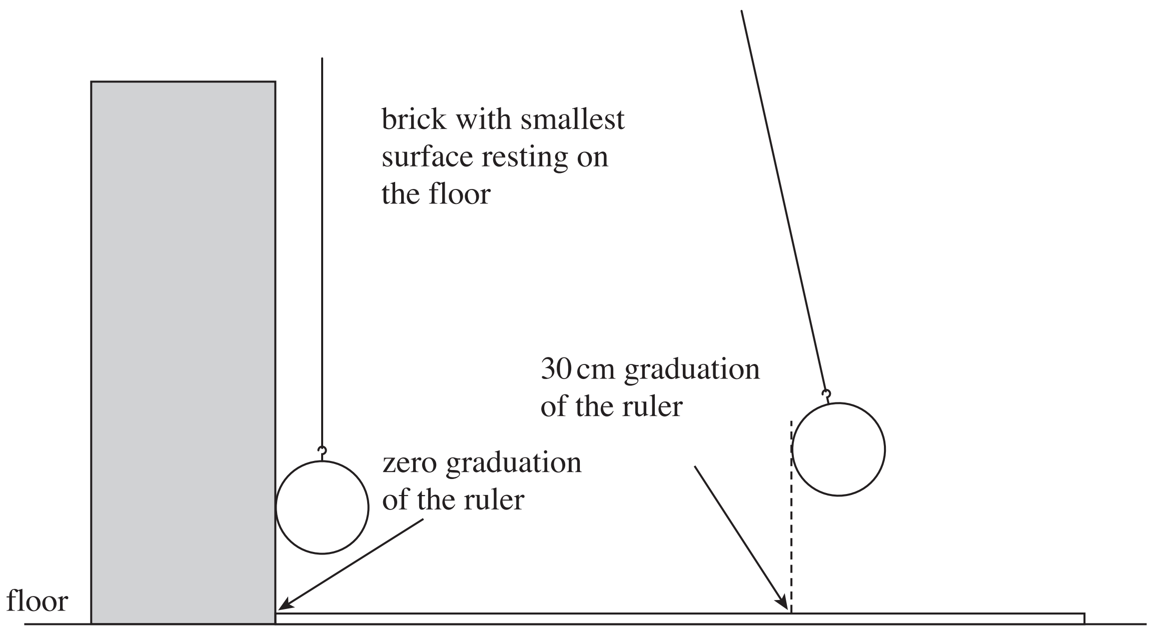
....

(2 marks)

1 (c) Using the same apparatus as in part (a), a student designs a different experiment in which energy is absorbed.

The apparatus is to be arranged as shown in **Figure 2** so that when at the equilibrium position, the golf ball rests against the brick.
The ruler is parallel to the bench and perpendicular to the brick. The graduated face of the ruler is uppermost with the zero graduation in contact with the brick.

Figure 2



Keeping the ball vertically above the ruler and the string straight, the golf ball is pulled to one side until displaced 30.0 cm horizontally and then released so it swings back to strike the brick.

A student intends to measure B, the amplitude of the oscillation of the golf ball after it has rebounded from the brick and intends to investigate whether the amplitude of the oscillation of the golf ball decreases exponentially.

The student intends to check this by calculating $\frac{B_n}{B_{n+1}}$, where B_n is the amplitude after striking the brick n times, and B_{n+1} is the amplitude after striking the brick $(n + 1)$ times.

Use the apparatus provided for part (a) to try out the student's idea and hence identify **two** difficulties in the procedure.

First difficulty ....

....

....

....

....

Second difficulty ....

....

....

....

....

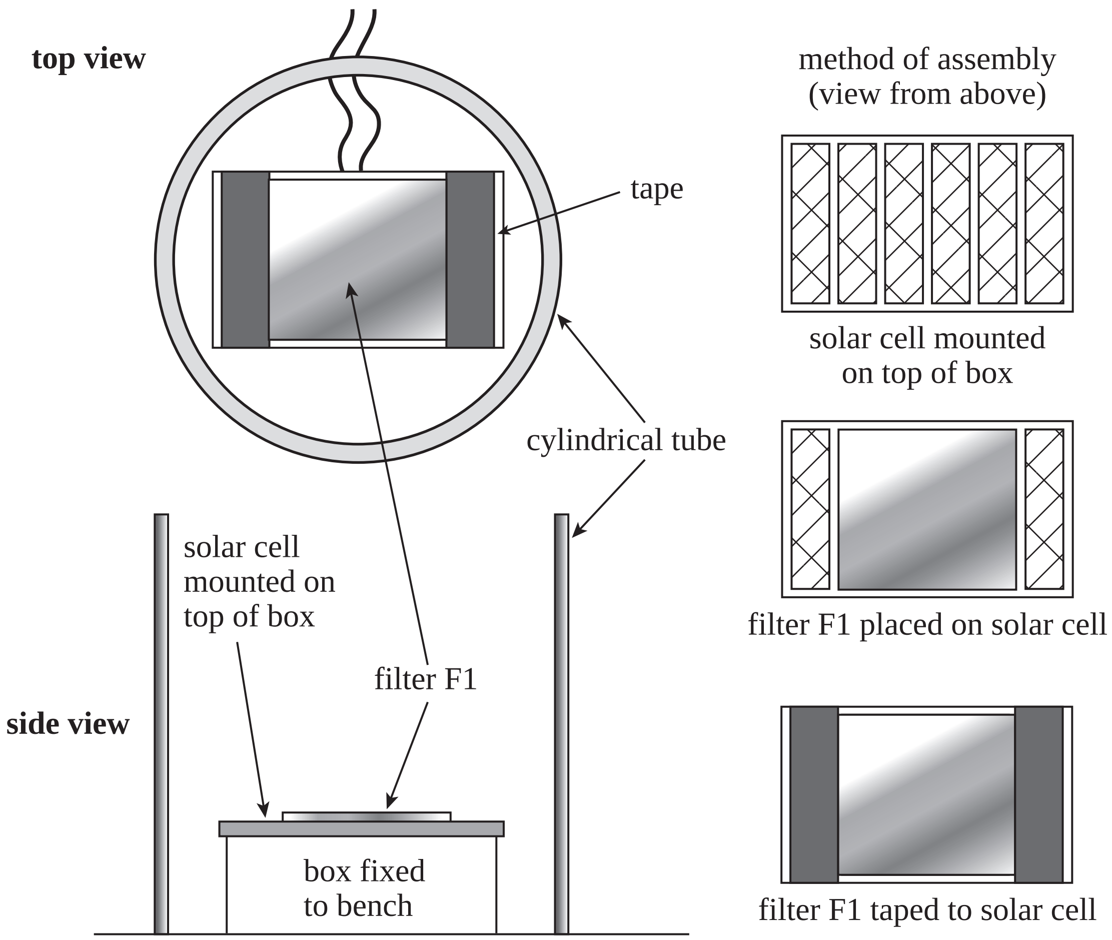
(2 marks)

6

Turn over ▶

2 You are to measure the output voltage of a solar cell as the intensity of light incident on it is varied by passing the light through two identical polarising filters.
The general arrangement and method of assembly is shown in top and side view in **Figure 3**.

Figure 3



Filter F1 has been taped to the surface of the solar cell that is sensitive to light.
The cell has been mounted on a box which has been fixed to the bench.
A cylindrical tube has been placed around this arrangement to shield it from unwanted light.

Place the circular scale centrally on top of the cylindrical tube with the printed side uppermost and fix this to the tube using Blu-Tack.

Position the clamped light source so that the lamp is directly above the hole in the circular scale.
Do not adjust the height of the lamp or the output voltage of the power supply.

The filter F2 has been mounted between two pieces of circular card.

2 (a) (i) Position this card centrally on the circular scale so that θ, the direction of the arrow = 0°. Switch on the lamp then read and record the voltmeter reading V_0.

V_0 = ...

Question 2 continues on the next page

2 **(a)** **(ii)** Keeping the card centrally on the scale, increase θ in 20° steps to obtain further values of V to complete the table.
Switch off the lamp once you have completed these measurements.

θ / °	V / mV	θ / °	V / mV	θ / °	V / mV
20		140		260	
40		160		280	
60		180		300	
80		200		320	
100		220		340	
120		240		360	

(1 mark)

2 **(b)** Adding a suitable scale to the vertical axis, plot on the grid on **page 9** a graph of your results from part (a)(ii).

(2 marks)

2 **(c)** **(i)** Read from your graph, and record below, V_{max} and V_{min}, the maximum and minimum values of V.

V_{max} = ...

V_{min} = ...

2 **(c)** **(ii)** Hence estimate the amplitude, A, of the variation V with θ.

A = ...

2 **(c)** **(iii)** Identify and explain from your graph any value of θ for which the experimental arrangement is most sensitive to changes in θ.

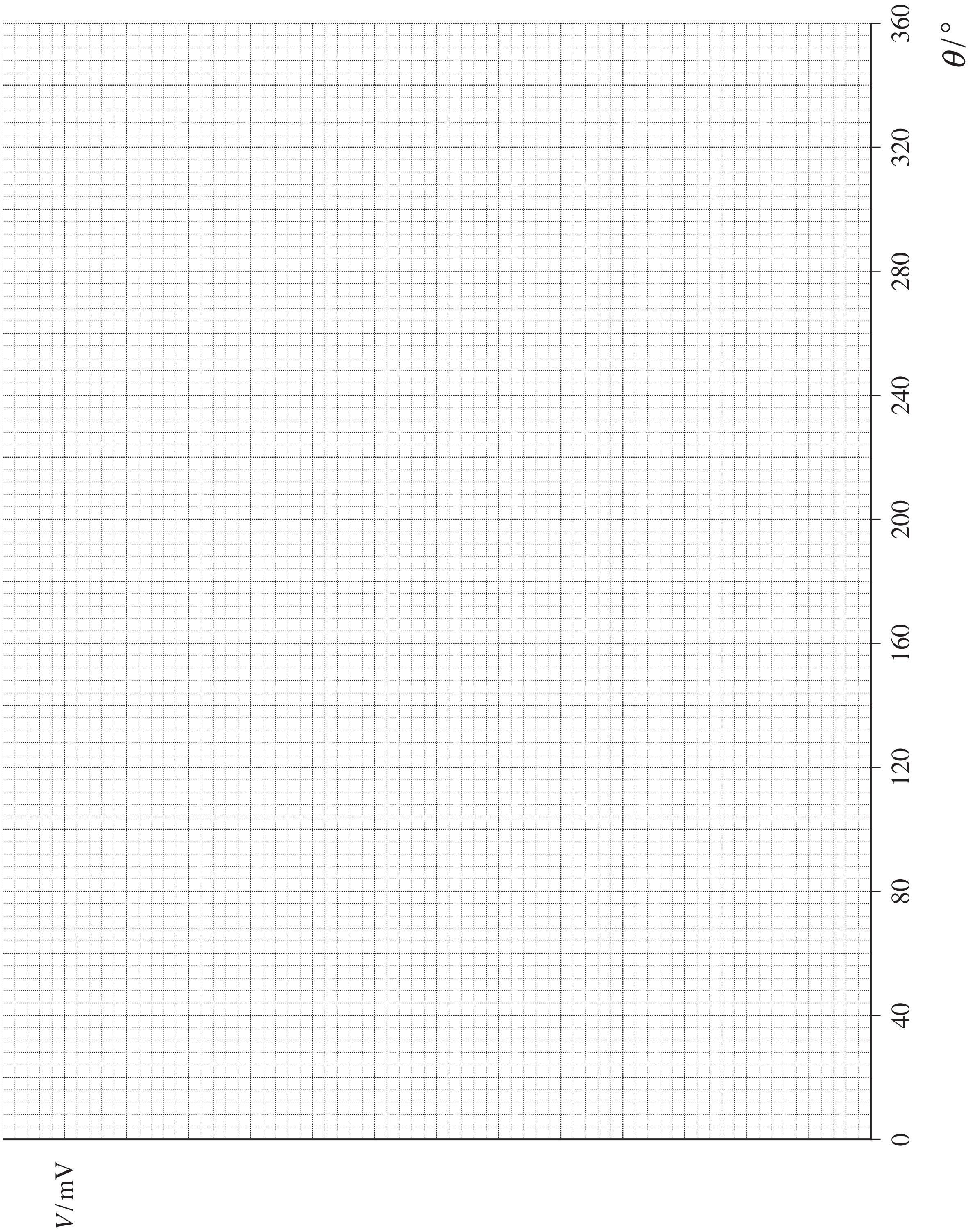
....

....

....

....

(3 marks)



Question 2 continues on the next page

Turn over ▶

2 (d) A student performs the experiment but fails to keep the edge of the card containing the filter F2 centrally on the circular scale.

2 (d) (i) State and explain the effect this may have on the readings of *V*.

....

....

....

....

....

....

2 (d) (ii) State **one** procedure that the student could take so that this error can be avoided.

....

....

....

....

(3 marks)

9

END OF SECTION A PART 1

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General Certificate of Education
Advanced Level Examination
June 2012

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 Part 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 Part 1 is 16.

Section A Part 1

Follow the instructions given below.

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

No descriptions of the experiments are required.

1 You are to measure the radius of curvature, R_1, of the concave surface of a spherical mirror by measuring the period of a ball bearing rolling on the mirror.

1 (i) Use the micrometer screw gauge to make suitable measurements to determine the radius, r, of the ball bearing.

....

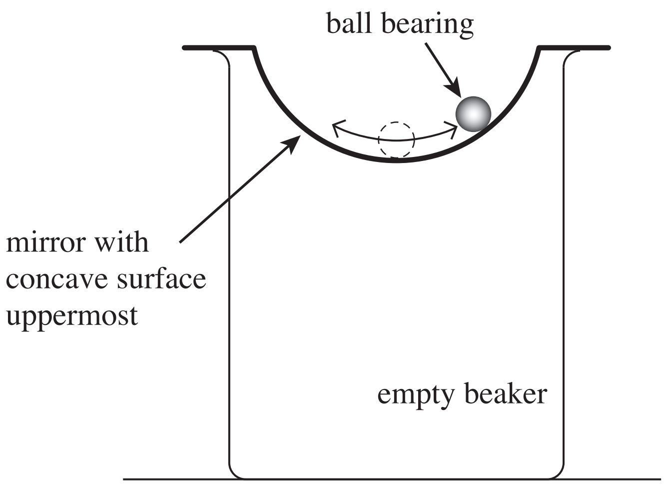
....

r = ...

(2 marks)

1 (ii) Place the mirror on top of the empty beaker with the concave surface uppermost. Place the ball bearing near the edge of the mirror so that when released, the ball bearing performs oscillations about the centre of the mirror, as shown in **Figure 1**.

Figure 1



Make suitable measurements to determine the mean period, T_1, of the oscillations. You may mark the inside of the mirror with a pencil to assist you with the measurement.

....

....

T_1 = ...

(1 mark)

Turn over ▶

1 **(iii)** It can be shown that T_1 is given by

$$T_1 = 2\pi\sqrt{\frac{7(R_1 - r)}{5g}}$$

where $g = 9.81\,\mathrm{N\,kg^{-1}}$.

Using your values of r and T_1, determine R_1.

....

....

....

....

....

....

....

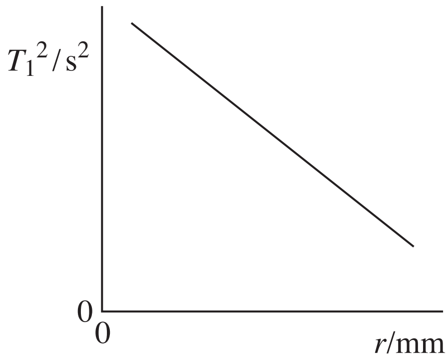
....

R_1 = ...

(2 marks)

1 **(iv)** A student is provided with a selection of ball bearings of different dimensions. Using each of these in turn, the student obtains values of T_1 for each corresponding value of r. The student then produces the graph of T_1^2 against r shown in **Figure 2**.

Figure 2



State and explain how the value of R_1 can be obtained from this graph.

....

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....

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....

....

....

(3 marks)

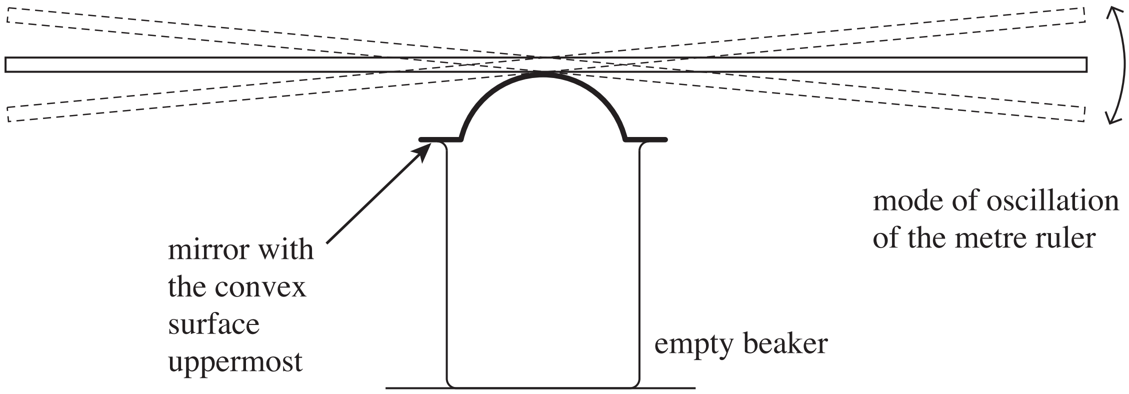
8

Turn over for next question

2 You are to measure the radius of curvature, R_2, of the convex surface of the mirror by measuring the period of an oscillating metre ruler placed on the top of the mirror.

Place the mirror on top of the empty beaker with the convex surface uppermost. Place the metre ruler, with the graduated face uppermost, on top of the mirror so that the ruler is parallel to the surface of the bench.
Slightly depress one end of the ruler then release it so that the ruler performs small-amplitude oscillations, as shown in **Figure 3**.

Figure 3



2 (i) Using the additional equipment provided, assemble a suitable fiducial mark, then make suitable measurements to determine the mean period, T_2, of the oscillations.

....

....

T_2 = ...

(1 mark)

2 (ii) If the thickness of the ruler is much less than its length, it can be shown that

$$R_2 \approx \frac{1}{3g}\left(\frac{x\pi}{T_2}\right)^2,$$

where x = the length of the ruler and $g = 9.81\ \text{N kg}^{-1}$.

Using your value of T_2, determine R_2.

....

....

....

R_2 = ...

(1 mark)

2 **(iii)** Show with the aid of a sketch where you positioned the fiducial mark in order to reduce uncertainty in the measurement of T_2. Explain why you chose this position for the fiducial mark.

....

....

....

....

(2 marks)

2 **(iv)** To determine T_2, a student makes five measurements of the time for 20 oscillations of the ruler.
The student's data are as follows:

$20T_2$/s	40.8	41.4	39.9	38.7	40.5

The student uses these data to determine T_2. Calculate the percentage uncertainty in the student's result.

....

....

....

....

....

(2 marks)

Turn over ▶

2 **(v)** It is reasonable to assume that your result for R_2 is similar to, but **not the same**, as that obtained for R_1. Give **two** reasons why you would not expect these results to be the same.

Reason 1 ....

....

....

....

....

Reason 2 ....

....

....

....

....

(2 marks)

8

END OF QUESTIONS

Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

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Question	Mark
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TOTAL	

General Certificate of Education
Advanced Level Examination
June 2013

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 descriptions of the experiments are required.

1 You are to perform two experiments involving the vertical oscillations of a spring-mass system.

1 (a) You are provided with a retort stand fitted with a clamp from which a spring is suspended. A metre ruler has been clamped vertically alongside the spring.
Do not adjust the positions of the clamps to which the spring and the metre ruler are attached.

You are also provided with masses labelled M_1 and M_2.

1 (a) (i) Attach M_1 to the lower end of the spring.
Record r_1, the metre ruler reading which is at the same horizontal level as the bottom of M_1 when M_1 is in equilibrium.

r_1 = ...

1 (a) (ii) Displace and then release M_1 so that it performs small amplitude vertical oscillations.
Make suitable measurements to determine T_1, the time period of the oscillations.
A fiducial mark has been provided for your use.

....

....

....

T_1 = ...

1 (a) (iii) Add M_2 to the mass already on the spring.
Record r_2, the metre ruler reading which is at the same horizontal level as the bottom of M_1 when in equilibrium.

r_2 = ...

1 (a) (iv) Displace and then release the mass on the spring and make suitable measurements to determine T_2, the time period of the oscillations.

....

....

....

T_2 = ...

(2 marks)

1 (b) Evaluate $\dfrac{r_2 - r_1}{(T_2 - T_1)\,(T_2 + T_1)}$

....

....

....

$\dfrac{r_2 - r_1}{(T_2 - T_1)\,(T_2 + T_1)}$ = ...

(2 marks)

1 (c) Explain how you reduced uncertainty in your readings of r_1 and r_2.
You may use a sketch to illustrate your answer.

....

....

....

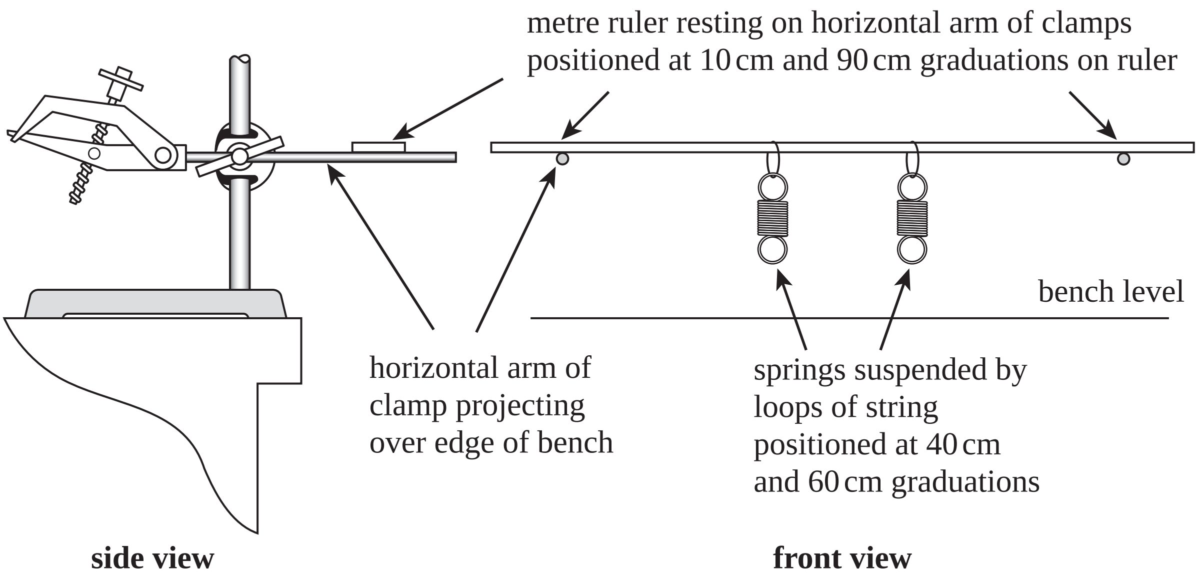
....

(2 marks)

Dismantle your apparatus and place M_1, M_2, and the spring to one side.
Inform the Supervisor that you require the additional apparatus to complete part (d) of this question.

1 (d) You are provided with an additional retort stand to which a clamp has been attached. Adjust the height of clamps on each retort stand so the horizontal arms of these clamps lie in the same horizontal plane, about 10 cm above the level of the bench.
Position the stands so that the arms of the clamps project over the edge of the bench, as shown in the side view in **Figure 1**.

Figure 1



Join the springs to the metre ruler using the loops of string fastened at one end of each spring, then place the ruler, with the graduated face uppermost, on the projecting arms of the clamps. Adjust the position of the stands until the ruler is supported at the 10 cm and 90 cm graduations. Move the loops of string so that the springs are positioned below the 40 cm and 60 cm graduations.

You are provided with masses M_3 and M_4.
Attach M_3 to the lower end of the spring suspended below the 40 cm graduation and attach M_4 to the lower end of the spring suspended below the 60 cm graduation.

With M_4 held at rest at the equilibrium position, displace M_3 vertically downwards through approximately 5 cm.
Release both masses simultaneously so that M_3 performs small-amplitude vertical oscillations.

1 (d) (i) Observe and describe the subsequent motions of M_3 and M_4, with particular reference to the amplitude variations and phase relationship between the motions of the masses.

....

....

....

....

....

....

....

....

....

....

....

....

1 (d) (ii) Make suitable measurements to determine τ, the time for the energy of M_3 to transfer to M_4 and then back again.

....

....

τ = ...

(4 marks)

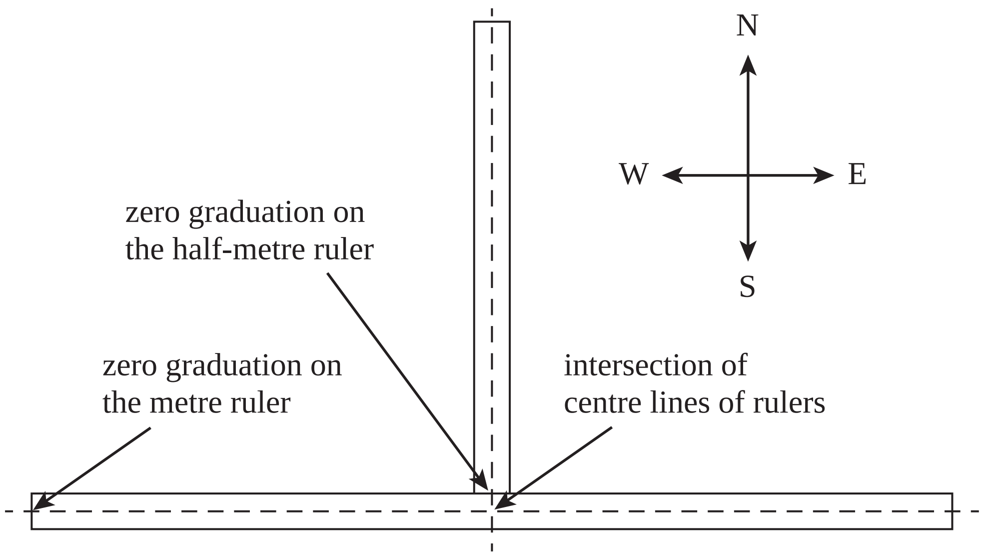
10

TURN OVER FOR NEXT QUESTION

2 You are to investigate how the magnetic flux density varies between two bar magnets.

You are provided with a metre ruler and a half-metre ruler.
Place the rulers with their largest faces in contact with the bench then use the compass, together with the set-square, to position the rulers with the alignment shown in **Figure 2**.

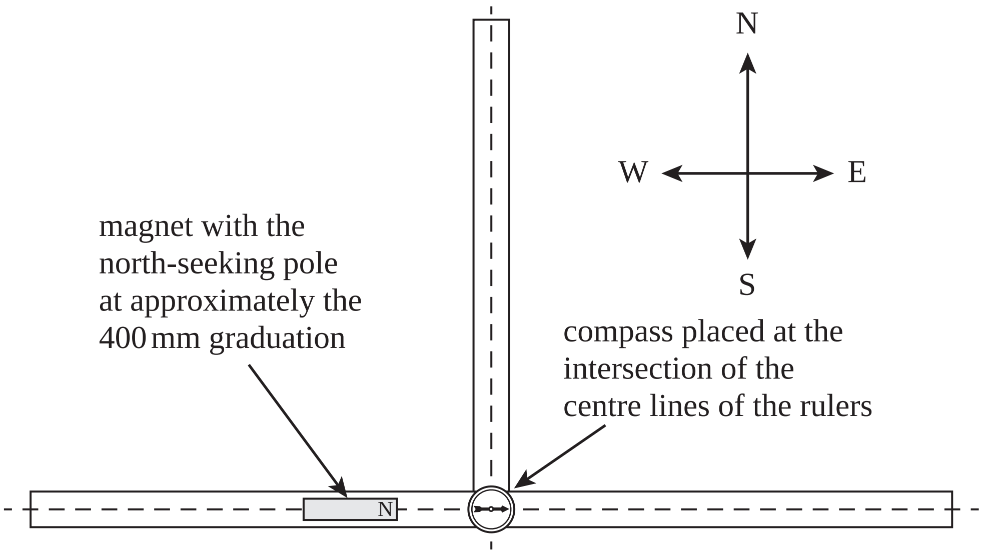
Figure 2



Place the compass at the intersection of the centre line of the rulers. Make any further small adjustment to the direction of the rulers that may be necessary so that the needle is aligned with the centre line of the half-metre ruler.
Once in position the rulers should be taped to the bench.

Place a bar magnet on the metre ruler with the north-seeking pole at approximately the 400 mm graduations. The north-seeking pole of this magnet should point eastwards. The magnet should be aligned with the centre line of the metre rule, as shown in **Figure 3.**

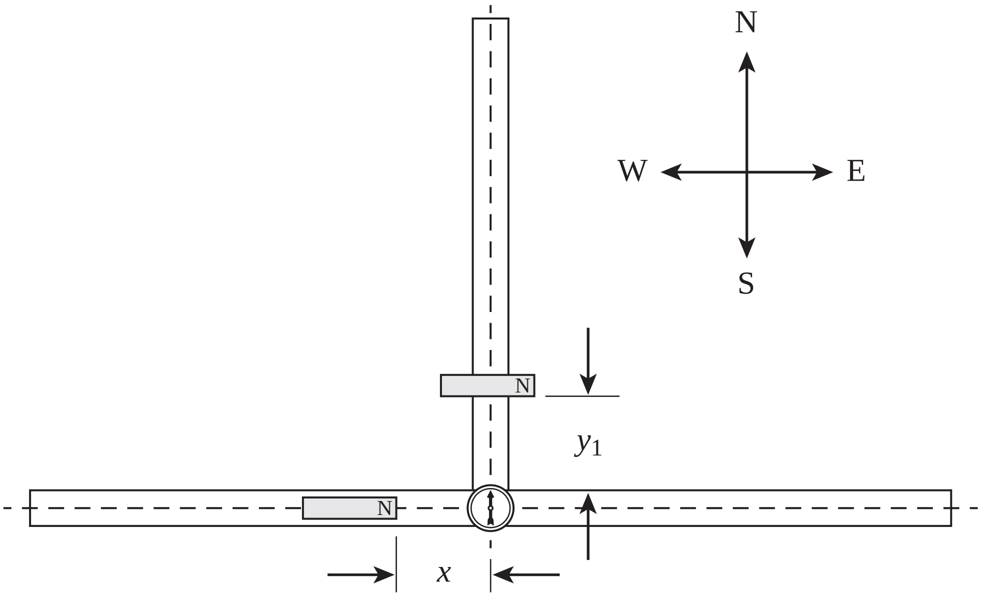
Figure 3



Place the other bar magnet at about the mid-point of the half-metre ruler with the north-seeking pole of the magnet pointing eastwards. The centre of this magnet should lie directly above the centre line of the half-metre ruler.
Move this magnet directly towards the compass until the needle points due north again.

2 (a) (i) Measure and record in **Table 1** below, the distances x and y_1 defined in **Figure 4**.

Figure 4



2 (a) (ii) Maintaining their orientation, interchange the positions of the two magnets.
With the same *x* value as before, adjust the position of the other magnet until the compass once again points due north.
Measure and record in **Table 1** y_2, the distance corresponding to y_1 in **Figure 4** when the magnets are interchanged.

2 (a) (iii) Calculate and record y, the mean value of the distances y_1 and y_2.

2 (a) (iv) Repeat the procedure for three **larger** values of x to complete **Table 1**.

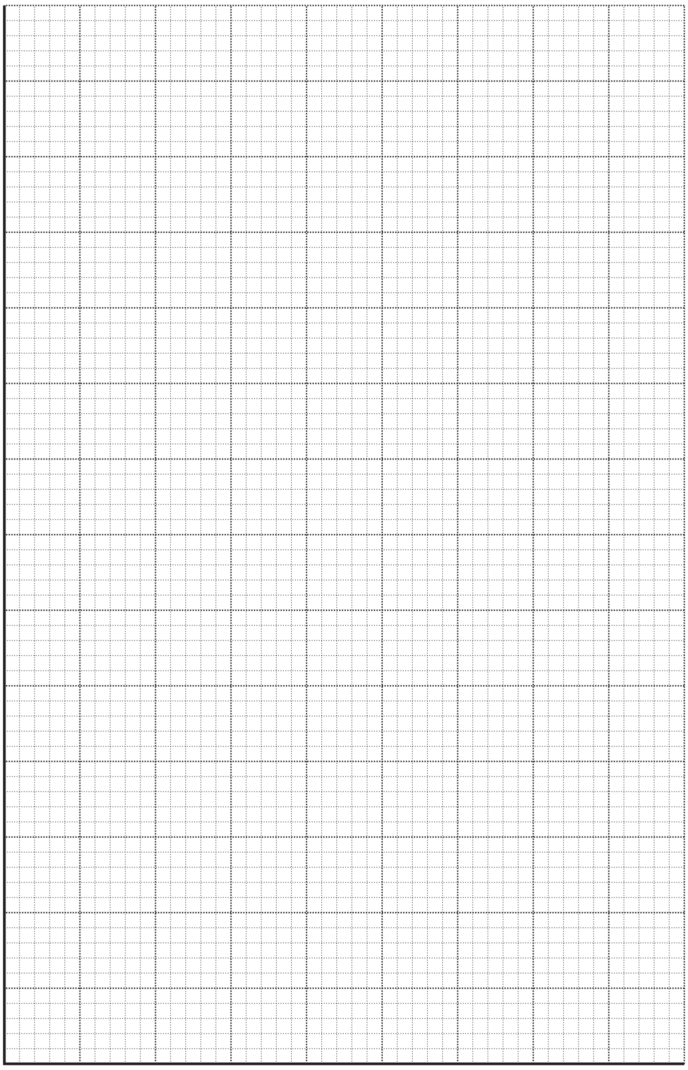
Table 1

x / mm	y_1 / mm	y_2 / mm	y / mm

(2 marks)

2 (b) Add suitable scales to the grid below and plot a graph to show how y varies with x.

y / mm



x / mm

(2 marks)

2 (c) Determine the gradient, G, of your graph.

....

....

G = ...

(2 marks)

6

END OF QUESTIONS