General Certificate of Education
June 2008
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) **PHB6/TN**

Instructions to Supervisors

CONFIDENTIAL

OPEN ON RECEIPT

This unit contains two exercises. Exercise 1 (Question Paper PHB6/1) will be between 3 March 2008 and 19 May 2008 and the date will be decided by the centre. The second exercise (Question Paper PHB6/2) will be held on Monday 19 May 2008 1.30 pm to 3.00 pm.

- It is the responsibility of the Examinations Officer to ensure that these *Instructions to Supervisors* are given immediately to the Supervisor of the practical examination.
- These Instructions are provided to enable centres to make appropriate arrangements for the examination.
- These instructions explain how to set up the equipment for all questions.
- The questions are printed in these instructions.
- Centres are at liberty to make any reasonable minor modifications to the apparatus which may be required for the successful working of the experiment but a note of all such modifications must be noted on the *Supervisor's Report*. Any such modifications must permit the experiment to be carried out in the specified manner.

INSTRUCTIONS TO THE SUPERVISOR OF THE PRACTICAL EXAMINATION

General

1 These instructions and details of materials contained in this document are for the use of the Supervisor and **are strictly confidential**. In no circumstances should information concerning apparatus or materials be given before the examination to a candidate or other unauthorised person. After use, these instructions must be kept in safe custody by the Examinations Officer until after the issue of results (in March or August as appropriate).

Using information for any purpose beyond that permitted in this document is potentially malpractice. Guidance on malpractice is contained in the JCQ document *Suspected Malpractice in Examinations and Assessments: Policies and Procedures*.

2 The Supervisor has now been granted access to the question papers for both Exercise 1 (PHB6/1) and Exercise 2 (PHB/2) as part of these Instructions. All the relevant questions are printed to enable the Supervisor to carry out the experimental parts of the Exercises in order to ensure that the apparatus and materials obtained are satisfactory and to seek advice from AQA if there are any problems. The Instructions must be returned to safe custody at the earliest possible moment after the Supervisor has ensured that all is in order.

3 Candidates are allowed 1 hour 30 minutes for each of Exercises 1 and 2.

4 Exercise 1 (PHB6/1) is undertaken at a time suited to the circumstances of the centre, but under examination conditions. It is preferred that all candidates at a given centre undertake Exercise 1 at the same time.

5 About two weeks before candidates at a particular centre undertake Exercise 1, each candidate should be given a copy of the Preliminary Material (Information for Candidates) (PHB6/PM). This gives details of the general subject area of this assessment. The information is given to all candidates so that those undertaking the assessment early are not disadvantaged.

6 Exercise 2 (PHB6/2) is a timetabled practical examination and should be undertaken on the stipulated day. In a centre with a large number of candidates, it may be necessary for two or more examination sessions to be organised for Exercise 2. Candidates waiting for their session must be fully invigilated in a separate room throughout the period from the time of the first session until they enter the examination room. Candidates completing their session before the published starting time for the examination must similarly be invigilated.

7 For Exercise 2, centres may provide sufficient sets of apparatus for half their candidates to work on Question 1, while the other half work on Question 2. Under strict supervision, the groups of candidates change over after 45 minutes. It will be necessary to allow a short period of time whilst the change over takes place. During this time the apparatus should be returned to its original state, ready for use by the next group of candidates. A similar short delay for the same purpose will be needed in centres running two or more sessions. Whatever arrangement is adopted enough apparatus and materials must be prepared to ensure that in the case of failure of a set of apparatus, a substitute is available so that the candidate does not lose time.

8 AQA will provide graph paper for both exercises. For PHB6/1 a question paper and separate 8-page answer book will be provided. For PHB6/2 a combined question paper/answer booklet will be provided. All other materials required for the assessment must be provided by the centre.

9 A suitable laboratory, or laboratories, must be reserved for the practical exercises. Unauthorised persons not involved in the preparation for the examination must not be allowed to enter. Candidates must not be admitted until the specified time for commencement of the examination. The examination room must be cleared of candidates immediately after the examination.

10 The apparatus and materials for each candidate must be arranged neatly, and ready to use, on the laboratory bench. No attempt should be made to connect together any parts or to wire up any electrical circuits except when specifically stated in these instructions.

11 Clear instruction must be given by the Supervisor to all candidates at the beginning of each examination concerning the organisation of the examination in the laboratory and the amount of time allowed for the examination. Candidates must also be instructed that all readings must be entered in the answer book provided and all working must be shown. **Scrap paper must not be used**.

12 If a candidate is unable to perform any experiment, or is performing an experiment incorrectly, the Supervisor is expected to give the minimum help required to enable the candidate to proceed. In this instance, a note bearing the candidate's name and number must be attached to the candidate's script reporting to the Examiner the extent of the help given. **No help should be given with the analysis of the experimental data**.

It is not the wish of the Examiner that a candidate should waste time because of, for example, an incorrect electrical connection. The Examiner wishes to test the candidate's ability to perform an experiment and carry out the subsequent analysis.
Any failure in the apparatus should also be reported to the Examiner.

13 Candidates' scripts **and**, where appropriate, the question papers for PHB6/1 should be collected at the end of each exercise. Under no circumstances should candidates be permitted to remove question papers from the examination room. Note that candidates will require separate sheets of A4 graph paper which should be secured to the script for the appropriate exercise using a treasury tag.

14 Used question papers must be returned to the safe custody of the Examinations Officer, by whom they should be retained until after the issue of results.

15 Candidates' scripts for Exercise 1 must be stored securely until the stipulated date for Exercise 2. Scripts for the two exercises should be collated and sent together to the Examiner.

16 If a candidate is absent on the stipulated date for Exercise 2, their script for Exercise 1 should still be sent to the Examiner. The flexibility in the timing for Exercise 1 should make it possible for all candidates to be given an opportunity to undertake Exercise 1.

17 The Supervisor is required to report details concerning the experiment, apparatus or materials to the Examiner on the *Supervisor's Report* located at the end of this document. **This *Supervisor's Repor*t must be attached to the topmost script before despatch to the Examiner.**

Details must be given on the *Supervisor's Report* if the apparatus or materials provided differ from that detailed in this document. Where specific information or data about apparatus or materials is requested in these instructions, it is important that it is given accurately. In some cases it may represent the only means available to the Examiner of assessing the accuracy of a candidate's work.

Centres may make copies of this *Supervisor's Report* for attachment to individual scripts if necessary. If all the information cannot easily be included on the *Supervisor's Report*, separate sheets of paper, bearing the candidates' names and numbers, can be attached to the relevant candidates' scripts.

In case of difficulty the Supervisor should telephone the Assistant Subject Officer for A Level Physics, Philip Bridgehouse, at AQA (Manchester Office), telephone number 0161 953 1180, or e-mail physics-gce@aqa.org.uk

Exercise 1

Candidates will be asked to charge capacitors using two circuits. The circuits are shown in **Figures A** and **B**. The circuit shown in **Figure A** should be set up for each candidate before the start of the exercise: **ensure that the positive terminal of the capacitor is connected to the positive terminal of the supply**.

The candidates will be expected to assemble the second circuit themselves.

Apparatus and materials

(a) 470 μF capacitor labelled **C** with its value obscured and the positive terminal clearly marked as such
(b) row of six 100 μF capacitors connected in series with the ends labelled **A** and **B**. End **A** should also be labelled with a minus sign and **B** with a plus sign
(c) switch, labelled **S**
(d) 100 kΩ resistor: this should be labelled with its value and mounted for easy connection into the circuit
(e) 1 MΩ resistor with its value obscured and labelled **R**: this should be mounted for easy connection into the circuit
(f) digital voltmeter
(g) 6 volt battery or stable power supply with the negative terminal clearly labelled as such
(h) stopclock or stopwatch reading to 0.1 or 0.01 s
(i) connecting leads
(j) two crocodile clips

The row of capacitors, **AB**, should be constructed with consistent polarity so that the end **A** is the negative terminal and end **B** positive. The connecting wires should be twisted and soldered together so that a crocodile clip can make good electrical contact between adjacent capacitors, as well as at **A** and at **B**.

Figure A

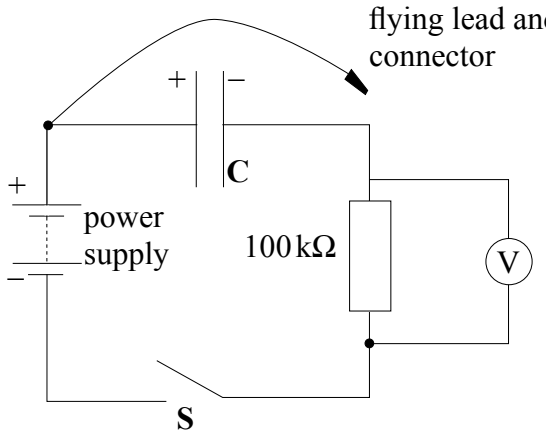
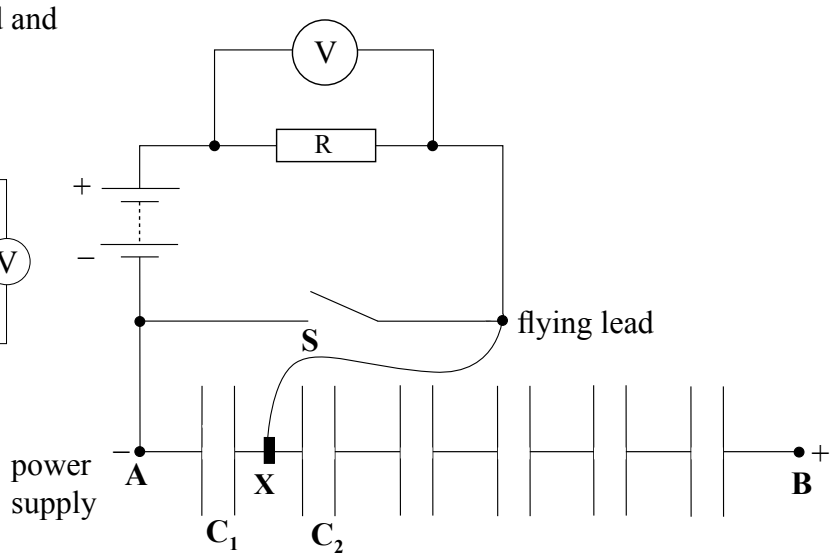


Figure B



Exercise 2

Question 1

Candidates will investigate the oscillations of a suspended bar magnet.

Apparatus and materials

(a) small bar magnet (e.g. ALN 050 from H Shaw Magnets of Sheffield, www.shawmagnets.com), the N-pole should be clearly marked as such

(b) non-magnetic 30 cm ruler

(c) two blocks of wood about 12 cm square and 2 or 3 cm thick

(d) a sticky label stirrup and a loop of thread for suspending the magnet: (see **Figure D** and the instructions below)

(e) a stopclock or stopwatch reading to 0.1 or 0.01 s

(f) a sheet of white paper fixed to the workbench with an arrow labelled N to show the direction a compass needle points when placed at that position

The candidates will assemble the apparatus as shown in **Figure C** with the magnet approximately 1 or 2 cm above the bench. The loop and stirrup suspension, shown in **Figure D**, can be made from a sticky address label and cotton thread with the thread holes a few mm apart. The suspension should be constructed so that the magnet makes *small* amplitude oscillations in a horizontal plane with a period of between 1 and 2 s when its rest position is as shown in **Figure C**. When the alignment of the magnet is reversed (S pole nearest north) the period of oscillation should be measurably longer: about 0.2 s longer would be ideal. To increase the period of oscillation, if necessary, the stirrup holes for the supporting thread should be positioned closer together.

Figure C

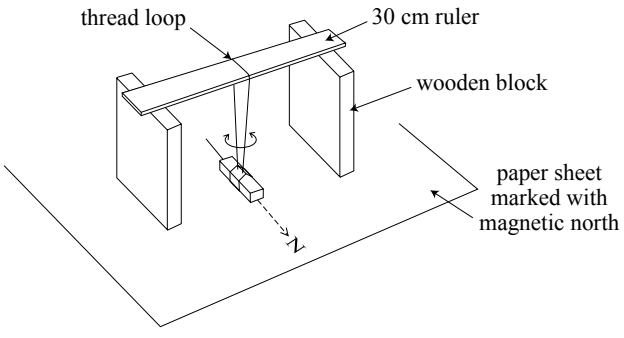
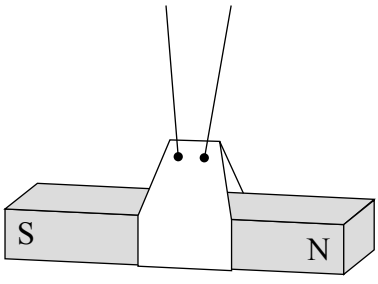


Figure D



Exercise 2

Question 2

The candidates will elastically stretch a length of nylon fishing line.

Apparatus and materials

(a) 80 – 90 cm length of 1.8 kg (4.0 lb) nylon fishing line

(b) two retort stands with bosses and clamps

(c) 100 g hanger and five 100 g masses

(d) triangular marker cut from a sticky address label

(e) metre ruler

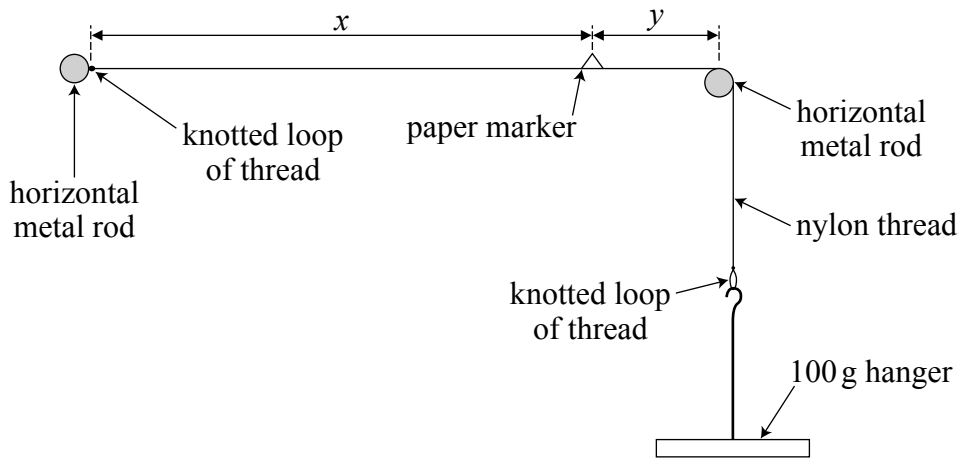
(f) micrometer screw gauge (may be shared by several candidates)

(g) means of ensuring that the retort stands do not slip e.g. G-clamps or weights

(h) safety goggles

The apparatus should be assembled for each candidate as shown in **Figure E**. The stands may need to be weighted, or clamped to the bench, so that they do not slip as the fishing line is loaded. The fishing line should be knotted firmly to the rod at one end and to the 100 g hanger at the other. The line should pass freely over the other metal rod, being held in position by the weight of the hanger. Distance *x* should be about 60 cm and *y* about 8 cm.

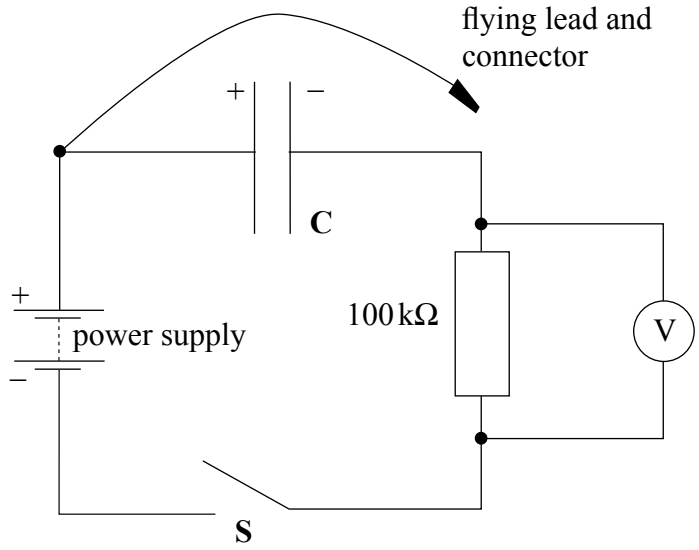
Figure E



Exercise 1

1 This question is about the process of charging capacitors in series.

Figure 1



(a) (i) The circuit shown in **Figure 1** has been set up for you and can be used to charge the unknown capacitor **C**.
Use the flying lead to fully discharge **C**.
With the flying lead disconnected, close switch **S** and, by taking readings every ten seconds, plot a graph of the potential difference, V, against time over a period of 100 s.
You are not required to take repeat readings for this part of the exercise.

(ii) Use your graph to find, as accurately as possible, the time taken for V to halve.
Hence calculate a value for the capacitance of **C**.

(iii) Explain why the potential difference across the 100 kΩ resistor decreases after the switch is closed.

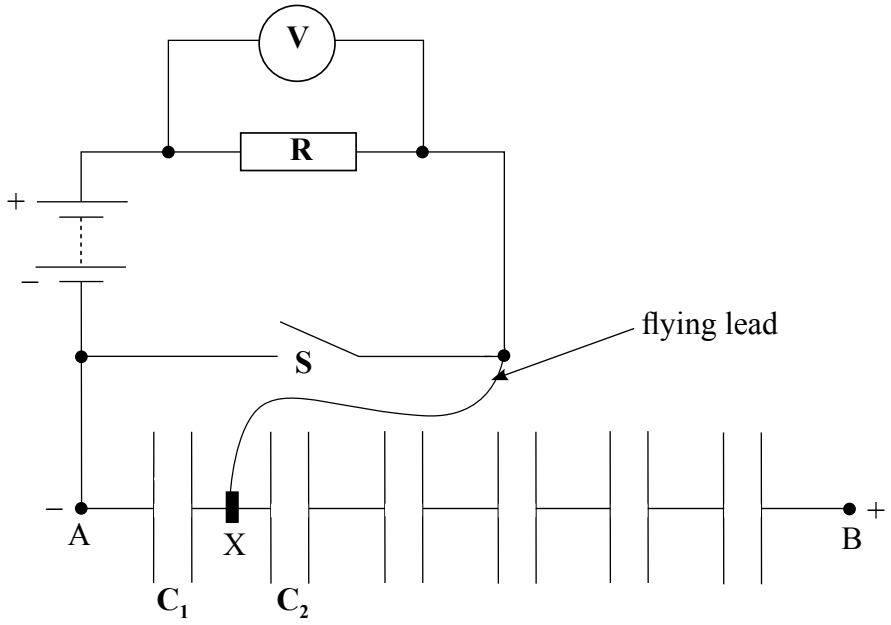
(12 marks)

(b) Fully dismantle your circuit and then connect the new circuit shown in **Figure 2**. **AB** is a row of six 100 μF capacitors connected in series. Use a crocodile clip for the connection at **A**.

Make sure that A is connected to the negative terminal of the supply.

X is a crocodile clip connection between $\mathbf{C_1}$ and $\mathbf{C_2}$, the first two capacitors in the row.

Figure 2



(i) Close switch **S**. With **S** closed, $\mathbf{C_1}$ remains fully discharged.
Record V_0, the reading on the voltmeter.
Open **S** and observe that the voltmeter reading decreases with time.
If your voltmeter reading does not decrease quite quickly when S is opened, ask your supervisor for help.

(ii) Close **S** to discharge $\mathbf{C_1}$.
When the voltmeter reads V_0 again, open **S** and start the stopclock.
Record V, the voltmeter reading after 10 seconds. *(2 marks)*

(c) Close **S**.
Attach the crocodile clip **X** between the second and third capacitors in the row **AB** so that $\mathbf{C_1}$ and $\mathbf{C_2}$ are charged in series when **S** is opened.

(i) Calculate the total capacitance of $\mathbf{C_1}$ and $\mathbf{C_2}$ connected in series.

(ii) Having first discharged $\mathbf{C_1}$ and $\mathbf{C_2}$, measure and record V, the voltmeter reading after 10 seconds, for $\mathbf{C_1}$ and $\mathbf{C_2}$ in series.

(iii) Measure V for 3, 4, 5 and 6 capacitors in series.
Record **all** of your readings for V in a table. Include in your table a column for n, the number of capacitors in series, and also a column for ln (V/V).
Complete the table. *(11 marks)*

(d) Plot a graph of ln (V/V) (y-axis) against n (x-axis).

(5 marks)

(e) Theory predicts that

$$V = V_0 \, e^{\frac{-nT}{RC}}$$

R is the resistance of the resistor shown in **Figure 2**, $C = 100\,\mu F$ and $T = 10\,s$.

(i) Use your graph to find R.

(ii) Use your graph to find a value for V_0 and compare it with your answer to part (b)(i).

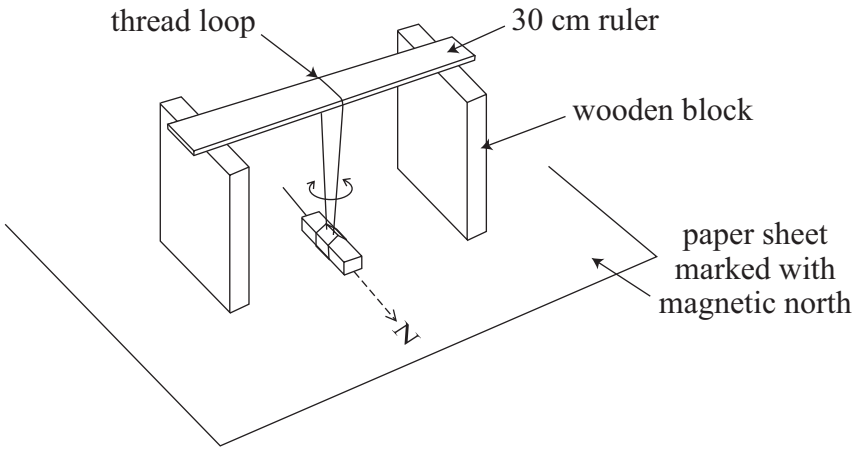
(iii) Suggest and explain **two** sources of uncertainty in your value of R.

(8 marks)

Exercise 2

1 This question is about a bar magnet oscillating in the Earth's magnetic field.

Figure 1



1 (a) Set up the apparatus as shown in **Figure 1**. The suspended magnet should be at rest a centimetre or two above, and parallel with, the marked line showing the direction of magnetic north. This line is drawn on a sheet of paper fixed to the bench. **The N pole of the magnet should point north**.

Displace the magnet and release it so that it oscillates through a small angle in the horizontal plane about a vertical axis through its centre.
Measure T_N, the period of oscillation of the magnet, and hence find its frequency of oscillation f_N .

(3 marks)

1 (b) Lift the ruler with the magnet and turn them around so that the magnet is at rest **with its S pole pointing north**.

Find the new frequency of oscillation, f_S.

(2 marks)

1 (c) (i) Calculate f_N^2 and estimate the absolute uncertainty in your answer.

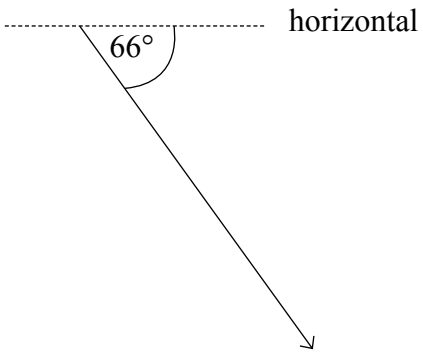
1 (c) (ii) Assuming that the absolute uncertainty in f_S^2 is the same as that for f_N^2, state the absolute uncertainty in $f_N^2 - f_S^2$.

1 (c) (iii) Calculate $f_N^2 - f_S^2$ and the percentage uncertainty in your answer. *(5 marks)*

1 (d) In the U.K., the flux density of the Earth's magnetic field is 1.7×10^{-4} T in a direction approximately 66° below the horizontal as shown in **Figure 2**.

Calculate B_H, the horizontal component of the Earth's magnetic field.

Figure 2



(2 marks)

1 (e) It can be shown that

$$f_N^2 - f_S^2 = kB_H ,$$

where k is a constant.

Since $f_N^2 - f_S^2$ depends on B_H, this experiment could be used as the basis for a method for investigating the variation in B_H around the World.

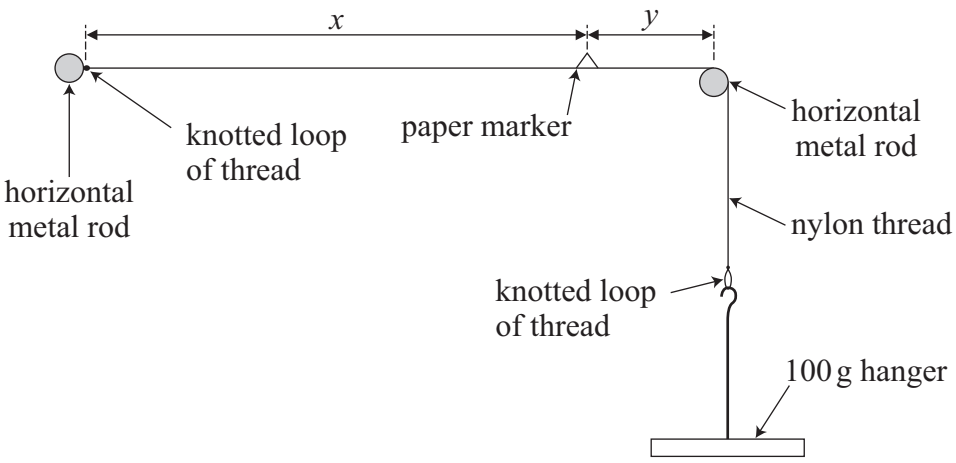
State the physical factors which affect the period of oscillation of the magnet and hence explain how the experiment could be made more sensitive to changes in B_H.

Two of the 8 marks are available for the quality of your written communication.

(8 marks)

2 This question is about elastic deformation of threads and wires.

Figure 3



2 (a) The apparatus shown in **Figure 3** has been set up for you. Measure and record the length, x, of the nylon thread, and the distance y.

(2 marks)

2 (b) Carefully increase the tension in the thread by adding five 100 g masses to the hanger, one at a time. Measure and record the distance y with the extra load of 500 g in place.

(1 mark)

2 (c) Carefully remove the 100 g masses one at a time until only the hanger is keeping the thread under tension once more.

2 (c) (i) Use the micrometer provided to measure the diameter of the thread.

2 (c) (ii) Use your readings from parts (a), (b) and (c)(i) to find the increase in stress and the increase in strain when the nylon thread was stretched by adding all five 100 g masses to the hanger.

gravitational field strength = $9.81\,\mathrm{N\,kg^{-1}}$

2 (c) (iii) How would doubling the length x affect your answers to part (c)(ii)? *(7 marks)*

2 (d) When a thread or wire is stretched, show that the Young modulus, E, for the material can be found from the formula

$$E = \frac{Fl}{A\Delta l}$$

where F is the stretching force, l is the unstretched length, A is the cross-sectional area and Δl is the increase in length. *(2 marks)*

Turn over ▶

2 (e) Two of the 8 marks in this question are available for the quality of your written communication.

2 (e) (i) If steel wire were to be used for the experiment instead of nylon thread, describe what changes should be made to the size of the sample under test to improve the accuracy of the measurement of the strain in the sample.

2 (e) (ii) Describe and explain what other changes could be made to the apparatus and to the method to find an accurate value for the Young modulus of steel.

(8 marks)

There are no notes printed on this page

General Certificate of Education
June 2008
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB6/TN
Unit 6

SUPERVISOR'S REPORT

When completed by the Supervisor, this Report must be attached firmly to the topmost script, before despatch to the Examiner.

Information from supervisor

Exercise 1 For circuit A: time for voltmeter reading to fall to half its initial value when switch S is closed.

.....s

For circuit B: typical voltmeter reading 10 s after switch S is opened with only C_1 connected to the circuit.

.....V

Exercise 2

Question 1: Typical period of oscillation with the N pole pointing north. .....s

Typical period of oscillation with the S pole pointing north. .....s

Question 2: Typical length of *y* with 100 g load .....m

Typical length of *y* with 600 g load .....m

Diameter of the nylon thread .....mm

Supervisor's Signature.....

Centre Number.....

Date.....

Centres may make copies of this *Supervisor's Report* for attachment to individual scripts where necessary.

There are no notes printed on this page