General Certificate of Education
January 2007
Advanced Subsidiary Examination

PHYSICS (SPECIFICATION B) **PHB3/TN**

ASSESSMENT and QUALIFICATIONS ALLIANCE

Instructions to Supervisors

CONFIDENTIAL

OPEN ON RECEIPT

The examination will be held on Wednesday 17 January 2007 1.30 pm to 3.30 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 strictly confidential and must be kept in safe custody by the Examinations Officer or by the Supervisor. They should be given to the Invigilator for the duration of the actual examination and afterwards returned to the Examinations Officer. Additional copies of these Instructions cannot be supplied by AQA.

INSTRUCTIONS TO THE SUPERVISOR OF THE PRACTICAL EXAMINATION

General

1 The 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.

2 The Supervisor has been granted access to the questions for the PHB3 examination as part of these Instructions. All the relevant questions are printed to enable the Supervisor to carry out the experimental parts of the paper in order to ensure that the apparatus and materials obtained are satisfactory. It is also hoped that they will be able to note that minor modifications can be made without jeopardising the integrity of the examination. Any problems should be discussed with AQA as early as possible. The Instructions must be returned to safe custody at the earliest possible moment after the Supervisor has ensured that all is in order.

3 A suitable laboratory, or laboratories, must be reserved for the examination and kept locked throughout the period of preparation. 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.

4 The examination paper contains three compulsory questions. Candidates are allowed 30 minutes on each of Questions 1 and 2, and 1 hour on Question 3.

5 In a centre with a large number of candidates it may be necessary for two or more examination sessions to be organised. 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.

6 Centres may provide sufficient sets of apparatus for half their candidates to work on Questions 1 and 2, while the other half work on Question 3. Under strict supervision, the groups of candidates change over after 1 hour. 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.

7 AQA will provide the question paper/answer books and A4 graph paper for use in Question 3. All other materials required must be provided by the centre.

8 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 wire up any electrical circuits except when specifically stated in these Instructions.

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

10 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.

11 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 Report 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 be included on the *Supervisor's Report*, separate sheets of paper, bearing the candidate's name and number, can be attached to the relevant candidate's script.

12 Note that candidates will require a separate sheet of A4 graph paper for Question 3. The graph paper for each candidate should be secured to their question paper/answer book using a treasury tag before despatch to the Examiner.

In case of difficulty the Supervisor should telephone the Senior Subject Officer for GCE Physics, David Baker at AQA (Manchester office), telephone number 0161 953 1180, or email dbaker@aqa.org.uk.

Question 1

Candidates will be asked to measure the current through different volumes of copper (II) sulphate solution.

Apparatus and materials

The following items should be supplied for each candidate:

(a) 100 ml beaker (see below)

(b) two strips of aluminium foil, 1 cm wide (see below)

(c) 1.5 V cell in a suitable holder

(d) about 120 ml of 0.5 M copper (II) sulphate solution in a suitable beaker. The beaker should be labelled *copper sulphate solution*

(e) measuring cylinder (100 ml or 50 ml would be suitable)

(f) switch

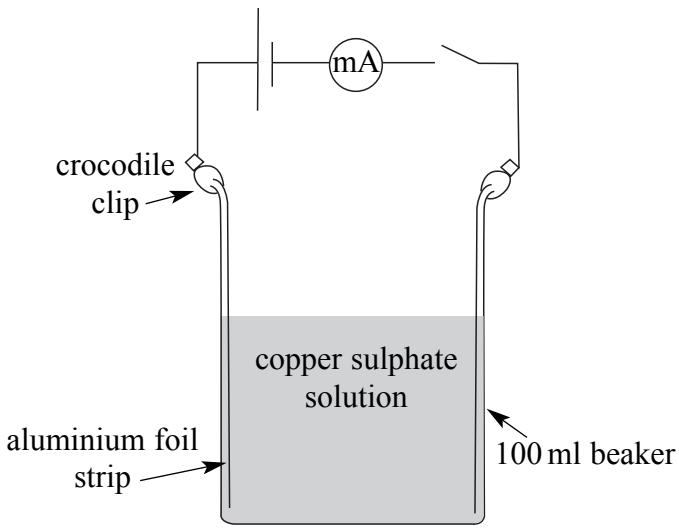
(g) ammeter capable of measuring currents up to 10 mA

(h) suitable connecting leads

(i) two crocodile clips to connect with the foil strips (see below).

The strips of aluminium foil should just reach the bottom of the 100 ml beaker and should be long enough to overlap the beaker rim. The strips should be fixed with the crocodile clips to opposite sides of the beaker as shown in **Figure A** ensuring good electrical contact. In tests it was found that it was easier to position the foil strips if the inside of the beaker was already wet.

Figure A



The circuit shown in **Figure A** is to be connected by the candidate. With 75 ml of the copper sulphate solution in the beaker the current should be at least 3 mA. It may be necessary to adjust the concentration of the solution and/or use more cells in series to achieve this.

Question 2

Candidates will be asked to take and analyse angular measurements for a pivoted ruler.

Apparatus and materials

The following items should be supplied for each candidate:

(a) 30 cm clear plastic ruler

(b) plastic protractor (radius about 5 cm)

(c) adhesive tape

(d) plumb line consisting of strong cotton thread with a mass attached

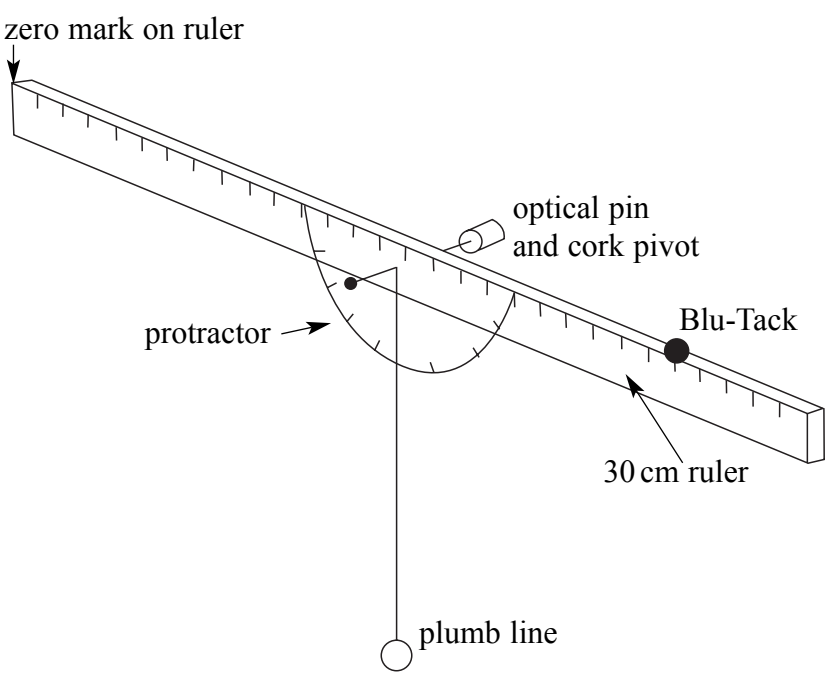
(e) retort stand, boss and clamp

(f) an optical pin pushed into a cork to act as a pivot

(g) a small piece of Blu-Tack of sufficient mass to give a declination of about 40 degrees when fixed above the 30 cm mark of the ruler.

The ruler should be firmly attached (eg with adhesive tape) to the plastic protractor so that the protractor origin coincides with the 15 cm mark on the ruler, and the straight edge of the protractor is aligned with the upper edge of the ruler. The fully assembled apparatus is shown in **Figure B**.

Figure B



A small hole should be pierced through the protractor and the ruler at the origin of the protractor so that the assembly swings freely when supported by the optical pin which is clamped horizontally. The plumb line should also be suspended from the optical pin.

Note: When supported by the pin without the Blu-Tack in place, the ruler should come to rest sloping downwards **to the left** by 2 or 3 degrees. This angle can be measured as the angle between the 90° line on the protractor and the plumb line. If necessary, extra adhesive tape can be attached to one end of the ruler to produce this zero error.

The apparatus should be fully assembled for the candidate.

Question 3

Candidates will be asked to time the oscillations of a loaded half-metre ruler which has one end resting on a horizontal rod and the other supported by a spiral spring. The apparatus is shown in **Figure C**.

Apparatus and materials

The following items should be supplied for each candidate:

(a) short spiral spring with a spring constant of about 25 N m^{-1} (an expendable spring (B6G87194) from Philip Harris is suitable). One end of the spring should have a loop of strong thread attached which is just large enough for the ruler to fit inside it;

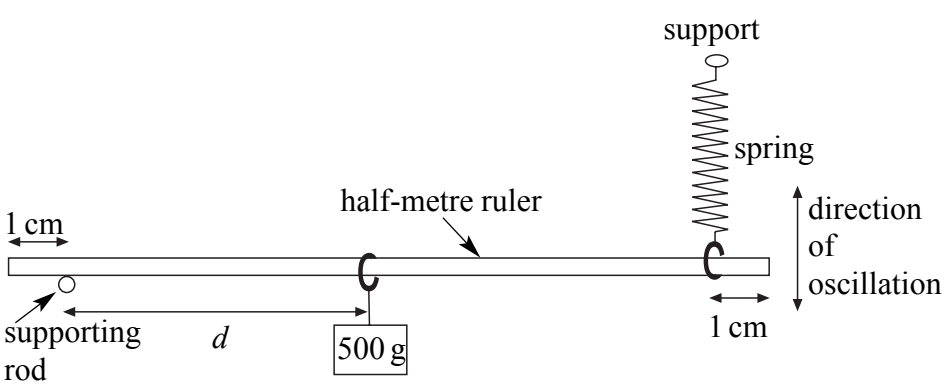
(b) two retort stands, each with a boss and clamp;

(c) 500 g load (eg. a 100 g hanger plus four 100 g masses) suspended from a short loop of strong thread which is just large enough to fit over the ruler;

(d) stopclock or stopwatch reading to 0.1 or 0.01 s;

(e) half-metre ruler.

Figure C

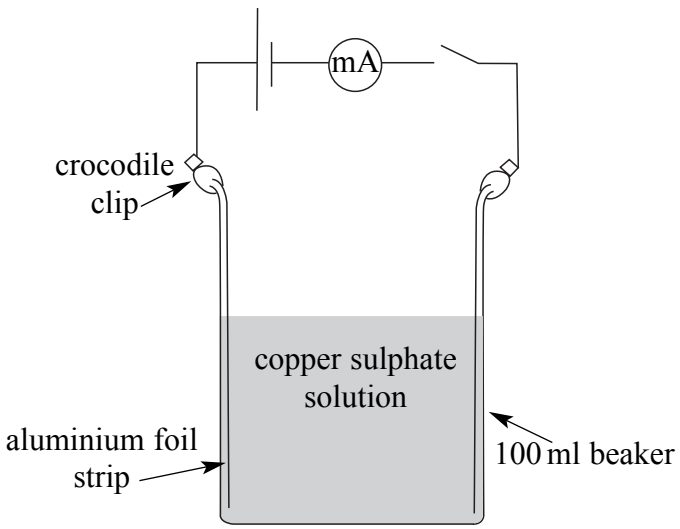


Note: the rod of one of the clamps is to be used as the supporting rod.

The apparatus should be assembled for the candidate with the supporting rod and the lower end of the spring several centimetres from the ends of the ruler.

1 You are going to investigate electrical conduction in a liquid and consider the physical factors that affect the magnitude of the current.

Figure 1



(a) (i) The apparatus is shown in **Figure 1**. Connect the circuit and, using the measuring cylinder, pour 25 cm^3 of the copper sulphate solution into the beaker. Switch on the circuit, measure and record the maximum current I and then switch off the circuit.

(ii) Add a further 25 cm^3 of the solution, switch on the circuit, measure and record I and then switch off the circuit.

(iii) Add a further 25 cm^3 of the solution, switch on the circuit, measure and record I and then switch off the circuit. *(4 marks)*

(b) It is suggested that I is directly proportional to the volume of liquid in the beaker. Without plotting a graph, use your data from part (a) to test this suggestion. Show your working and clearly state your conclusion. *(4 marks)*

(c) The value of I is affected by the volume of liquid in the beaker, the separation of the foil strips and the properties of the power supply circuit. State **two** other physical factors that you would expect to affect I. *(2 marks)*

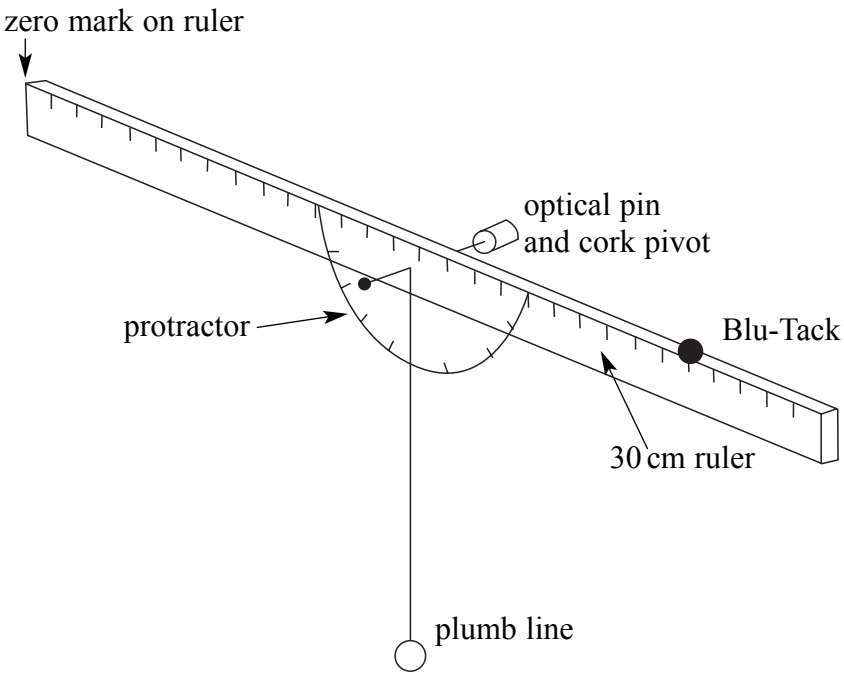
(d) With the aid of a sketch graph, explain how you would expect I to vary with the separation of the foil strips. *(3 marks)*

(e) Carefully describe how you would perform an experiment to test the prediction implied by your answer to part (d).

Two of the 7 marks in this question are for the quality of your written communication. *(7 marks)*

2 The apparatus has been set up for you as shown in **Figure 2**.

Figure 2



(a) Remove the Blu-Tack and measure the angle between the plumb line and the 90° line on the protractor. This is the zero error for your apparatus. *(1 mark)*

(b) (i) Attach the piece of Blu-Tack at the 20 cm mark on the ruler and record the angle between the plumb line and the 90° line on the protractor.

(ii) Calculate the angle θ given by your value from part (b)(i) corrected by the zero error recorded in part (a). *(2 marks)*

(c) Take appropriate readings and complete the table in **Figure 3**. d is the distance between the Blu-Tack and the pivot and ϕ is the mean value of θ.

Figure 3

***d*/cm**	**θ/degrees**			**ϕ/degrees**	**tanϕ**
5.0					
10.0					
15.0					

(4 marks)

(d) Estimate the absolute uncertainty in your readings for θ and show clearly how you arrived at this estimate. *(3 marks)*

(e) Theory suggests that for this experiment the ratio $\frac{d}{\tan\phi}$ is a constant. Using data, estimate the percentage uncertainty in the value of $\frac{d}{\tan\phi}$ for $d = 5.0\,\text{cm}$. Show your working clearly.

In this case, you may assume that the percentage uncertainty in $\tan\phi$ is the same as the percentage uncertainty in ϕ.

(3 marks)

(f) Describe an experiment, based on the apparatus used in this question, to verify as accurately as possible that $\frac{d}{\tan\phi}$ = constant.

You should clearly identify sources of uncertainty and then suggest ways to minimise them.

Two of the 7 marks in this question are for the quality of your written communication. *(7 marks)*

Turn over for the next question

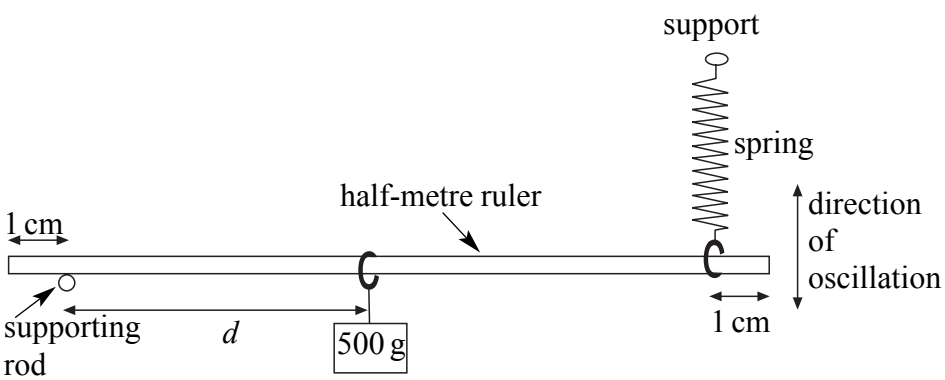
3 You are going to investigate how vertical oscillations of a supported beam are affected by the loading of that beam. Assemble the apparatus as shown in **Figure 4**.

The supporting rod at one end, and the loop at the bottom of the spring at the other end, should each be positioned **1 cm from the end of the ruler**.

Initially, the 500 g load should be suspended so that $d = 0.450$ m.

The spring should be vertical.

Figure 4



It is important that, each time the apparatus is adjusted, the half-metre ruler is resting horizontally with its supports 1 cm from its ends, before it is set in motion.

(a) Carefully displace the right-hand end of the ruler a short distance downwards and then release it so that it oscillates in a vertical plane. Take sufficient measurements to determine accurately the period T of these oscillations. *(4 marks)*

(b) You are going to investigate how the period of oscillation T varies with the distance d shown in **Figure 4**, where d is measured in metres.

(i) In the space below, draw a table in which to record **all** of your measurements. Include in your table columns for recording d^2 and T^2.

(ii) Complete your table making measurements of T for values of $d = 0.250$, 0.300, 0.350 and 0.400 m. *(18 marks)*

(c) (i) On a separate sheet of graph paper, plot a graph of T^2 (y-axis) against d^2. Start both origins at zero.

Draw the best straight line through your points. *(7 marks)*

(ii) Determine the gradient of your graph. *(3 marks)*

(d) Theory suggests that the equation for your line is

$$T^2 = \frac{A}{k}d^2 + B$$

where $A = 86\,\text{kg}\,\text{m}^{-2}$
k is the spring constant
and B is a constant for the apparatus.

The equation for a straight line graph is $y = mx + c$.

Use your gradient to calculate k. *(3 marks)*

(e) (i) Determine the period when d is zero.

(ii) Suggest a reason why the graph does not pass through the origin. *(3 marks)*

END OF QUESTIONS

There are no instructions printed on this page

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ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) **PHB3/TN**
Unit 3

SUPERVISOR'S REPORT

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

Information to be provided by the centre

Question 1 No information is required

Question 2 No information is required

Question 3 Period of oscillation of the apparatus when arranged as in **Figure C** for values of $d = 0.450$ m and $d = 0.250$ m.

***d*/m**	**Period/s**
0.450	
0.250	

Supervisor's Signature.....

Centre Number.....

Date.....

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