

General Certificate of Education
June 2006
Advanced Subsidiary Examination



PHYSICS (SPECIFICATION B)

PHB3/TN

Instructions to Supervisors

CONFIDENTIAL

OPEN ON RECEIPT

The examination will be held on Wednesday 17 May 2006 9.00 am to 11.00 am

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 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. Requests for such arrangements, giving full details of invigilation arrangements and times, must be made in writing to AQA, Devas Street, Manchester, M15 6EX.
- 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 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.

- 6 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.
- 7 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.
- 8 Clear instructions 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.**

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- 9 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.

- 10 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.

- 11 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.
- 12 The examination room must be cleared of candidates immediately after the examination.

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

Question 1

Candidates will make measurements of the horizontal distance travelled by a marble as it falls from the work bench, having been propelled by a compressed spring.

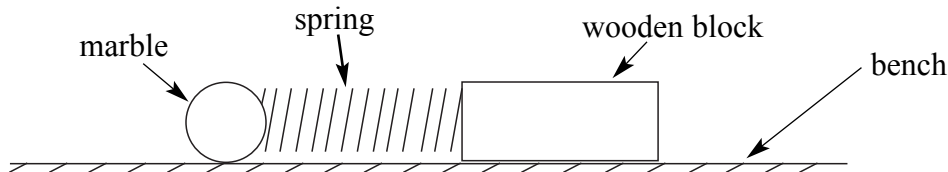
Apparatus and materials

The following items should be supplied for each candidate:

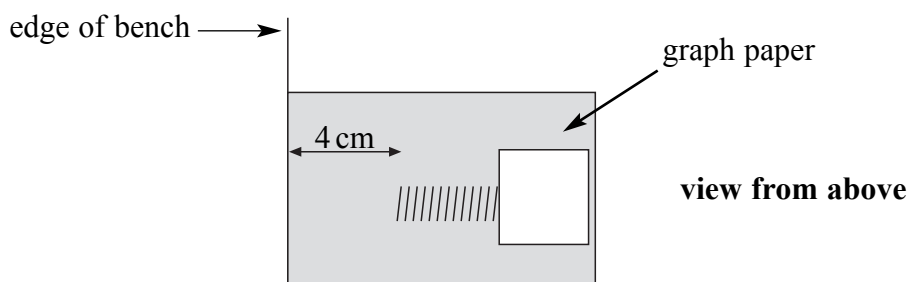
- (a) a disposable spring, pre-stretched to a length of approximately 7 cm (not counting the rings at the ends);
- (b) a small wooden block (approximate size 2 cm × 3 cm × 3 cm);
- (c) a piece of A4 2 mm graph paper;
- (d) a G-clamp to keep the wooden block in position;
- (e) a 2.5 cm diameter marble;
- (f) a thick cardboard sheet of approximately A3 size to protect the floor;
- (g) an additional answer sheet;
- (h) a marker pen for candidates to mark the position at which the marble lands;
- (i) a metre ruler;
- (j) a card, positioned near the apparatus showing the time taken by the marble to fall from the bench and the mass of the marble.

The rings at the ends of the spring should be removed using pliers or wire cutters and care should be taken that the ends do not protrude dangerously. The spring should be attached by staples to the small wooden block that can be clamped to the bench. See **Figure A**.

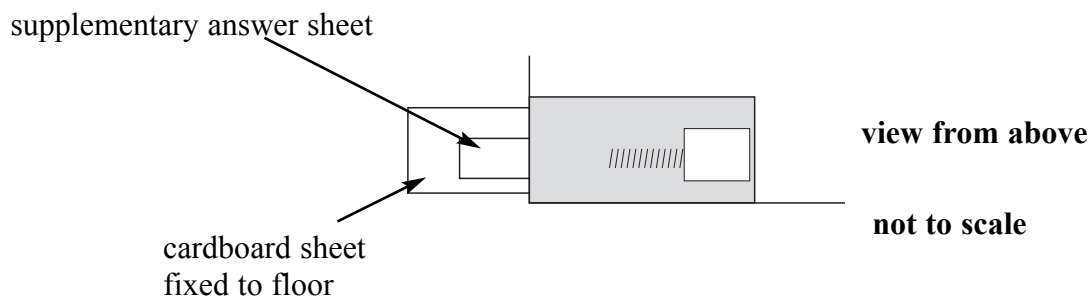
Figure A



The piece of graph paper is to be positioned under the block and spring so that candidates can easily judge the compression of the spring when the marble is pushed back against it. See **Figure B**. One of the graticule lines should be aligned with the free end of the spring, which should be approximately 4 cm from the edge of the bench.

Figure B

One edge of the cardboard should be fixed to the floor and aligned with the edge of the bench so that candidates can easily measure the horizontal distances travelled by the marble as it falls off the bench. This edge should be clearly marked “Position of the Edge of the Bench”. See **Figure C**. The supplementary answer sheet should be provided for each candidate, with the top of the sheet aligned with the edge of the bench and fixed appropriately. **The supplementary answer sheet must be included with the candidate’s script.**

Figure C

The time t , calculated by centres should be expressed to 2 significant figures with an uncertainty of 2% marked. For example “Time for marble to fall = $t = 0.32 \text{ s} \pm 2\%$ ”. t may be calculated by the formula:

$$t = \sqrt{2 \times \frac{\text{height of bench}}{9.81}}$$

The mass of the marble should be given in kg, in standard form and quoted to 2 significant figures with an uncertainty of 5% marked. For example “Mass of the marble = $m = 2.1 \times 10^{-2} \text{ kg} \pm 5\%$ ”

Question 2

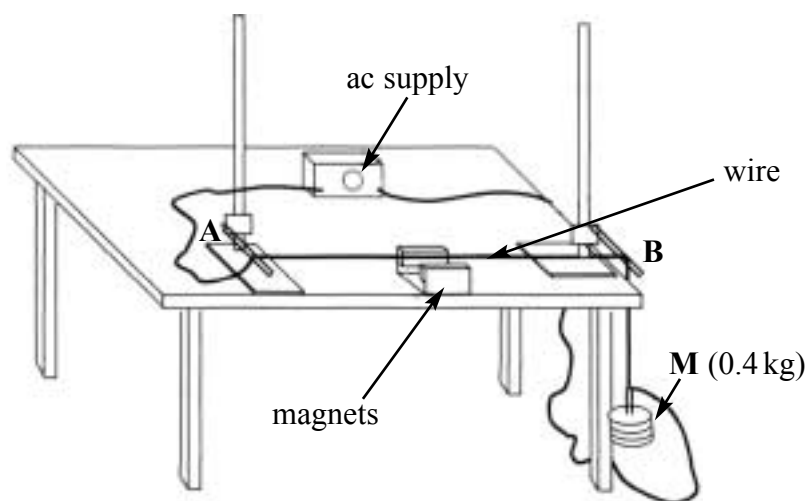
Candidates will investigate standing waves on a stretched wire. The vibrations will be produced by passing an ac current through the wire which is positioned between a pair of magnets.

Apparatus and materials

The following items should be supplied for each candidate:

- approximately 3 m of 32 swg or 33 swg copper wire (diameter approximately 0.26mm). The wire should be polyurethane coated;
- a low voltage ac supply capable of delivering approximately 5 V at 50 Hz;
- connecting wires and crocodile clips;
- two magnadur magnets, with opposite poles facing, on a yoke;
- two sets of retort stands, clamps and bosses;
- G-clamps to prevent the retort stands from sliding along the bench;
- one 100 g mass hanger and three 100 g masses;
- two metre rulers;
- a length of masking tape.

Figure D



The apparatus should be set up as shown in **Figure D** with the distance **AB** less than the resonant length. The copper wire should be attached to the horizontal rod of stand **A** with an appropriate knot that will not weaken the wire. The wire should hang freely over the clamp's horizontal rod on stand **B**. A loop should be tied in the wire in a suitable position for the attachment of the masses so that the length between **A** and **B** can be varied. Sufficient of the copper wire should be left dangling on the floor so that the weight of the connecting wires does not increase the tension in the wire. The insulation should be cleaned from the copper wire before connections are made to its ends. The stand at the end of the bench (**B**) must be positioned so that the wire hangs freely over the edge of the bench. The other stand (**A**) should be made easy to release from the G-clamp so that the candidates can move it along the bench and clamp it in a new position.

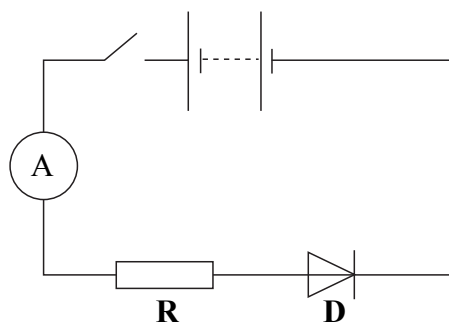
The supervisor should establish the resonant length of the wire in the manner described in the question. A 20 cm length of masking tape should be stuck near the edge of the table parallel to the wire. On the tape should be written: “the position of the end of the wire (A) required is within this range”. It may be advisable to have new lengths of copper wire available but it is not necessary routinely to change the wire for each candidate.

Turn over for Question 3

Question 3

Candidates will make measurements of the current in an electrical circuit that contains a diode.

Figure E



Apparatus and materials

The following items should be supplied for each candidate:

- three 3D type cells in holders. Fresh cells should be available for each candidate. Centres could substitute a stabilised voltage supply giving approximately 5 V but candidates may have difficulty in determining the internal resistance of the supply;
- a card marked with the combined emf of the cells given to 3 significant figures eg “emf of cells, $E = 4.66 \text{ V}$ ”;
- two 10Ω , one 33Ω and one 68Ω resistors labelled with their values and with suitable holders to allow candidates to place them in series combinations in the circuit (**Figure E**). The resistors should be able to stand a current of up to 0.4 A. 2 W resistors would be appropriate.
(for example Rapid Electronics PR02 2W 5% metal film resistors, numbers 62-6708, 62-6714 and 62-6718 respectively);
- a 1N5401 diode (available for example from Rapid Electronics; item number 47-3144) or similar;
- an ammeter capable of reading up to 0.4 A to a precision of 0.01 A;
- connecting wires;
- a switch.

The circuit should be set up with a gap where the combination of resistors, **R**, should go. New resistors should be available for each candidate. Spare cells and diodes should be available. Supervisors should check that the diodes are connected the correct way round by trying the experiment and making sure that there is a reading on the ammeter.

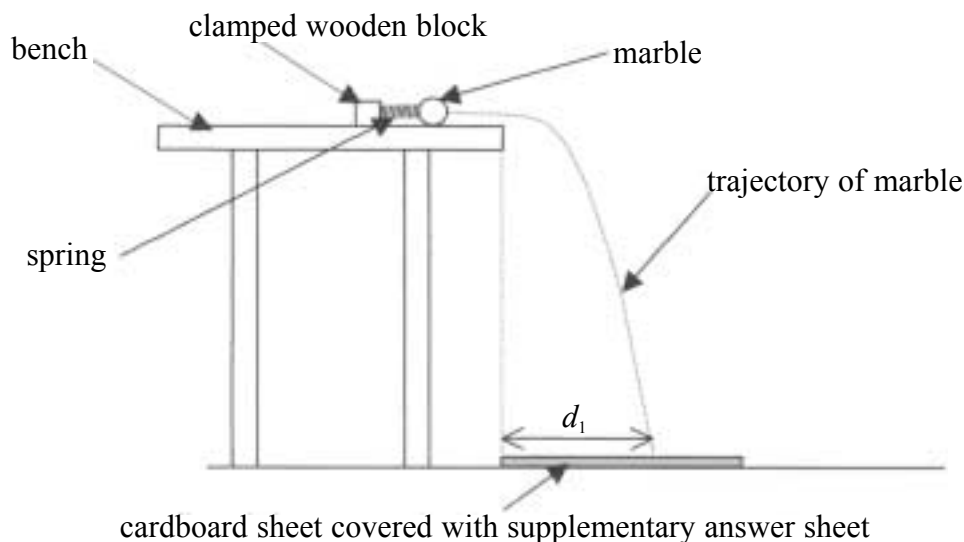
END OF TEACHERS NOTES

Answer **all** questions.

30 minutes are allowed for this question.

- 1 You are going to investigate the kinetic energy given to a marble which is fired from a compressed spring.

Figure 1



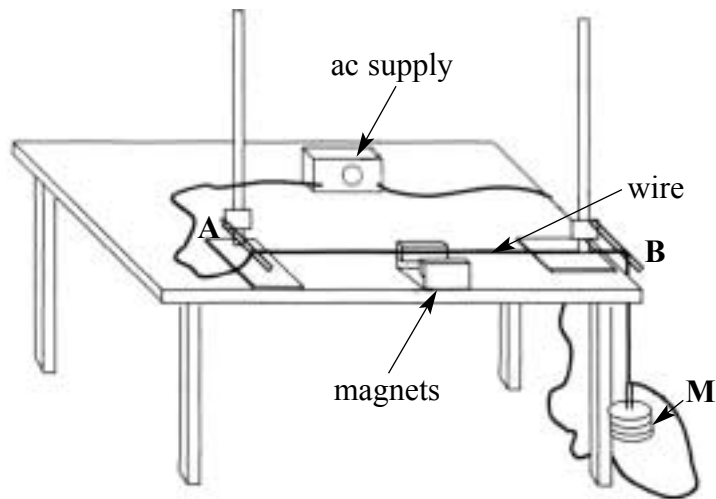
- (a) (i) Compress the spring by 1.0 cm by pushing the marble against it. Release the marble so that it is projected over the edge of the bench. The marble must land on the supplementary answer sheet. Observe where the marble falls and mark the position with the marker pen. Measure and record d_1 , the horizontal distance moved by the marble as it falls from the bench. The edge of the cardboard sheet is aligned with the edge of the bench.
- (ii) Calculate the horizontal component of the velocity of the marble. You will need to use the value of t , the time taken for the marble to fall from the bench to the floor. The time, t , is given on the card near your apparatus.
- (iii) Assume that the horizontal component of the velocity of the marble as it falls is the same as the velocity of the marble as it leaves the spring. Calculate the kinetic energy of the marble as it leaves the spring. The mass of the marble is given on the card near your apparatus.

(6 marks)

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- (b) (i) Compress the spring by 3.0 cm by pushing the marble against it. Release the marble so that it is projected over the edge of the bench. Observe where the marble falls and mark the position with the marker pen. Measure and record d_2 , the new horizontal distance moved by the marble as it falls from the bench.
- (ii) Calculate the new horizontal component of the velocity of the marble.
- (iii) Calculate the new kinetic energy of the marble as it leaves the spring. *(3 marks)*
- (c) Theory suggests that the kinetic energy of the marble as it leaves the spring is directly proportional to the square of the compression of the spring. By making suitable calculations, determine whether or not your measurements support this theory. *(3 marks)*
- (d) (i) State the absolute uncertainty in your measurement of d_1 .
- (ii) Calculate the percentage uncertainty in your measurement of d_1 .
- (iii) Calculate the percentage uncertainty in your value of the horizontal component of the velocity of the marble when the spring was compressed by 1.0 cm.
- (iv) Calculate the percentage uncertainty in your value of the kinetic energy of the marble when the spring was compressed by 1.0 cm. *(4 marks)*
- (e) Without considering any other uncertainty, state and explain whether the uncertainty in your value of the kinetic energy of the marble affects your conclusion in part (c). *(3 marks)*

- 2 You are going to investigate standing waves on a stretched wire. The wire is tensioned by the load **M**. It is made to vibrate by the effect of passing an alternating electric current through the wire that is positioned between two magnets. The frequency of the alternating current is 50 Hz and the wire is made to vibrate at that frequency. For best results, the magnets should be placed on each side of the midpoint of the wire.

Figure 2



- (a) Switch on the variable voltage ac supply and move stand **A** away from stand **B** until you see a large amplitude single loop standing wave on the wire. Adjust the position of stand **A** until the amplitude of oscillation is a maximum. You may find that when you stop moving the stand, the oscillation dies away. The required length, l , is the length of the wire between **A** and **B** at which you first observe the maximum amplitude oscillations of the wire.
- Measure and record the length, l , in metres.
 - State the wavelength of the standing wave on the wire.
 - Sketch below **two** further possible modes of vibration for the wire, other than the fundamental. For each mode, write down the frequency of vibration of the wire.
 - Suggest reasons why it is difficult to determine precisely the length at which the wire vibrates with maximum amplitude.

(7 marks)

- (b) The equation for the magnitude, in Hz, of the fundamental frequency of vibration for the wire is:

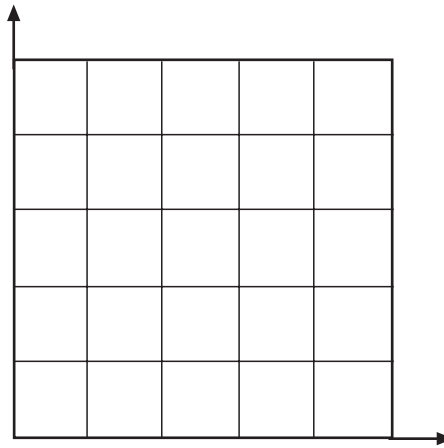
$$f^2 = \frac{T^2}{4l^2m}$$

where m = the mass per unit length of the wire, in kg m^{-1}

and l = the length of the wire in m

T = the tension in the wire = 4.0 N

- (i) Calculate a value for m , using your measured value for l .
- (ii) Sketch the graph you would expect of f^2 against m for wires of the same length and tension.



(4 marks)

- (c) Describe how you would investigate the relationship between the mass per unit length of a wire and the fundamental frequency. You should include the following in your account:

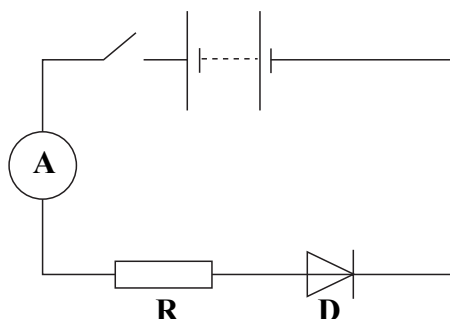
- the measurements you would make and the instruments you would use to perform a fair and accurate investigation,
- any improvements you would make in the apparatus and any safety precautions that may be necessary,
- the ranges of values you would use,
- details of how you would demonstrate whether or not your results supported the validity of the equation give in part (b).

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

(8 marks)

- 3 You are going to make measurements that will allow you to investigate the variation of the current in a circuit containing a diode. Do not reverse the connections to the battery or the diode.

Figure 3



- (a) In the space below, sketch a graph to show the variation of current with applied potential difference for a diode, giving typical values on the potential difference axis. (2 marks)
- (b) Explain how it is possible to use the resistors you have available to get a range of resistances, giving numerical examples. Two of the 6 marks are available for the quality of your written communication. (6 marks)
- (c) (i) Use a series combination of some or all of the four resistors labelled **R** to make a resistance of approximately $100\ \Omega$. Place your combination of resistors in series with the diode and record the current, I , in amps. Also record $\frac{1}{I}$ and R , the value of your combination of resistors.
- (ii) You are going to create five **additional, smaller** values of R and, for each value, measure the appropriate value of I . You should use only series combinations of resistors. Create a table in which to record all of your sets of values of R and I . Your table should also include space for values of $\frac{1}{I}$.
- (iii) Measure and record in the table corresponding values of R and I . **You should not use values of R that are less than $10\ \Omega$.** Also record values of $\frac{1}{I}$ in your table. (17 marks)
- (d) (i) On a sheet of graph paper, plot a graph of $\frac{1}{I}$ (on the y -axis) against R (on the x -axis). Include the origin on both axes.
- (ii) Draw the best fit straight line for your plotted points.
- (iii) Determine the gradient of your best fit line. (11 marks)

(e) The equation describing the graph is:

$$\frac{1}{I} = \frac{k}{E} R + \frac{r}{E}$$

where E = the combined emf of the cells (given on a card near your apparatus)

r = the combined internal resistance of the cells

k = a constant

The general equation for a straight line graph is:

$$y = mx + c$$

- (i) Use your value of the gradient of the graph and the data given on the card to calculate the value of the constant, k .
- (ii) Use the intercept of the graph and the data given on the card to calculate the value of the combined internal resistance, r , of the cells.

(4 marks)

END OF QUESTIONS

General Certificate of Education
June 2006
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**PHYSICS (SPECIFICATION B)
Unit 3**

PHB3/TN

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 required

Question 2 No information required.

Question 3 No information required

Comments:

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 questions printed on this page