

General Certificate of Education  
January 2006  
Advanced Subsidiary Examination



**PHYSICS (SPECIFICATION B)**

**PHB3/TN**

**Instructions to Supervisors**

**CONFIDENTIAL**

**OPEN ON RECEIPT**

The examination will be held on Tuesday 17 January 2006 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.**

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## 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 examinations. 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.

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- 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.

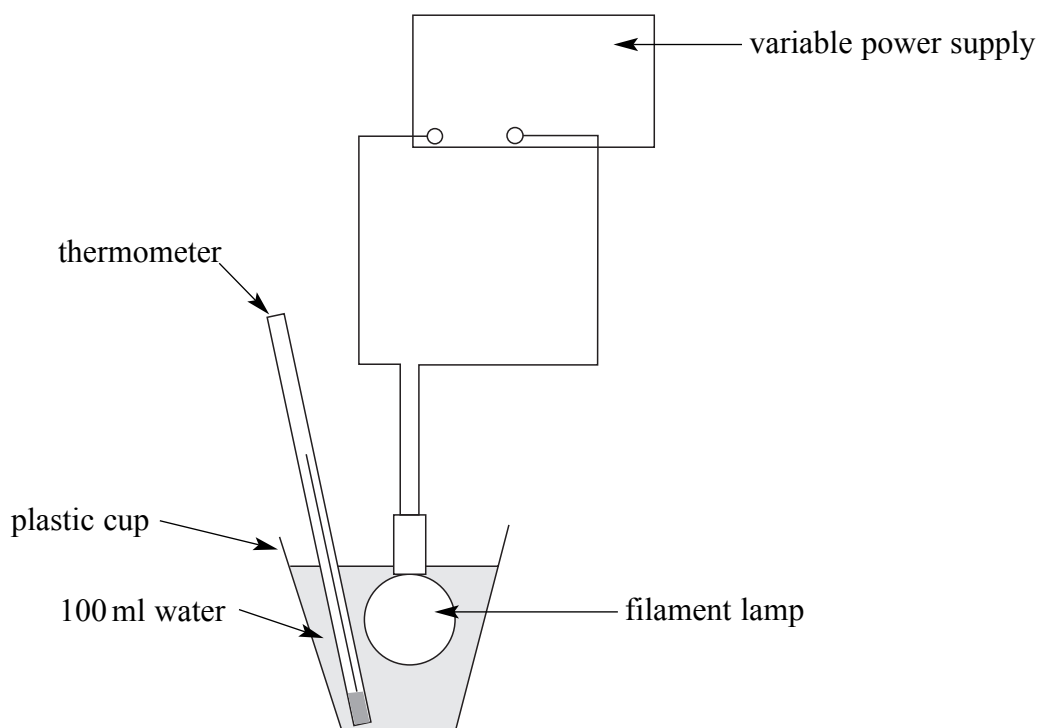
Centres may make copies of this *Supervisor's Report* for attachment to individual scripts if necessary. If all the information cannot be included on the *Supervisor's Report*, separate sheets of paper, bearing the candidate's name and number, can be attached to the relevant candidate's script.

- 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](mailto:dbaker@aqa.org.uk).

**Question 1**

Candidates will measure the temperature rise of 100 ml of water which is heated by a filament lamp.

**Apparatus and materials**

The following items should be supplied for each candidate:

- disposable plastic or polystyrene cup containing 100 ml of cold water;
- thermometer capable of measuring temperatures in the range 0 – 100 °C;
- 12 V 21 W, 12 V 24 W or 12 V 36 W filament lamp in a suitable bulb holder or having leads soldered to the connections at the base of the lamp. Suitable lamps may be those taken from some types of ray boxes or car headlamp bulbs or brake light bulbs available from car accessory shops or from RS components (part number 307-8416);
- variable voltage supply capable of providing at least 10 V to power the lamp;
- connecting wires;
- clamp and stand;
- card stating the power delivered to the lamp to 2 significant figures. The card should read, for example, “power input to the lamp = 17 W”;
- stopwatch or stopclock;
- Blu-Tack;
- switch, if power supplies are to be shared.

The circuit should be set up for the candidates. The variable voltage supply should be set to an appropriate setting for the lamp and should be provided with a label instructing candidates not to adjust the voltage.

The cup should be stuck down with Blu-Tack or similar, to prevent it falling over.

The lamp should be placed in the cup and the connecting wires gently supported by a clamp and stand so that the glass part of the bulb is immersed in the water.

Should centres need to share power supplies between candidates, they should provide wires long enough to do so and a switch for each candidate. Candidates should be advised that they may ignore any power fluctuations that occur when other candidates turn their lamps on or off. The marking of the work will not be affected by such fluctuations.

## **Question 2**

Candidates will be expected to make observations of a light ray travelling through a rectangular glass or perspex block. They will also take measurements from a ray diagram, provided for them, in order to determine the refractive index of the material of a similar block.

### **Apparatus and materials**

The following items should be supplied for each candidate:

- (a) a rectangular glass or perspex block of approximate size  $13\text{ cm} \times 7\text{ cm}$ ;
- (b) a ray box, power supply and slit so that candidates can shine a single ray of light through the block;
- (c) a protractor;
- (d) a 30 cm ruler.

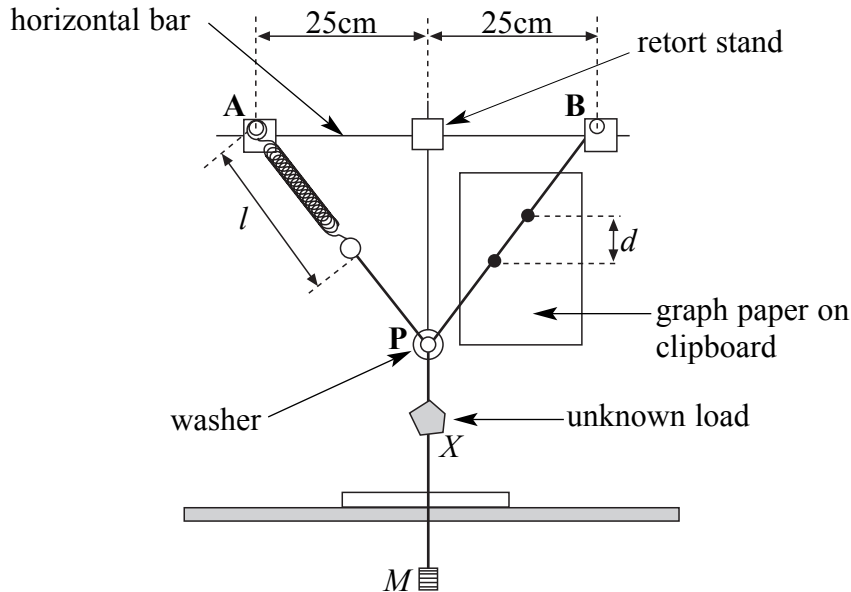
Power supplies may be shared between 2 or 3 candidates, in which case centres should provide wires long enough for candidates to be able to work independently.

The ray box should be connected ready for use. The glass or perspex block should be placed on a sheet of white paper (A4).

A blackout is not necessary for this experiment but the workspace needs to be dim enough for candidates to be able to observe the rays.

### Question 3

Candidates will be expected to make measurements of the extension of a spring in a network of strings. They will then be expected to determine a value for an unknown mass suspended in the string network.



### Apparatus and materials

The following items should be supplied for each candidate:

- disposable spring;
- card marked with the unstretched length of the spring;
- approximately 100 cm of fine white string;
- two retort stands, clamps and bosses;
- metal bar (eg retort stand rod) or wooden bar from which to suspend the network;
- small washer of internal diameter approximately 6 mm;
- 0.10 kg mass hanger and 5 additional 0.10 kg slotted masses;
- load of between 0.10 kg and 0.20 kg (labelled  $X$ ) with no indication of mass shown on it;
- 30cm ruler;
- clipboard, or piece of hardboard, with piece of mm graph paper attached.

The disposable spring should have been pre-stretched so that its coils are just separated when the spring is unloaded.

The card described in (b) above, should give the data to 2 significant figures. So, for example, the card may read: unloaded length of the spring = 0.053 m

One retort stand should be used to support the network. A boss should be used to support a horizontal bar, holding two further bosses and clamps. Alternatively, if a wooden horizontal bar is used, eyelets may be screwed into the bar to act as attachment points. The second stand should support the clipboard holding the graph paper close behind the right-hand side section of the string. The graph paper must be accurately aligned horizontally and vertically. G-clamps or other suitable means should be used to stabilise the stands.

One length of fine string should be attached to the spring, the washer should be threaded onto it and the other end of the string should be attached to the right hand clamp. When knotted and in place between the spring and the clamp, the string should be approximately 50 cm long.

The washer should be able to slide along the string attached to the spring. The movement of the washer along the string need not be frictionless. A second piece of string should be suspended from the washer. The unknown load should be tied half way along this string. The lower end of the string should be tied in a loop so that the mass hanger may be suspended from it. The system should be symmetrically placed so that **P** is directly in front of the vertical retort stand.

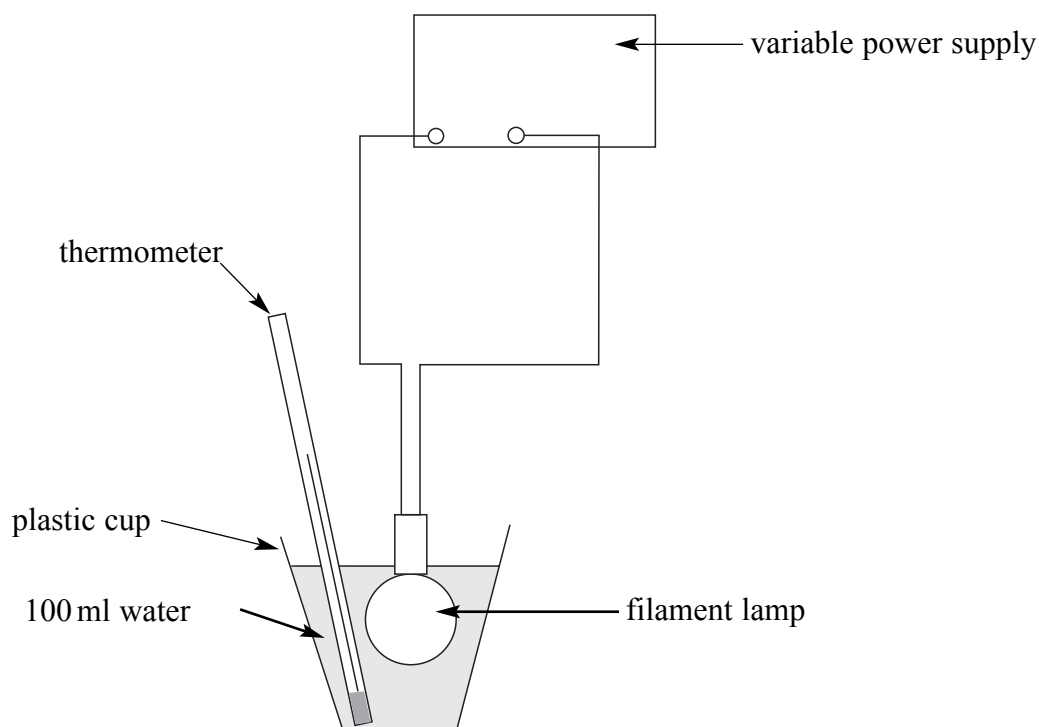
Two small but clear ink marks should be made on the string 100 mm apart. They should be added in a suitable position when the string is arranged as required in the question with the 0.100 kg hanger in place.

A fresh sheet of graph paper should be available for each candidate.

The apparatus should be assembled for the candidates (with the mass hanger unattached).

- 1 You are going to make measurements that will allow you to determine the amount of electrical energy used by a filament lamp. You will also be able to determine how much of that energy is given out as light energy. Assume that the energy output of the lamp is just used to heat the water and to provide light energy.

Figure 1



- (a) (i) Measure and record the temperature of the water.
- (ii) Your variable power supply has been set to give its maximum output. **Do not adjust it.** Turn the power supply on and begin timing at the same time. Measure and record the temperature of the water after 4.0 minutes (240 s) of heating and find the temperature rise. **You are not required to repeat this measurement.**
- (iii) Use the formula given below to calculate  $E$ , the energy used to heat the water.

$$E = 420 \Delta\theta$$

$\Delta\theta$  = the temperature change of the water

- (iv) Use your answer to part (a)(iii) and the value of the electrical power input to the lamp given on the card near your apparatus, to determine the amount of light energy emitted by the lamp during the 240 s it was turned on.

(7 marks)



(b) Predict how the total energy given out by the lamp will vary with the applied voltage. Justify your answer. (3 marks)

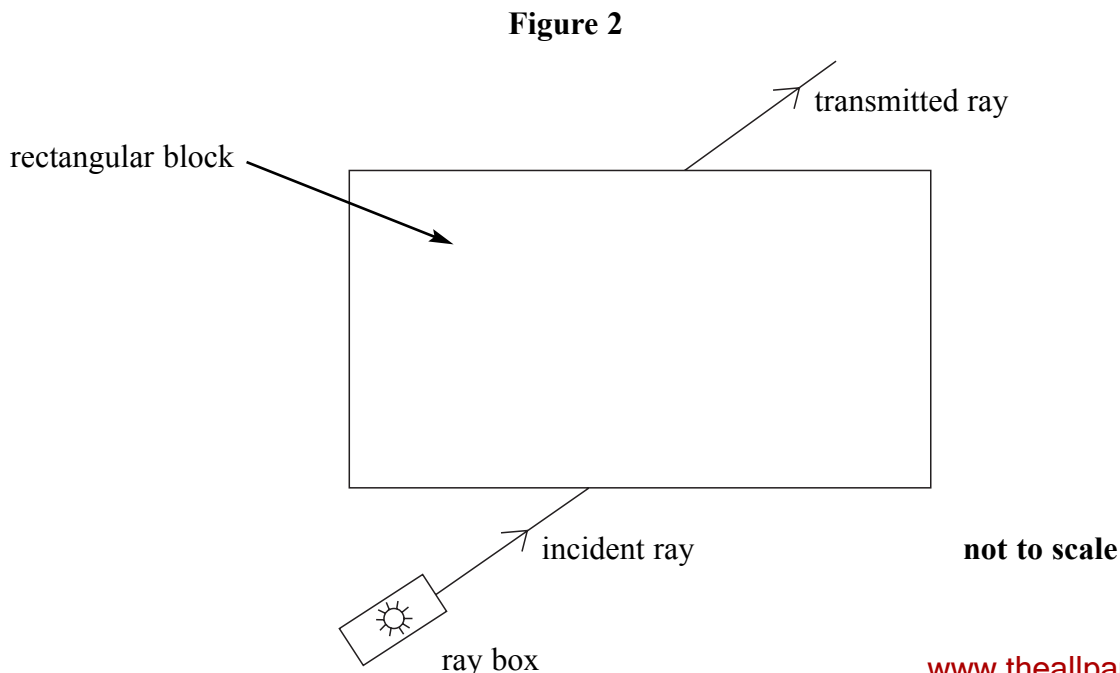
- (c) (i) State the additional measurements you would need to make to check the power input to the lamp.
- (ii) Draw on the circuit in **Figure 1** any additional, correctly connected apparatus you would need to use in order to determine the power input to the lamp.
- (iii) State a formula you would use in part (a)(iv) for calculating the light energy output from the lamp. (4 marks)

- (d) Describe in detail how you would investigate how the variation of applied voltage affects the light energy output of the lamp. You should state:
- the measurements you would make
  - the ranges of measurements you would use
  - the quantities you would keep constant
  - the method of display of the results

Two of the 6 marks in this question are available for the quality of your written communication.

(6 marks)

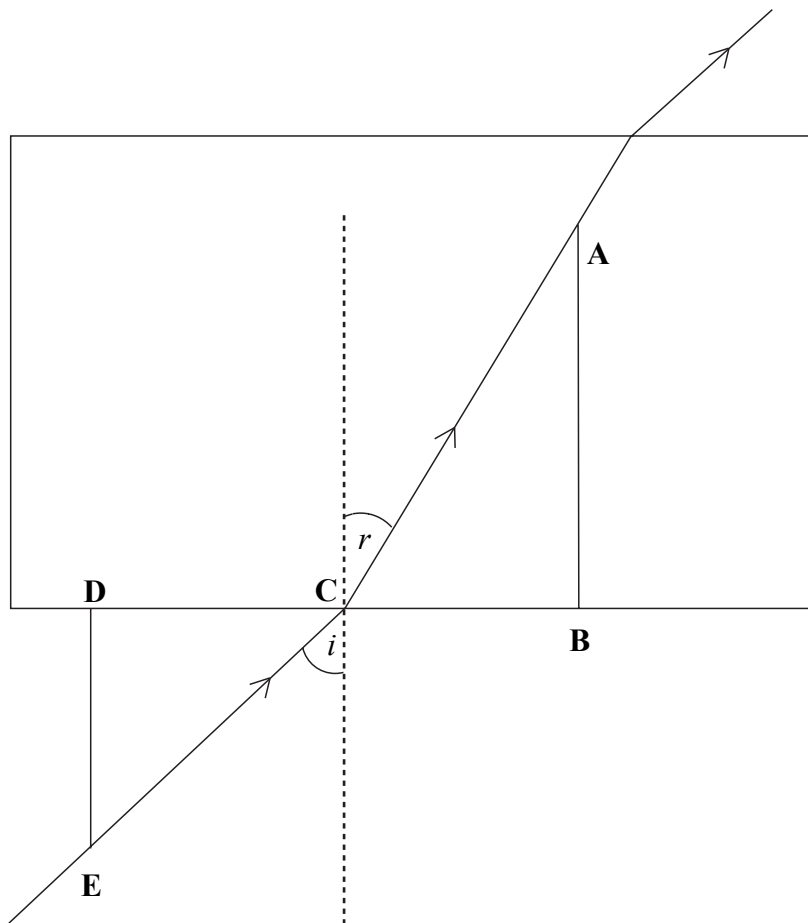
- 2 You are going to inspect a ray of light transmitted through a transparent rectangular block and determine  $n$ , the refractive index of the material from which the block is made. The refractive index is a measure of how much the light bends as it enters or leaves the block.



- (a) Switch on the ray box and direct the ray so that it goes through the block, entering and leaving through opposite faces as shown in Figure 2. Vary the angle the incident ray makes with the block by changing the position of the ray box. Observe the effects of changing the angle on the transmitted ray. Describe any patterns you observe in the transmitted ray as the angle is changed.

(2 marks)

- (b) An accurate ray diagram for the situation you observed in part (a) is given in **Figure 3**.

**Figure 3**

- (i) From **Figure 3**, measure and record the distances:

$$EC = h =$$

$$AC = k =$$

$$DC = d =$$

$$BC = x =$$

**Do not attempt to repeat and average these measurements.**

- (ii) Calculate the refractive index,  $n$ , of the material from which the block is made, using the formula:

$$n = \frac{kd}{xh}$$

- (iii) State the absolute uncertainties in each of your values for  $h$ ,  $d$ ,  $x$  and  $k$ .
- (iv) Calculate the percentage uncertainties in each of your values for  $h$ ,  $d$ ,  $x$  and  $k$ .
- (v) Calculate the percentage uncertainty in your value for  $n$ . (9 marks)
- (c) The refractive index can also be determined by measuring the angles  $i$  and  $r$  as marked on **Figure 3**.
- (i) From **Figure 3**, measure and record the angles  $i$  and  $r$ .
- (ii) Calculate the refractive index of the material from which the block is made, using the formula:

$$n = \frac{\sin i}{\sin r}$$

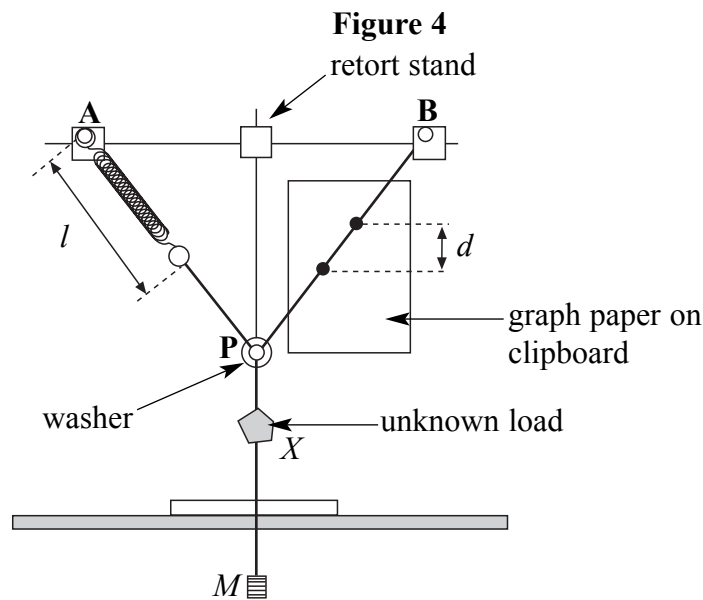
(2 marks)

- (d) Considering your observations in part (a), discuss any difficulties you think you might have had if you had been required to obtain an accurate ray diagram experimentally and to make accurate measurements from it to determine the refractive index of the material.

Two of the 5 marks in this question are available for the quality of your written communication.

(5 marks)

3 You are going to investigate the extension of a spring set in a network of strings.

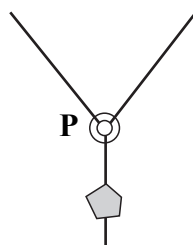


- (a) Suspend a mass,  $M$ , of 0.100 kg on the end of the string. Adjust the position of the washer, **P**, so that  $M$  hangs midway between the two suspension points, **A** and **B**. Use the vertical retort stand supporting the network as a reference. Measure and record  $l$  (the complete length of the spring, in m) and  $d$  (the vertical separation, in mm, of the two ink dots on the string).

(4 marks)

- (b) (i) On **Figure 5**, mark and label the forces acting on the washer **P** when it is aligned with the retort stand rod. State which **two** forces you think should have the same magnitude. Assume that there is no friction between the washer and the string.

**Figure 5**



- (ii) Write down an equation connecting all of the forces on the washer when it is in equilibrium

(4 marks)

- (c) You are going to vary the mass,  $M$ . For each value of  $M$ , measure and record the corresponding values of  $l$  and  $d$ . Each time you change  $M$ , adjust the position of the washer **P**, so that it aligns with the vertical retort stand behind it, before measuring  $l$  and  $d$ .
- (i) In the space below, draw a table in which to record 6 sets of values of  $M$ ,  $l$  and  $d$ , including the set you have already taken in part (a). The maximum value of  $M$  should be 0.600 kg.
- (ii) Measure and record in the table the corresponding values of  $M$ ,  $l$  and  $d$ .  
(12 marks)
- (d) Draw a second table to record values of  $M$ ,  $e$ , and  $ed$ , where  $e$  is the total extension of the spring. The unloaded length of the spring is given on a card near your apparatus.  
(4 marks)
- (e) (i) On a sheet of graph paper, plot a graph of  $ed$  (on the  $y$ -axis) against  $M$  (on the  $x$ -axis). The scales on each of your axes should begin at zero.
- (ii) Draw the best fit straight line for your points.  
(9 marks)
- (f) The equation of your straight line is:

$$ed = \frac{50gM}{k} + \frac{50gX}{k}$$

where  $k$  = the spring constant, measured in  $\text{N m}^{-1}$

$X$  = the mass of the unknown load hanging below the washer

$g$  = the Earth's gravitational field strength in  $\text{N kg}^{-1}$

The general equation of a straight line is:

$$y = mx + c$$

- (i) Determine the gradient of your line.
- (ii) Determine the intercept of your line with the  $ed$  axis
- (iii) Use your data from the graph to determine a value for the mass,  $X$ .  
(7 marks)

**END OF QUESTIONS**

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

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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**

No information is required for any question for this examination

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**