New Specification

Rewarding Learning

ADVANCED

General Certificate of Education

2018

Centre Number

Candidate Number

Physics

Assessment Unit A2 3A

assessing

Practical Techniques and Data Analysis

APH31

[APH31]

WEDNESDAY 9 MAY, MORNING

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Answer **both** questions.
The Supervisor will tell you the order in which you are to answer the questions. Not more than 28 minutes are to be spent in answering each question, and after 26 minutes you must stop using the apparatus in Questions 1 and 2 so that it can be re-arranged for the next candidate. At the end of the 28-minute period you will be instructed to move to the station for the next question. At the end of the Test a 4-minute period will be provided for you to complete your answer to any question, but you will not have access to the apparatus during this time.

INFORMATION FOR CANDIDATES

The total mark for this paper is 40.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You may use an electronic calculator.

For Examiner's use only	
Question Number	Marks
1	
2	
Total Marks	

BLANK PAGE

1 In this experiment you will investigate the oscillation of a bifilar pendulum. The arrangement consists of a half-metre rule suspended horizontally and symmetrically by two vertical threads of fixed length. The rule can be made to oscillate about a vertical axis through the centre of the rule.

Aims

The aims of the experiment are:

- to measure the time period of the oscillation of the bifilar arrangement about a vertical axis, for various distances D;
- to analyse the results and plot a linear graph;
- to use the graph to find unknown constants.

Apparatus

You are provided with a bifilar pendulum arrangement, made of two half-metre rules arranged horizontally, with a fixed vertical separation. The distance D between the suspension threads can be varied by moving the loops along the rules. The upper rule should remain securely clamped.
Fig. 1.1 is a diagram of the arrangement.

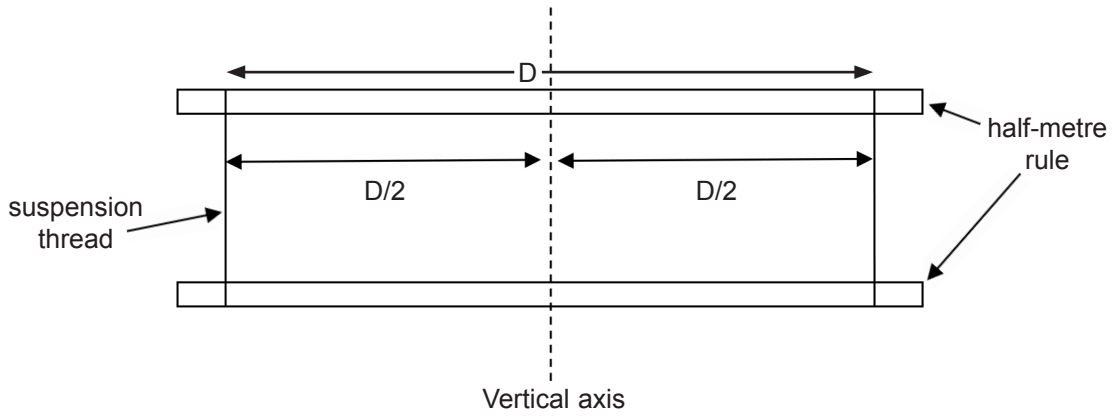

Fig. 1.1

The lower rule can be set into oscillation about the vertical axis, as shown in **Fig. 1.2**.

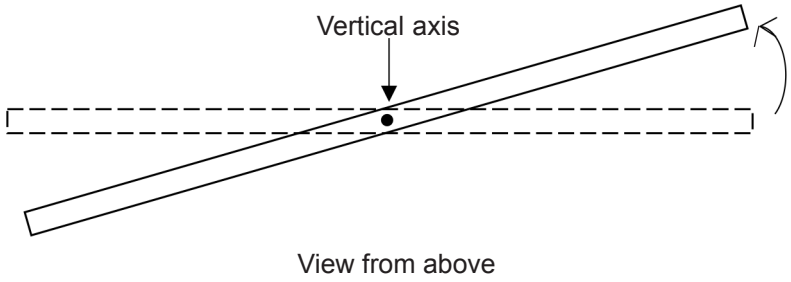

Fig. 1.2

This is best achieved by holding the rule lightly at its centre between finger and thumb and twisting gently. When you release the rule, it will execute horizontal oscillations of small angular amplitude about the central vertical axis.

Procedure

Examiner Only	
Marks	Remark

(a) Use the stop-clock provided to determine an accurate value of the period T of oscillation of the lower rule. The first distance D has been set at 14.0 cm, with the thread loops at 18.0 cm from each end of both upper and lower rules. Repeat the procedure for four further D values to a maximum of about 38.0 cm. Ensure that the threads are always at equal distances from each end of the rules, so the arrangement is symmetrical about the axis of oscillation. Record **all** your results in **Table 1.1**. Label and use the second column as necessary.

[4]

Table 1.1

D /cm		T /s		
14.0				

Analysis

The period of this bifilar pendulum is described by **Equation 1.1**.

$$T = k\,D^{\,b} \qquad \textbf{Equation 1.1}$$

where k and b are constants.

(b) (i) Show that a graph of $\log_{10} T$ against $\log_{10} D$ will result in a straight line graph from which values of k and b can be determined.

[2]

(ii) State how b may be determined from the graph of $\log_{10} T$ against $\log_{10} D$.

_____ [1]

(c) To draw the graph, it is necessary to calculate additional quantities from your results. Complete the final two blank columns of **Table 1.1** with appropriate headings and values recorded to **2 decimal places**. [4]

(d) Plot the graph of $\log_{10}$ T against $\log_{10}$ D on the grid of **Fig. 1.3** below and draw the best fit straight line. [5]

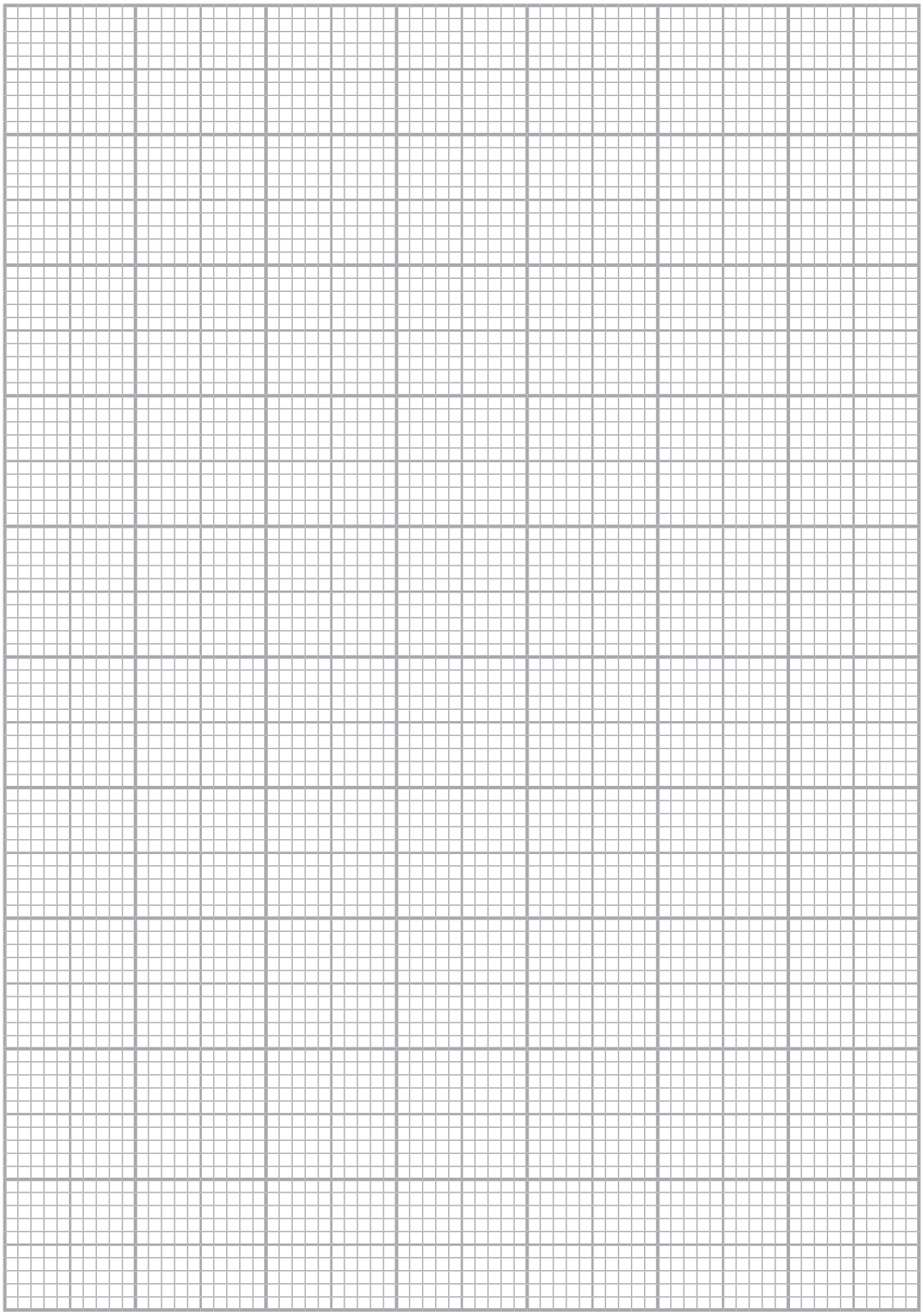

Fig. 1.3

Examiner Only	
Marks	Remark

(e) Use your graph to determine the value of the constant b.

Value of b: _____ [4]

Examiner Only	
Marks	Remark

BLANK PAGE

(Questions continue overleaf)

2 In this experiment, you are provided with an illuminated object, a screen and a converging lens. When the screen and object are a suitable distance apart, there are two positions of the lens which will produce a sharp image on the screen. You will locate the two positions of the lens which give sharp images for different separations between the object and the screen.

Aims

The aims are:

- to adjust the position of the lens so that focussed images are formed;
- to take measurements using the optical bench arrangement;
- to plot an appropriate graph and use it to determine the focal length of a converging lens.

Apparatus

Fig. 2.1 shows an illuminated object and a screen, separated by a distance y. The light box and metre rule are secured to the desk, and the lens holder and screen can be moved along the ruler. The distance x is the separation of the two positions of the lens at which sharp images are formed on the screen.

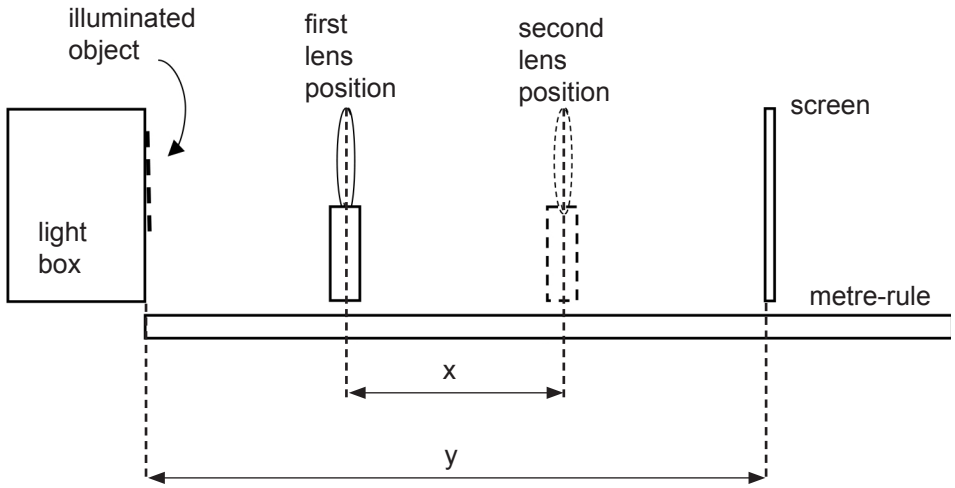

Fig. 2.1

The relationship between x, y and the focal length of the lens f is given by **Equation 2.1**.

$$y^2 - x^2 = 4fy \qquad \textbf{Equation 2.1}$$

Procedure

(a) Place the screen at a distance of 640 mm from the object, this is the initial value of y. Place the lens between the object and screen and move it until a sharp image of the object is seen on the screen. Record this initial position of the lens (1) in **Table 2.1**.

Move the lens along the metre rule until a second sharp image of the object is seen and record this second position of the lens (2) in **Table 2.1**.

Calculate and record the distance x between these two positions. Repeat for four further values of y between 640 mm and 800 mm. [4]

Table 2.1

y /mm	lens position /mm		x /mm		
	1	**2**			
640					

Examiner Only

Marks	Remark

Analysis

Examiner Only	
Marks	Remark

(b) (i) Use **Equation 2.1** to show that a graph of y against $\frac{x^2}{y}$ will result in a straight line graph from which a value of the focal length can be determined.

[2]

(ii) State how the value of f can be determined from the graph of y against $\frac{x^2}{y}$.

_____ [1]

(iii) Calculate any additional values needed to allow you to draw the linear graph described in **(b) (i)** and record these values in the blank columns of **Table 2.1**. Head any columns that you use with the appropriate quantity and unit. [2]

(c) (i) Use the grid of **Fig. 2.2** to plot the graph of y against $\frac{x^2}{y}$.

The vertical axis has been labelled and a scale added for you. Label the horizontal axis and select a suitable scale starting from zero. Plot the values from **Table 2.1**. Draw the best fit straight line for the points plotted. [5]

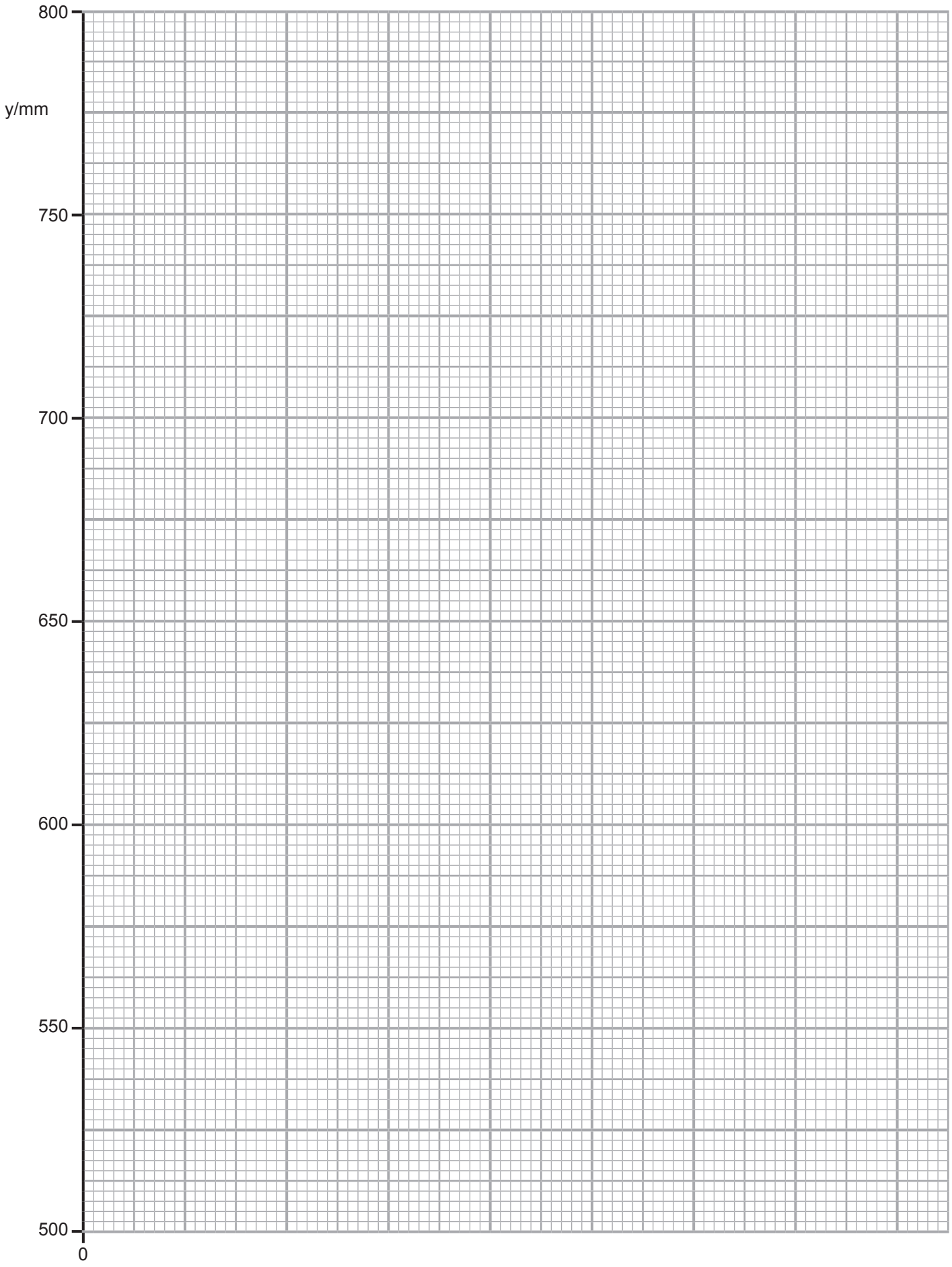

Fig. 2.2

(ii) Use your graph to calculate a value for the focal length f of the lens.

f = _____ mm [3]

(iii) Use the points on your graph to calculate the percentage uncertainty in f.

% uncertainty in f = _____ % [3]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

237083

New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2018

Physics

Assessment Unit A2 3A

Practical Techniques and Data Analysis

[APH31]
WEDNESDAY 9 MAY, MORNING

CONFIDENTIAL INSTRUCTIONS

1 Confidential Instructions

These instructions will give detailed guidance on setting up and testing the apparatus and materials to be used. **Again, information contained within the Confidential Instructions must not be relayed to candidates under any circumstances**. If at this point, centres find that the testing process produces results different to those specified in the Confidential Instructions, they must contact the CCEA Science Officer (ggray@ccea.org.uk) immediately.

2 Final Apparatus Testing

The practical assessment question paper will be made available to the Head of Physics **two** working days before the timetabled starting time so that teachers and technicians can carry out a final test on the experiments. If on checking the apparatus gives unexpected results, the CCEA Physics Subject Officer should be contacted immediately (ggray@ccea.org.uk). If the problem cannot be resolved, then the centre must e-mail the CCEA Physics Subject Officer stating the centre name and number, the specific nature of the problem and the range of anomalous results produced. CCEA will respond by acknowledging receipt of the e-mail. If you do not receive a response within 24 hours, please contact the CCEA Physics Subject Officer by telephone (028 90261200 Ext 2270) to confirm that CCEA has received your e-mail.

3 Practical Assessment A2 3A

The A2 3A Practical Techniques Assessment is a test of practical skills comprised of 2 experimental tests. The duration of the assessment is 1 hour. Some of this time will be set aside for supervisors to re-set the apparatus ready for the next candidates. The assessment should be run as a circus of experiments with candidates moving to the next experiment at the designated time. The assessment should be timed as follows:

Questions	**Time**
Q1 (practical test)	26 minutes
Changeover and practical write-up	2 minutes
Q2 (practical test)	26 minutes
Changeover and practical write-up	2 minutes
End of test write-up	4 minutes

At the end of the 26 minute period, candidates must stop using the apparatus. During each 2 minute changeover period candidates may continue with their write up, however they will not have access to the apparatus. At the end of the test a 4 minute period is provided to complete their answer to any question, but will not have access to the apparatus.

4 After the Practical Assessments

When the individual exam sessions have finished, please return the A2 3A practical scripts together with the corresponding advice notes to the examinations officer (EO). We will collect these by the day after the examination. If we don't, please contact us immediately to arrange another time for collection.

Where the centre finds that a candidate may have been disadvantaged because the apparatus did not function as intended, the supervising teachers should make a report to the EO. The EO will forward the confidential report on the issue and the candidates affected to the centre support section at CCEA for special consideration. Candidates should be identified by their examination number.

IMPORTANT NOTICE
Centres are urged to order items needed for the Physics Practical Tests from the suppliers as soon as possible.

Question 1

Requirements

- 2 × wooden half-metre rules
- Thread
- Stop-clock
- Retort stand, boss head and clamp

Preparation

Suspend one half-metre rule at a distance of 30 cm below the other, using 2 pieces of thread which are tied in loops around each rule. The loops must be reasonably secure, but free enough to be moved along the rules. Check that there are no splinters! The upper rule should be clamped securely in position above the desk, so that both rules are horizontal and so that the lower rule can complete an oscillation about a vertical axis.

Testing

Periods of oscillation for the lower rule should fall between *approx*. 1 s for a 14 cm separation and 0.8 when the strings are separated by 38 cm.

Action at changeover

The loops of thread should be positioned 18 cm from each end of both upper and lower rules, 14 cm apart, and the arrangement is symmetrical about the centre of oscillation. Re-set the stop-clock.

Question 2

Requirements

- Wooden metre-rule 1
- Light box/ray box 1
- Constructed illuminated object (washer with internal diameter 10± mm) and crosswires as used in 2011 A23 shown in **Fig. 2.1**. 1
- Lens holder 1
- Screen (plain white screen) 1
- Converging lens, f = 15 cm 1

Illuminated object (washer and cross) construction

Measure the height H of the centre of the lens, mounted in the lens holder above the surface of the bench. Take a sheet of stiff card and use a sharp knife to cut a square aperture of side 40 mm so that the centre of the square is a distance H from the marked edge of the card. The width W of the card depends on the dimensions of the lens holder. Cut a piece of tracing or greaseproof paper about 60 mm square. In the centre of this square use a fine felt tip pen (of similar) to mark an "X" with the arms at least 10 mm long. Place the washer over the "X" so that the intersection of the arms is at the centre of the circular hole in the washer. Using transparent self-adhesive tape, attach the washer to the tracing paper. Avoid covering any part of the hole in the washer. Place the tracing paper on the card so that the washer is at the centre of the 40 mm square aperture, with the washer inside the opening. Tape the tracing paper to the cardboard. The completed object is illustrated in **Fig. 2.1**.

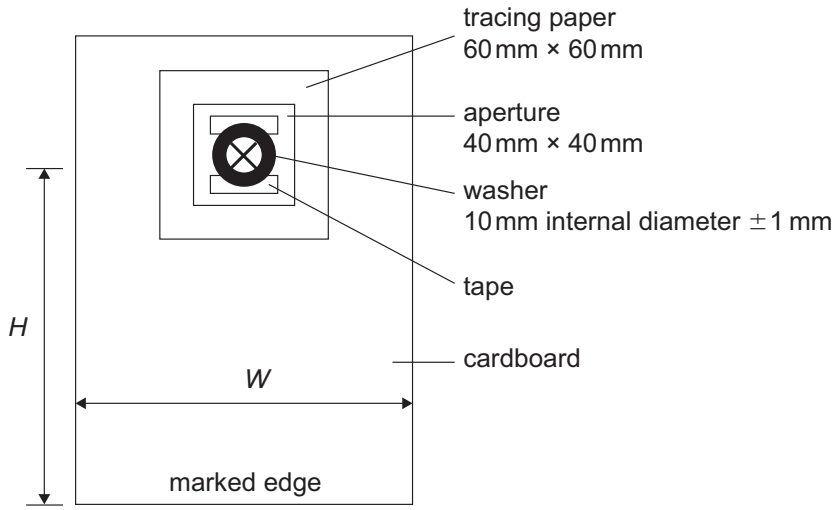

Fig. 2.1 Washer and "X" object (not to scale)

Preparation

The metre-rule should be secured to the desk with the light box secured to the 0 cm mark. The lens should be placed in the lens holder in an upright position. The lens holder and screen should be placed along the metre-rule. Check that for a screen position of 650 mm from the object clear images are visible at approx. 360 mm and 280 mm

Before the Examination

The object and lens should be aligned so that an image is visible on the screen. Place the screen at the 50 cm mark.

Action at Changeover

Ensure the rule and light box are fixed in their positions. Replace the screen at the 50 cm mark and ensure the lens is upright in its holder.

New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2018

Physics

Assessment Unit A2 3A

Practical Techniques and Data Analysis

[APH31]
WEDNESDAY 9 MAY, MORNING

APPARATUS AND MATERIALS LIST

PHYSICS UNIT 3 (A2 3A)
APPARATUS AND MATERIALS REQUIRED FOR PRACTICAL ASSESSMENT

CONFIDENTIAL

This document gives preliminary information on the apparatus and materials required for the A2 Practical Assessment.

Information about the apparatus and materials required for this assessment must NOT be communicated to students. If apparatus/materials have their serial code and/or manufacturer specified then it is essential that centres use this exact apparatus/material.

On receipt of this APPARATUS AND MATERIALS LIST, centres must contact Gavin Gray, ggray@ccea.org.uk immediately if they have difficulty in sourcing the specified apparatus or materials.

Teachers will be given detailed instructions for setting up the experiment in the *Confidential Instructions for Physics Practical Test*, to which they will have confidential access from April 2018.

Teachers will have confidential access to a copy of the experimental test two working days (48 hours) before the start of the assessment.

The A2 3 Practical Techniques Assessment is a test of practical skills consisting of **two** experimental tests (40 marks). The duration of the assessment is 1 hour.

The apparatus in the following list will allow for **one experiment** to be set up for the practical test which makes up questions 1–2. In other words, each set of apparatus (as listed on **page 3**) will accommodate two candidates when doing the circus of experiments.

The apparatus can be used for alternative sessions according to the following schedule:

9 May 2018 Physics A2 3A (APH31)

(Main Session) **9.15 am–10.15 am**
(First Alternative) **10.30 am–11.30 am**
(Second Alternative) **11.45 am–12.45 pm**
(Third Alternative) **1.15 pm–2.15 pm**
(Fourth Alternative) **2.30 pm–3.30 pm**

One set of apparatus for A2 3A (APH31) will therefore be sufficient for ten candidates on **9 May** if the Main Session and all four alternatives are used. A laboratory may contain one, two, three or more sets of apparatus. This means that two, four, six, eight or more candidates can be accommodated in the same session. **To maintain the confidentiality of details of the practical tests, candidates entered for any of the alternative sessions must be segregated within the centre so that there can be no contact with candidates who have taken an earlier test in any centre.**

IMPORTANT NOTICE
Centres are urged to order items needed for the Physics Practical Test from the suppliers as soon as possible.

Question 1

Requirements
- 2 × wooden half-metre rules
- Thread
- Stop-clock
- Retort stand, boss head and clamp

Question 2

Requirements
- Wooden metre-rule 1
- Light box/ray box 1
- Constructed illuminated object (washer with internal diameter 10± mm) and crosswires as used in 2011 A23 shown in **Fig. 2.1** below. 1
- Lens holder 1
- Screen (plain white screen) 1
- Converging lens, f = 15 cm 1

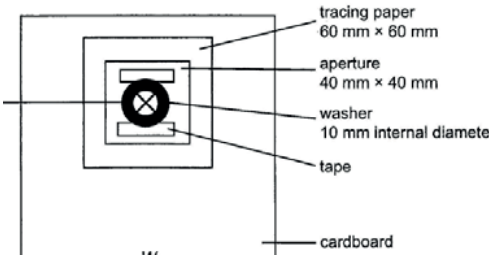

Fig. 2.1