Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED
General Certificate of Education
2013

Physics

Assessment Unit A2 3
Practical Techniques
(Internal Assessment)
Session 2

[AY232]

AY232

FRIDAY 10 MAY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Turn to page 2 for further Instructions and Information.

Question Number	Marks		
	Teacher Mark	Examiner Check	Remark
1			
2			
3			
Total Marks			

INSTRUCTIONS TO CANDIDATES

Answer **all** questions in this paper. Rough work and calculations must also be done in this paper. Except where instructed, do not describe the apparatus or experimental procedures.
The supervisor will tell you the order in which you are to answer the questions. Not more than 30 minutes are to be spent in answering each question. You may be told to start with the experimental tests in Section A, or with the single question in Section B.
Section A consists of two experimental tests. A 28-minute period is allocated for you to use the apparatus. Two minutes is allocated to the supervisor to prepare the station for the next candidate. At the end of the 30-minute period you will be instructed to move to the area set aside for your next question. Section B consists of one question in which you will be tested on aspects of planning and design.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.
All questions carry 20 marks each.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each part question.
You may use an electronic calculator.

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(Questions start overleaf)

Section A

Teacher Mark	Examiner Check	Remark

1 In this experiment you will use both a converging lens and a diverging lens to focus images of an object onto a screen in order to determine the focal length of the diverging lens.

The aims of this experiment are:

- to verify that the focal length of the converging lens is 0.1 m;
- to obtain focused images of the object and take measurements from an optical bench arrangement;
- to use the results to plot a linear graph; and
- to use the graph to determine the focal length of the diverging lens.

(a) You are provided with an illuminated object, a converging lens in a holder, a screen and a metre rule, arranged as shown in **Fig. 1.1**. The illuminated object consists of two crossed lines with a flat circular ring. The lines are to assist focusing.

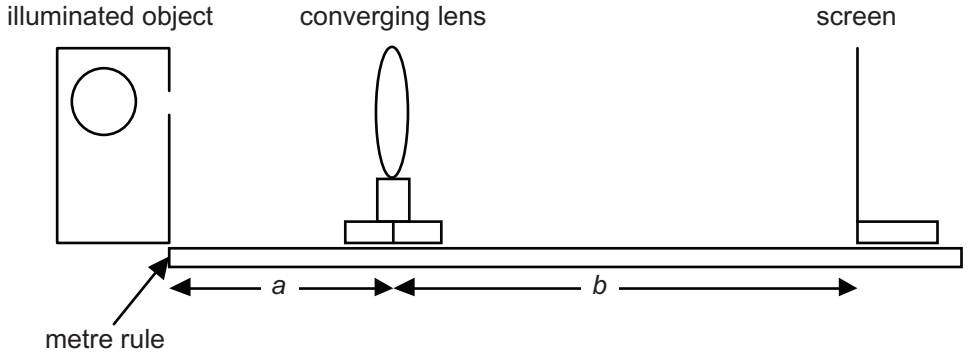

Fig. 1.1

(i) For the three object distances, ***a***, given in **Table 1.1**, adjust the position of the screen to obtain a sharply focused image. Measure the corresponding image distance, ***b***, for each ***a*** value. Record your values in **Table 1.1**.

Table 1.1

***a*/cm**	***b*/cm**
15	
20	
25	

[3]

Teacher Mark	Examiner Check	Remark

(ii) Calculate a reliable value for the focal length, f_1, of the converging lens by using **Equation 1.1** and the data from **Table 1.1**.

$$\frac{1}{f_1} = \frac{1}{a} + \frac{1}{b} \qquad \textbf{Equation 1.1}$$

Focal length = _____ cm [2]

(iii) Explain whether or not your calculated focal length verifies that the focal length of the converging lens is 0.1 m.

_____

_____ [1]

(b) A diverging lens is introduced. Alter the optical bench arrangement of **Fig. 1.1** so that you have the arrangement shown in **Fig. 1.2**. **The converging lens must be placed 24.0 cm from the illuminated object and not moved from this position.**

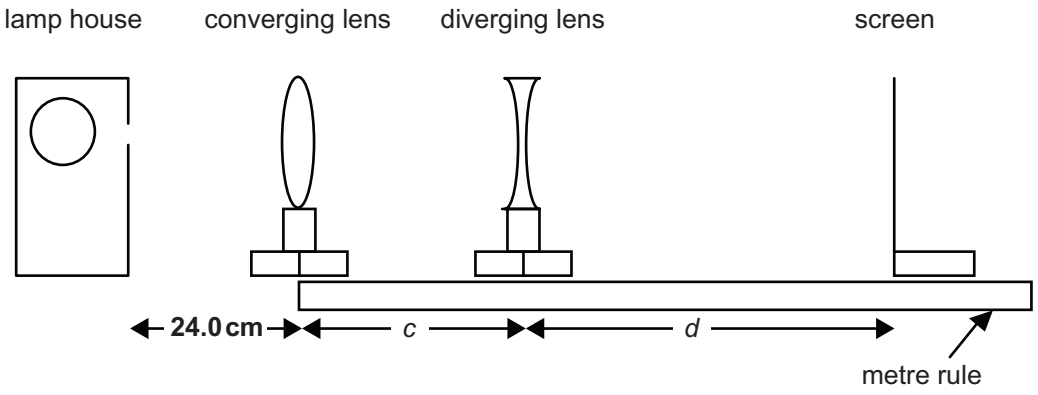

Fig. 1.2

With the converging lens 24.0 cm from the illuminated object, re-position the metre rule so that the zero position corresponds to the converging lens position. Place the diverging lens at each distance, ***c***, listed in **Table 1.2**. Distance, ***c*** is the distance between the converging and diverging lenses. Adjust the position of the screen until a clearly focused image is obtained. Now record the distance ***d***, the distance between the screen and the diverging lens.

Teacher Mark	Examiner Check	Remark

Table 1.2

Distance *c*/cm	Distance *d*/cm	$\left[\left(\frac{d+c-17}{d}\right)\right]$
12		
11		
10		
9		
8		

[3]

(c) The relationship between the distances ***c*** and ***d*** is given by **Equation 1.2**.

$$c = f_2\left(\frac{d+c-17}{d}\right)+17 \qquad \textbf{Equation 1.2}$$

where f_2 is the focal length of the diverging lens.

(i) In the space below, use **Equation 1.2** to show what the gradient and y-intercept will be if ***c*** is plotted on the *y*-axis and $\left(\frac{d+c-17}{d}\right)$ is plotted on the *x*-axis.

Gradient = _____

Intercept = _____ [2]

(ii) Complete **Table 1.2** by calculating the values for $\left(\frac{d+c-17}{d}\right)$.

Insert values that are correct to **two** significant figures. [2]

(iii) On the graph grid of **Fig. 1.3**, choose a suitable scale for the horizontal axis, plot the points and draw the best-fit line. [4]

Teacher Mark	Examiner Check	Remark

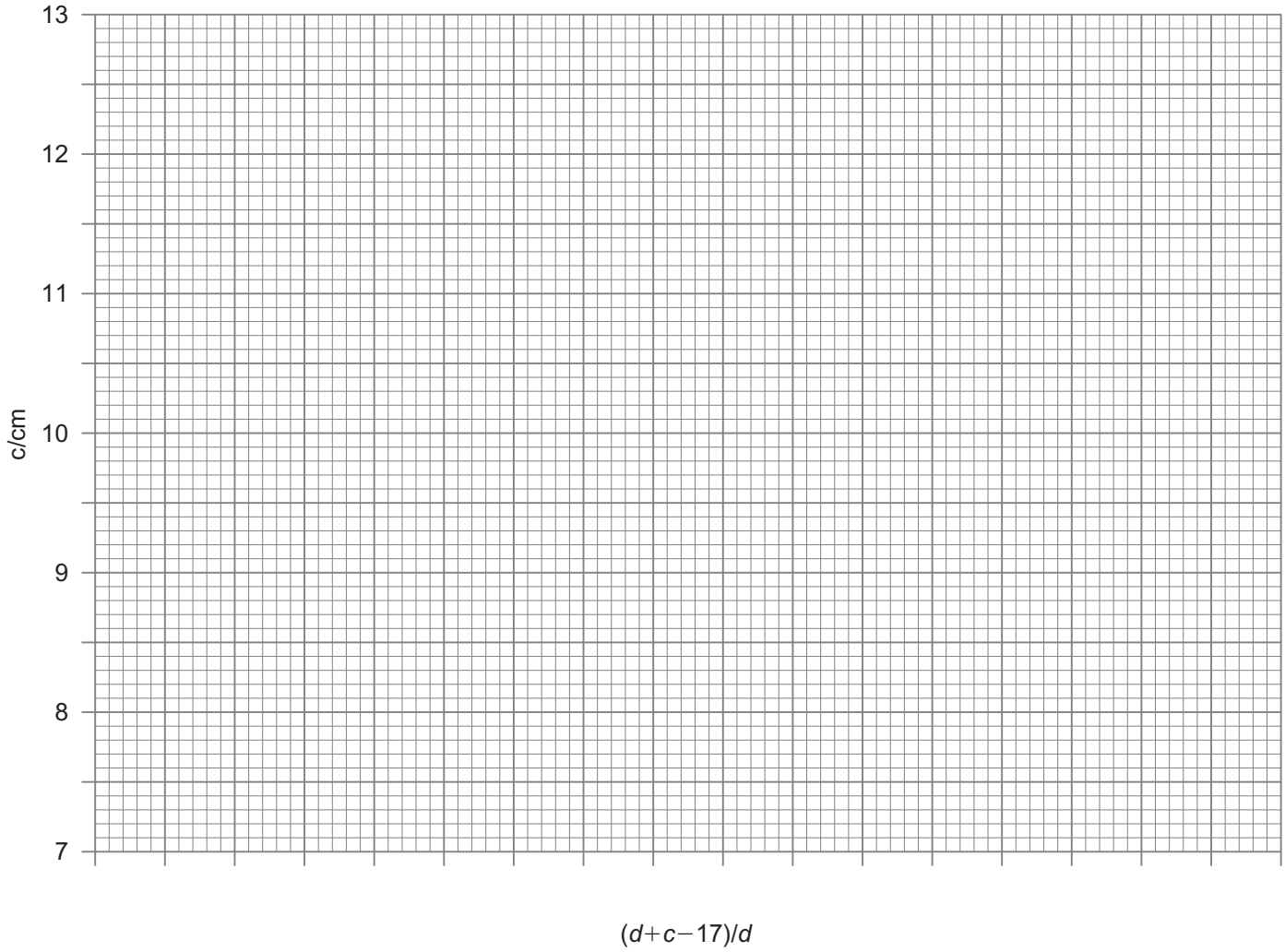

Fig. 1.3

Teacher Mark	Examiner Check	Remark

(d) Use your graph to determine the value for the focal length, f_2, of the diverging lens.

f_2 = _____ cm [3]

Teacher Mark	Examiner Check	Remark

2 In this experiment you will use a stopwatch to measure the time taken for the voltage across a capacitor to decay in order to determine the capacitance of the capacitor.

The aims of this experiment are:

- to determine the resistance of a resistor;
- to record the capacitor voltage as it discharges;
- to use the results to plot a linear graph; and
- to use the graph to determine the capacitance of the capacitor.

(a) You are provided with a mounted resistor, a voltmeter, a **microammeter**, a power supply unit and some connecting wires. For **three** different settings on the power supply unit determine a **reliable** value for the resistance of the mounted resistor using the ammeter-voltmeter method. Tabulate your results in the space below.

Average resistance = _____ Ω [3]

Teacher Mark	Examiner Check	Remark

(b) An identical resistor to that used in **(a)** has been placed in series with a capacitor in the circuit provided. The arrangement is shown in **Fig. 2.1**. The switch will allow the capacitor to be charged from the power supply unit when in position C and discharged through the resistor when in position D.

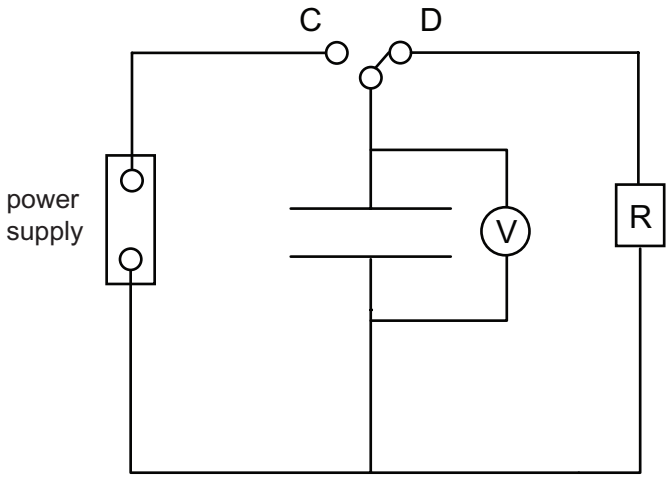

Fig. 2.1

Set the switch to the charge position C for a few seconds. Then set the switch to the discharge position D and at the same time begin timing. You are to take a series of discharge voltage V_d readings at 10 second intervals for 90 seconds. Record your results in **Table 2.1**.

Table 2.1

***t*/s**	***V_d*/V**	
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		

[2]

(c) (i) In order to obtain a linear graph it is necessary to obtain the natural logarithm (ln) of the discharge voltage, V_d. In the right hand column of **Table 2.1**, insert the title for the column and the corresponding natural logarithm values. [2]

Teacher Mark	Examiner Check	Remark

(ii) On the grid of **Fig. 2.2** you will plot the natural logarithm of the discharge voltage on the *y*-axis and time on the *x*-axis. [5]

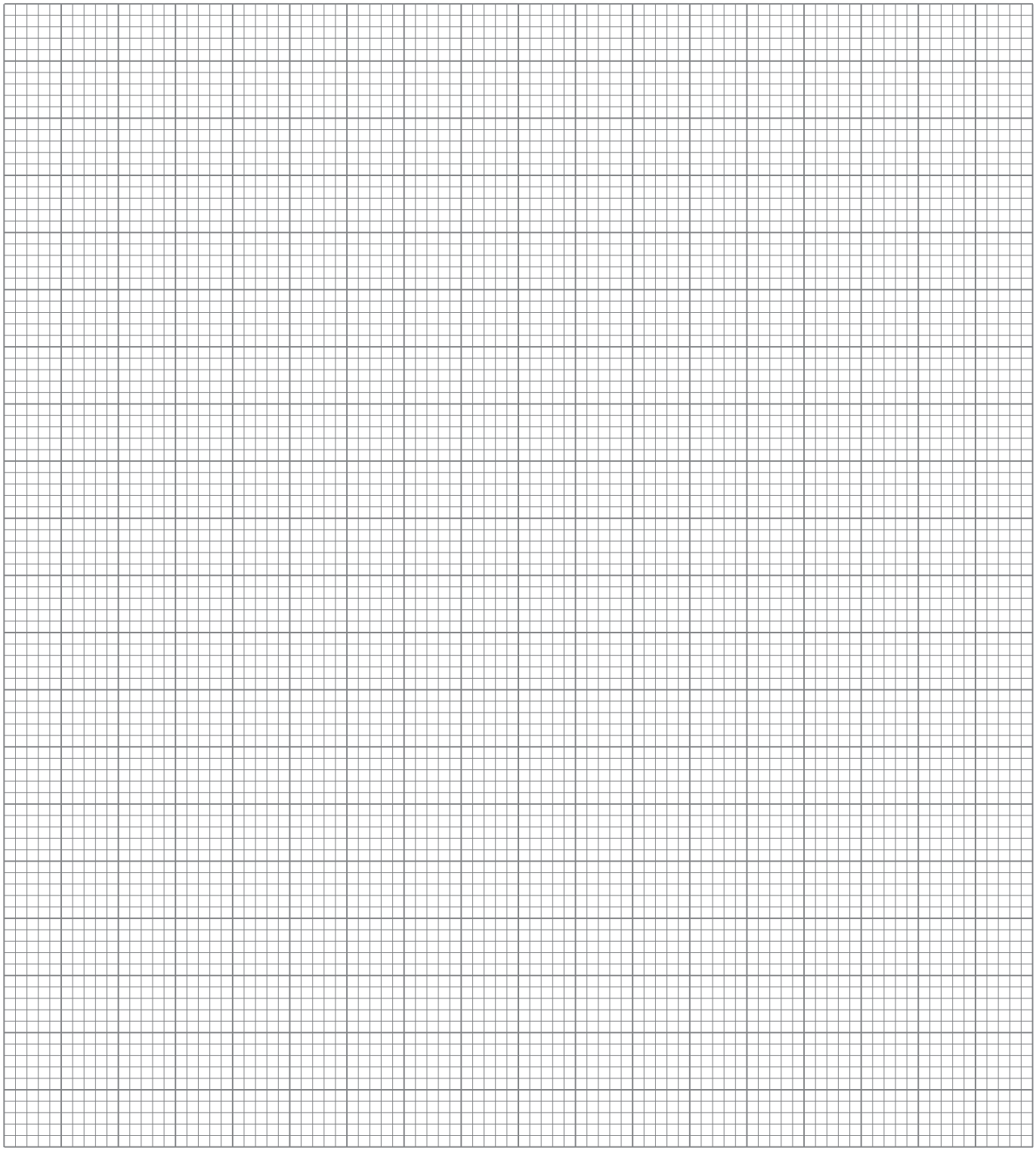

Fig. 2.2

Teacher Mark	Examiner Check	Remark

(d) (i) The mathematical relationship for this experiment is given by **Equation 2.1**.

$$V_d = V_0 e^{-t/CR} \qquad \textbf{Equation 2.1}$$

Explain how the gradient of the graph you have drawn equals $-\frac{1}{CR}$.

[2]

(ii) Use your results to determine a value for C, the capacitance of the capacitor.
N.B. R is the value obtained in **(a)**.

Capacitance = _____ F [3]

(iii) Use the graph to obtain a value for V_0, the initial voltage.

V_0 = _____ V [3]

Teacher Mark	Examiner Check	Remark

Section B

3 In this exercise you are to plan and analyse two distinct methods for determining the mass per unit length, μ, of a string. **Equation 3.1** defines mass per unit length, μ.

$$\mu = \frac{m}{l} \qquad \textbf{Equation 3.1}$$

where m is the mass and l the length.

Method 1: Direct measurement

(a) Direct measurements of the string provide the following data: The total length of the string is 69.4 cm and it has a mass of 4.38 g.

(i) The length was measured using a metre rule. State the absolute uncertainty in this measurement and explain how you arrived at your answer.

Absolute uncertainty = ± _____

_____

_____

_____ [2]

Five balances are available for measuring the mass. **Table 3.1** provides information about the balances.

Table 3.1

Balance	Range	Precision	Analogue or Digital	
A	0 g–100 g	±1 g	Analogue	Spring balance
B	0 g–20 g	±0.1 g	Analogue	Spring balance
C	0 g–4100 g	±0.1 g	Digital	Top-pan balance
D	0 g–210 g	±0.01 g	Digital	Top-pan balance
E	0 g–2000 g	±0.1 mg	Digital	Top-pan balance

Teacher Mark	Examiner Check	Remark

(ii) On which balance was the measurement of mass made? Explain your answer.

_____

_____

_____ [2]

(iii) Calculate the mass per unit length, μ, in $kg\,m^{-1}$ quoting your answer to the correct number of significant figures, and state the percentage uncertainty in your value.

μ = _____ $kg\,m^{-1}$

Uncertainty = _____ % [4]

Teacher Mark	Examiner Check	Remark

Method 2: Indirect measurement using standing waves

(b) The velocity, v, of a transverse wave along a stretched string is given by **Equation 3.2**

$$v = \sqrt{\frac{T}{\mu}} \qquad \textbf{Equation 3.2}$$

where T is the tension in the string and μ is the mass per unit length.

One end of the string is attached to a vibrator and the other end is attached to a slotted mass hanger. The vibrator oscillates producing transverse waves in the string, with a frequency given by the signal generator to which it is connected. The string is looped over a pulley and the slotted masses hang freely, as shown in **Fig. 3.1**. At certain frequencies of vibration resonance is established and standing waves are set up on the string.

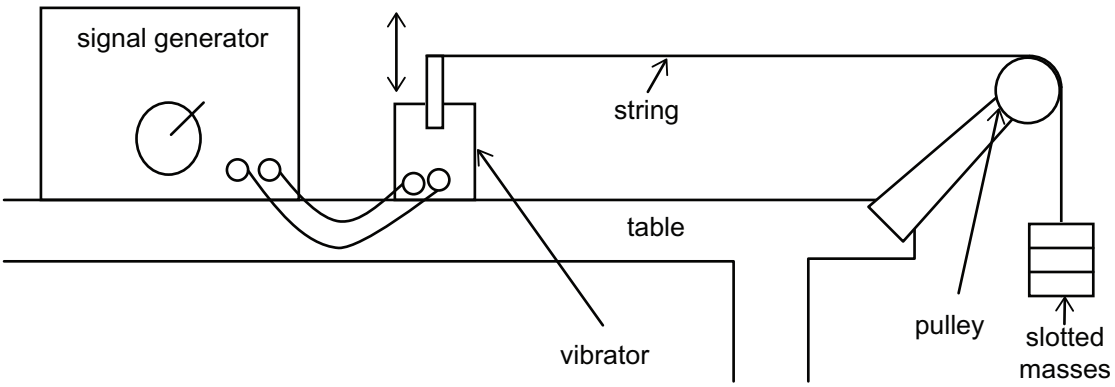

Fig. 3.1

(i) Explain how a value for the tension is determined in the arrangement shown in **Fig. 3.1**.

_____

_____

_____ [2]

When the **second position of resonance** of the standing wave exists on the string, the velocity of the transverse wave can be determined using **Equation 3.3**.

$v = lf$ **Equation 3.3**

where f is the frequency of the wave and l is the length of the vibrating string.

(ii) Using standing wave theory for the second position of resonance, derive **Equation 3.3**.

[2]

(iii) On **Fig. 3.1**, clearly identify the length, l, that should be measured. [1]

(iv) Describe how you would use the apparatus in **Fig. 3.1** to obtain the wave velocity for a particular string tension.

_____

_____

_____

_____

_____ [2]

Teacher Mark	Examiner Check	Remark

Teacher Mark	Examiner Check	Remark

(v) The frequency value from the signal generator dial lacks precision. An alternative method by which the frequency could be determined is the use of a cathode ray oscilloscope (CRO). Explain how the CRO is used to determine frequency.

_____

_____

_____

_____ [2]

(vi) Assume five pairs of values of wave velocity and the corresponding string tension are available. Describe how you would analyse these results graphically to obtain a value for the mass per unit length.

_____

_____

_____ [3]

THIS IS THE END OF THE QUESTION PAPER

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2013

Physics

Assessment Unit A2 3

assessing

Practical Techniques
Sessions 1 and 2

[AY231] [AY232]

THURSDAY 9 MAY AND FRIDAY 10 MAY

AY231 AY232

APPARATUS AND MATERIALS LIST

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

CONFIDENTIAL

Information about the apparatus and materials required for the A2 Practical Assessments **must not** be communicated to candidates sitting the examination.

This document gives preliminary information on the apparatus and materials required for the A2 Practical Assessments. The Practical Assessments will be marked by teachers as part of the internal assessment requirements for the GCE Physics Specification.

Teachers will be given detailed instructions for setting up the experiments in the *Confidential Instructions for Physics (A2) Practical Tests*, to which they will have confidential access from March 2013.

Teachers will have confidential access to a copy of the experimental tests 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 Section A and Section B. Section A comprises 2 experimental tests (40 marks) and Section B consists of one question which tests aspects of planning and design (20 marks). The duration of the assessment is 1 hour 30 minutes. Some of this time will be set aside for supervisors to re-set apparatus for the next candidates. In each of the experimental tests (Q1 and Q2), candidates must stop using the apparatus after 28 minutes. At the end of each 28 minute period, a changeover time of 2 minutes will be set aside for the supervisor to re-set the apparatus for the next candidates. During the changeover periods, candidates may write-up anything they have not completed, however they will not have access to the apparatus. Candidates will move on to the next question after 30 minutes. The time allocation for **question 3** (planning and design) is 30 minutes. As the time allocation for each question is effectively the same, the supervisor can decide in which order the candidates should attempt the questions.

The apparatus in the following list will allow for **one experiment** to be set up for each of the practical tests which make up **questions 1 and 2**. In other words, each set of apparatus (as listed on page 4) will accommodate three candidates.

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

Thursday 9 May 2013 Physics A2 3A (AY231)

(Main Session) **9.15 am–10.45 am**
(First Alternative) **11.00 am–12.30 pm**
(Second Alternative) **1.15 pm–2.45 pm**
(Third Alternative) **3.00 pm–4.30 pm**

Friday 10 May 2013 Physics A2 3B (AY232)

(Main Session) **9.15 am–10.45 am**
(First Alternative) **11.00 am–12.30 pm**
(Second Alternative) **1.15 pm–2.45 pm**
(Third Alternative) **3.00 pm–4.30 pm**

One set of apparatus for A2 3A (AY231) will therefore be sufficient for twelve candidates on **9 May** if the Main Session and all three alternatives are used. Similarly, one set of apparatus for A2 3B (AY232) will be sufficient for twelve candidates on **10 May** if the Main Session and all three alternatives are used. A laboratory may contain one, two, three or more sets of apparatus. This means that three, six, nine or more candidates can be accommodated in the same session. **When alternative sessions are used care must be taken to segregate candidates who have taken the examination from those who have still to sit the examination.**

IMPORTANT NOTICE

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

Question 1

Ref	Component	Session 1	Session 2
1.1	Converging lens; focal length 20 cm	1	0
1.2	Converging lens; focal length 10 cm	0	1
1.3	Diverging lens; focal length –20 cm	1	1
1.4	Illuminated object; circle (~10 mm) with cross wires (lamp house or washer, ray box arrangement)	1	1
1.5	Screen	1	1
1.6	Metre rule	1	1
1.7	Lens holder; marked to indicate the plane of the lens	2	2
1.8	Blu Tack	✓	✓
1.9	Power Supply Unit; capable of supplying ~12 V d.c.	1	1

Question 2

Ref	Component	Session 1	Session 2
2.1	Microammeter; 0–200 μA in 1 μA, digital	1	1
2.2	Voltmeter; 0–20 V in 0.01 V, digital	2	2
2.3	Stopwatch/stopclock; reading to 0.01 s, digital	1	1
2.4	Resistor; 56 kΩ ± 10% (power rating not critical)	2	0
2.5	Resistor; 28 kΩ ± 10% (power rating not critical)	0	2
2.6	Power Supply Unit; capable of supplying ~12 V d.c.	2	2
2.7	Capacitor; 470 μF electrolytic, working voltage ⩾16V	1	0
2.8	Capacitor; 1000 μF electrolytic, working voltage ⩾16V	0	1
2.9	Component channel; any variety (crocodile clip, 4 mm socket etc.)	3	3
2.10	Switch; double pole double throw	1	1
2.11	Connecting wires; 4 mm plugs at each end	12	12
2.12	Masking tape; opaque	✓	✓

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General Certificate of Education
2013

Physics

Assessment Unit A2 3

assessing

Practical Techniques (Internal Assessment)

[AY231] [AY232]

THURSDAY 9 MAY AND FRIDAY 10 MAY

CONFIDENTIAL INSTRUCTIONS TO TEACHERS

CONFIDENTIAL INSTRUCTIONS FOR PHYSICS A2 PRACTICAL TEST

Confidentiality

To maintain the integrity of the Test, no question papers or any material pertaining to the Test should be publicly released until after the final session.

General

The Practical Test will contain three compulsory questions, of which two are 30-minute experimental tests and the third is a 30-minute question testing Planning and Design. The total time allowed is 1 hour 30 minutes. The order in which candidates are to take the questions is to be decided by the Supervisor. Candidates will have access to the apparatus in the experimental tests for 28 minutes each, the final two minutes being reserved for adjustment of the apparatus by the Supervisor. The question paper includes spaces for answers; candidates will write their answers in the Question/Answer booklet.

Question 1

Ref.	Component	Session 1	Session 2
1.1	Converging lens; focal length 20 cm	1	0
1.2	Converging lens; focal length 10 cm	0	1
1.3	Diverging lens; focal length –20 cm	1	1
1.4	Illuminated object; circle (~10 mm) with cross wires or washer, ray box arrangement)	1	1
1.5	Screen	1	1
1.6	Metre rule	1	1
1.7	Lens holder; marked to indicate the plane of the lens	2	2
1.8	Blu Tack	✓	✓
1.9	Power Supply Unit; capable of supplying ~12 V d.c	1	1

SESSION 1

Preparation

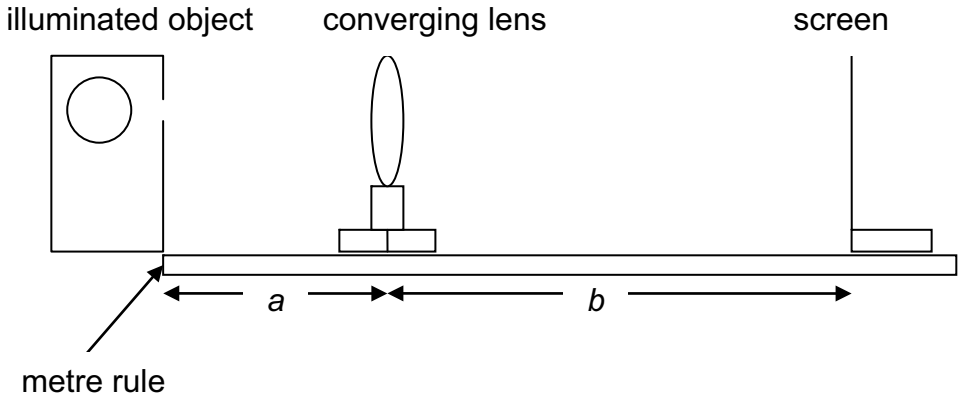

Fig. 1.1

Arrange the illuminated object, metre rule, converging lens and screen, into an optical bench, as shown in **Fig. 1.1**. Use Blu Tack to hold the illuminated object and the metre rule in place. The converging lens and screen must be able to slide along the metre rule.

Check 1: A real image will be formed when distance *a* is 40 cm and distance *b* ~40 cm.

Place the diverging lens into a lens holder and use Blu Tack to keep it vertical if necessary.

Check 2: Set the converging lens 50 cm from the illuminated object, place the diverging lens 75 cm from the illuminated object; a real image should be located between ~83 cm and ~100 cm from the illuminated object.

Before the Examination

Arrange the illuminated object, metre rule, converging lens and screen, into the optical bench, as shown in **Fig. 1.1**. Use Blu Tack to hold the illuminated object and the metre rule in place. The converging lens and screen must be able to slide along the edge of the metre rule. Set the distance *a* to 10 cm and distance *b* to 15 cm.

Place the diverging lens in its holder adjacent to the illuminated object.

Action at Changeover

Re-set the apparatus to its arrangement as described in “Before the Examination”.

Information required by Examiners

None.

SESSION 2

Preparation

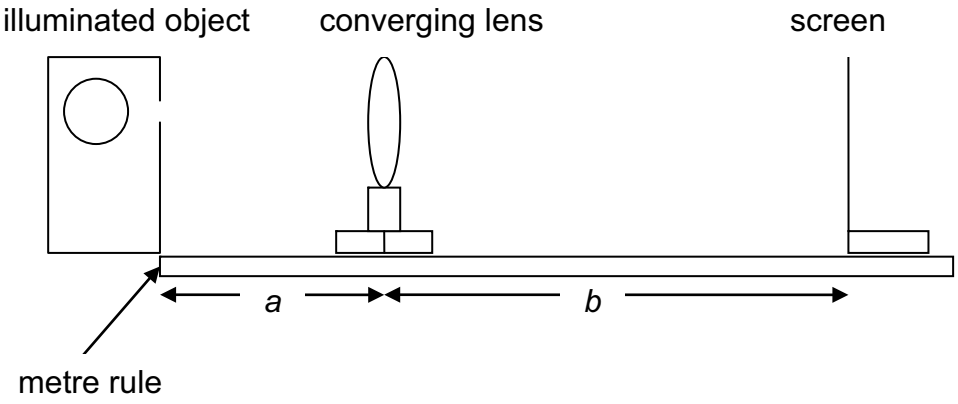

Fig. 1.1.

Arrange the illuminated object, metre rule, converging lens and screen, into an optical bench, as shown in **Fig. 1.1**. Use Blu Tack to hold the illuminated object and the metre rule in place. The converging lens and screen must be able to slide along the metre rule.

Check 1: A real image will be formed when distance *a* is 20 cm and distance *b* ~20 cm.

Place the diverging lens into a lens holder and use Blu Tack to keep it vertical if necessary.

Check 2: Set the converging lens 24 cm from the illuminated object, place the diverging lens 34 cm from the illuminated object; a real image should be located between ~45 cm and ~55 cm from the illuminated object.

Before the Examination

Arrange the illuminated object, metre rule, converging lens and screen, into an optical bench, as shown in **Fig. 1.1**. Use Blu Tack to hold the illuminated object and the metre rule in place. The converging lens and screen must be able to slide along the edge of the metre rule. Set the distance *a* to 10 cm and distance *b* to 15 cm.

Place the diverging lens in its holder adjacent to the illuminated object.

Action at Changeover

Re-set the apparatus to its arrangement as described in “Before the Examination”.

Information required by Examiners

None.

Question 2

Ref.	Component	Session 1	Session 2
2.1	Microammeter; 0–200 µA in 1 µA, digital	1	1
2.2	Voltmeter; 0–20 V in 0.01 V, digital	2	2
2.3	Stopwatch/stopclock; reading to 0.01 s, digital	1	1
2.4	Resistor; 56 kΩ ± 10% (power rating not critical)	2	0
2.5	Resistor; 28 kΩ ± 10% (power rating not critical)	0	2
2.6	Power Supply Unit; capable of supplying ~12 V d.c	2	2
2.7	Capacitor; 470 µF electrolytic, working voltage ⩾16 V	1	0
2.8	Capacitor; 1000 µF electrolytic, working voltage ⩾16 V	0	1
2.9	Component channel; any variety (crocodile clip, 4 mm socket etc)	3	3
2.10	Switch; double pole double throw	1	1
2.11	Connecting wires; 4 mm plugs at each end	12	12
2.12	Masking tape; opaque	✓	✓

SESSION 1

Preparation

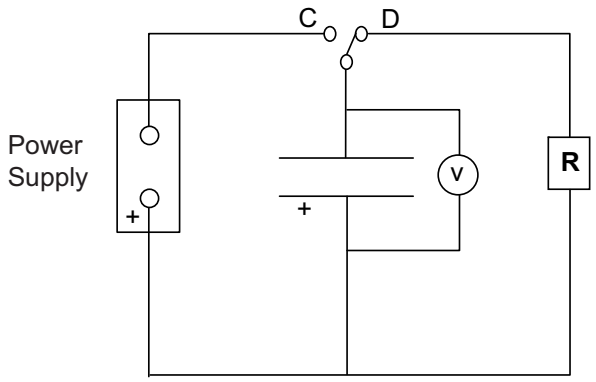

Fig. 2.1

Mask the capacitor and insert it into a component channel. Label the component channel “CAPACITOR”.

Mask both resistors and insert each into a component channel. Label each component channel “resistor R”.

Label the microammeter “MICROAMMETER”.

Label the DPDT switch “C” on the capacitor charge side and “D” on the capacitor discharge side.

Set up the circuit shown in **Fig. 2.1**.

Set the power supply unit used in the capacitor circuit to provide a maximum of ~10 V across the fully charged capacitor. Tape the control dial to prevent its use.

Check: Ensure that the voltage drops to approximately one third of the initial voltage after 30 seconds.

Before the Examination

Provide the circuit as shown in **Fig. 2.1**. Ensure the capacitor is fully discharged, leave the switch in position D.

Plug in the second power supply unit, set it to its lowest voltage and switch it off. Leave the other resistor, microammeter, voltmeter and 5 connecting wires close to the second power supply unit, but obviously separate from the capacitor circuit.

Action at Changeover

Ensure the capacitor is fully discharged and that the setting on the power supply unit has not been changed.

Ensure the circuit shown in **Fig. 2.1** is set up as in “Before the Examination”.

Switch off the second power supply unit and set it to its lowest voltage. Disconnect the other resistor, microammeter, voltmeter and 5 connecting wires and leave close to the second power supply unit, but obviously separate from the capacitor circuit.

Information required by Examiners

None.

SESSION 2

Same as Session 1.

Question 3 – Session 1 and Session 2

Apart from the provision of a suitable working area, no apparatus is required for the planning and design question.

Information required by examiners

None.