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Centre Number

71	

Candidate Number

ADVANCED
General Certificate of Education
2011

Physics

Assessment Unit A2 3

Practical Techniques
(Internal Assessment)
Session 2

[AY232]

AY232

WEDNESDAY 11 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
1		
2		
3		
Total Marks		

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INSTRUCTIONS TO CANDIDATES

Answer **all** questions in this booklet. Rough work and calculations must also be done in this booklet. 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)

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Section A

Teacher Mark	Examiner Check	Remark

1 In this experiment you will use a converging lens to focus images of an object on to a screen. You will measure the object and image distances, and the size of the image.

The aims of this experiment are:

- to obtain focused images of the object and take measurements of object and image distances, and of image size;
- to use the results to plot a linear graph;
- to use the graph to determine the focal length of the lens.

Apparatus

The apparatus consisting of an illuminated object, a converging lens, a screen, and a metre rule has been set up as shown in **Fig. 1.1.** The object consists of two crossed lines with a flat circular ring as shown in **Fig. 1.2.** The lines are to assist focusing. The screen is a graph grid of **2 mm** squares.

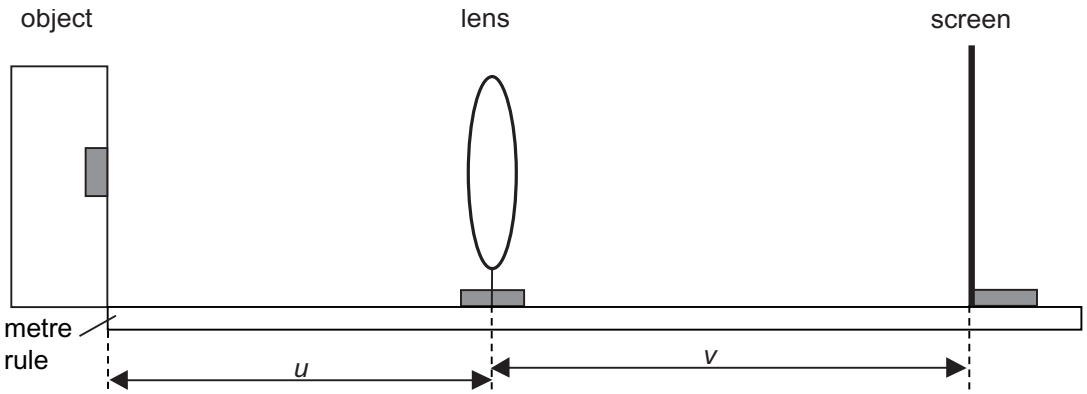

Fig. 1.1

In **Fig. 1.1**, *u* is the distance between the illuminated object and the lens (the object distance), and *v* is the distance between the lens and the corresponding sharply-focused image on the screen (the image distance).

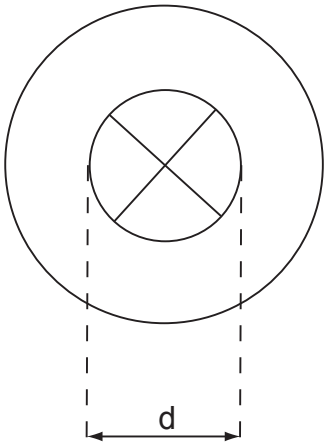

Fig. 1.2

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Teacher Mark	Examiner Check	Remark

(a) Set the object distance u to 200 mm and adjust the position of the screen until a clearly-focused image of the object is obtained. Measure the image distance v and the internal diameter d of the image (see **Fig. 1.2**). Record these values in **Table 1.1**.

Repeat this procedure to obtain five sets of results for the values of u given in **Table 1.1** and record these results.

Table 1.1

u/mm	v/mm	d/mm
200		
220		
240		
260		
280		

[5]

(b) Plot a graph of v on the y-axis against d on the x-axis on the grid of **Fig. 1.3**. Choose a suitable scale, label the axes, plot the points and draw the best fit line. [4]

The relationship between v and d is given by the **Equation 1.1**

$$v = Ad + F \qquad \textbf{Equation 1.1}$$

where A and F are constants for this experimental arrangement.

(c) Use your graph to find a value of the constants A and F. Show clearly how the values are obtained and give the values, with units where appropriate, below.

$A =$ _____

$F =$ _____ [5]

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Teacher Mark	Examiner Check	Remark

(d) For each **image** distance there is experimental uncertainty in the value.

(i) State **two** experimental factors which contribute to this uncertainty.

1. _____

2. _____ [2]

(ii) Estimate the experimental uncertainty in the value for the distance between the lens and the image.

Uncertainty = ± _____ [1]

(iii) Explain how using your graph, the uncertainty in the value of *F* can be found. Find this value and enter it below.

Uncertainty in *F* = ± _____ [2]

(iv) *F* is the focal length of the lens. The manufacturer's value of *F* is given as 150 mm. Calculate the percentage difference between the value you have calculated in part **(c)** and the manufacturer's value.

Percentage difference in values of *F* = _____ % [1]

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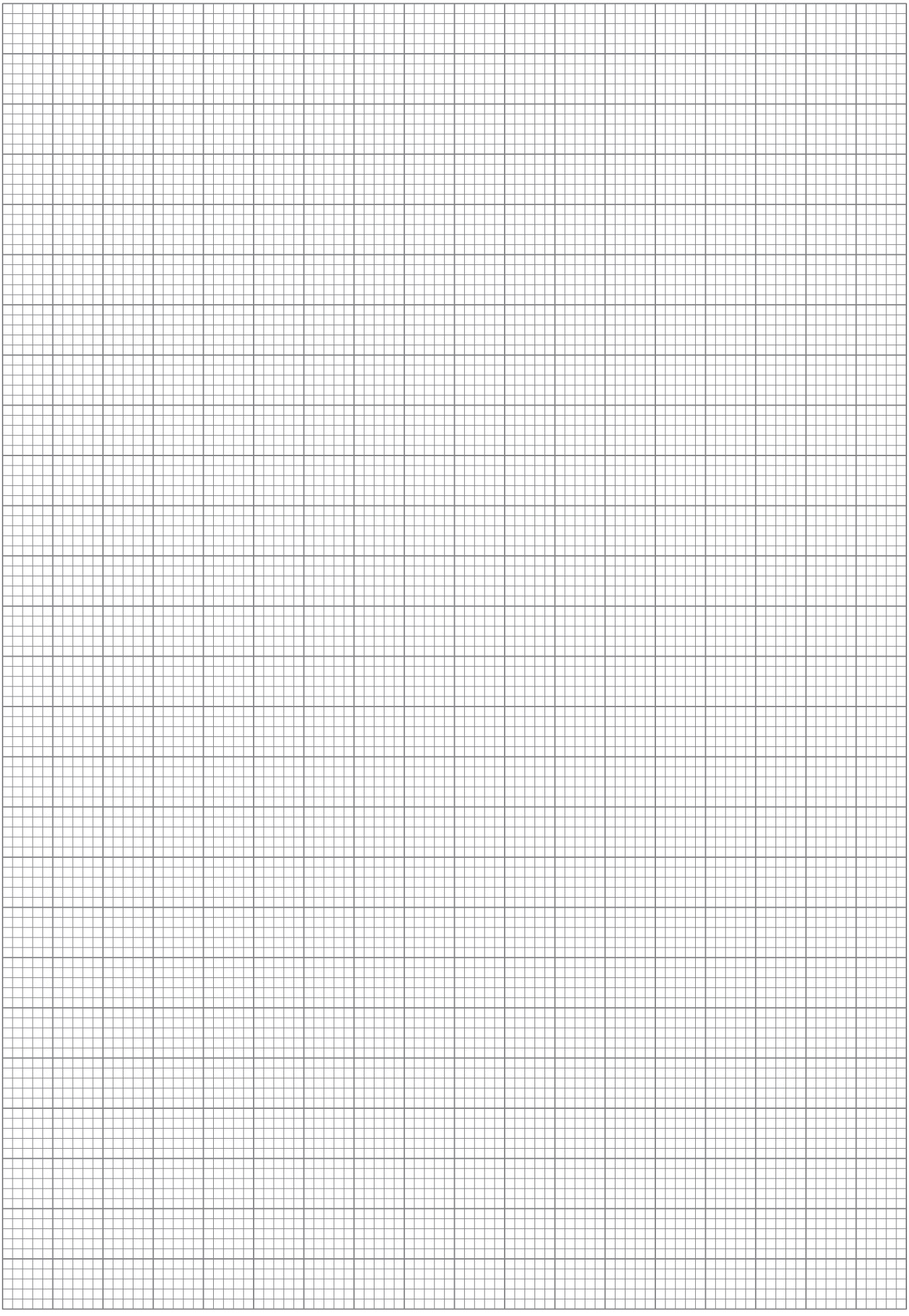

Fig. 1.3

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Teacher Mark	Examiner Check	Remark

2 In this experiment you will investigate the discharge of a capacitor network through a resistor.

The aims of this experiment are:

- to take measurements of the discharging current as a function of time;
- to use the results to plot a natural log straight line graph;
- to use the graph to determine the capacitance from a measurement of the time constant of the circuit;
- to deduce the arrangement of the capacitors in the network.

Apparatus

You are provided with a box containing a resistor and a two capacitor network. A switch is provided to allow the capacitor network to charge and discharge. A d.c. supply is connected to one pair of terminals on the box. A digital microammeter is connected to the other pair of terminals. You are also provided with a stop clock.

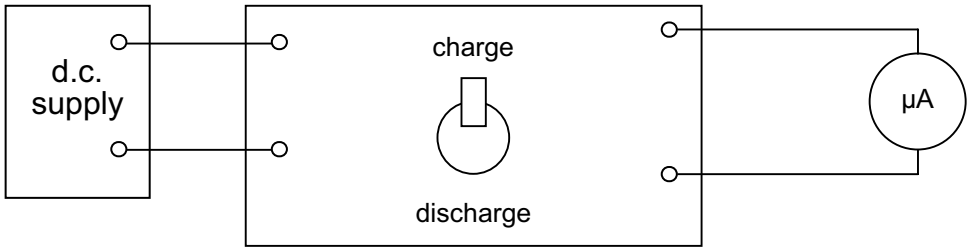

Fig. 2.1

(a) Set the switch to the charge position for a few seconds. Then set the switch to the discharge position and at the same time start the stop clock. You are to take a series of current I readings at ten second intervals for 90 seconds.
Record your results in **Table 2.1**.

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Table 2.1

t/s	I/μA	
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		

[5]

When a charged capacitor network of capacitance C discharges through a resistor of resistance R, the current I through the resistor varies according to the equation

$$I = I_o e^{-\frac{t}{CR}} \qquad \textbf{Equation 2.1}$$

where I_o is the initial current and CR is the time constant of the circuit.

(b) You are to find the value of the time constant CR from the linear graph obtained by plotting the **natural logarithm *ln* of the current I against the time *t*.**
Using **Equation 2.1** as a starting point, show that this plot will produce a linear graph.

[2]

Teacher Mark	Examiner Check	Remark

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Teacher Mark	Examiner Check	Remark

(c) **(i)** Make the necessary calculations to enable you to plot the linear graph and enter the values in the blank column in **Table 2.1**. Label the column appropriately. [2]

(ii) Use the graph grid of **Fig. 2.2**, select suitable scales, label the axes, plot the values and draw the best straight line. [5]

(iii) Find the time constant for the discharge circuit and record the value with the appropriate unit.

CR = _____ [4]

(d) The resistance of the resistor in the discharge circuit is 56 kΩ and the capacitance of each of the two capacitors is 1000 μF. Using this information and the value you have obtained for the time constant of the circuit, deduce whether the two capacitors are in series or in parallel. Indicate your choice by placing a tick in the appropriate box and explain your choice.

☐ series

☐ parallel

_____

_____

_____ [2]

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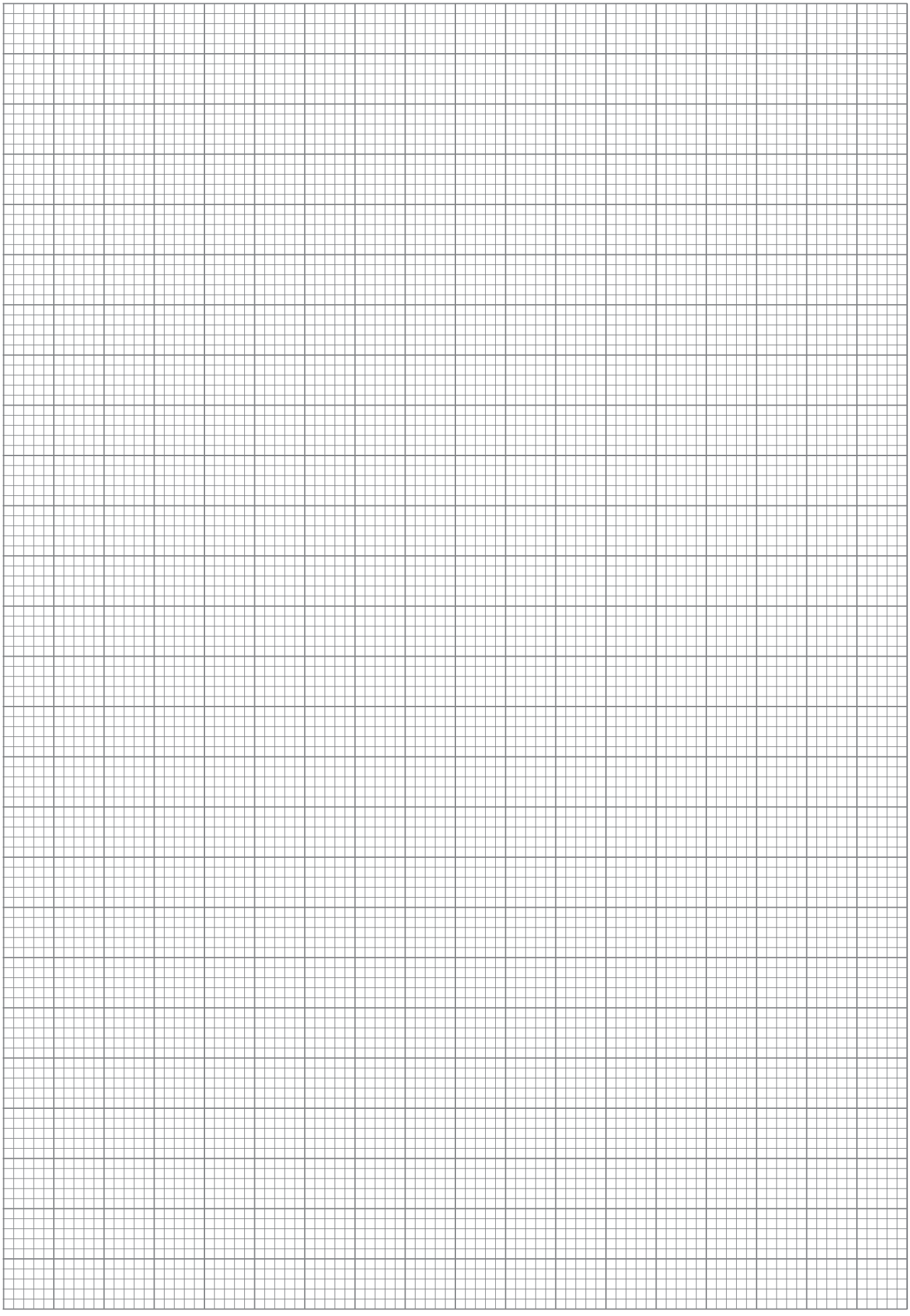

Fig. 2.2

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Section B

Teacher Mark	Examiner Check	Remark

3 In this question you will plan an experiment to find the period of oscillation of a liquid in a U-tube of uniform cross-sectional area.

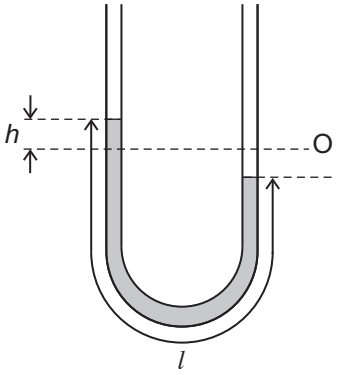

Fig. 3.1

If the liquid on one side of the U-tube is depressed by blowing gently down on one side, the levels of the liquid will oscillate for a short time about the equilibrium position O before finally coming to a rest, see **Fig. 3.1**.

(a) (i) Describe an experiment to find how the period of oscillation T depends on the total length l of the liquid in the tube. In your answer you should include:

- the procedure, including the measurements that are to be taken and how they are taken;
- how the results should be processed to find the values of the period of oscillation T for different lengths l

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Teacher Mark	Examiner Check	Remark

[6]

(ii) State **two** experimental difficulties that arise in this method.

[2]

(iii) Suggest a safety precaution which should be adopted in the experiment.

[1]

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Teacher Mark	Examiner Check	Remark

(b) The relationship between the period of oscillation T and the total length l of the liquid in the tube is given by the equation

$$T = 2\pi\sqrt{\frac{l}{2g}} \qquad \textbf{Equation 3.1}$$

(i) A straight line graph is to be drawn of the results. Label the axes on **Fig. 3.2** to show the quantity you would plot on each axis and sketch the line you would expect to obtain.

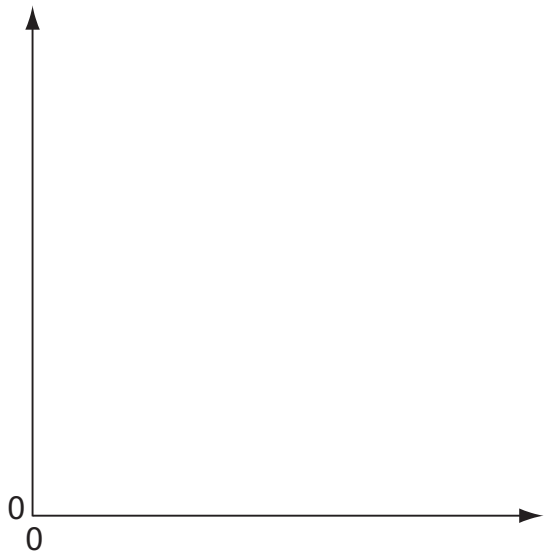

Fig. 3.2

[2]

(ii) Explain how you could use the graph to find a value for the acceleration of free fall g.

_____

_____

_____ [2]

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Teacher Mark	Examiner Check	Remark

(c) When the liquid of density ρ in the U-tube is displaced a distance h above the equilibrium position there is excess pressure P exerted on the liquid in the tube. This excess pressure is given by **Equation 3.2**.

$$P = 2h\rho g \qquad \textbf{Equation 3.2}$$

To calculate the excess pressure P in the liquid the student must use the equations for pressure and density. She starts this process by finding the density ρ of the liquid. The mass of the liquid was found using a balance reading to 0.01 g and was 543.53 g. The length of the liquid in the tube was found to be 15.3 $\pm$ 0.1 cm and the internal diameter of the tube was measured by vernier callipers to be 1.81 cm.

(i) Find the density of the liquid $\left(\text{density} = \dfrac{\text{mass}}{\text{volume}}\right)$.

Density = _____ [2]

(ii) The value of the density is derived from the measurements of several quantities. State which quantity contributes most to the overall percentage uncertainty, explain your choice and evaluate the percentage uncertainty in this quantity.

_____

_____

_____ [3]

(iii) **Equation 3.2** was obtained by analysis of experimental results. Check the validity of **Equation 3.2** by comparing the units of the quantities on both sides of the equation in terms of base units.

N.B. $\text{pressure} = \dfrac{\text{force}}{\text{area}}$.

_____

_____

_____ [2]

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Physics

Assessment Unit A2 3

assessing

Practical Techniques
Sessions 1 and 2

[AY231] [AY232]

MONDAY 9 MAY AND WEDNESDAY 11 MAY

AY231 AY232

APPARATUS AND MATERIALS LIST

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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 2011.

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 below) will accommodate three candidates.

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

Monday 9 May 2011 Physics A2 3A (AY231)

(Main Session) **9.15 a.m. – 10.45 a.m.**
(First Alternative) **11.00 a.m. – 12.30 p.m.**
(Second Alternative) **1.15 p.m. – 2.45 p.m.**
(Third Alternative) **3.00 p.m. – 4.30 p.m.**

Wednesday 11 May 2011 Physics A2 3B (AY232)

(Main Session) **9.15 a.m. – 10.45 a.m.**
(First Alternative) **11.00 a.m. – 12.30 p.m.**
(Second Alternative) **1.15 p.m. – 2.45 p.m.**
(Third Alternative) **3.00 p.m. – 4.30 p.m.**

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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 **11 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.

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Question 1

Ref	Item	Session 1	Session 2
1.1	Light box with illuminated circular object (e.g. washer) of internal diameter 10 mm with cross wires	1	1
1.2	metre rule	1	1
1.3	screen	1	1
1.4	2 mm squared paper	1	1
1.5	lens, biconvex, 50 mm diameter, focal length 100 mm ± 5 mm	1	–
1.6	lens, biconvex, 50 mm diameter, focal length 150 mm ± 5 mm	–	1
1.7	lens holder	1	1

Question 2

Ref	Item	Session 1	Session 2
2.1	6 V d.c. power supply	1	1
2.2	Resistor 0.5 W carbon film 15 kΩ ± 10%	1	0
2.3	Capacitor 1000 μF, 16 V electrolytic RS108–4885	2	2
2.4	D.C. digital microammeter 0–600 μA	1	1
2.5	Switch SPDT (1 pole on) e.g. RS 394–459	1	1
2.6	Connecting leads, fitted with 4 mm plugs	4	4
2.7	Stopclock to 0.01 s	1	1
2.8	Box, metal or opaque plastic, dimensions not critical	1	1
2.9	Sockets 4 mm, black and 4 mm, red	2	2
2.10	Resistor 0.5 W carbon film 56 kΩ ± 10%	0	1

Question 3

No apparatus is required for this question, which tests planning and design.

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Physics

Assessment Unit A2 3

assessing

Practical Techniques (Internal Assessment)

[AY231] [AY232]

MONDAY 9 MAY AND WEDNESDAY 11 MAY

CONFIDENTIAL INSTRUCTIONS TO TEACHERS

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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.

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Session 1

Experiment 1

Principal Requirements

Light box with illuminated object (washer) and crosswires
Metre rule
Screen covered in 2 mm squared paper
Lens, biconvex, 50 mm diameter, focal length 100 mm
Lens holder

Preparation

Place a reference mark on the lens holder below the optical centre of the lens when it is in the holder. Attach the metre rule to the bench with adhesive tape. Position the light box at the zero end of the rule in such a way that the lens and screen can be moved along the edge of the rule to form an image of the object on the screen. If necessary, adjust the height of either screen or lens holder so that the image on the screen is always formed at the same height above the bench as that of the object.

The optical bench arrangement is to be left assembled for the candidate's use.

Illuminated object (washer) and crosswires construction

Measure the height *H* of the centre of the lens, mounted in the lens holder, above the surface of the bench. Take the 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 a 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 black felt-tip pen (or similar) to mark an "**X**" with 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. 1.1**.

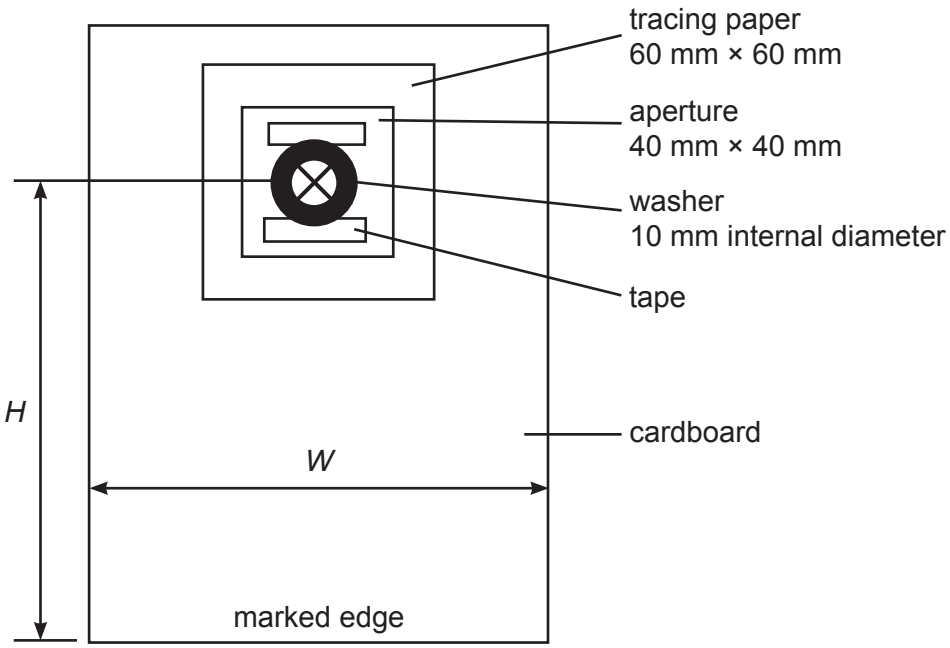

Fig. 1.1 Washer and "X" object (not to scale)

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Testing

Check that, with the lens 120 mm from the object, a sharp image can be formed before the screen passes the 960 mm mark.

Before the examination

Switch on light box. Set the lens at the 100 mm mark and the screen at the 150 mm mark.

Action at changeover

Return the lens and screen to the 100 mm and 150 mm positions respectively. Ensure light box is switched on.

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Experiment 2

Principal Requirements

d.c. power source to provide 6 V
Resistor carbon, 15 kΩ ± 10%, power rating not critical (~0.5 W)
Two 1000 μF capacitors, 16 V RS 108–4885
Digital microammeter capable of reading to 600 μA d.c.
Switch SPDT (1 pole on), e.g. 394–459
Stopclock to 0.01 s
Connecting leads, fitted with 4 mm plugs
Box, metal or opaque plastic, dimensions not critical
Sockets, 4 mm, black
Sockets, 4 mm, red

Preparation

(a) The candidates' view of the apparatus is shown in **Fig. 2.1.**

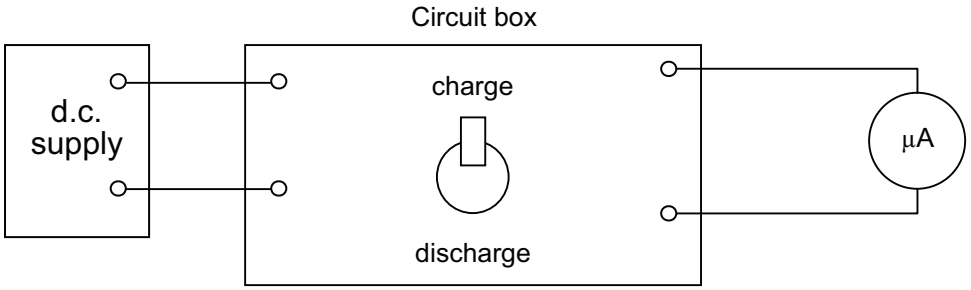

Fig. 2.1

(b) Circuit box construction

1. On underside of box lid mount 2 red and 2 black 4 mm terminals as shown in **Fig. 2.2.**

2. Mount switch on box lid.

3. Connect circuit as shown in **Fig. 2.2**. Observe correct polarity for capacitors. (Note: diagram shows the underside of the box lid viewed from above).

4. With switch in the "charge" position, capacitors charge and with switch in the "discharge" position, capacitors discharge.

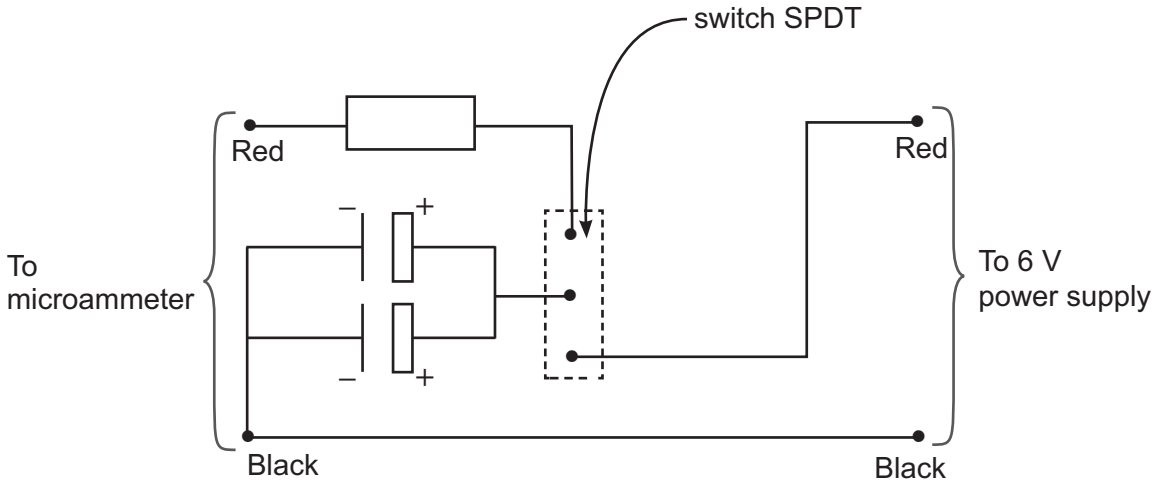

Fig. 2.2

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Testing

Connect the microammeter and d.c. power supply.

Charge the capacitors. This should only take a few seconds. Check that the capacitors discharge so that the current decays from approximately 417 μA to about 21 μA in 90 seconds.

Before the Examination

Leave the connected components on the bench with a stopclock.

Action at changeover

Discharge capacitors and leave switch in discharge position. Set stopclock to zero.

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Question 3

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

Information required by examiners

None.

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Session 2

Experiment 1

Principal Requirements

Light box with illuminated object (washer) and crosswires
Metre rule
Screen covered in 2 mm squared paper
Lens, biconvex, 50 mm diameter, focal length 150 mm
Lens holder

Preparation

Place a reference mark on the lens holder below the optical centre of the lens when it is in the holder. Attach the metre rule to the bench with adhesive tape. Position the light box at the zero end of the rule in such a way that the lens and screen can be moved along the edge of the rule to form an image of the object on the screen. If necessary, adjust the height of either screen or lens holder so that the image on the screen is always formed at the same height above the bench as that of the object.

The optical bench arrangement is to be left assembled for the candidate's use.

Illuminated object (washer) and crosswires construction

See instructions for Session 1.

Testing

Check that, with the lens 200 mm from the object, a sharp image can be formed before the screen passes the 900 mm mark.

Before the examination

Switch on light box. Set the lens at the 100 mm mark and the screen at the 250 mm mark.

Action at changeover

Return the lens and screen to 100 mm and 250 mm positions respectively. Ensure the light box is switched on.

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Experiment 2

Principal Requirements

6 V d.c. battery pack
Resistor carbon, 56 kΩ ± 10%, power rating not critical
Two 1000 μF capacitors
Digital microammeter capable of reading 0 to 600 μA d.c.
Switch SPDT (1 pole on), e.g. RS 394–459
Stopclock to 0.01 s
Connecting leads, fitted with 4 mm plugs
Box, metal or opaque plastic, dimensions not critical but a guide is about 10 cm × 10 cm × 5 cm
Sockets, 4 mm, black
Sockets, 4 mm, red

Preparation

(a) The candidates' view of the apparatus is shown in **Fig. 2.1.**

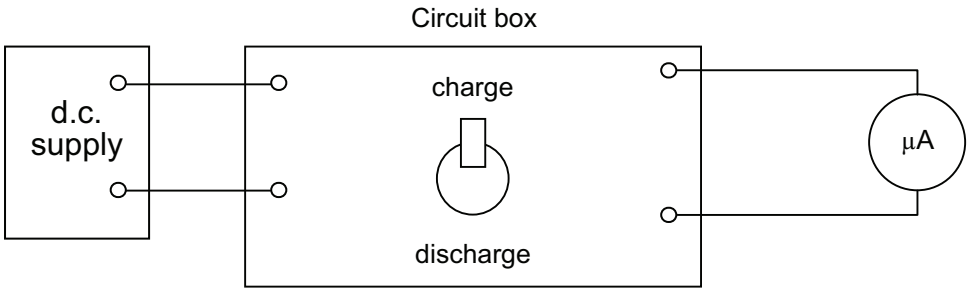

Fig. 2.1

(b) Circuit box construction

1. On underside of box lid mount 2 red and 2 black 4 mm terminals as shown in **Fig. 2.2.**
2. Mount switch on box lid.
3. Connect circuit as shown in **Fig. 2.2**. Observe correct polarity for capacitors. (Note: diagram shows the underside of the box lid viewed from above).
4. With switch in the "charge" position, capacitors charge and with switch in the "discharge" position, capacitors discharge.

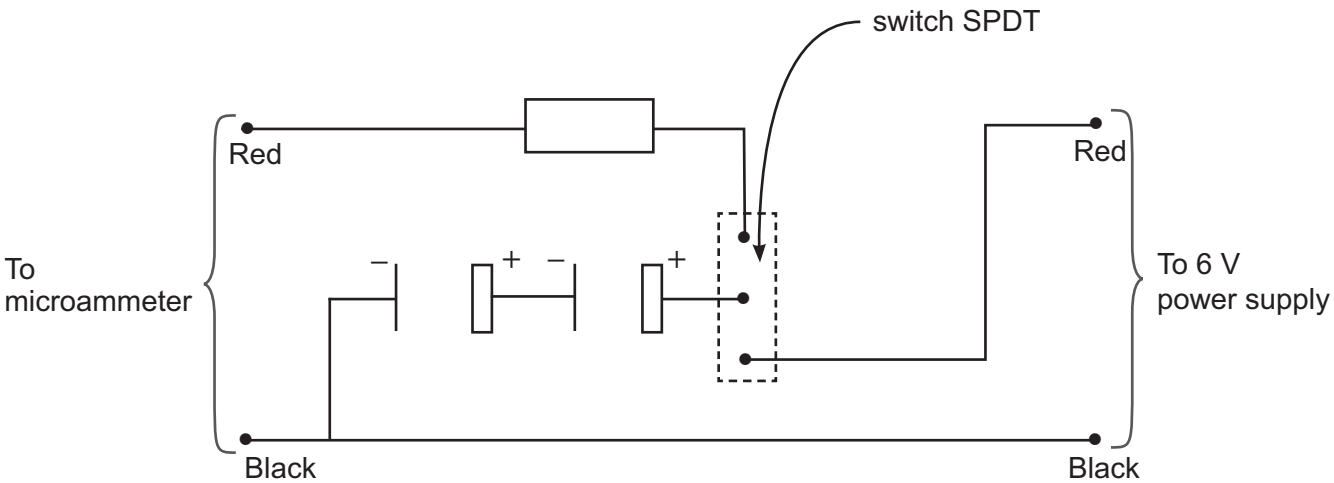

Fig. 2.2

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Testing

Connect the microammeter and d.c. power supply.

Charge the capacitors. This should only take a few seconds. Check that the capicators discharge so that the current decays from approximately 109 μA to about 5 μA in 90 seconds.

Before the Examination

Leave the connected components on the bench with a stopclock.

Action at changeover

Discharge capacitors and leave switch in discharge position. Set stopclock to zero.

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Question 3

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

Information required by examiners

None.

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