Rewarding Learning

ADVANCED

General Certificate of Education

2022

Centre Number

Candidate Number

Physics

Assessment Unit A2 3A

assessing

Practical Techniques and Data Analysis

APH31

[APH31]

FRIDAY 13 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	Remark
1		
2		
Total Marks		

BLANK PAGE

1 In this experiment you will investigate how the height of a column of water in a cylinder changes with time as the water leaves the cylinder through a hole.

Aims

The aims of this experiment are to:

- measure the internal diameter of the cylinder;
- measure the height of the column of water at specified times;
- analyse the results and plot a linear graph;
- use the results to determine the diameter of the hole.

Apparatus

You are provided with a cylinder which has a small hole near the base, as shown in **Fig. 1.1**. A ruler has been placed vertically on the cylinder to allow the height h of the column of water above the hole to be read.
There is a large beaker of coloured water provided to fill the cylinder.

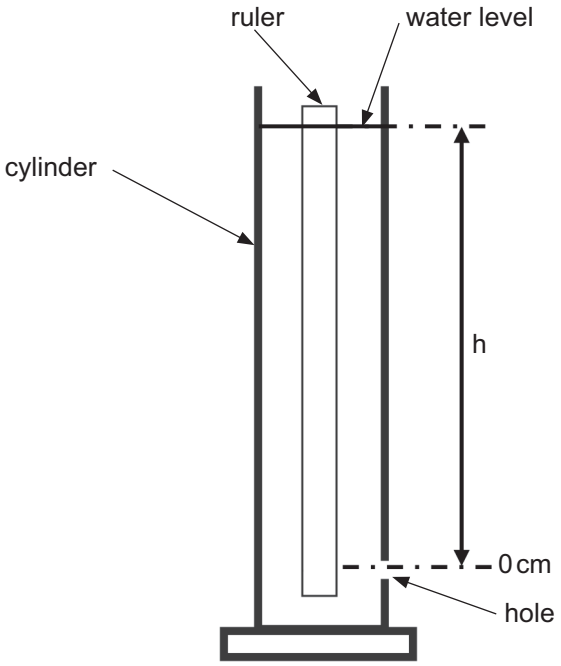

Fig. 1.1

Procedure

(a) Almost fill the cylinder using the beaker of coloured water provided.
Start the stop clock when the height h of the column of water above the hole is equal to 20 cm.
Use the middle column of **Table 1.1** to record h every 10 seconds for 50 seconds.
Repeat the procedure and calculate the average h values.

Table 1.1

time / s	h / cm			
	1	2	Average	
10.00				
20.00				
30.00				
40.00				
50.00				

[3]

Analysis

Equation 1.1 describes how the height h of the column of water above the hole varies with time t.

$$t = B\sqrt{h} + D \qquad \textbf{Equation 1.1}$$

where B and D are constants.

(b) (i) In order to draw a straight line graph which will allow B and D to be determined, $\sqrt{h}$ must be calculated. Complete the final column in **Table 1.1** with an appropriate heading and values of $\sqrt{h}$ to the correct number of significant figures. [3]

Examiner Only

Marks	Remark

(ii) On the grid of **Fig. 1.2**, plot t against $\sqrt{h}$ and draw the best fit straight line for the points plotted. [5]

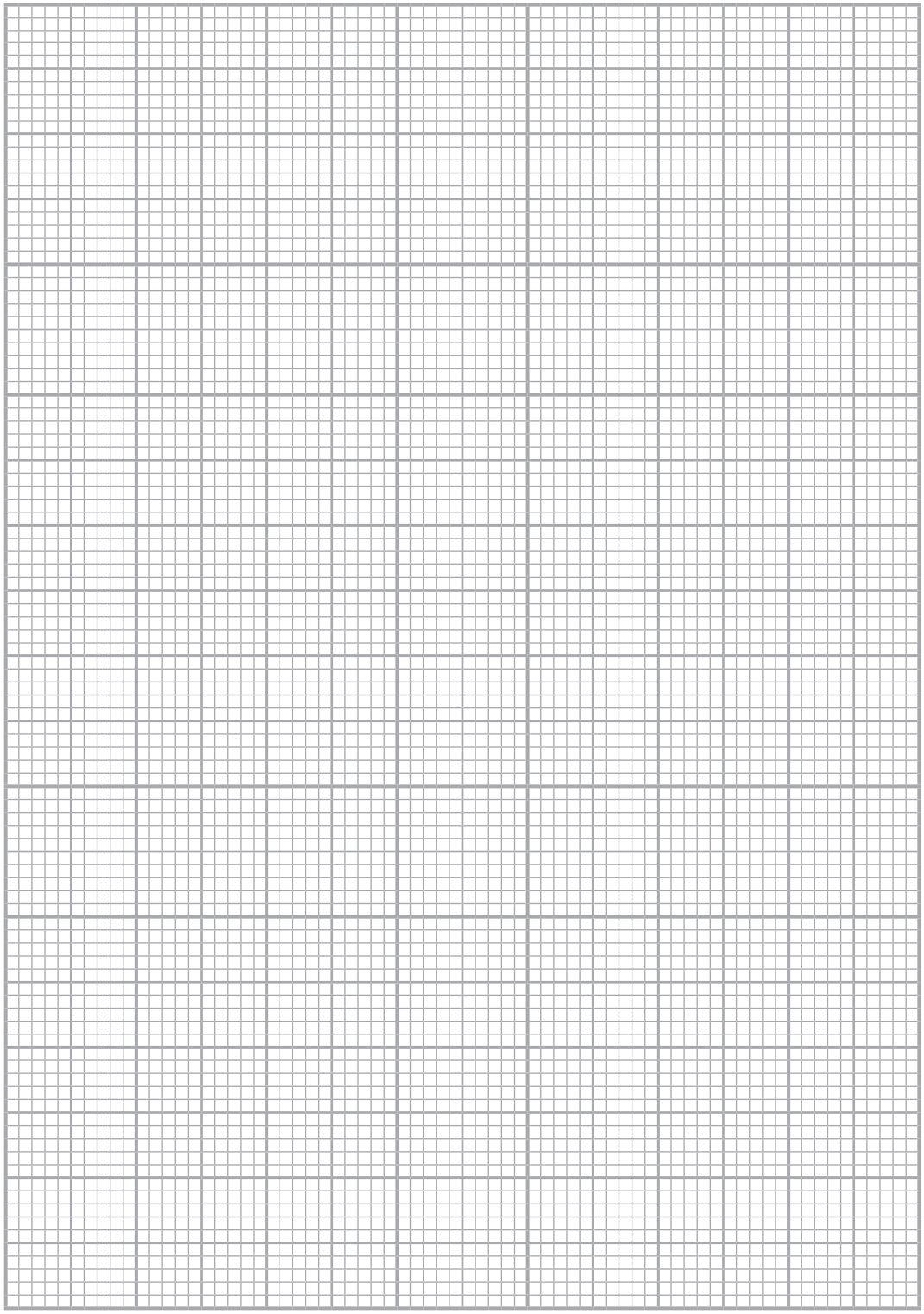

Fig. 1.2

Examiner Only	
Marks	Remark

(c) (i) Use your graph to determine the value of the constant B. Include the correct unit of B.

B = _____

unit of B = _____ [4]

Theory suggests that the constant B is given by **Equation 1.2**.

$$B = \frac{\varnothing_{cylinder}^{\ 2}}{\varnothing_{hole}^{\ 2}} \sqrt{\frac{2}{g}} \qquad \textbf{Equation 1.2}$$

where

$\varnothing_{cylinder}$ is the internal diameter of the cylinder
$\varnothing_{hole}$ is the internal diameter of the hole
g is the acceleration of free fall, 981 cm s^{-2}

(ii) Measure the internal diameter of the cylinder using the vernier calipers provided.

$\varnothing_{cylinder}$ = _____ cm [2]

(iii) Use **Equation 1.2** and your answers to parts **(c)(i)** and **(ii)** to determine the internal diameter of the hole.

$\varnothing_{hole}$ = _____ cm [3]

BLANK PAGE

(Questions continue overleaf)

2 In this experiment you will investigate capacitor discharge.

Examiner Only	
Marks	Remark

Aims

The aims of this experiment are to:

- measure how the voltage across a charged capacitor decreases when it is repeatedly discharged to another capacitor;
- analyse the results and plot a linear graph;
- use the graph to determine the capacitance of the charged capacitor.

Apparatus

You are provided with a sealed box that contains the circuit shown in **Fig. 2.1**. The switch can be toggled to connect and disconnect capacitor C_1 and capacitor C_2.

The two leads from the circuit can either be connected to a cell to charge C_1, or to the voltmeter to measure the voltage across C_1.

The leads are labelled positive and negative.

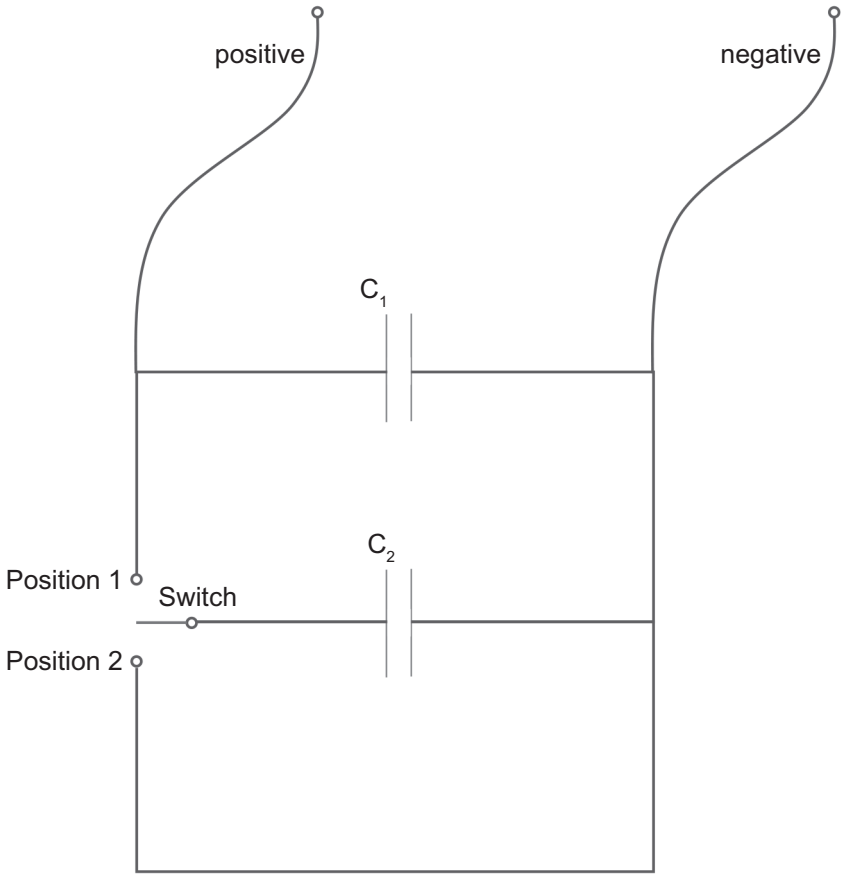

Fig. 2.1

Procedure

(a) Ensure the switch is turned to position 2. This will fully discharge C_2 and isolate it from C_1.

Connect the positive and negative leads to the corresponding terminals of the cell.

Disconnect the leads from the cell and connect them to the voltmeter.

Record the initial voltage across C_1 for $n = 0$ in **Table 2.1**, where n is the number of times C_1 has been connected to C_2.

Move the switch to position 1. This will allow some of the charge to flow from C_1 to C_2. Record the new voltage across C_1 in the table for $n = 1$.

Repeat the procedure of moving the switch to position 2 and back to position 1. Record the new voltage each time the switch is moved to position 1 in **Table 2.1**.

Table 2.1

n	V / V	
0		
1		
2		
3		
4		
5		

[2]

Examiner Only

Marks	Remark

Analysis

The voltage across C_1 is given by **Equation 2.1**.

$$V = k Z^n \qquad \textbf{Equation 2.1}$$

where k and Z are constants.

(b) (i) What quantity is represented by the constant k in **Equation 2.1**?

_____ [1]

(ii) Show that a graph of $\log_{10} V$ against n will produce a straight line graph.

[3]

(iii) In order to draw the graph it is necessary to calculate $\log_{10} V$ from your results. Complete the final column of **Table 2.1** with an appropriate heading and values recorded to **2 decimal places**. [3]

(c) Plot the graph of $\log_{10} V$ against n on the grid of **Fig. 2.2** and draw a best fit straight line for the points plotted. [5]

Examiner Only

Marks	Remark

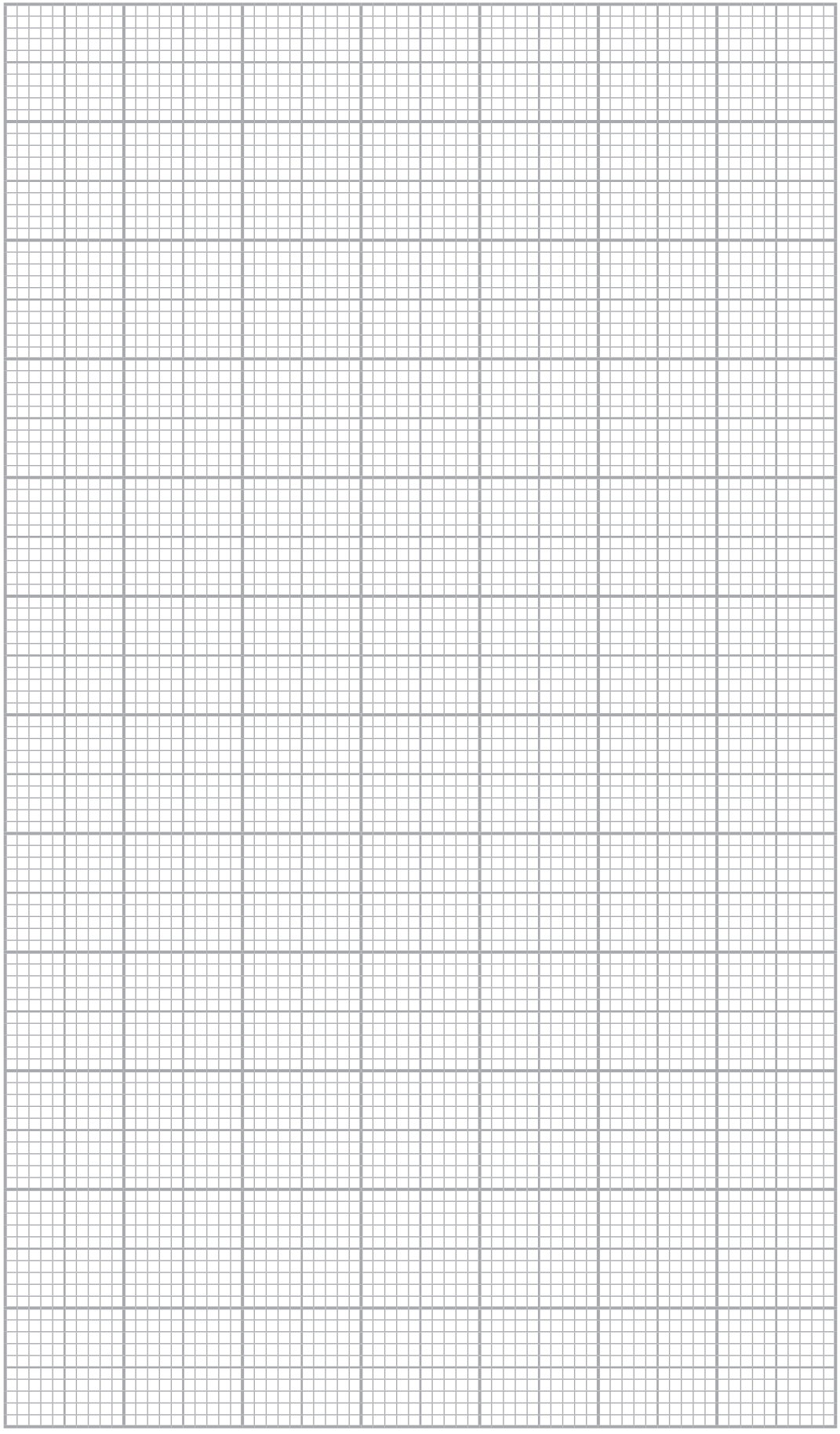

Fig. 2.2

(d) Determine the gradient of the best fit straight line.

Examiner Only

Marks	Remark

Gradient = _____ [2]

(e) The quantity Z is given by **Equation 2.2**.

$$Z = \frac{C_1}{C_1 + C_2} \qquad \textbf{Equation 2.2}$$

Given that $C_2 = 120\,\mu F$ calculate the capacitance of C_1.

C_1 = _____ μF [4]

THIS IS THE END OF THE QUESTION PAPER

Rewarding Learning

ADVANCED
General Certificate of Education
2022

Physics

Assessment Unit A2 3A

Practical Techniques and Data Analysis

[APH31]
FRIDAY 13 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) 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

- plastic measuring cylinder capacity 250 ml
- 2 × 500 ml beaker
- 30 cm ruler reading to 0.1 cm
- 2 mm drill bit and drill
- sink or basin to collect water
- stopclock reading to 0.01 s
- vernier caliper
- adhesive tape
- red food colouring

Preparation

Drill a single 2 mm diameter hole in the measuring cylinder level with the 30 ml marking on the cylinder. Tape the ruler vertically to the outside of the measuring cylinder so that the **0 cm marking** on the ruler is horizontally level with the centre of the hole as shown in **Fig. 1.1**.

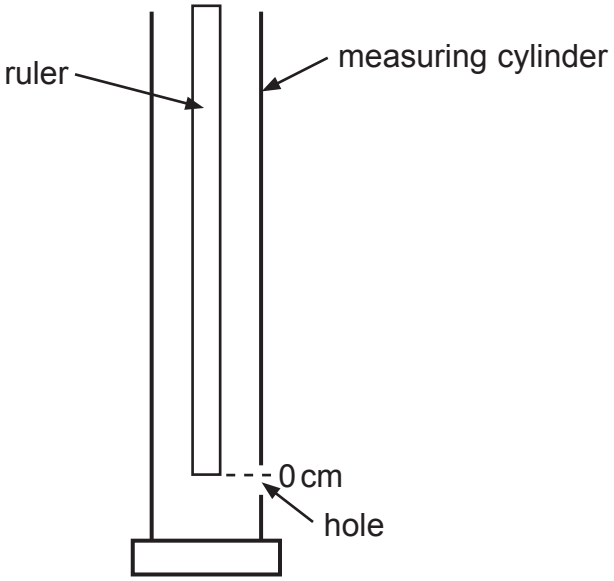

Fig. 1.1

Place the measuring cylinder so that when filled the water drains into a basin/sink. Fill two 500 ml beakers with approx. 350ml of water and add a few drops of food colouring to make it easier to determine the level of water when in the measuring cylinder. Please note, spare beakers of coloured water should be available in case candidates do a trial run or wish to repeat a run. Place the stopwatch and vernier caliper next to the measuring cylinder.

Action at changeover

Empty the measuring cylinder, reset the stopclock, close the vernier caliper and refill the beaker with water and drops of food colouring.

Question 2

Requirements

- 1 × 820 μF capacitor > 2 V working voltage
- 1 × 120 μF capacitor > 2 V working voltage
- 1 × red, 1 × black 4 mm binding post panel mount
- 2 × 4 mm connecting wire
- white adhesive labels
- SPDT switch
- enclosure 85 × 60 × 40 mm or larger
- 1.5 V cell
- 1.5 V cell holder
- digital voltmeter range 0 – 2 V reading to 0.001V

Preparation

Drill holes in the enclosure and mount the SPDT switch and the red and black binding posts in the front panel. Solder the capacitors inside the box so the circuit and the underside of the lid of the box will look like **Fig. 2.1**.

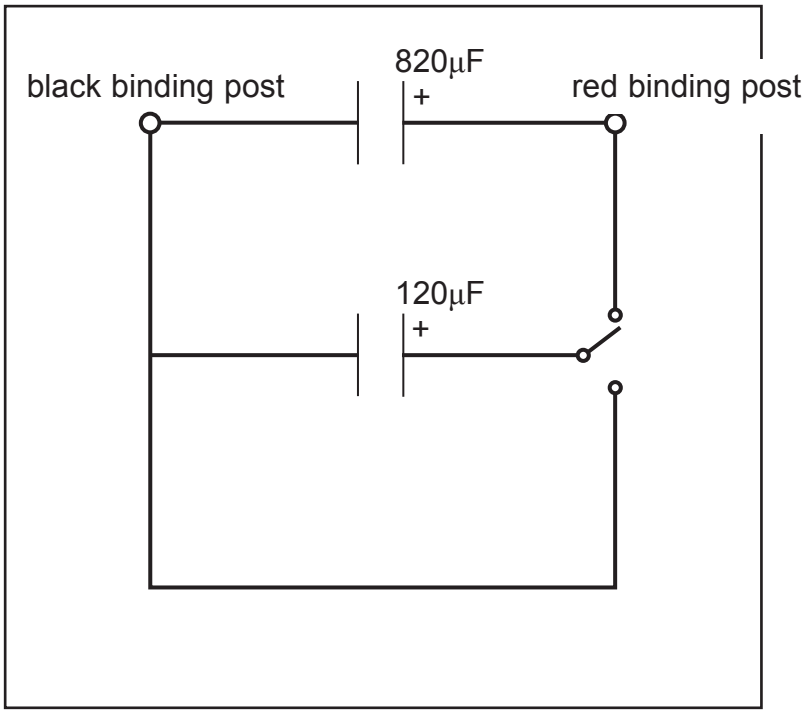

Fig. 2.1

Ensure the circuit and capacitors are sealed inside the box so that they cannot be viewed by the students. Use the white sticky labels to draw the corresponding circuit as shown in **Fig. 2.2** onto the front of the box between the exposed switch and binding posts. Label position 1 and position 2 on the label as shown in the **Fig 2.2**.

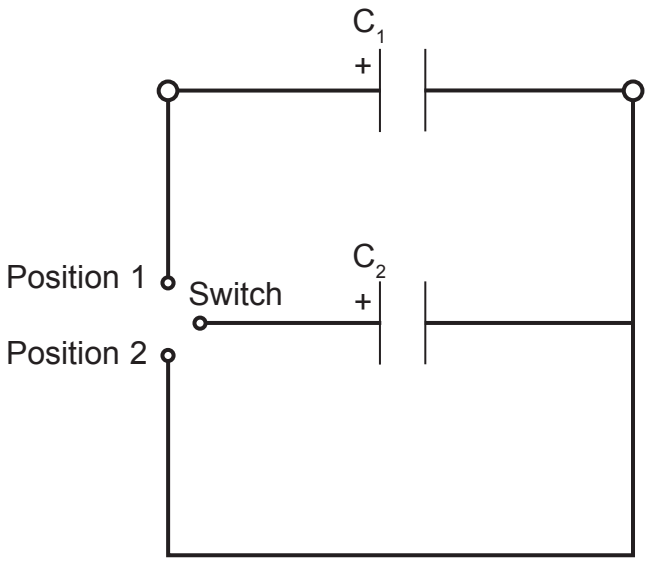

Fig. 2.2

Check

Turn the switch to position 2. Place two connecting wires in the red and black post bindings. Connect the wires to the +ve and –ve terminals of the 1.5 V cell. Remove the wires from the cell and attach to the voltmeter. The voltmeter should read approximately 1.5 V. Turn the switch to position 1 then back to position 2 again. The reading on the voltmeter should drop to about 87% of its original value.

Setup for Practical

Place the enclosure on the desk next to the voltmeter and cell inside the cell holder. Place two connecting wires in the red and black post bindings and label these wires positive and negative respectively. Ensure the SPDT switch is in position 2. Touch the positive and negative wires together to ensure C_1 is fully discharged.

Action at changeover

Disconnect circuit from cell/voltmeter. Return switch to position 2. Touch the positive and negative wires together to ensure C_1 is fully discharged.

Rewarding Learning

ADVANCED
General Certificate of Education
2022

Physics

Assessment Unit A2 3A

Practical Techniques and Data Analysis

[APH31]
FRIDAY 13 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 2022.

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:

Friday 13 May 2022 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 **Friday 13 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

- plastic measuring cylinder capacity 250 ml
- 2 × 500 ml beaker
- 30 cm ruler to 0.1 cm
- 2 mm drill bit and drill
- sink or basin to collect water
- stopclock reading to 0.01 s
- vernier caliper
- adhesive tape
- red food colouring

Question 2

Requirements

- 1 × 820 μF capacitor > 2 V working voltage
- 1 × 120 μF capacitor > 2 V working voltage
- 1 × red, 1 × black 4mm binding post panel mount
- 2 × 4 mm connecting wire
- white adhesive labels
- SPDT switch
- enclosure 85 × 60 × 40 mm or larger
- 1.5 V cell
- 1.5 V cell holder
- digital voltmeter range 0 – 2 V, reading to 0.001V