Rewarding Learning

ADVANCED

General Certificate of Education

2019

Centre Number

Candidate Number

Physics

Assessment Unit A2 3A

assessing

Practical Techniques and Data Analysis

APH31

[APH31]

WEDNESDAY 8 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		

1 In this experiment you will investigate the oscillations of a mass suspended from a spring system.

Aims

The aims of the experiment are:

- to measure the extended length and period of oscillation of the spring system as the mass attached is increased;
- to analyse the results and plot a linear graph;
- to use the results to find a value for the unknown constant.

Apparatus

You are provided with a spring system of total length L_0, which consists of three springs connected in series. The spring system is suspended from a clamp on a retort stand as shown in **Fig. 1.1**.

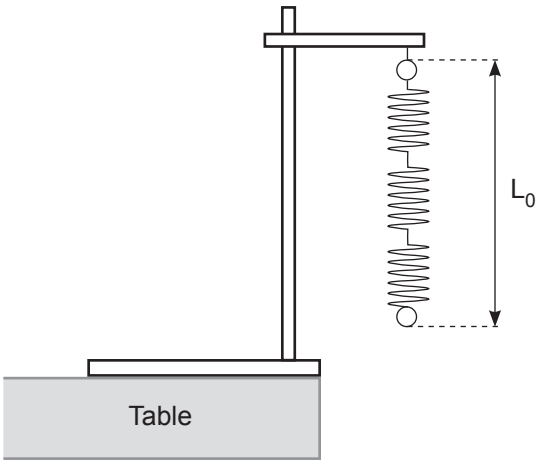

Fig. 1.1

A 100 g mass hanger, four 100 g masses, a stopclock and a metre rule are also provided.

Procedure

(a) Attach the 100 g mass hanger to the bottom of the spring system.

Measure the length L of the spring system as shown in **Fig. 1.2** and record the value in **Table 1.1**.

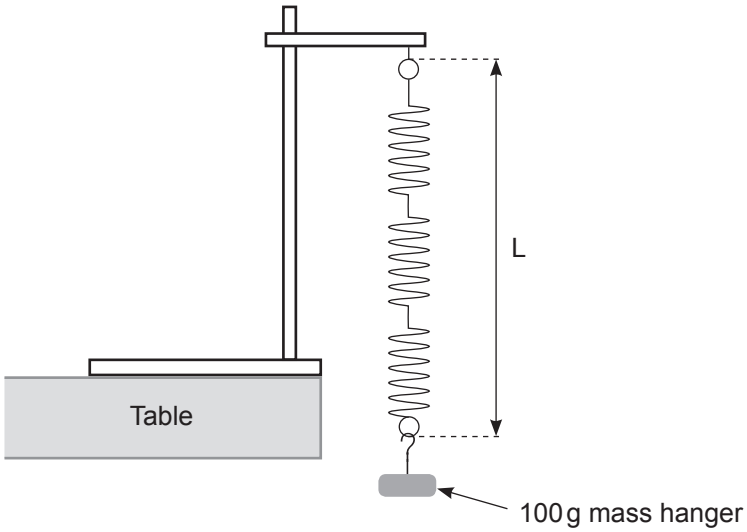

Fig. 1.2

Displace and release the mass so that it oscillates **vertically** with small amplitude. Take readings to allow you to determine an accurate value for the period of oscillation T.

Record all your results in **Table 1.1** adding any extra headings required.

Repeat the procedure until you have five sets of corresponding values of L and T for the masses up to 500 g.

Table 1.1

Mass / g	L / m		T / s	
100				
200				
300				
400				
500				

[4]

Examiner Only	
Marks	Remark

Theory

Theory suggests that the relationship between T and L is given by **Equation 1.1**.

$$T = 2\pi\sqrt{\frac{L - L_0}{P}} \qquad \textbf{Equation 1.1}$$

where P and L_0 are constants.

(b) Show that a graph of T^2 against L will result in a straight line from which the values of the constants P and L_0 can be determined.

[3]

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

(ii) Plot the graph of T^2 against L on the grid of **Fig. 1.3** and draw the best-fit straight line for the points plotted. [5]

Examiner Only	
Marks	Remark

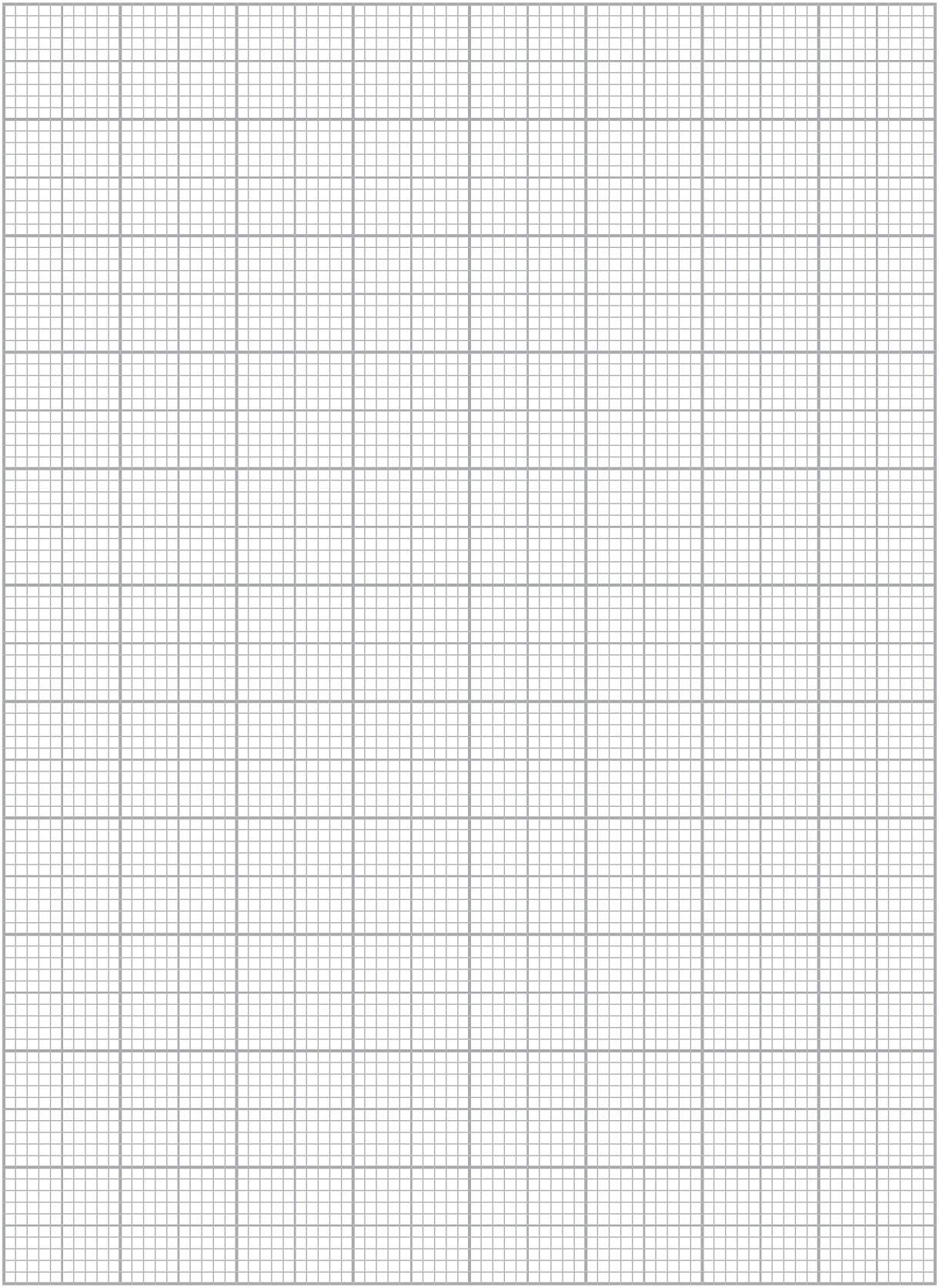

Fig. 1.3

(iii) Calculate the gradient of your graph.

Examiner Only

Marks	Remark

Gradient = _____ [3]

(iv) Use the value of the gradient from part **(iii)** to obtain a value for the constant P. Include an appropriate unit for P.

P = _____ Unit _____ [2]

(d) What does the intercept of your graph with the L-axis represent?

_____

_____ [1]

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(Questions continue overleaf)

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

Aims

The aims of the experiment are:

- to take measurements of the discharging current as a function of time;
- to use the results to plot two discharge curves;
- to use these plots to obtain values for the two time constants;
- to deduce the values of the capacitance of the two capacitors.

Apparatus

The circuit has been constructed as shown in **Fig. 2.1** with the "flying lead" connected to terminal A of the box containing two capacitors.

A microammeter has been provided to measure the current when the capacitor is discharged through the 33 kΩ resistor, marked R.

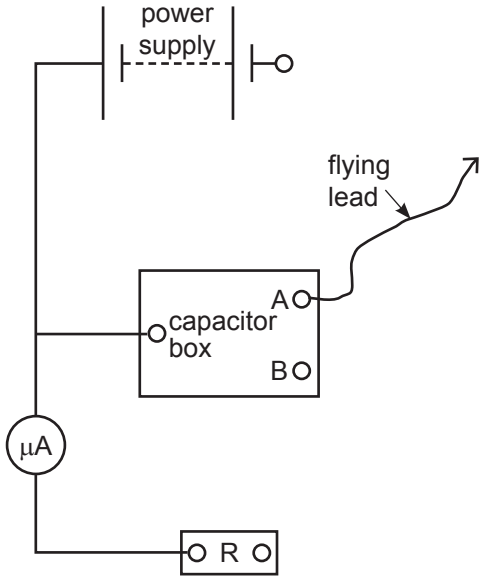

Fig. 2.1

(a) (i) Connect the flying lead to the negative terminal of the power supply in order to charge the first capacitor.

Remove the flying lead from the power supply and connect it to resistor R to discharge the capacitor. At the same time start the stopclock. You are to take a series of current I readings at **twenty** second intervals for **120 s**.

Record your results in **Table 2.1**.

Table 2.1

t / s	0	20	40	60	80	100	120
I / μA							

[2]

(ii) Using the grid on **Fig. 2.2** plot the values of current I against time t.

Select suitable scales, label the axes, plot the values and draw a best-fit curve for the points plotted. [5]

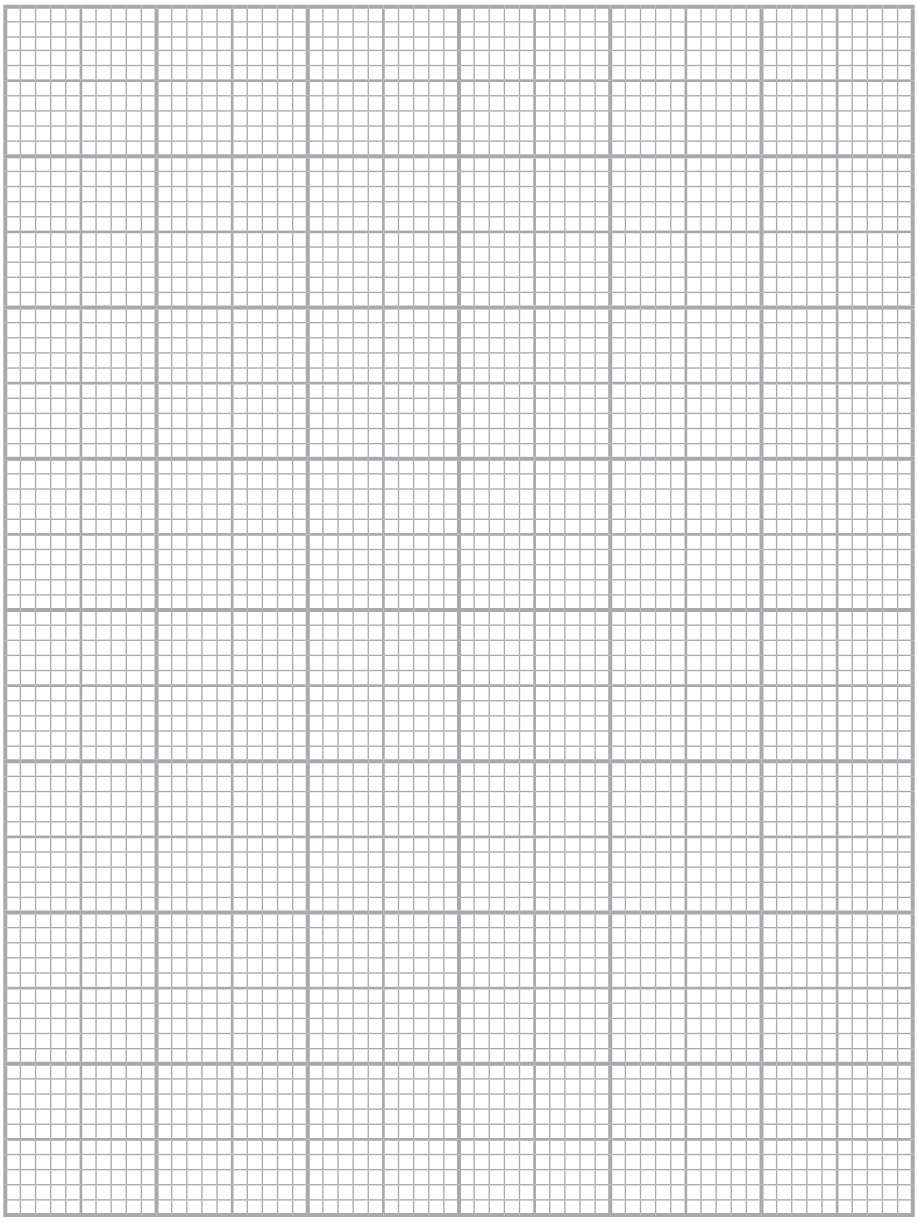

Fig. 2.2

Examiner Only	
Marks	Remark

The time constant τ is equal to the time taken for the current to reduce to 37% of its initial value.

(iii) From your graph find a **reliable** value for the time constant τ and record the value.

τ = _____ s [4]

The time constant τ equals the product of the resistance R and capacitance C.

(iv) Determine the value of the capacitance of the first capacitor.

Capacitance = _____ μF [2]

(b) Disconnect the flying lead from resistor R. Change the connection point of the flying lead on the capacitor box from A to B as shown in **Fig. 2.3**.

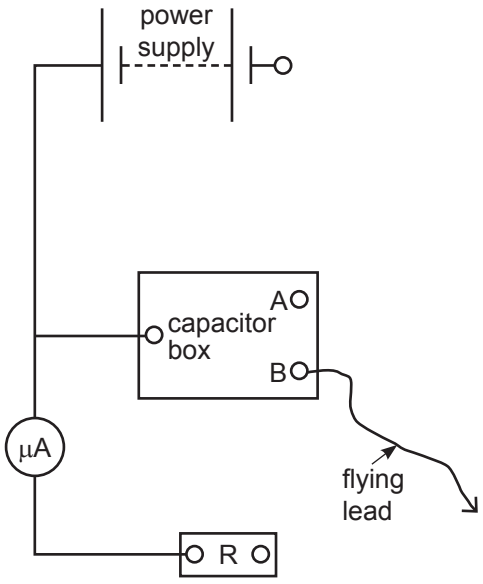

Fig. 2.3

Examiner Only

Marks	Remark

By connecting to terminal point B a second different capacitor is placed in **series** with the first capacitor.

Reconnect the flying lead to the power supply to charge both capacitors.

(i) Repeat the measurement of discharge current by removing the flying lead from the power supply and connect it to resistor R to discharge the two capacitors. At the same time start the stopclock. Take current I readings every **ten** seconds for **60 s**.

Record your results in **Table 2.2**.

Table 2.2

t / s	**0**	**10**	**20**	**30**	**40**	**50**	**60**
I / μA							

[1]

(ii) Using the **same grid**, **Fig. 2.2**, plot the values of current I against time t and draw a best-fit curve for the points plotted. [2]

(iii) From your graph determine the new value of the time constant τ.

τ = _____ s [1]

(iv) Using the equation for capacitors connected in series, **Equation 2.1**, determine the value of the capacitance of the second capacitor.

$$\frac{1}{C_{TOTAL}} = \frac{1}{C_1} + \frac{1}{C_2}$$ **Equation 2.1**

Capacitance = _____ μF [3]

Examiner Only

Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

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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

Principal Requirements
Ref. Component

- Retort stand
- Boss & clamp
- G-clamp
- Metre rule
- Helical spring ≈ 20 mm length e.g. Timstar Ref: **SP13863** × 3
- Stopclock to 0.01 s
- 100 g mass hanger
- 100 g slotted mass × 4

Preparation

G-clamp a retort stand to the edge of a bench.
Attach the boss head and clamp.
Hang three springs in series from the jaws of the clamp.
Ensure that when a total load of 500 g is suspended from the spring system it oscillates freely over the edge of the bench.
Place a metre rule, stopclock, 4 × 100 g masses and a 100 g mass hanger on the bench.

Testing

With a load of:
100 g the stretched length should be ≈ 20 cm and the period T should be ≈ 0.7s.
500 g the stretched length should be ≈ 60 cm and the period T should be ≈ 1.5 s.

Action at Changeover

Remove the 100 g masses and 100 g mass hanger from the spring system.
Reset the stopclock.

Question 2

Principal Requirements

- 12 V d.c. power supply
- Carbon film resistor 33 kΩ RS Components Ref: **707 – 7789**
- Capacitor 1000 µF RS Components Ref: **315 – 0754**
- Capacitor 470 µF RS Components Ref: 7**11 – 1110**
- d.c. digital microammeter capable of reading 0–400 µA to the nearest µA
  e.g. CPC Ref: I**N07220** Multimeter D03046
- Connecting leads, fitted with 4 mm plugs × 4
  *one Green labelled "Flying lead"
- Stopclock to 0.01 s
- Box, metal or opaque plastic, to hold capacitors
  (dimensions not critical) e.g. Rapid Electronics Ref: **30 – 0505**
- Component holder
- Sockets 4 mm, black (×3) and red (×2)

Preparation

1. On the box lid mount 1 red and 2 black 4 mm terminals as shown in Fig. 2.1 below.
   O = RED, A = Black, B = Black
2. Connect the two capacitors as shown in **Fig. 2.1** on the **underside** of the lid.
   Observe correct polarity for capacitors. Assemble the box and label terminals A and B on the top of the box.

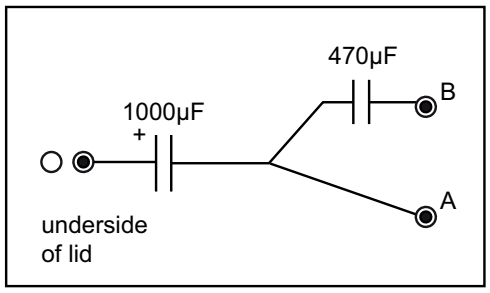

Fig. 2.1

3. Mount the 33 kΩ resistor into a component holder using the other red and black 4 mm terminals.
4. Label one of the connecting leads (the green one) "Flying lead"
5. Set the power supply to 12V d.c., leaving only red and black d.c. terminals exposed.
6. Construct the circuit as shown in **Fig. 2.2**.

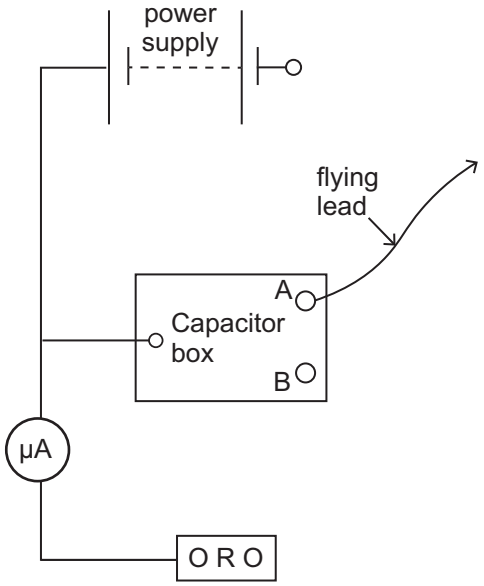

Fig. 2.2

Testing
Connect one end of the flying lead to A. Connect the other end to the d.c. power supply to charge the first capacitor. Disconnect from the power supply and connect to the resistor. The capacitor should discharge from approx. 360 µA to 120 µA in 40 seconds. When repeated for connection B, the current should decay from approx. 360 µA to 20 µA in 40 seconds.

Before the Examination
Ensure the circuit is connected correctly and the flying lead is connected into A.

Action at Changeover
Ensure the circuit is connected correctly and the flying lead is connected into A. Reset the stopclock.