

YEAR 2 | MODULE 6 | PACK 03

Discharge graphs and experiments

Official past-paper questions

2017-2023 | OCR A H556 | 6.1.3(a)-(e); practical analysis and uncertainties

22 marks | 4 question entries

One practice session

Use: attempt the session after learning its content. Try without notes; record any help used. Mark the session, identify the reason for lost marks, then revisit those questions after a few days.

Format: all MCQs appear first with their complete answer boxes. Written extracts retain the original paper's answer space. Only the subparts named in the source reference are assigned.

Reserved: all 2024 and 2025 papers are excluded. These files contain official examination questions only; no sample, specimen or practice papers.

Name: _____

First attempt: _____ Score: _____ / 22

[Official data, formulae and relationships booklet](#)

Question index

CP identifiers are stable across the question packs and mark schemes; Q numbers refer to this pack. This pack has no selected MCQs.

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Q01 | CP08A

2 marks

June 2018 | H556/02 | Q22(a)

22 A student wishes to determine the permittivity ϵ of paper using a capacitor made in the laboratory.

The capacitor consists of two large parallel aluminium plates separated by a very thin sheet of paper.

The capacitor is initially charged to a potential difference V_0 using a battery. The capacitor is then discharged through a fixed resistor of resistance $1.0\text{ M}\Omega$.

The potential difference V across the capacitor after a time t is recorded by a data-logger. The student uses the data to draw the $\ln V$ against t graph shown in Fig. 22.

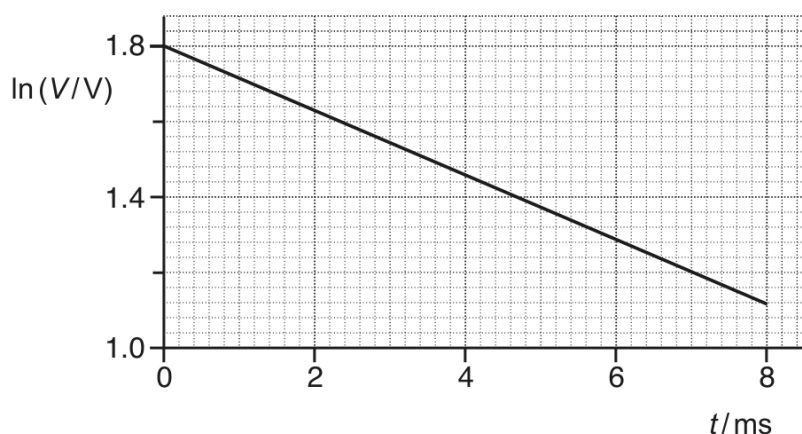


Fig. 22

(a) Show that the magnitude of the gradient of the line shown in Fig. 22 is equal to

$$\frac{1}{CR}$$

where C is the capacitance of the capacitor and R is the resistance of the resistor.

[2]

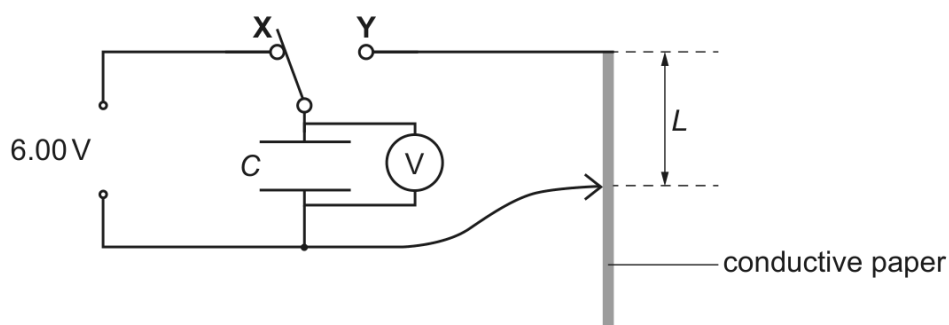
Only (a) is assigned. The original discharge description and logarithmic graph are retained. Deriving its gradient does not require the omitted permittivity investigation in (b).

Q02 | CP17B

4 marks

November 2021 | H556/02 | Q20(b)

(b) A capacitor of capacitance C is connected across a strip of conductive paper.



The switch is moved from **X** to **Y**, and the time t for the potential difference across the capacitor to halve is measured.

The time t is given by the expression

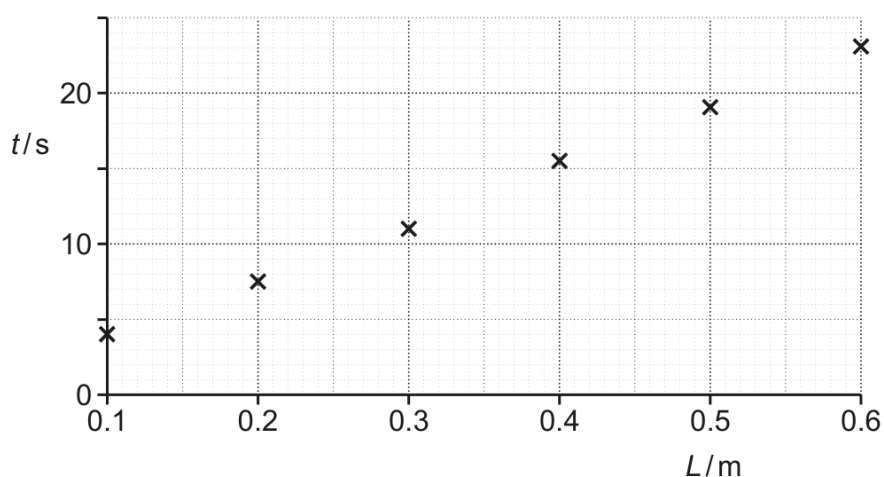
$$t = (Ck \ln 2) \times L$$

where k is the resistance of the conductive paper per unit length and L is the length of the conductive paper.

The value of C is $1.2 \times 10^{-3} \text{ F}$.

In an experiment, L is changed and t measured.

The data points are plotted on a t against L grid as shown below.



Only (b) is assigned. Its own circuit, capacitance, half-voltage expression and data graph are retained. Part (a) uses a separate circuit and is not required.

Q02 | CP17B - continued

4 marks

November 2021 | H556/02 | Q20(b)

Draw a straight line of best fit through the data points, and use the gradient of this line to determine k .

$k = \dots\dots\dots \Omega \text{ m}^{-1}$ [4]

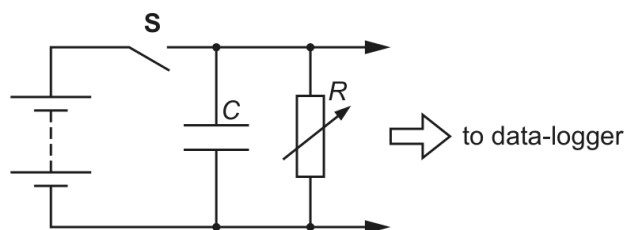
Only (b) is assigned. Its own circuit, capacitance, half-voltage expression and data graph are retained. Part (a) uses a separate circuit and is not required.

Q03 | CP18B1

5 marks

June 2022 | H556/02 | Q22(b)(i), (b)(ii)1

- (b) A student discharges a capacitor of capacitance C through a variable resistor of resistance R using the arrangement below.



The capacitor is made from two parallel metal plates separated by a sheet of paper of thickness $8.0 \times 10^{-5} \text{ m}$. The area of overlap between the plates is $3.1 \times 10^{-2} \text{ m}^2$.

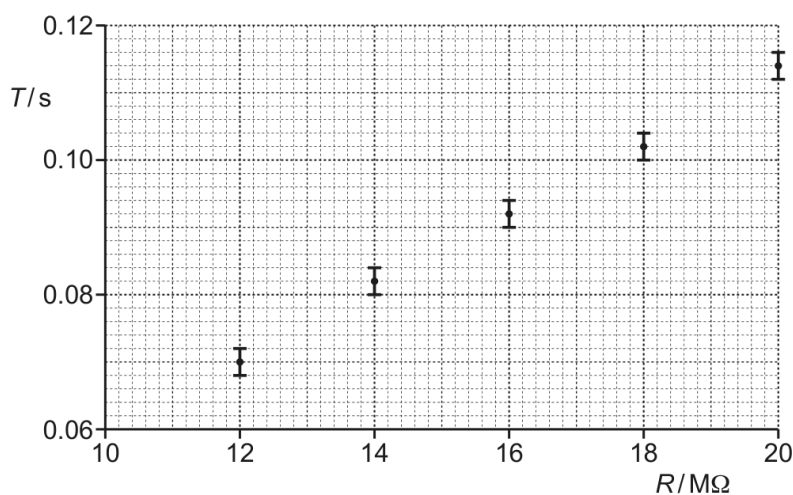
The capacitor is charged fully by closing switch **S**. At time $t = 0$, **S** is opened and the capacitor discharges through the resistor. After $t = T$, the potential difference across the capacitor is halved. The student repeats this for several values of R .

- (i) The student decides to plot T against R to obtain a straight-line graph.

Show that the line has gradient $= C \ln 2$.

[2]

- (ii) The data points plotted by the student are shown below.



- 1 Draw a best-fit straight line through the data points and use the gradient of this line to determine C .

$C = \dots\dots\dots \text{ F}$ [3]

Only (b)(i) and (b)(ii)1 are assigned. The original circuit, half-voltage definition and graph are retained. No answer from (a) is required; the permittivity calculation in (b)(ii)2 is omitted.

Q04 | CP05

11 marks

June 2017 | H556/03 | Q3

- 3 A student is investigating how the discharge of a capacitor through a resistor depends on the resistance of the resistor.
The equipment is set up as shown in Fig. 3.1.

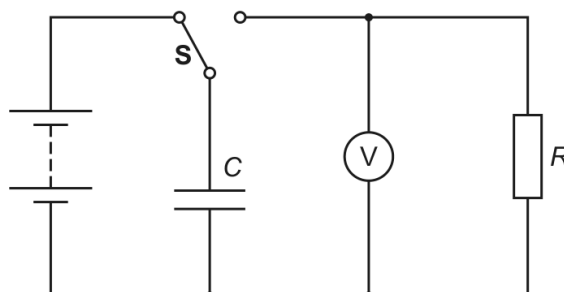


Fig. 3.1

The student charges the capacitor of capacitance C and then discharges it through a resistor of resistance R using switch **S**. After a time $t = 15.0\text{ s}$ the student records the potential difference V across the capacitor. The student repeats this procedure for different values of R .

It is suggested that V and R are related by the equation

$$V = V_0 e^{-\frac{t}{CR}}$$

where V_0 is the initial potential difference across the capacitor and t is the time over which the capacitor has discharged.

- (a) The student decides to plot a graph of $\ln(V/V_0)$ on the y -axis against $\frac{1}{R}$ on the x -axis to obtain a straight line graph. Show that the magnitude of the gradient is equal to $\frac{15}{C}$.

[2]

- (b) Values of R and V at $t = 15.0\text{ s}$ are given in the table below.

$R/\text{k}\Omega$	V/V	$\left(\frac{1}{R}\right)/10^{-6}\text{ }\Omega^{-1}$	$\ln(V/V_0)$
56	3.0 ± 0.2	18	
68	3.7 ± 0.2	15	1.31 ± 0.06
100	5.0 ± 0.2	10	1.61 ± 0.04
150	6.4 ± 0.2	6.7	1.86 ± 0.03
220	7.3 ± 0.2	4.5	1.99 ± 0.03
330	8.1 ± 0.2	3.0	2.09 ± 0.03

- (i) Complete the missing value of $\ln(V/V_0)$ and its absolute uncertainty in the table above.

[1]

The complete question is assigned. The data table, error bars, graph and original answer space are retained. The capacitance determined in (b)(iii) is available for the final resistance calculation in (c).

Q04 | CP05 - continued

11 marks

June 2017 | H556/03 | Q3

- (ii) Use the data to complete the graph of Fig. 3.2. Four of the six points have been plotted for you. [2]

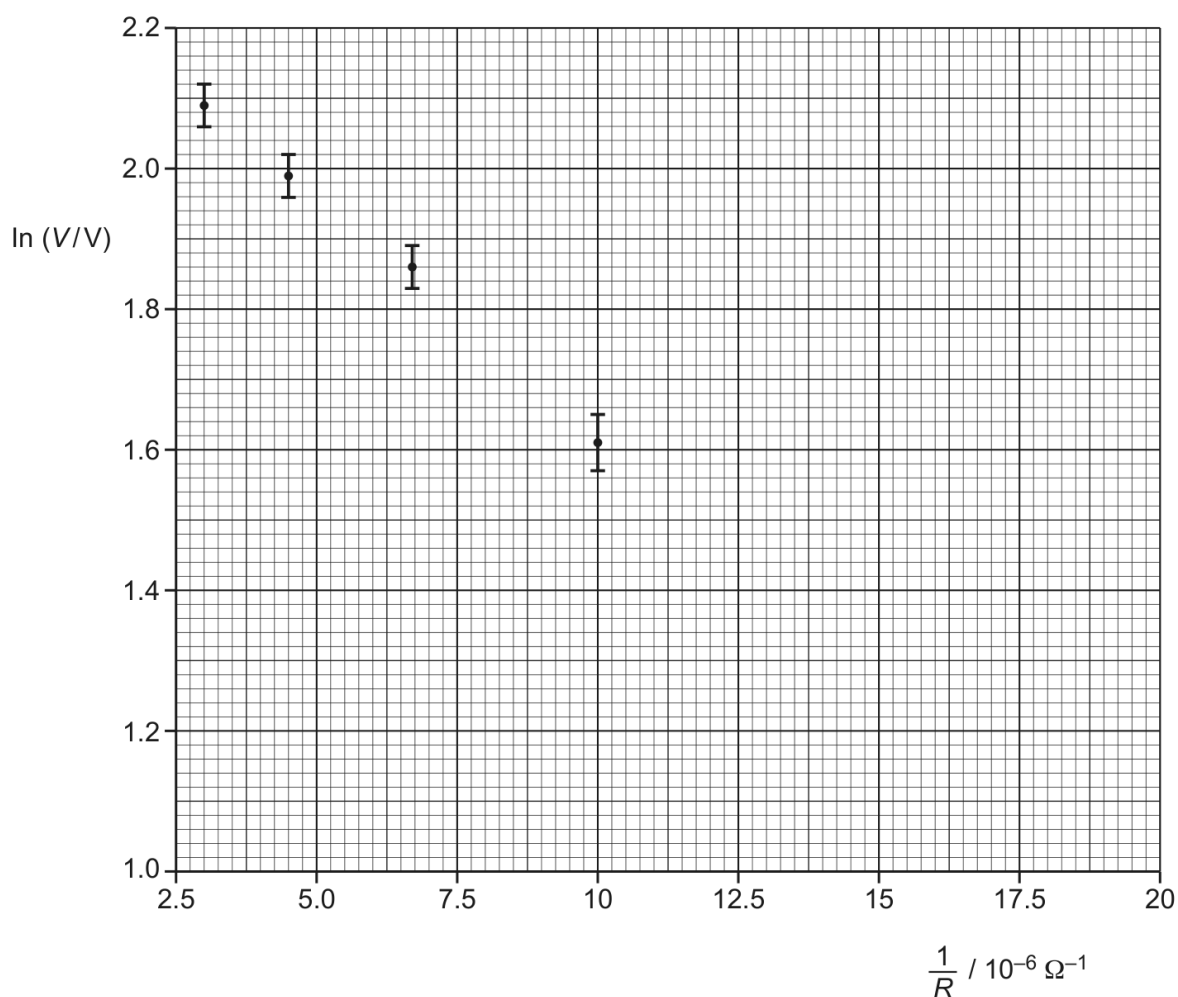


Fig. 3.2

- (iii) Use the graph to determine a value for C . Include the absolute uncertainty and an appropriate unit in your answer.

$C = \dots \pm \dots$ unit $\dots$ [4]

The complete question is assigned. The data table, error bars, graph and original answer space are retained. The capacitance determined in (b)(iii) is available for the final resistance calculation in (c).

Q04 | CP05 - continued

11 marks

June 2017 | H556/03 | Q3

- (c) Determine the value of R , in $\text{k}\Omega$, for which the capacitor discharges to 10% of its original potential difference in 15.0 s. Show your working.

$R = \dots\dots\dots \text{k}\Omega$ [2]

The complete question is assigned. The data table, error bars, graph and original answer space are retained. The capacitance determined in (b)(iii) is available for the final resistance calculation in (c).