A Level · OCR · Physics

16 mins 2 questions

Structured Questions

Charging & Discharging Capacitors

Capacitor Charge & Discharge / Capacitor Charge & Discharge Equations / Modelling Capacitor Discharge

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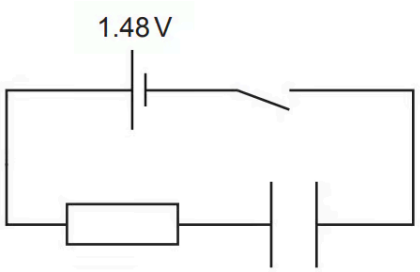
Total Marks /16

1 (a) The diagram below shows a circuit to charge a capacitor.



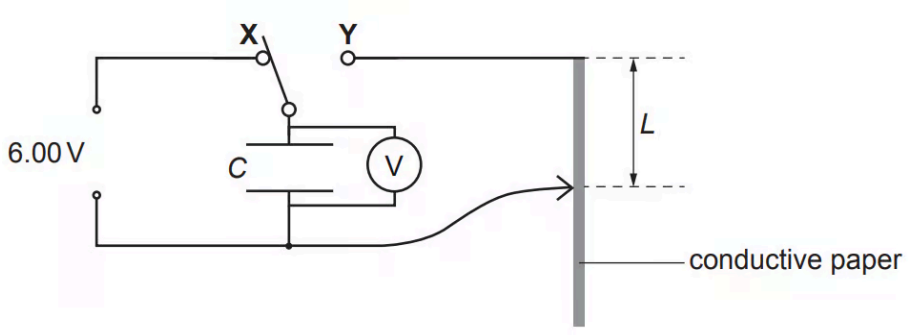
The electromotive force (e.m.f.) E of the cell is 1.48 V and it has negligible internal resistance. The resistance of the resistor is 120 kΩ and the capacitance of the capacitor is 2000 μF. At time t = 0 the capacitor is uncharged. The switch is closed at time t = 0.

Calculate the time t when the potential difference across the capacitor is 1.00 V.

t = ... s **[4]**

(4 marks)

(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

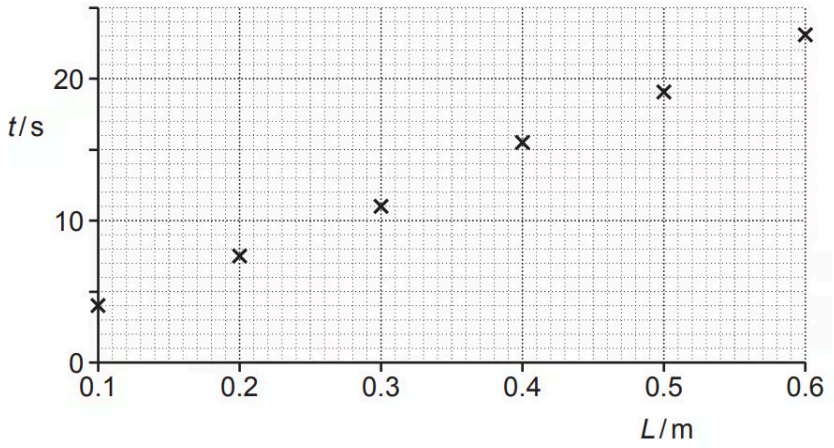
$t = (Ck\ ln2) \times L$

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 1.2×10^{-3} F.

In an experiment, L is changed and t measured.

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



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

k = ... $\Omega\ m^{-1}$ **[4]**

(4 marks)

2 (a) 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 MΩ. 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.

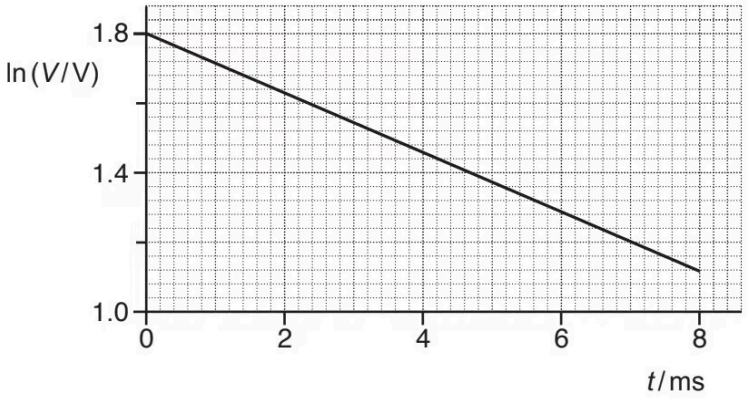


Fig. 22

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]

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(2 marks)

(b) Use Fig. 22 to determine the capacitance C of the capacitor. Describe how the student can then use this value of C to determine a value for ε. In your description, mention any additional measurements required on the capacitor.

[6]

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(6 marks)