A Level · OCR · Physics

16 mins 2 questions

Structured Questions

Capacitors in Circuits

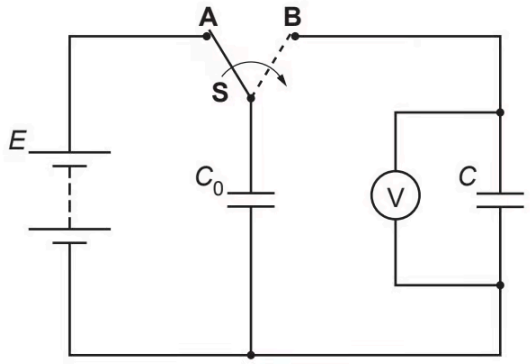
Capacitance / Electron Flow in Charging & Discharging / Capacitors in Series & Parallel Circuits / Circuits Containing Capacitors & Resistors / Energy Stored by a Capacitor

Scan here to return to the course
or visit savemyexams.com

Total Marks **/16**

1 (a) The diagram below shows a circuit containing two capacitors which are both initially uncharged. The battery has e.m.f. E and negligible internal resistance.

The switch **S** is first moved to position **A** until the capacitor of capacitance C_0 is fully charged.



The switch **S** is then moved to position **B**. The initial charge stored by the capacitor of capacitance C_0 is shared between the two capacitors. The final reading on the voltmeter is V.

Show that $V = \frac{C_0}{C + C_0}E$.

[2]

.....

.....

(2 marks)

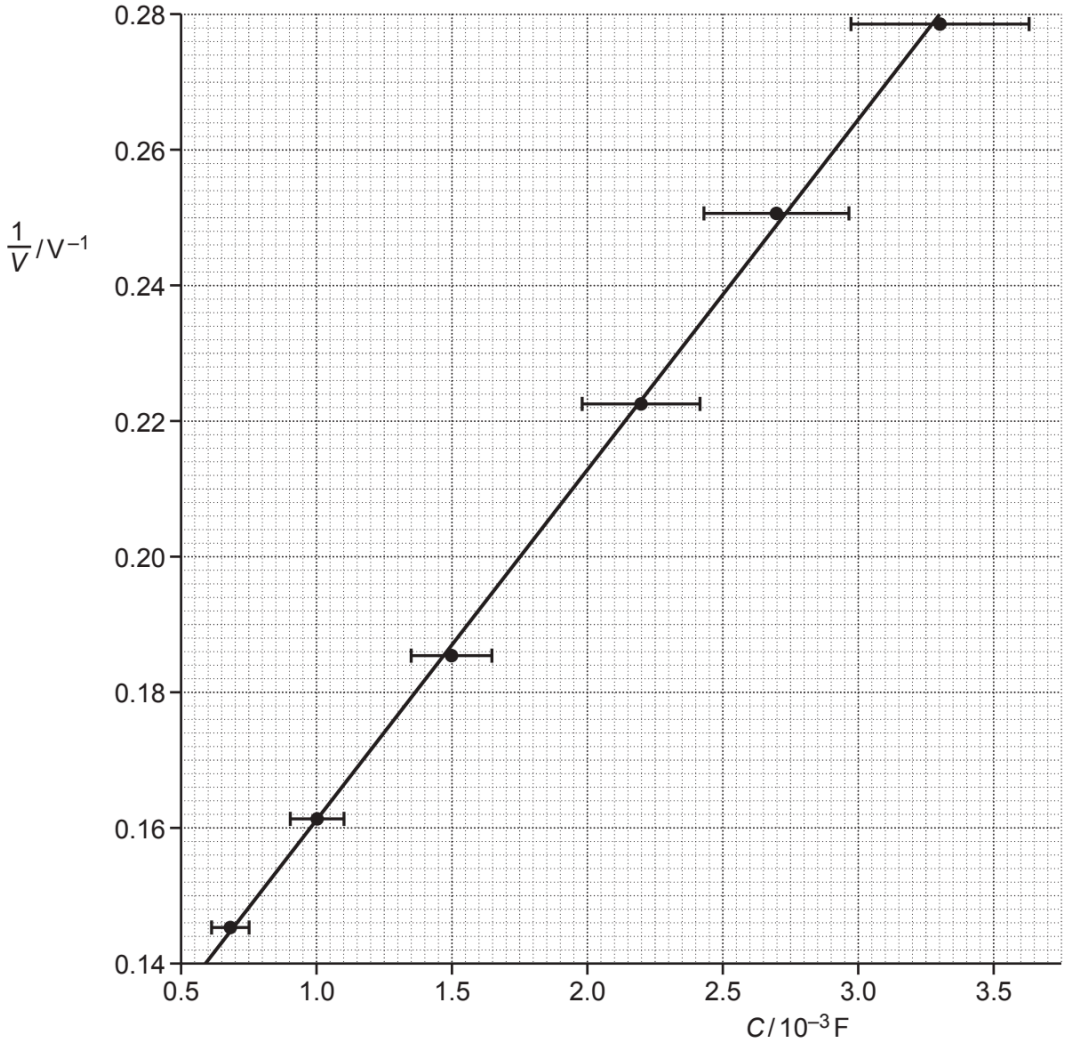
(b) A student wants to determine the values of E and C_0 by repeating the experiment above and measuring the potential difference (p.d.) V for a selection of capacitors of capacitance C.

The student decides to plot a graph of $\frac{1}{V}$ against C.

i) Use the expression in **(a)** to show that the graph should be a straight line of gradient $\frac{1}{C_0 E}$ and y-intercept $\frac{1}{E}$.

[1]

ii) The data points, error bars and the line of best fit drawn by the student are shown in the graph below.



The gradient of the line of best fit is 51 V^{-1} F^{-1}. The value of E is 9.1 V.

Determine the value of C_0 in millifarads (mF). Write your answer to 2 significant figures.

C_0 = ... mF **[2]**

iii) Draw on the graph a straight line of worst fit.

Use this line to determine the absolute uncertainty in your value of C_0. Write your answer to an appropriate number of significant figures.

absolute uncertainty = ... mF **[4]**

(7 marks)

(c) The experiment is repeated with a resistor of resistance 10 kΩ placed in series between **S** and the capacitor of capacitance C_0.

State with a reason what effect, if any, this would have on the experiment.

[1]

(1 mark)

2 (a) A capacitor of capacitance 7.2 pF consists of two parallel metal plates separated by an insulator of thickness 1.2 mm. The area of overlap between the plates is 4.0×10^{-4} m^2.

Calculate the permittivity of the insulator between the capacitor plates.

permittivity = ... F m^{-1} **[2]**

.....

.....

(2 marks)

(b) Fig. 21 shows a circuit.

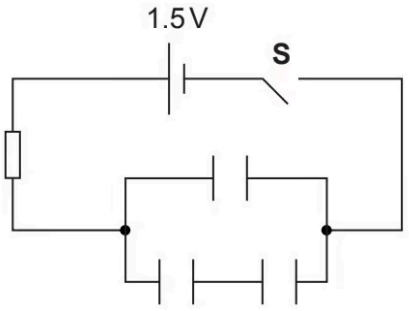


Fig. 21

The capacitance of each capacitor is 1000 μF. The resistance of the resistor is 10 kΩ. The cell has e.m.f. 1.5 V and negligible internal resistance.

i) Calculate the total capacitance *C* in the circuit.

C = ... μF **[2]**

ii) The switch **S** is closed at time *t* = 0. There is zero potential difference across the capacitors at *t* = 0.

Calculate the potential difference *V* across the resistor at time *t* = 12 s.

V = ... V **[2]**

.....

.....

(4 marks)