Capacitors – 2021/20 GCE Physics A Component 02

1. Nov/2021/Paper_H556_02/No.6

A student is modelling the decay of charge for a capacitor discharging through a resistor using the equation $\frac{\Delta Q}{\Delta t} = -0.2Q$.

The student decides to use $\Delta t = 0.5$ s.
The initial charge on the capacitor is 1000 μC.

Part of the modelling spreadsheet from the student is shown below.

t / s	Charge *Q* left on capacitor at time *t* / μC	Charge Δ*Q* decaying in the next 0.5 s / μC
0	1000	100
0.5	900	
1.0		
1.5		

What is the value of *Q* in μC at *t* = 1.5 s?

A 700

B 720

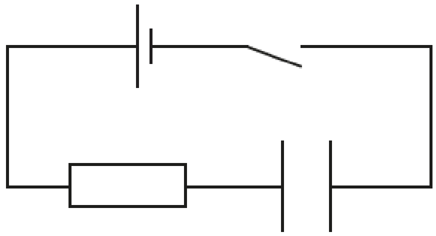
C 729

D 800

Your answer ☐ **[1]**

2. Nov/2021/Paper_H556_02/No.20

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

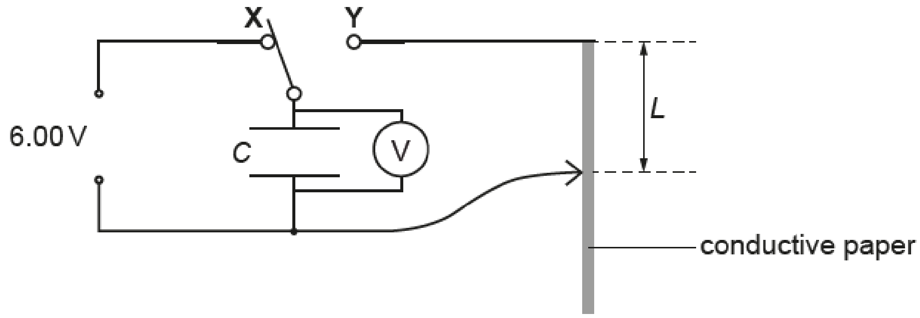


The electromotive force (e.m.f.) E of the cell is 1.48 V and it has negligible internal resistance.
The resistance of the resistor is 120 kΩ and the capacitance of the capacitor is 2000 μF.
At time $t = 0$ the capacitor is uncharged.
The switch is closed at time $t = 0$.

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

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

(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

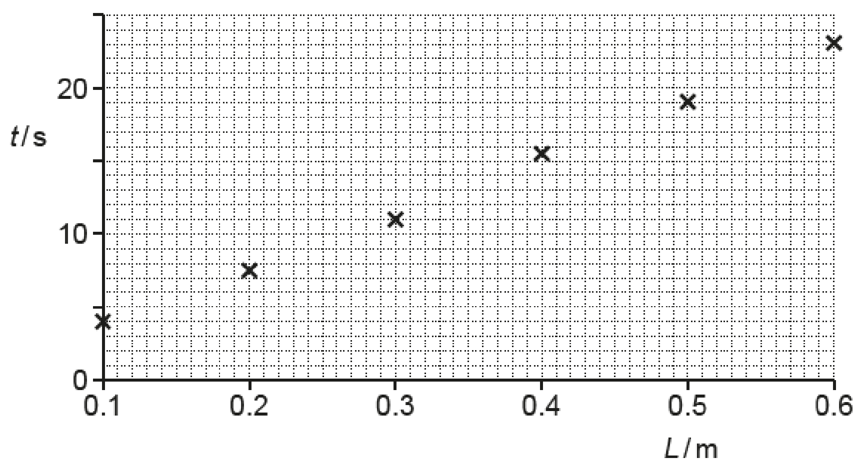
$t = (Ck \ln 2) \times L$

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 1.2×10^{-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.

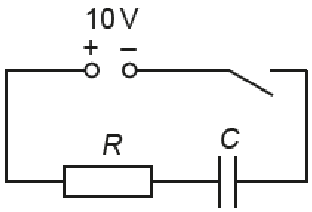


Draw a straight line of best fit through the data points, and use the gradient of this line to determine *k*.

k = ... Ω m^{-1} **[4]**

3. Nov/2020/Paper_H556_02/No.7

The diagram below shows a circuit used to charge a capacitor.



The power supply has electromotive force (e.m.f.) 10 V and negligible internal resistance.
The capacitor has capacitance C and the resistor has resistance R.
The switch is closed at time $t = 0$.
The table below shows potential difference V across the resistor at various values of time t.

V/V	10	6.3	5.0	3.7
t/s	0	2.8	4.2	6.0

What is the product $C \times R$ for this circuit?

A 0 s

B 2.8 s

C 4.2 s

D 6.0 s

Your answer ☐ **[1]**

4. Nov/2020/Paper_H556_02/No.8

A capacitor discharges through a resistor.
At time $t = 0$ the potential difference V across the capacitor is V_0.
At time $t = 2.0$ s, $V = 0.90\ V_0$.

Which statement is **not** correct?

A At $t = 4.0$ s, $V = 0.81\ V_0$.

B The capacitor is fully discharged after $t = 10$ s.

C The potential difference across the resistor is the same as that for the capacitor.

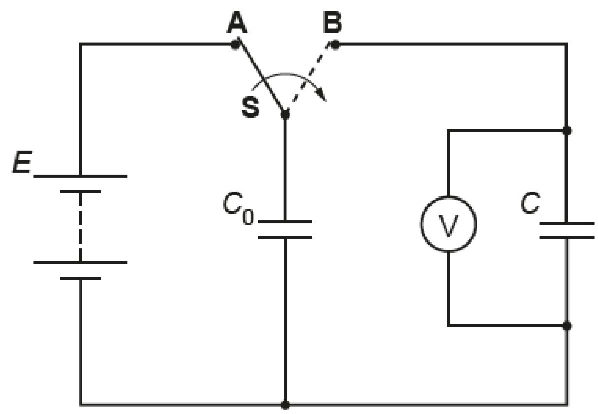
D The potential difference V decreases exponentially with time t.

Your answer ☐ **[1]**

5. Nov/2020/Paper_H556_03/No.2

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.

(a) Show that $V = \dfrac{C_0}{C + C_0} E$.

[2]

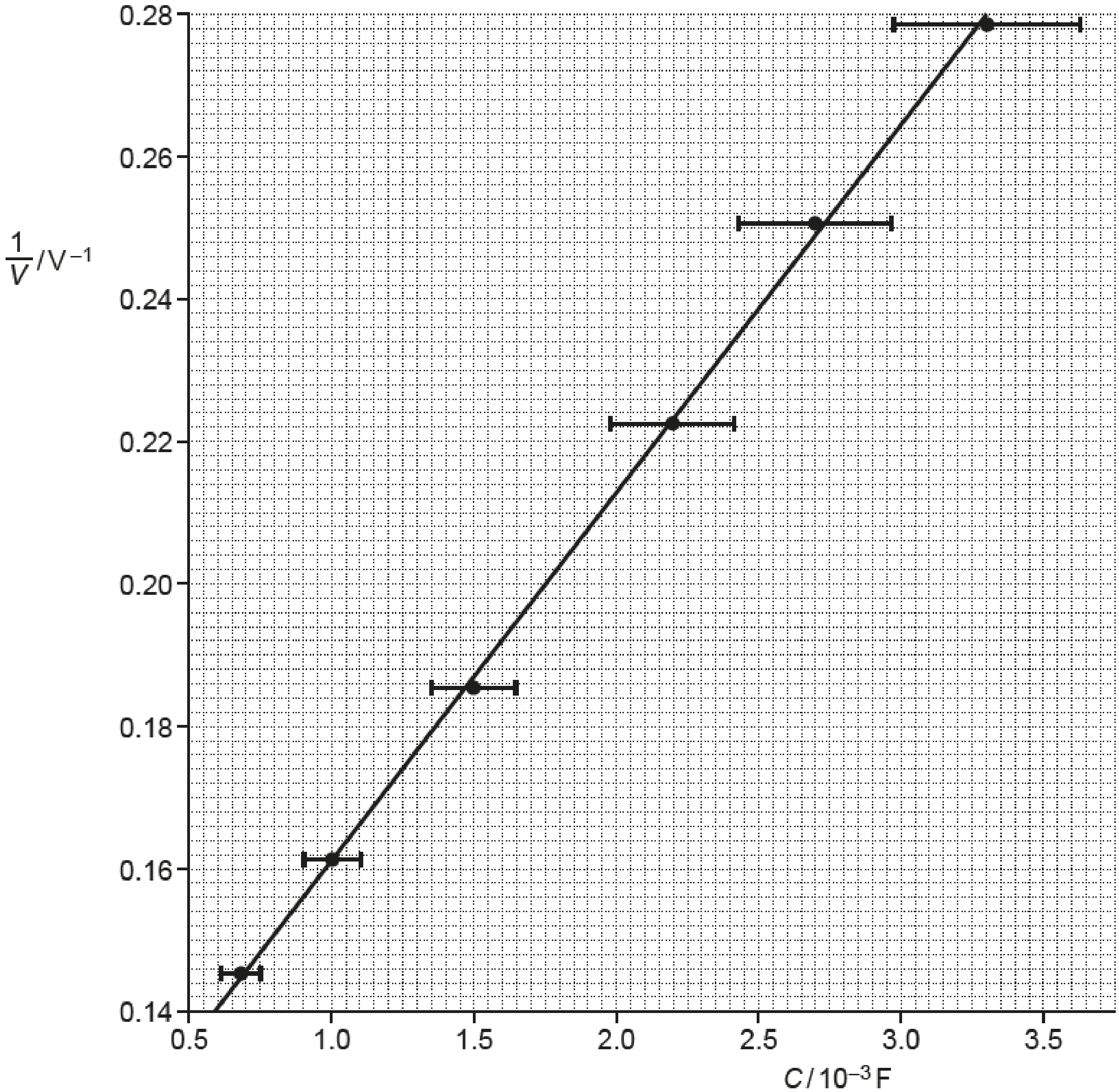
(b) A student wants to determine the values of E and C_0 by repeating the experiment above and measuring the potential difference (p.d.) V for a selection of capacitors of capacitance C.

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

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

[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]**

(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]**