1. Nov/2023/Paper_9702/42/No.6

A capacitor C is charged so that the potential difference (p.d.) V across its terminals is 8.0 V. The capacitor is connected into the circuit of Fig. 6.1.

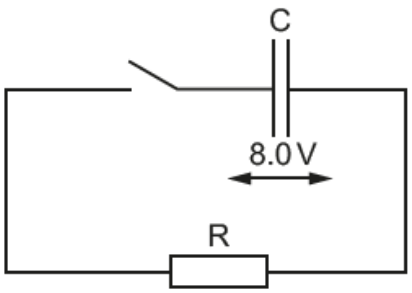

Fig. 6.1

The switch is initially open. The switch is closed at time $t = 0$.

(a) Fig. 6.2 shows the variation of V with the charge Q on the plates of capacitor C as the capacitor discharges.

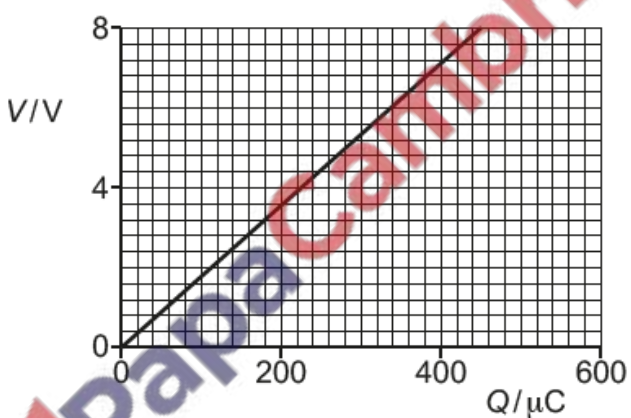

Fig. 6.2

(i) Show that the energy stored in capacitor C at time $t = 0$ is 1.8 mJ.

[2]

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(ii) Determine the capacitance of capacitor C. Give a unit with your answer.

capacitance = ... unit ..... [2]

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(b) Fig. 6.3 shows the variation with t of $-\ln\left(\frac{V}{8.0\,\text{V}}\right)$.

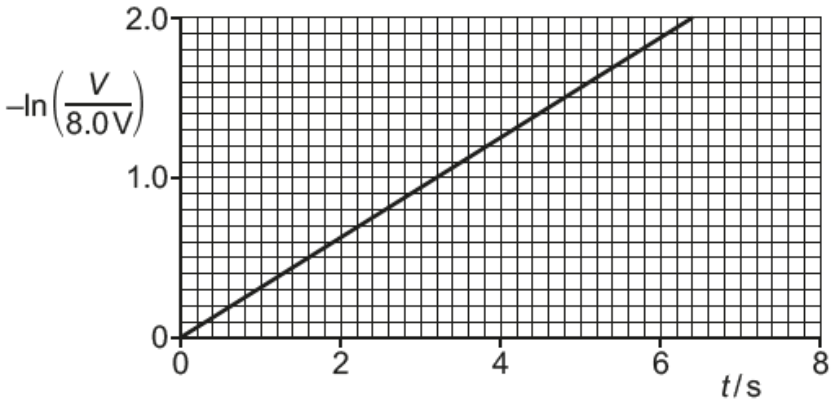

Fig. 6.3

(i) Show that, when t is equal to one time constant, the value of $-\ln\left(\frac{V}{8.0\,\text{V}}\right)$ is equal to 1.0.

[2]

(ii) Determine the time constant τ of the circuit in Fig. 6.1.

τ = ... s [1]

(iii) Calculate the resistance of resistor R.

resistance = ... Ω [2]

[Total: 9]

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2. June/2023/Paper_9702/41/No.5(b)

Part of an electric circuit is shown in Fig. 5.1.

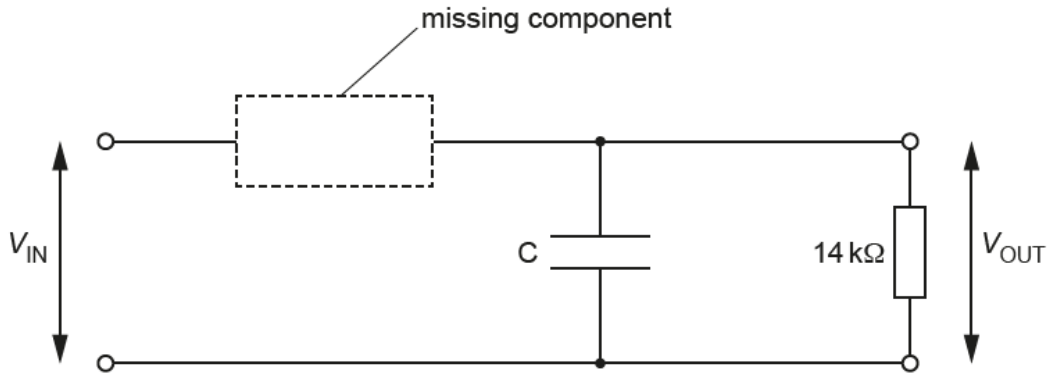

Fig. 5.1

The circuit is used to produce half-wave rectification of an alternating voltage of potential difference (p.d.) V_{IN}.

The output p.d. across the 14 kΩ resistor is V_{OUT}.

(b) Fig. 5.2 shows the variation with time t of V_{IN}.

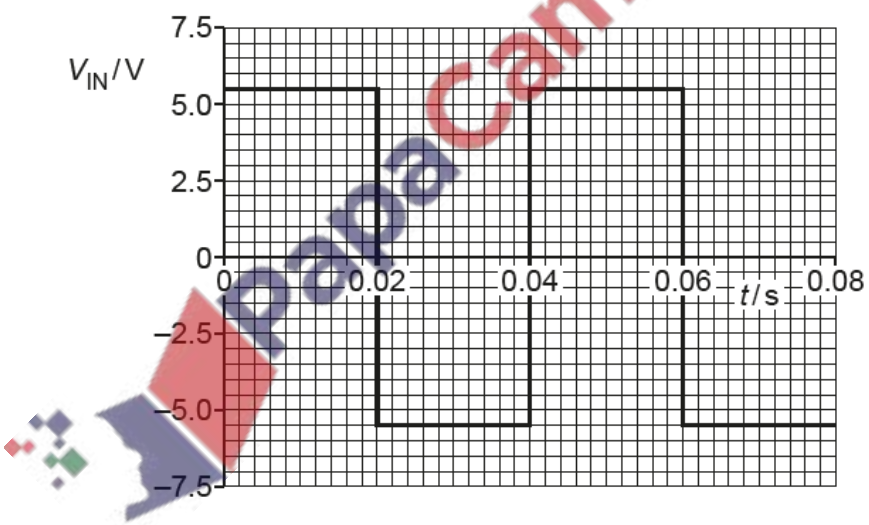

Fig. 5.2

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Fig. 5.3 shows the variation with t of V_{OUT}.

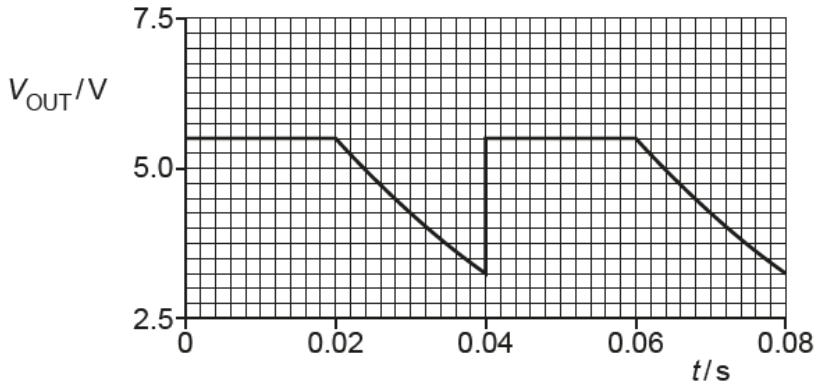

Fig. 5.3

(i) Determine the frequency of V_{IN}.

frequency = ... Hz [1]

(ii) Show that the time constant τ for the discharge of the capacitor through the resistor is 0.038 s.

[2]

(iii) Calculate the capacitance of C. Give a unit with your answer.

capacitance = ... unit ..... [2]

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3. June/2023/Paper_9702/42/No.5

Two capacitors A and B are connected into the circuit shown in Fig. 5.1.

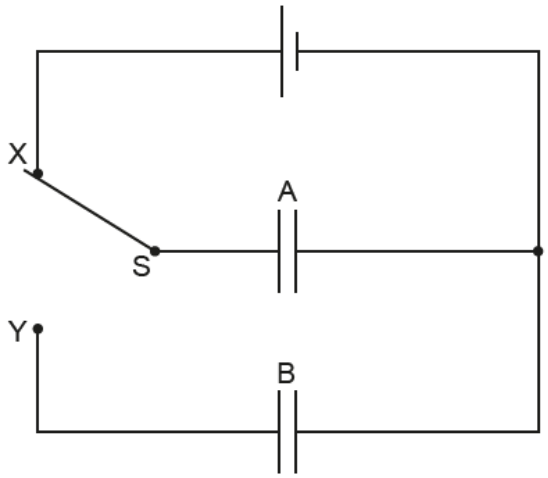

Fig. 5.1

Capacitor A has capacitance C and capacitor B has capacitance $3C$.
The electromotive force (e.m.f.) of the cell is V.
The two-way switch S is initially at position X, and capacitor B is initially uncharged.

(a) State, in terms of V and C, expressions for:

(i) the initial charge Q_A on the plates of capacitor A

Q_A = ... [1]

(ii) the initial energy E_A stored in capacitor A.

E_A = ... [1]

(b) The two-way switch S is now moved to position Y.

(i) State and explain what happens to the charge that was initially on the plates of capacitor A.

.....

.....

..... [2]

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(ii) Show that the final potential difference (p.d.) V_B across capacitor B is given by

$$V_B = \frac{V}{4}.$$

Explain your reasoning.

[3]

(iii) Determine an expression, in terms of V and C, for the decrease ΔE in the total energy that is stored in the capacitors as a result of the change of the position of the switch.

ΔE = ... [2]

[Total: 9]

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4. March/2023/Paper_9702/42/No.5

A capacitor, a battery of electromotive force (e.m.f.) 12 V, a resistor R and a two-way switch are connected in the circuit shown in Fig. 5.1.

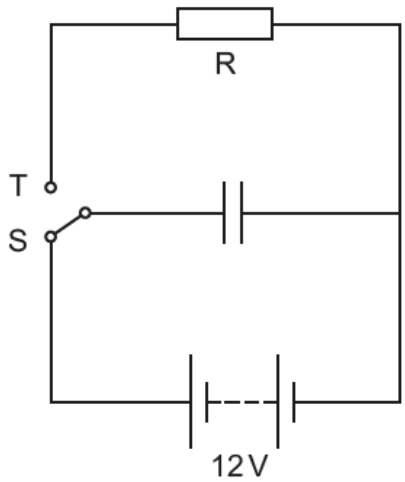

Fig. 5.1

The switch is initially in position S. When the capacitor is fully charged, the switch is moved to position T so that the capacitor discharges. At time t after the switch is moved the charge on the capacitor is Q.

The variation with t of $\ln(Q/\mu C)$ is shown in Fig. 5.2.

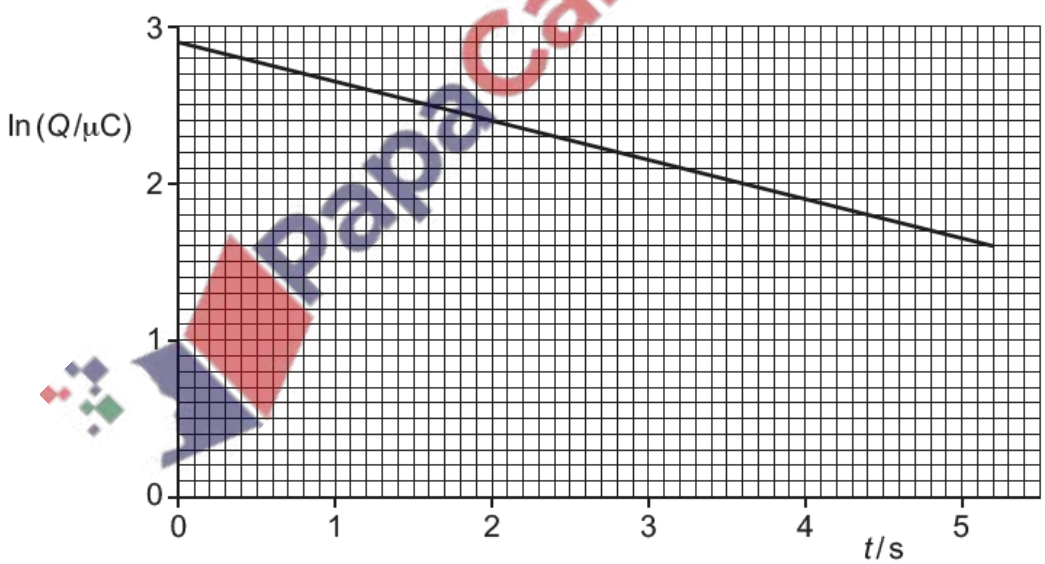

Fig. 5.2

(a) Show that the capacitance of the capacitor is 1.5 μF.

[3]

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(b) Determine the resistance of R.

resistance = ... Ω [3]

(c) Calculate the energy stored in the capacitor at time $t = 0$.

energy = ... J [2]

(d) A second identical resistor is now connected in parallel with R.

The switch is initially in position S. When the capacitor is fully charged, the switch is moved to position T so that the capacitor discharges. At time t after the switch is moved the charge on the capacitor is Q.

On Fig. 5.2, sketch a line to show the variation of $\ln(Q/\mu C)$ with t between time $t = 0$ and time $t = 5.0\,s$. [2]

[Total: 10]

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