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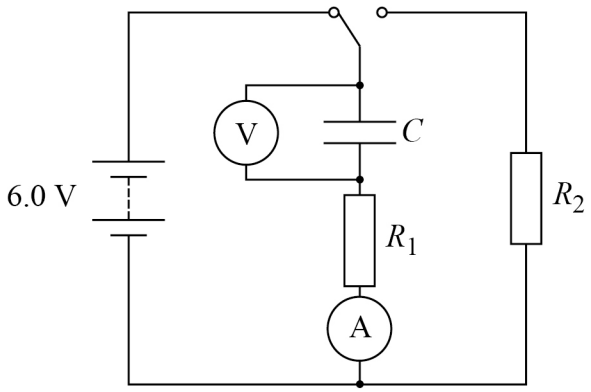
0 5 **Figure 8** shows a circuit used to investigate the charge and discharge of a capacitor of capacitance C using resistors of resistances R_1 and R_2.

Figure 8



The battery has an emf of $6.0\ \text{V}$ and negligible internal resistance.

0 5 . 1 Show that the time taken for the capacitor to charge from $2.0\ \text{V}$ to $4.0\ \text{V}$ is approximately $0.7R_1C$.

[3 marks]

Question 5 continues on the next page

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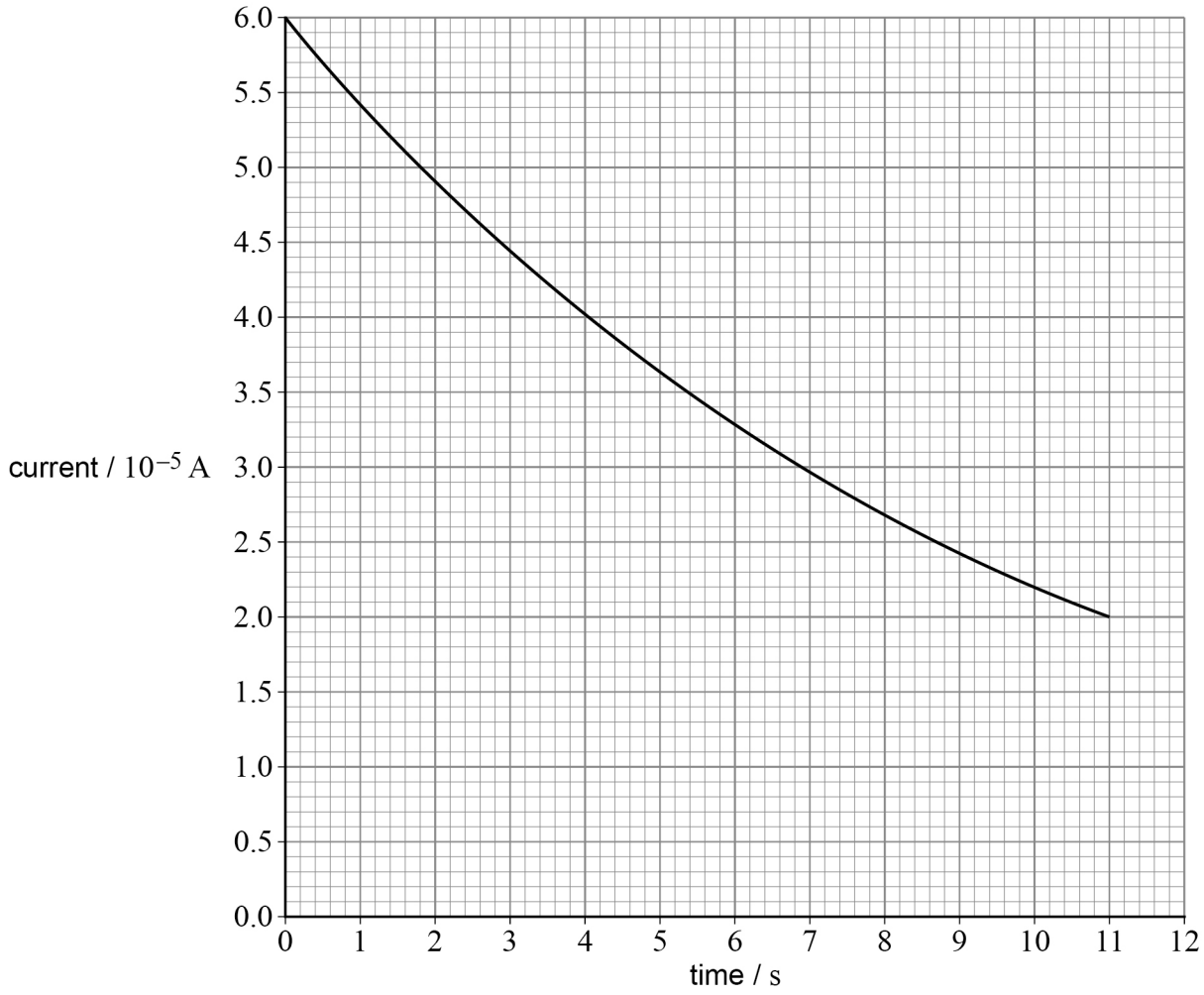
The capacitor is fully discharged.
The capacitor is then charged until the potential difference (pd) across it is $4.0\ \text{V}$.
Figure 9 shows the variation with time of the ammeter reading as the capacitor is charged.

Figure 9



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0 5 . 2 Show that the capacitance of the capacitor is about 1×10^{-4} F.

[4 marks]

Question 5 continues on the next page

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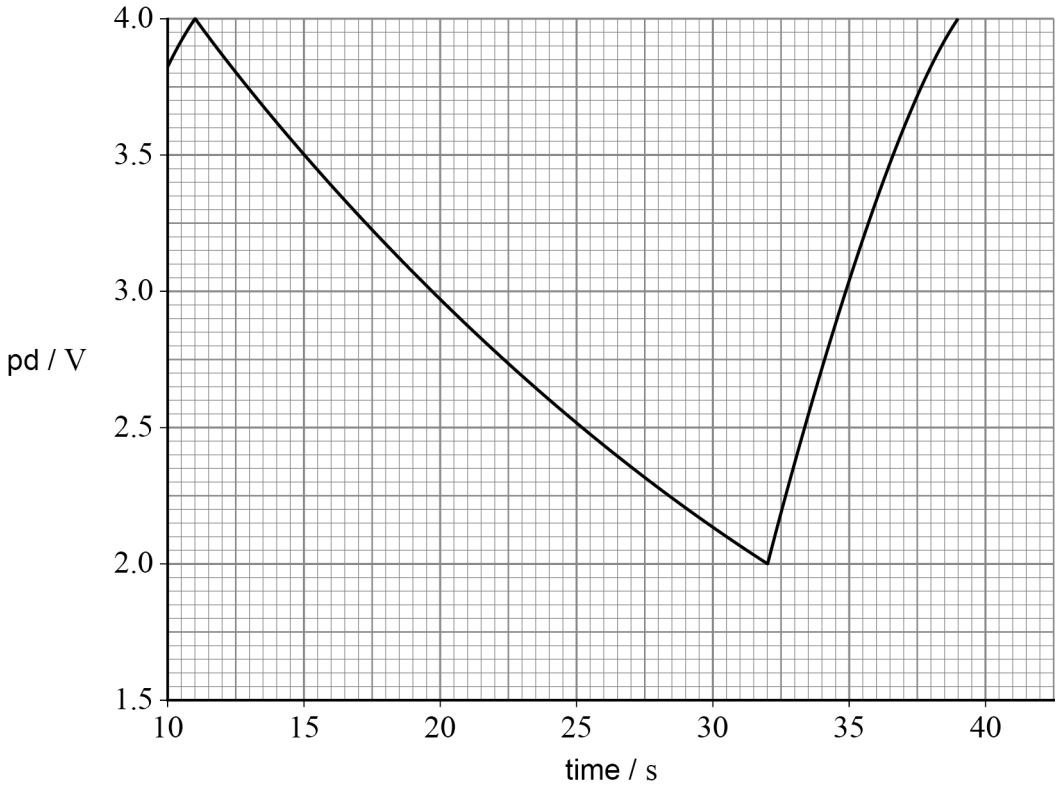
0 5 . 3 When the pd reaches 4.0 V the switch is immediately set to discharge the capacitor. When the pd reaches 2.0 V the switch is immediately set to charge the capacitor.

Figure 10 shows how the pd across the capacitor varies with time.

Figure 10



Determine the value of R_2.

[3 marks]

$R_2 =$ _____ Ω

10

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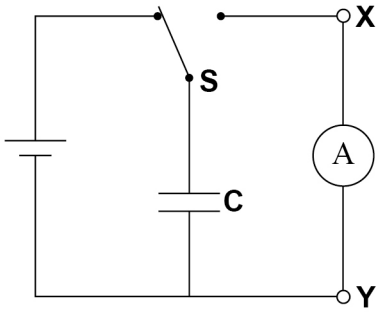
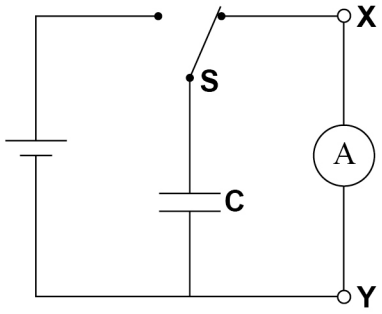
1 7 A switch **S** allows capacitor **C** to be completely charged by a cell and then completely discharged through an ammeter.
The emf of the cell is $4.0\ \text{V}$ and it has negligible internal resistance.
The capacitance of **C** is $0.40\ \mu\text{F}$ and there are 8000 charge–discharge cycles every second.



charging



discharging

What are the magnitude and direction of the average conventional current in the ammeter?
[1 mark]

	Magnitude of current / A	Direction of current	
A	1.3×10^{-2}	**X** to **Y**	⬭
B	1.3×10^{-2}	**Y** to **X**	⬭
C	2.0×10^{-10}	**X** to **Y**	⬭
D	2.0×10^{-10}	**Y** to **X**	⬭

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1 8 A $30\ \mu\text{F}$ capacitor is charged by connecting it to a battery of emf $4.0\ \text{V}$.
The initial charge on the capacitor is Q_0.

The capacitor is then discharged through a $500\ \text{k}\Omega$ resistor.
The time constant for the circuit is T.

Which is correct?

[1 mark]

A T is $15\ \text{ms}$. ⬭

B Q_0 is $12\ \mu\text{C}$. ⬭

C After a time T the pd across the capacitor is $1.5\ \text{V}$. ⬭

D After a time $2T$ the charge on the capacitor is $Q_0 e^2$. ⬭

1 9 Capacitor **X** of capacitance C has square plates of side length l and separation d and is made with a dielectric of relative permittivity ε.

Capacitor **Y** has square plates of side length $3l$ and separation $\frac{d}{3}$ and is made with a dielectric of relative permittivity $\frac{\varepsilon}{3}$.

What is the capacitance of **Y**?

[1 mark]

A $\frac{C}{27}$ ⬭

B $\frac{C}{9}$ ⬭

C $9C$ ⬭

D $27C$ ⬭

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2 0 A parallel plate capacitor is connected across a battery and the energy stored in the capacitor is E.
Without disconnecting the battery, the separation of the plates is halved.

What is the energy now stored in the capacitor?

[1 mark]

A $0.5E$ ⬭

B E ⬭

C $2E$ ⬭

D $4E$ ⬭

2 1 A fully charged capacitor of capacitance $2.0\ \text{mF}$ discharges through a $15\ \text{k}\Omega$ resistor.

What fraction of the stored energy remains after 1.0 minute?

[1 mark]

A $\frac{1}{4}$ ⬭

B $\frac{1}{e^2}$ ⬭

C $\frac{1}{16}$ ⬭

D $\frac{1}{e^4}$ ⬭

2 2 A horizontal wire of length $0.25\ \text{m}$ carrying a current of $3.0\ \text{A}$ is perpendicular to a magnetic field. The mass of the wire is $3.0 \times 10^{-3}\ \text{kg}$ and the weight of the wire is supported in equilibrium by the magnetic field.

What is the flux density of the magnetic field?

[1 mark]

A $2.6\ \text{T}$ ⬭

B $3.9 \times 10^{-2}\ \text{T}$ ⬭

C $2.2 \times 10^{-2}\ \text{T}$ ⬭

D $4.0 \times 10^{-3}\ \text{T}$ ⬭