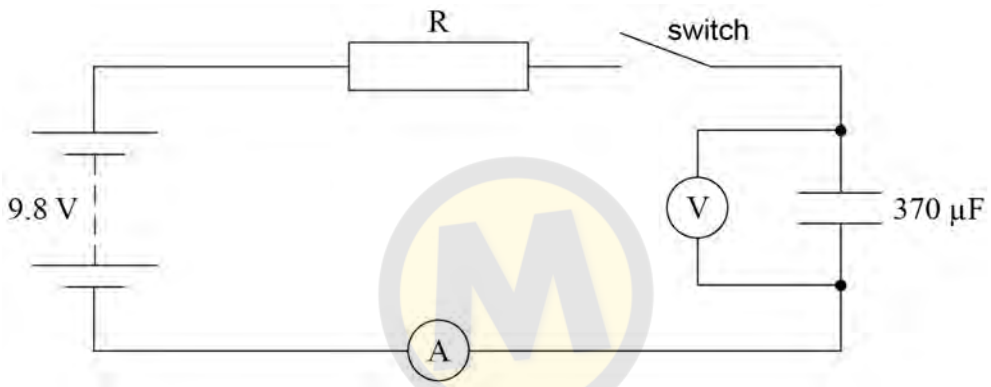
0 3 . 1 State what is meant by a capacitance of $370\ \mu F$

[2 marks]

0 3 . 2 The charging of a $370\ \mu F$ capacitor is investigated using the circuit shown in **Figure 4**. Both meters in the circuit are ideal.

Figure 4



The power supply of emf $9.8\ V$ has a negligible internal resistance. The capacitor is initially uncharged. When the switch is closed at time $t = 0$ charge begins to flow through resistor R. The time constant of the charging circuit is $1.0\ s$

Calculate the resistance of R.

[1 mark]

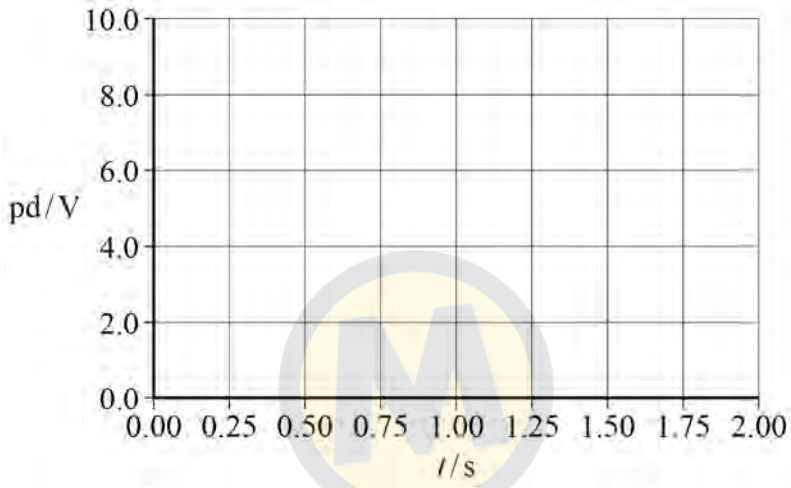
resistance of R = _____ Ω

Question 3 continues on the next page

0 3 . 3 Identify, with the symbol X on **Figure 5**, the potential difference (pd) across the capacitor when the switch has been closed for 2.0 s
Sketch the graph that shows how the pd varies from $t = 0$ to $t = 2.0$ s

[2 marks]

Figure 5



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0 3 . 4 Calculate the time taken for the charging current to fall to half its initial value.

[1 mark]

time = _____ s

0 3 . 5 Calculate the time taken for the charge on the capacitor to reach $3.0\ \text{mC}$

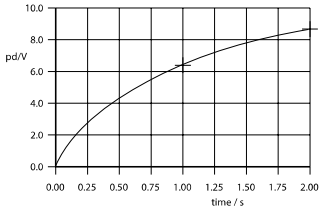
[3 marks]

time = _____ s

9

Turn over for the next question

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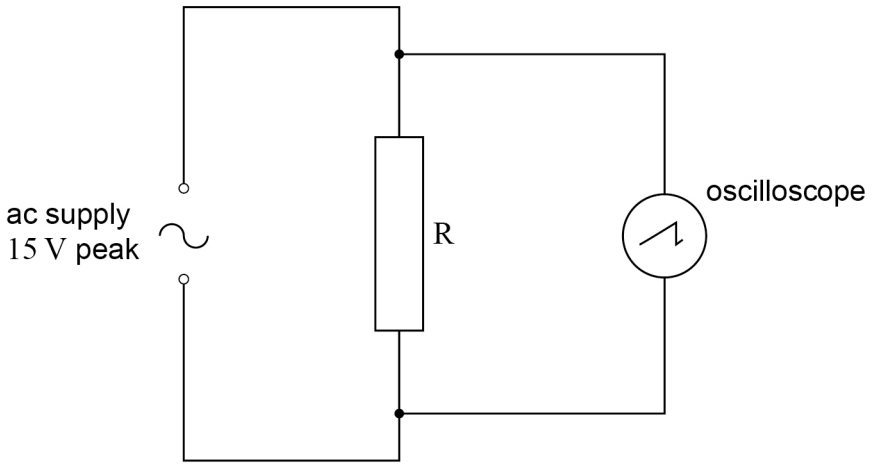
Question	Answers	Additional Comments/Guidance	Mark	ID details
03.1	(refers to a capacitor that) stores/holds/changes by $370\ \mu C$ of charge ✓ for every (1) volt/volt change (of pd across its plates) ✓ **OR** reference to charge to pd OR charge to voltage ratio✓ includes units C or coulomb and V or volt ✓	"Unit of pd" is no substitute for using volt and "unit of charge" is no substitute for coulomb. However the alternative marking could give a single mark for 370×10^{-6} units of charge per unit of pd. An equation may contribute towards the first mark but only if the symbols are identified. A second mark can be given if the units are identified. Ignore poor phrasing like 'per unit volt passing through'.	2	AO1
03.2	(Using time constant = $R\ C$) (R = $1.0 / 370 \times 10^{-6}$) R = $2.7 \times 10^{3}\ (\Omega)$ ✓	Check that the unit on answer line has not been altered	1	AO1
03.3	First mark for marking a cross at 2 s and 8.5 V (by eye) ✓ Second mark for graph starting at the origin and having a decreasing gradient ie not reaching horizontal ✓ 	Cross must be in the bottom half but not on the 8.0 V major grid line or exactly half way up (9.0 V) If a series of plotting crosses are given only consider the one placed at 2 s for the first mark.	2	AO2

03.4	(Using $T_{½} = 0.69\ RC = 0.69 \times 1.0$) $T_{½} = 0.69$ (s) ✓	1 sig fig is not acceptable	1	AO1
03.5	(Use of $Q = Q_o(1 - e^{-\frac{t}{RC}}) = CV_o(1 - e^{-\frac{t}{RC}})$) mark for max charge = CV_o which may come from substitution or seeing 3.6(2) × 10^{-3} C ✓ $3.0 \times 10^{-3} = 370 \times 10^{-6} \times 9.8\ (1 - e^{-t})$ ✓ mark for substitution ($0.8274 = (1 - e^{-t})$ so $e^t = 1/0.173 = 5.79$) t = 1.7 s or 1.8 s ✓ **OR** voltage $V = Q/C = 3 \times 10^{-3} / 370 \times 10^{-6}$ $= 8.1(1)$ V✓ (Substitute into $V = V_o(1 - e^{-\frac{t}{RC}})$) $8.1 = 9.8\ (1 - e^{-t})$ ✓ t = 1.7 s or 1.8 s ✓	Alternative mark scheme uses the voltage as proportional to the charge. Do not allow use of the graph for 2nd mark and 3rd mark. An answer only gains only the last mark. Evidence of working must be shown which shows substitution into a (1-e^{-t}) form of the equation.	3	AO2
Total			**9**	

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0 4 **Figure 6** shows an oscilloscope connected across resistor R which is in series with an ac supply. The supply provides a sinusoidal output of peak voltage 15 V.

Figure 6



0 4 . 1 Calculate the rms voltage of the supply.

[1 mark]

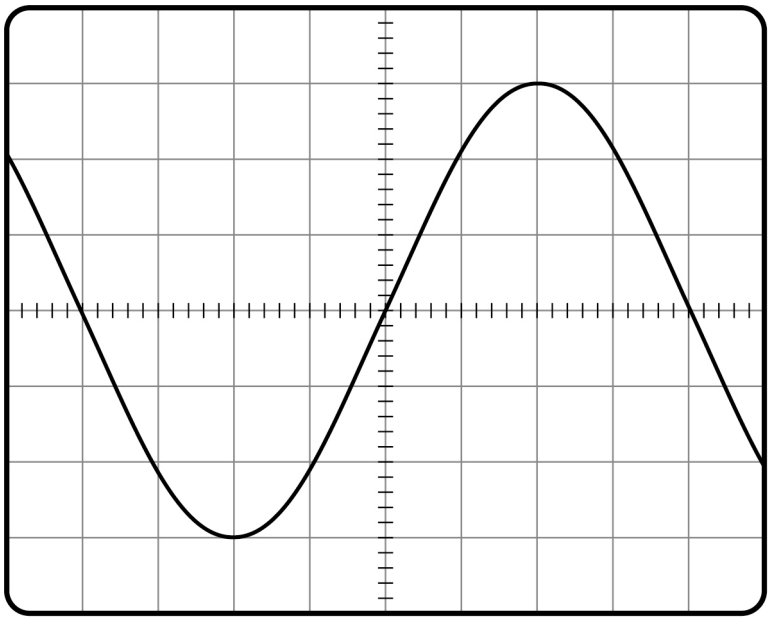
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rms voltage = _____ V

Question 4 continues on the next page

Figure 7 shows the trace of the waveform displayed on the oscilloscope.

Figure 7



0 4 . 2 Determine the y-voltage gain of the oscilloscope used for **Figure 7**.

[1 mark]

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y-voltage gain = _____ V div^{-1}

0 4 . 3 A dc supply gives the same rate of energy dissipation in R as the ac supply in **Figure 6**.

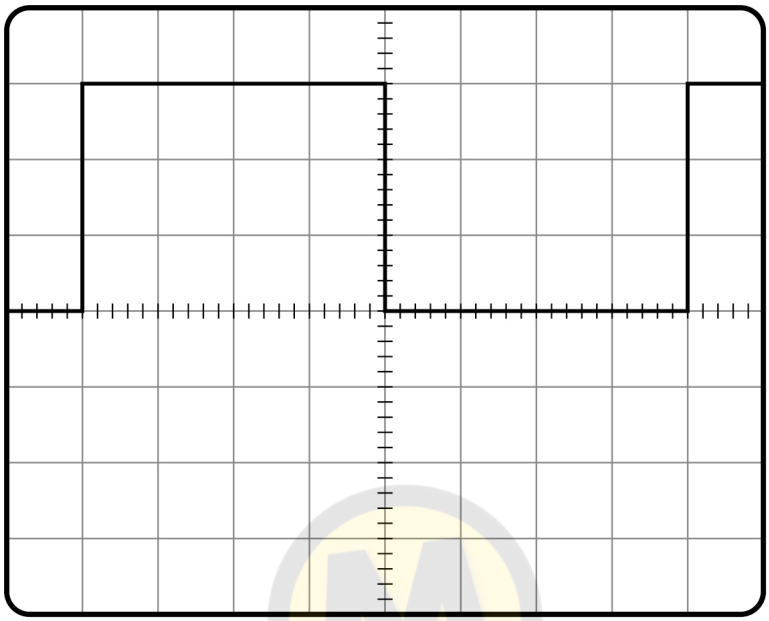
Draw the trace of the output of the dc supply on **Figure 7**.
The oscilloscope settings remain the same.

[1 mark]

0 4 . 4 The ac supply shown in **Figure 6** is replaced with a square-wave generator operating between 0 and +15 V.

Figure 8 shows the trace of the new waveform displayed on the oscilloscope.
The time-base is set to 5.0×10^{-4} s div^{-1}.

Figure 8



Calculate the frequency of the square waves.

[1 mark]

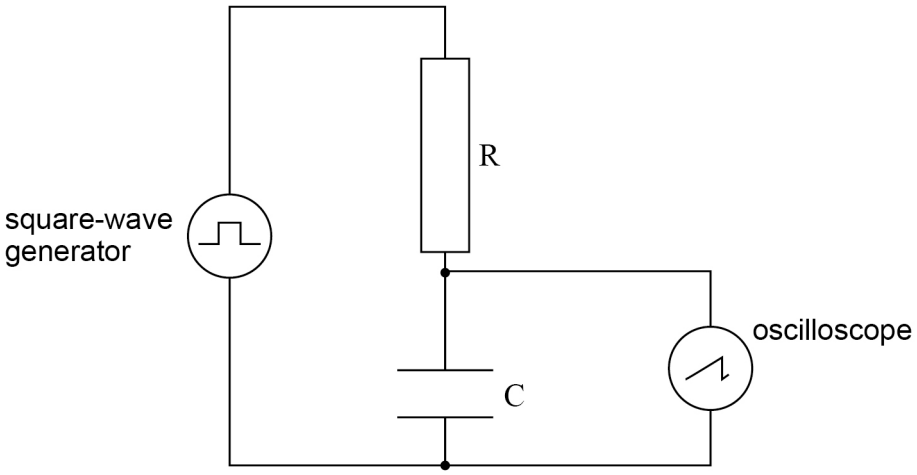
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frequency = _____ Hz

Question 4 continues on the next page

0 4 . 5 **Figure 9** shows the arrangement with the square-wave generator connected to an RC circuit.
A capacitor C is placed in series with the resistor R.
The oscilloscope is connected across the capacitor C.

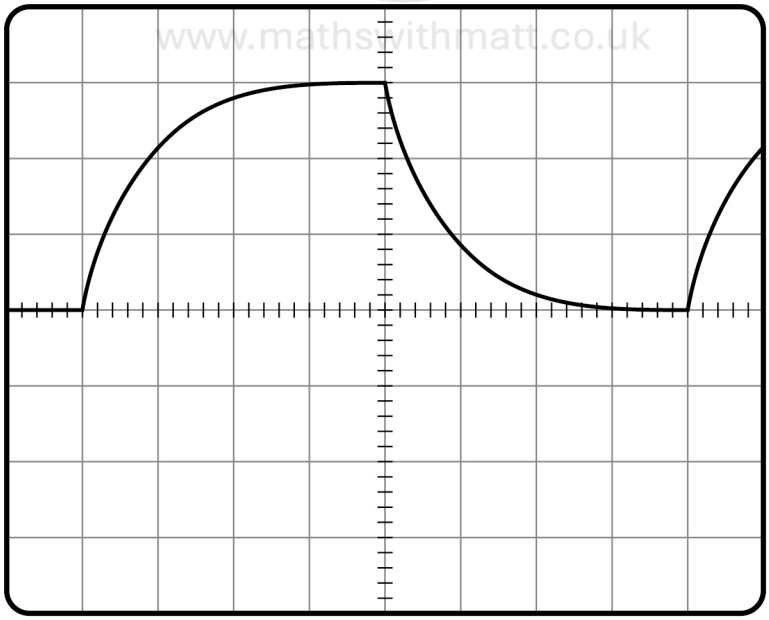
Figure 9



The capacitor charges and discharges.

Figure 10 shows the trace of the waveform displayed on the oscilloscope.
The settings of the oscilloscope remain the same as in Question **04.4**.

Figure 10


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Deduce the time constant for the RC circuit, explaining each step of your method.

[3 marks]

time constant = _____ s

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0 4 . 6 State and explain a change to **one** control setting on the oscilloscope that would reduce the uncertainty in the value of the time constant.

[2 marks]

9

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	$V_{rms}\left(=\frac{V_{peak}}{\sqrt{2}}=\frac{15}{\sqrt{2}}\right)=10.6$ (V) ✓ {allow 11 V to 2 sig figs}		1	AO1.1b
04.2	(Peak voltage 3 divisions corresponding to 15 V) y-voltage gain = 5 (V div^{-1}) ✓		1	AO2.1d M2
04.3	A horizontal line drawn at 10.6 V ✓	Tolerance – must be between 10 and 11 up from the centre Allow ecf from 04.1	1	AO2.1d M2
04.4	(Period T = corresponds to 8 divisions $T = 8 \times 5.0 \times 10^{-4}$ s = 0.0040 s Frequency = 1/T = 1/0.0040) = 250 (Hz) ✓	Answer only gains the mark.	1	AO2.1h M2

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04.5	~~Time constant $= 4 \times 10^{-4}$ (s) ✓1 {only needs 1 sig fig}~~ The second and third mark can come from the following alternatives. Note the mark is for the method so allow arithmetic slips and imprecise measurements. Make use of the equation $V_t = V_o e^{-\frac{t}{\text{time constant}}}$ ✓2a Substitute values for V_t and V_o (confirmed by the graph) and calculate the (unknown) time constant. ✓3a OR $\text{Ln}2\ (= 0.69) = = \frac{t_{\frac{1}{2}}}{\text{time constant}}$ ✓2b Substute time for *V* to decrease to half its value (confirmed by the graph) and calculate the time constant ✓3b OR The voltage falls to $1/e$ or 37% in a time constant ✓2c {owtte} Find the time that corresponds to this fall in voltage confirmed by the graph (normally the start of the discharge This gives the τ directly) ✓3c	To use a number of small divisions rather than grid divisions is not an arithmetic error. This error comes from not knowing how the oscilloscope is used. Full marks can be awarded from consideration of the charging part of the cycle. The equation can be presented in a number of variations using RC or τ for example. Typical calculation might be: $\frac{V_t}{V_o} = \frac{1}{12}$ in 2 time divisions. Substitution into the equation will give τ V_t and V_o both need to be defined in relation to the graph OR *V* halves its value in 0.5 time divisions. Substituting gives τ $t_{\frac{1}{2}}$ needs to be defined in relation to the graph OR 37% of 3 divisions is 1.1 divisions which occurs in time ¾ time divisions giving τ	3	AO2.1g AO2.1h AO3.1a M2 ×2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.6	Reduce the time-base setting ✓1a Uncertainty is due to the smallness of the divisions and this action means the waveform/trace stretched horizontally/in x-direction. ✓2a {owtte} OR Increase the y-gain ✓1b Uncertainty is due to the smallness of the divisions and this action means the waveform/trace stretched vertically/in y-direction. (The trace will need to be moved vertically to fit on the screen) ✓2b {owtte}	1 Stated answer must be a practicable change 2 Explanation must refer to both the trace and its relation to uncertainty and follow a correct change.	2	AO3.2b ×2
Total			**9**	

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Do not write outside the box

Section A

Answer **all** questions in this section.

0 1 A capacitor of capacitance $63\ \text{pF}$ is made from two parallel metal plates separated by an air gap.
The capacitor is charged so that it stores a charge of $7.6 \times 10^{-10}\ \text{C}$; it is then isolated.

A sheet of mica of dielectric constant 6.0 is inserted between the plates so that it completely fills the space between them. The mica does not discharge the capacitor and does not change the separation of the plates.

0 1 . 1 Explain what is meant by a dielectric constant of 6.0

[1 mark]

0 1 . 2 Mica is made up of polar molecules. As the mica is inserted, the capacitance of the capacitor changes.

Explain how the polar molecules cause this change in capacitance.

[3 marks]

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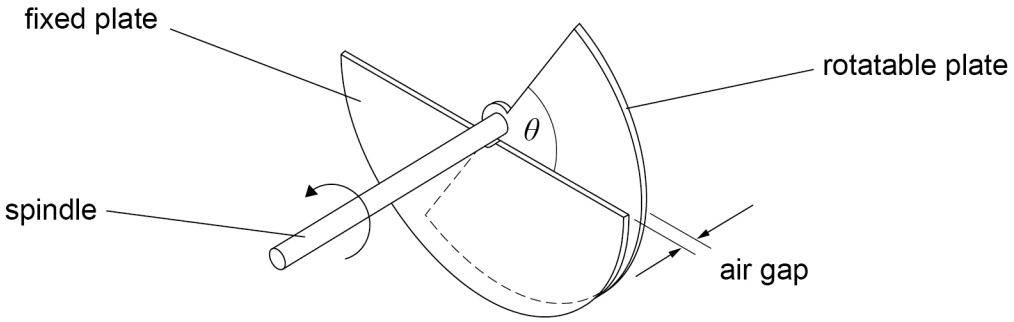
0 1 . 3 Calculate the difference between the initial energy stored by the capacitor and the energy stored when the mica has been fully inserted.

[3 marks]

energy difference = _____ J

Figure 1 shows the structure of a variable capacitor used for measuring angular movement. The capacitor consists of two semicircular metal plates. These plates are parallel and are separated by an air gap.

Figure 1

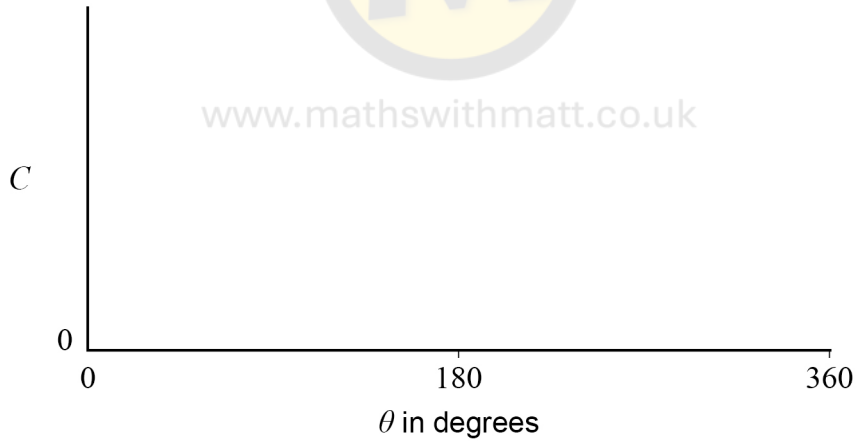


To vary the capacitance, one of the plates is rotated through an angle θ using the spindle. The other plate remains fixed.

0 1 . 4 Sketch a graph on **Figure 2** to show how the capacitance C varies with θ as the spindle is turned through $360°$.
When θ is $0°$, the plates completely overlap.

[2 marks]

Figure 2



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0 1 . 5 In one situation, the variable capacitor is too large for the available space.

The same maximum capacitance is required using plates that have half the diameter of the original capacitor.

Explain, with numerical detail, **two** ways in which this can be achieved.

[3 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

12

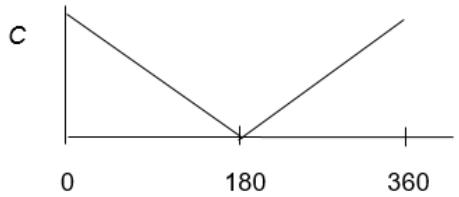
Turn over for the next question

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Question	Answers	Additional comments/Guidelines	Mark	AO
01.1	(Dielectric constant is) $\frac{\text{permittivity of medium}}{\text{permittivity of free space}}$ and is equal to 6 ✓ OR The permittivity of the dielectric is 6 times the permittivity of free space	Allow: $\frac{C \text{ with dielectric (between plates)}}{C \text{ in a vacuum}} = 6.$ Its not enough to quote relative permittivity = 6	1	AO1 1a

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	(Electric field exists between plates) Polar molecules align with their positive side facing the negative plate (owtte) ✓1 producing a counter electric field/reducing the field between the plates ✓2 The pd V reduces between the capacitor plates but charge Q remains the same so capacitance Q/V increases. ✓3	✓1 or vice versa. ✓3 This mark may be approached from the idea that more charge would be required to maintain pd hence C increases by referencing $C = Q/V$	3	AO1 1a ×3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	Q remains the same ✓1 New C is $6 \times$ previous C ✓2 Energy difference = 3.8×10^{-9} J ✓3	✓2 May be seen in the substitution in the energy difference calculation ✓3 Calculates change in energy using $E = ½Q^2\left(\frac{1}{c_2} - \frac{1}{c_1}\right)$ = 4.58x10^{-9} – 7.64x10^{-10} Where $Q = 7.6 \times 10^{-10}$ C : $c_1 = 63 \times 10^{-12}$ F and $c_2 = 6 \times 63 \times 10^{-12}$ $E = 378 \times 10^{-12}$ J Condone a negative final answer If no marks given award single mark for the initial energy stored = 4.58x10^{-9} J	3	AO2 1h ×3

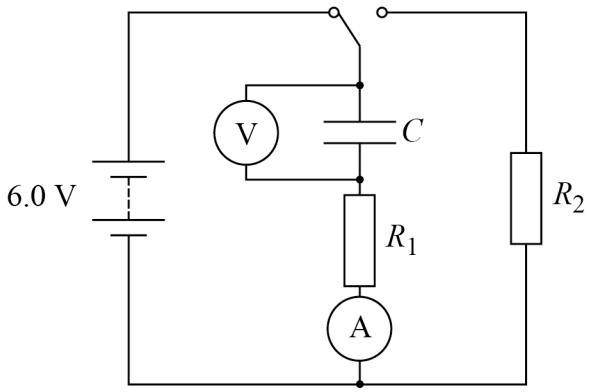
Question	Answers	Additional comments/Guidelines	Mark	AO
01.4	showing a linear decrease and increase ✓ points correct at 0, 180 and 360 degrees ✓	 Ignore graph beyond 360 degrees	2	AO2 1h × 1 AO3 1b × 1

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Question	Answers	Additional comments/Guidelines	Mark	AO
01.5	Insert dielectric between plates/attach dielectric to one plate OR reduce air gap explained ✓ Dielectric has $\varepsilon_r = 4$ ✓ air gap reduced to ¼ ✓	1st mark for <u>quantitative</u> answer for air gap or dielectric or both. (Allow: more plates when explained) 2nd and 3rd marks for numerical analysis for air gap **and** dielectric change. Do not allow incorrect physics.	3	AO3 1a × 3
Total			**12**	

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 V and negligible internal resistance.

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

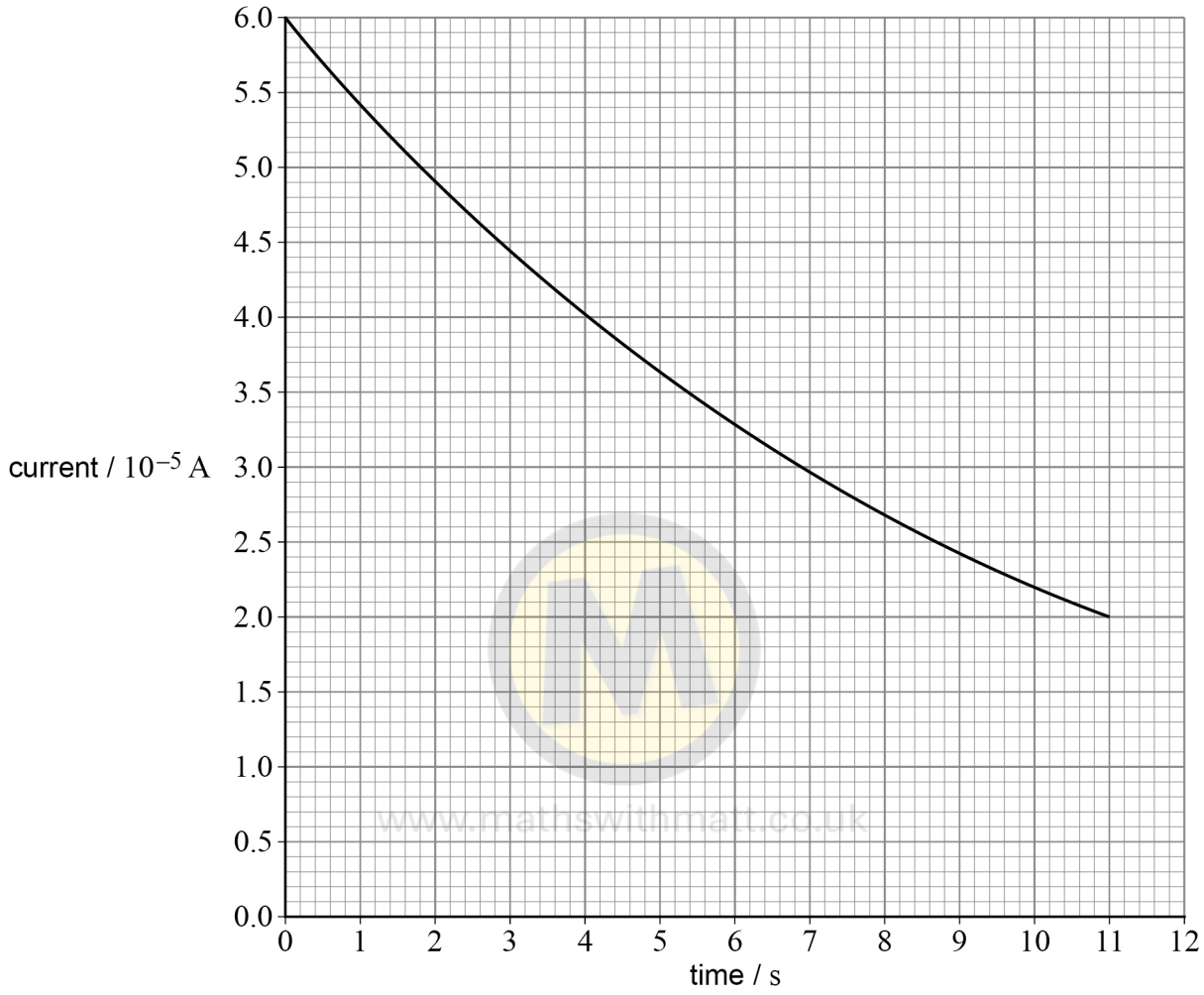
[3 marks]

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Question 5 continues on the next page

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

Figure 9



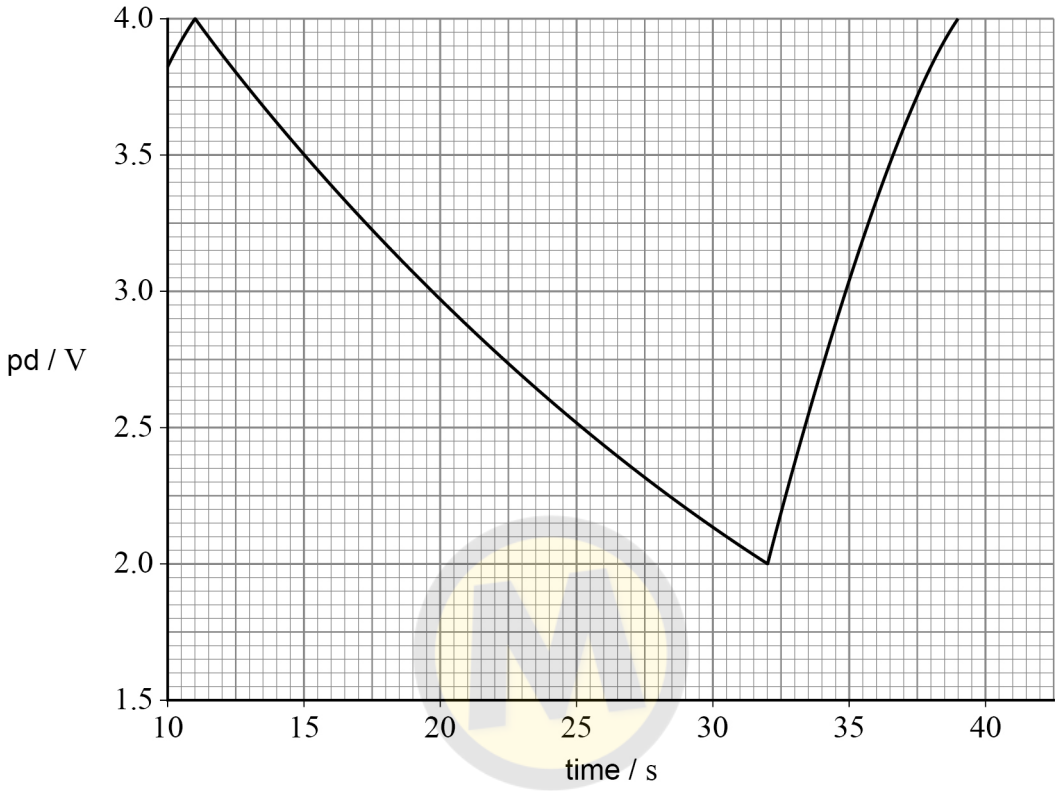
0 5 . 2 Show that the capacitance of the capacitor is about 1×10^{-4} F.

[4 marks]

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



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Determine the value of R_2.

[3 marks]

$R_2 =$ _____ Ω

10

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	$V = V_0\left(1 - e^{-\frac{t}{RC}}\right)$ with substitution attempted with V_0 being larger than V ✓1 Time to charge to 4.0 V = $t_2 = -R_1 C \ln\left(1 - \frac{4}{6}\right)$ **OR** Time to charge to 2.0 V = $t_1 = -R_1 C \ln\left(1 - \frac{2}{6}\right)$ ✓2 $t = t_2 - t_1 = -R_1 C \ln\left(\frac{1}{3}\right) - \left\{-R_1 C \ln\left(\frac{2}{3}\right)\right\}$ $\left(= -R_1 C\left(\ln\frac{1}{3} - \ln\frac{2}{3}\right) = -R_1 C \ln\left(\frac{\frac{1}{3}}{\frac{2}{3}}\right)\right) = -R_1 C \ln\left(\frac{1}{2}\right) = 0.69 R_1 C$ **OR** $= R_1 C(1.10 - 0.41) = 0.69 R_1 C$ ✓3	NB The answer can be obtained incorrectly by finding the time to charge to 2V using a 4V supply. This approach may only gain the first mark for an attempted use of the equation. Award 0 for a solution using the discharge equation. Condone R for R_1 ✓2 If given in an equation then then time must be the subject or be in a form that is used to obtain mp3 can be awarded for $t_2 = 1.10 \times R_1 C$ **OR** $t_1 = 0.41 \times R_1 C$ ✓3 Must see $0.69\, R_1 C$ for 3 marks. Only award MP3 for $0.69 R_1 C$ if the solution involves a time difference.	3	AO1 AO2 ×2

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Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	Attempt to find usable data from **Figure 9** ✓1 Determine scaling factor **OR** Determine R_1 ✓2 Calculate Q the charge stored at 4 V or the charging time constant **from a valid method** ✓3 Determine C to a value that rounds to 1×10^{-4} (F) to 2 or more sf (expect to see 1.0×10^{-4} F) ✓4 **Method 1 (from area)** ✓1a Attempt at finding area under I–t graph by counting boxes ✓2a 1 cm^2 box corresponds to charge 0.5×10^{-5} C ✓3a Number of 1 cm^2 boxes = 80 (78 to 80) $Q = (80 \times 0.5 \times 10^{-5}) = (3.9 \text{ to } 4.1) \times 10^{-4}$ (C) ✓4a $C = \frac{\text{their } Q}{4}$ = a value that rounds to 1×10^{-4} (F) (≥ 2 sf required) Award **MAX 1** for estimating the average current by sight and using $C = \frac{IT}{V}$.	**Method 2 (from individual data points)** Possible methods are shown but only final answers requested are needed to gain marks. ✓1b Use of a current and voltage across the resistor, e.g. $I = 2.0 \times 10^{-5}$ A and voltage across resistor = 2 V (when capacitor has 4 V) **OR** $I = 6.0 \times 10^{-5}$ A and voltage across resistor = 6 V (when capacitor has 0 V) ✓2b $R_1 = \frac{V}{I} = \frac{2.0}{2.0 \times 10^{-5}}$ **OR** $\left(\frac{V}{I} = \frac{6}{6 \times 10^{-5}}\right) = 1.0 \times 10^5$ (Ω) ✓3b Charging time constant = R_1C Eg using $I = I_0 e^{\frac{-t}{R_1 C}}$ then $R_1C = \frac{t}{\ln\left(\frac{I_0}{I}\right)}$ Substituting $I = 2 \times 10^{-5}$ A and $I_0 = 6 \times 10^{-5}$ A and $t = 11$ s. OR Graphical method must include evidence from Figure 9 charging time constant $(R_1C) = 10.(0)$ (s) ✓4b $C = \frac{\text{time constant}}{R_1} = \frac{10.0}{1.0 \times 10^5}$ = a value that rounds to 1×10^{-4} (F) (≥ 2 sf required)	4	AO2 ×3 AO3

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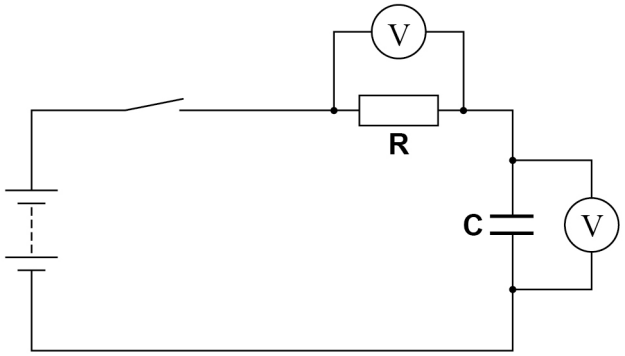
Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	Reading of relevant discharge data from **Figure 10** provided there is an attempt to use data ✓1 A valid substitution of their data into a relevant equation to find R_1 or R_{Total} ✓2 $R_2 = R_{\text{Total}} - \text{their } R_1 = 2.0 \times 10^5\ \Omega$ ✓3 allow **one** ecf from either their R_{Total} **or** their R_1 When R_1 is derived in an earlier question accept this value of R_1 and allow ecf for R_{total} When R_1 is derived in this question, allow one ecf from either their R_{total} or their R_1	✓1 From **Figure 10** this can be the time taken for the voltage to fall to half its value. ✓2 Finding R_{Total} from **Figure 10** 4.0 V to 2.0 V in $(32 - 11)$ s using $t_{\frac{1}{2}} = 0.69RC$ allow $= 0.7RC$ $R_{\text{Total}} = 3.0 \times 10^5\ \Omega$ Finding R_1 from **Figure 9** 6.0 A to 3.0 A in 6.8 s using $t_{\frac{1}{2}} = 0.69RC$ allow $= 0.7RC$ $R_1 = 1.0 \times 10^5\ \Omega$ **OR** Using $I = I_o e^{\frac{-t}{R_1 C}}$ for example, with $I = 2 \times 10^{-5}$ A and $I_o = 6 \times 10^{-5}$ A and $t = 11$ s Note R_1 may be taken from **05.2** and not use the graph information.	3	AO3 ×3

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Total			10

0 2 **Figure 1** shows a circuit used to charge capacitor **C**.
The battery has negligible internal resistance.

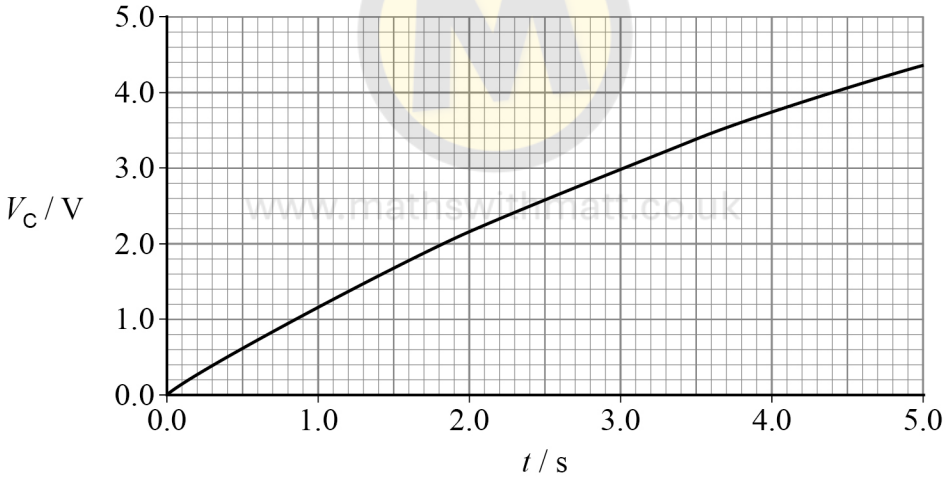
Figure 1



The capacitance of **C** is known.

0 2 . 1 The switch is closed at time $t = 0$ and the potential difference V_C across **C** is recorded at different times t.
Figure 2 shows the variation of V_C with t.

Figure 2

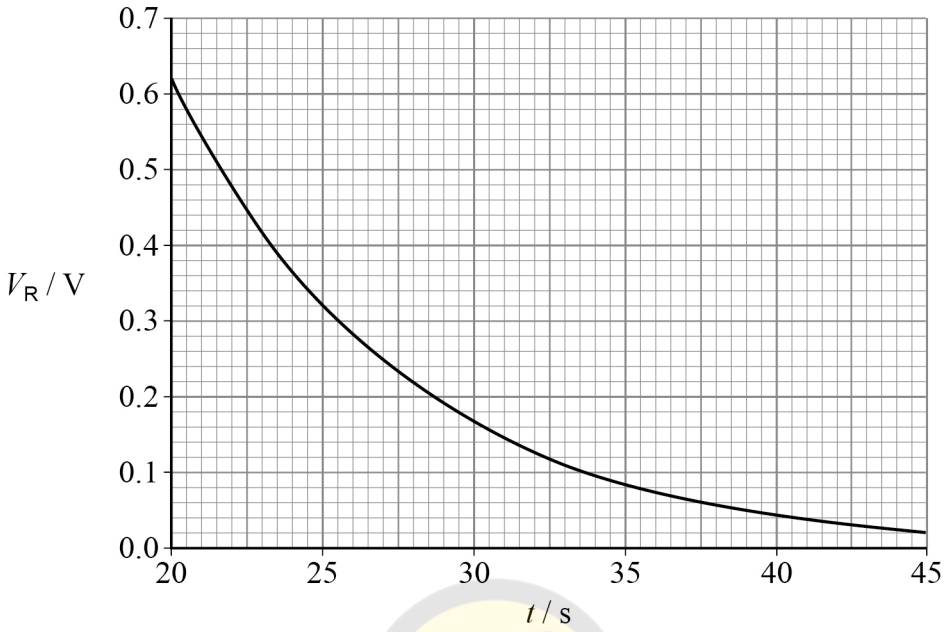


Explain how a gradient of the graph in **Figure 2** can be used to determine the initial current I_0 in the circuit.

[2 marks]

0 2 . 2 The potential difference V_R across **R** is also recorded.
Figure 3 shows the variation of V_R with t between $t = 20$ s and $t = 45$ s.

Figure 3



The capacitance of **C** is $31.0\ \mu F$.

Determine, using **Figure 3**, the time constant of the circuit.
Go on to show that the resistance of **R** is about $2.4 \times 10^5\ \Omega$.

[2 marks]

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time constant = _____ s

resistance = _____ Ω

Question 2 continues on the next page

0 2 . 3 The current I_0 at time $t = 0$ is 3.6×10^{-5} A.

Determine the time at which V_C is 6.0 V.

[3 marks]

time = _____ s

0 2 . 4 **Figure 4** shows two fully charged parallel-plate capacitors $\mathbf{C}_1$ and $\mathbf{C}_2$ in a circuit.
A dielectric fills the space between the plates of $\mathbf{C}_1$ and air fills the space between the plates of $\mathbf{C}_2$.

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Figure 4

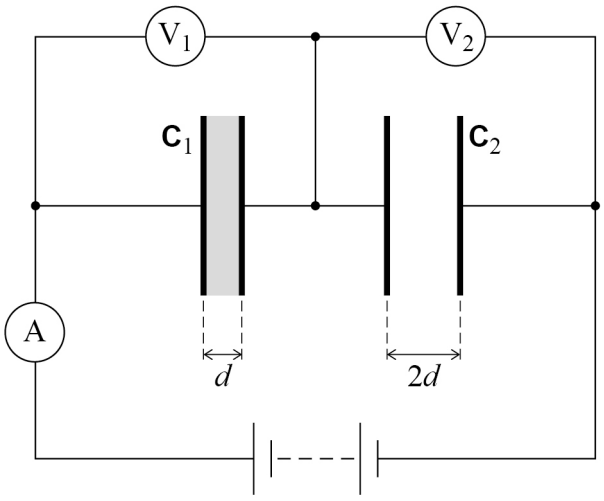


Table 2 gives information about $\mathbf{C_1}$ and $\mathbf{C_2}$.

Table 2

	$\mathbf{C_1}$	$\mathbf{C_2}$
charge	Q	Q
surface area	S	S
potential difference	V_1	V_2
plate separation	d	$2d$
dielectric constant	4.0	1.0

Determine $\frac{V_1}{V_2}$.

[2 marks]

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$\frac{V_1}{V_2} =$ _____

9

Turn over for the next question

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	Show attempted use of all three equations: gradient $= \frac{\Delta V}{\Delta t}$ AND $I = \frac{\Delta Q}{\Delta t}$ AND $Q = CV$ ✓ $I_0 = C \times$ **initial** gradient ✓	mp2 $V = \frac{Q}{C}$ so $\Delta V = \frac{\Delta Q}{C}$ so gradient $\frac{\Delta V}{\Delta t} = \frac{\Delta Q}{C\Delta t} = \frac{I}{C}$ hence $I_0 = C \times$ initial gradient $(\Delta)Q = I(\Delta)t$ can be seen via substitution if **both** (Δ)Q and $I(\Delta)t$ are seen in equivalent expressions e.g. $I(\Delta)t = CV$ is insufficient without $(\Delta)Q = CV$. Condone omission of Δ's in MP1. Condone C or initial gradient as subject for mp2. Condone a calculation and an **initial** gradient shown on Figure 2 mp1 and mp2 are independent. If no other marks award 1 for $I = C \times$ gradient or C or gradient as subject.	2	AO2c

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Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	time constant = 7.5 ± 0.5 (s) ✓ evaluated $R = \frac{\text{their } T}{C}$ correctly ✓	Do NOT allow $T = RC$ for mp1. Value must come from Figure 3 using a valid method. 7.44 s is likely to come from RC and not from the graph. mp1 Time taken to fall to $1/e$ or 0.37 of its value = time constant eg 0.45 V to 0.166 V takes 7.5 s This may be calculated over a larger range or the time to halve the voltage found and this value divided by $\ln 2$ eg 0.45 V to 0.225 V takes 5.2 s giving = 7.5 s Half life 5.2 ± 0.5 (s) and $T = \frac{T_{\frac{1}{2}}}{\ln(2)} = \frac{T_{\frac{1}{2}}}{0.69}$ mp2 $T = RC$ so $R = \frac{T}{C} = \frac{7.5}{31.0 \times 10^{-6}} = 2.4(2) \times 10^5\ \Omega$ Condone 2SF for mp2 if working is shown.	2	1 × AO1b 1 × AO3-1a

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Question	Answers	Additional comments/Guidelines	Mark	AO
02.3	Supply voltage $V_0 = I_0R$ (expect 8.6 V)✓$_1$ Use of $V = V_0\left(1 - e^{\frac{-t}{RC}}\right)$ ✓$_2$ **Alternative** Use of $V_0 = I_0R$ so $I = \frac{I_0R-6}{R}$ (expect 1.1×10^{-5} A)✓$_1$ Use of $I = I_0e^{-\frac{t}{RC}}$ ✓$_2$ Calculation of the time from correct physics (expect 8.8 to 9.0 s) ✓$_3$	Allow 9V for mp1 or mp2 but do not allow ecf for rounded value in mp3 mp2 allow substitutions OR rearrangements using ln or use of $V = \frac{Q}{C}$ and $Q = Q_0\left(1 - e^{\frac{-t}{RC}}\right)$ Allow ecf for ✓$_3$ R, T values but not from the wrong equation or mix up of V and I.	3	1 × AO2d 2 × AO3-1a

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Question	Answers	Additional comments/Guidelines	Mark	AO
02.4	use of $C = Q/V$ and $C = \varepsilon_r\varepsilon_0 A/d$ ✓ $\frac{V_1}{V_2} = 0.125$ ✓	mp1 $V = \frac{Qd}{\varepsilon_r\varepsilon_0 A}$ may be seen anywhere in the working, possibly with subscripts or rearranged. mp2 $\frac{V_1}{V_2} = \frac{d}{4\times 2d} = 0.125$ Condone $\frac{1}{8}$ for mp2 Award 1 mark for 8 regardless of working mp2 implies mp1	2	AO2f

Total			**9**

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