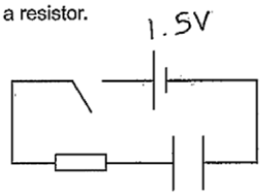
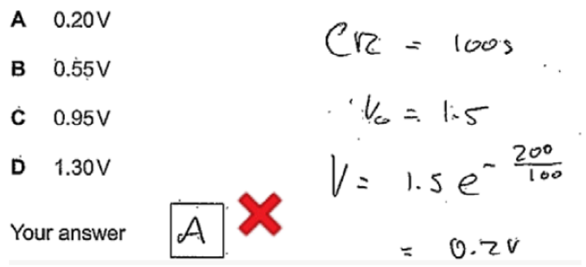
Mark scheme - Capacitors

Question			Answer/Indicative content	Marks	Guidance
1			C	1	**Examiner's Comments** The correct response is **C**. Although this question may not have followed the traditional route for a capacitor decay, it proved to be accessible to many candidates. Several filled in the table completely which appeared to be a helpful strategy, or set up stages of the calculation alongside the question. Those that showed little or no working tended to opt for response **A** using a constant subtraction for each time interval.
			Total	**1**	
2			D	1	
			Total	**1**	
3	a		gradient = b and *y*-intercept = lg a	B1	
	b	i	1.70;	B1	both values for the mark
		i	0.41 ± 0.03	B1	**allow ecf** to find uncertainty value
		ii	two points plotted correctly;	B1	**ecf** value and error bar of first point
		ii	line of best fit	B1	**allow ecf** from points plotted incorrectly
	c	i	b = gradient = 1.60	B1	**allow** 1.56 to 1.64; **allow** 1.6
		i	y = 0.86 (± 0.01); × = 1.98 so *y*-intercept = 0.86 − 1.6 × 1.98 = −2.3(1)	B1	**ecf** gradient in finding y-intercept
		i	a = $10^{-2.3}$ = 0.005	B1	
		ii	worst acceptable straight line	B1	steepest or shallowest possible line that passes through the error bars; should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar **allow (**1.6) ± 0.1 or 0.2 where plausible working is shown
		ii	b = gradient of steepest line = 1.75 giving uncertainty ± 0.15	B1	
			Total	**10**	
4	a		(initial charge) $Q = EC_0$ **or** (Q conserved so final) $Q = V(C + C_0)$ (as capacitors are in parallel) <u>so</u> $EC_0 = V(C + C_0)$ (and hence $V = C_0 E / (C + C_0)$)	M1 A1	At least one correct expression for Q for first mark The two correct expressions equated for the second mark

					Examiner's Comments Some candidates obtained $Q = EC_0$ by applying the definition of capacitance at A, but then did not realise that charge would be conserved on switching from A to B. Some chose the wrong formula for capacitors in parallel or attempted to use the potential divider equation.
	b	i	$1/V = 1/E + C/EC_0$ (and compare to $y = c + mx$)	B1	Mark is for rearrangement into linear equation **Examiner's Comments** Some candidates correctly took the reciprocal of both sides of the given equation but were then unable to show a rearrangement into the standard linear form. A common difficulty was an inability to expand the bracket in $\frac{1}{E} \times \frac{(C + C_0)}{C_0}$ to give $\frac{C}{EC_0} + \frac{C_0}{EC_0}$
		ii	$1/EC_0 = 51 = 1/(9.1\ C_0)$ giving $C_0 = 1/(51 \times 9.1)$ F $C_0 = 2.2$ (mF)	B1 B1	$C_0 = 2.1547 \times 10^{-3}$ F Answer must be correct, rounded correctly and given in mF Candidate's answer must be given to 2 SF **Examiner's Comments** Some candidates gave their response to 2 d.p. instead of to 2 s.f. as required.
		iii	(at least) one correct worst fit line drawn gradient calculated correctly using a large triangle uncertainty = C_0 – 1/(wfl gradient x 9.1) uncertainty given is to the same number of decimal places as C_0	B1 B1 B1 B1	Top and bottom points chosen must be from opposite extremes of uncertainty limits, accurate to within half a small square $\Delta x \geq 1.5 \times 10^{-3}$; **expect** 59±1 or 44±1 (**or** 0.059 **or** 0.044); **allow ECF** from poorly drawn line; readings must be accurate to within half a small square **ECF** from **b(ii)**; **expect** uncertainty of up to 0.4(mF) **ECF** from **b(ii)** **If** no value for C_0 given in b(ii), **allow** any answer given to 1dp **Examiner's Comments** Most candidates gained the mark for using a large triangle (spanning more than 1.5 on the x–axis) to determine the gradient of the worst-fit line. Lower ability candidates were unable to gain credit for finding the gradient of their line because they read the scales on the axes incorrectly. Candidates should take a ruler into the examination and be careful about the positioning of the ruler for drawing a worst-fit straight line. A worst-fit line should join opposite extremes of uncertainty limits and pass between all the uncertainty limits. The Practical Skills Handbook is helpful on this topic. Several candidates performed the unnecessary step of calculating the fractional (or percentage) uncertainty instead of using $\Delta C_0 = \pm \lvert C_{0\ best} - C_{0\ worst} \rvert$ directly.
	c		Only effect is to slow the charging and / or discharging (of capacitor(s)) <u>and so</u> the final charges are	B1	**Allow** and so the experiment takes longer

			unchanged / the values for *V* are unchanged / the graph is unchanged / the gradient is unchanged / there is no effect on the experiment (results)		
			Total	**10**	
5			**C**	1	
			Total	**1**	
6			**D**	**1**	**Examiner's Comments** This question provided good discrimination with most to-end candidates scoring 1 mark for the correct answer **D**. Extracting all the information was the prerequisite for success. The potential difference across the capacitor is required. This could either be done by calculating the potential difference across the resistor (0.20 V), and then subtracting this from the e.m.f. of 1.50 V, or in one step using the equation $V = V_0(1 - e^{-t/CR})$. It is worth pointing out the answer 0.20 V proved to be the most popular distractor for low-scoring candidates. **Exemplar 2** A capacitor is charged through a resistor.  The cell has e.m.f. 1.50 V and negligible internal resistance. The capacitor is initially uncharged. The time constant of the circuit is 100 s. The switch is closed at time $t = 0$. What is the potential difference across the capacitor at time $t = 200$ s? **A** 0.20 V **B** 0.55 V **C** 0.95 V **D** 1.30 V $v = V_0(1 - e^{-t/CR})$ $v = 1.5(1 - e^{-200/100})$ $= 1.296$ Your answer D This exemplar illustrates the effortless strategy adopted by this A-grade candidate. The circuit diagram has been annotated with the e.m.f. of 1.50 V, and the time constant *CR* of 100 s has been underlined. The correct equation has been used to get 1.30 V. Compare and contrast this answer with the exemplar 3 below from a C-grade candidate.

					Exemplar 3  The answer calculated here of 0.2 V, is the potential difference across the resistor and not the capacitor. This candidate was one step away from getting the correct answer – this value just had to be subtracted from the e.m.f. of 1.50 V. Deciphering the question is vital, as is the analysis that follows.
			Total	**1**	
7			B	1	
			Total	**1**	
8			**D**	**1**	
			Total	**1**	
9			**D**	**1**	
			Total	**1**	
10			A	1	
			Total	**1**	
11			**A**	**1**	
			Total	**1**	
12			B	1	
			Total	**1**	
13			A	1	**Examiner's Comments** All the key equations for capacitor-resistor circuits are in the Data, Formulae and Relationship Booklet. As the capacitor charges, the potential difference V across the resistor will fall exponentially with respect to time. The time constant of the circuit CR is 10 s. Therefore, according to the equation $V = V_0e^{-t/CR}$, the correct expression after substitution will be $0.60 = 1.50e^{-0.10t}$. The correct answer is **A**. Just on the knowledge of time constant, neither **C** nor **D** can be the correct answers because of the '10' in the expression. The choice then is between **A** and **B**; as demonstrated above, **A** is the answer. All the distractors were equally popular.
			Total	**1**	

14			A	1	
			Total	**1**	
15	a		Take ln to give ln$V = -(t / C).1/R$ + ln V_0 gradient (m) = (−) t / C where t = 15	**M1** **A1**	**allow** ln $(V / V_0) = -(t / C).1/R$ **Examiner's Comments** The whole question produced a full range of marks and discriminated well. About 70% gained more than half marks. In (a) here was some confusion about V_0. Many candidates correctly stated that ln(V / V_0) = $-t / RC$ but some looked again at the question and wrote ln(V / V) instead not realising that V here related to the unit volt. A smaller number correctly stated the expanded form ln $V = -t / RC$ + ln V_0.
	b	i	1.10 ± 0.07	**B1**	value plus uncertainty required for the mark
		ii	two points plotted correctly to within ½ small square on x-axis; line of best fit	**B1** **B1**	**ignore** accuracy of length of error bar; **ecf bi** value **or both** worst acceptable lines drawn
		iii	gradient (= 15/C) = 6.6 (× 10^4); C = 15 / 6.6 × 10^4 = 2.3 × 10^{-4} (F) worst acceptable straight line drawn (C) ± 0.3 × 10^{-4} F	**C1** **A1** **B1** **B1**	**accept** 6.4 to 6.8 **ignore** power of 10 **accept** 2.3 ± 0.1 × 10^{-4} **allow ecf** for the point calculated incorrectly in **b(ii);** steepest or shallowest possible line that passes through all the error bars; should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar **allow** e.g. (C) ± 0.2 × 10^{-4}; **allow** value of C to 4 SF **but N.B.** the uncertainty and the value of C **must be** to the same number of decimal places **allow** 230 ± 30 μF etc **allow** equivalent unit including s Ω^{-1}, C V^{-1}, A s V^{-1} **Examiner's Comments** Candidates were given several opportunities to score marks by plotting points, drawing the best and worst lines on a graph and then extracting data from the graph. Many failed to draw the worst straight line losing themselves two possible marks. Many forgot the power of 10^{-6} in the unit on the x-axis. The normal requirement that the final value for the capacitance C should to be given to 2 significant figures (SF) and the absolute uncertainty to 1 SF (e.g. 230 ± 0.20 μF) was waived. However the absolute uncertainty had to be stated to the same number of decimal places as the calculated value of C to gain the mark.
	c		ln(0.1) = −15/RC **or** R = −15/C ln(0.1) **or** R = 0.65/C R = 0.65/2.3 × 10^{-4} giving R = 28 kΩ	**C1** **A1**	ln(0.1) = −2.30 **ecf (b)(iii)** **Examiner's Comments** About half of the candidates gained full marks here. Some confused 10% and 90% and about a tenth of the candidates did not attempt an answer.
			Total	**11**	
16			Electrons in the circuit move in a clockwise	B1	**Allow**: conventional current is in anticlockwise direction.

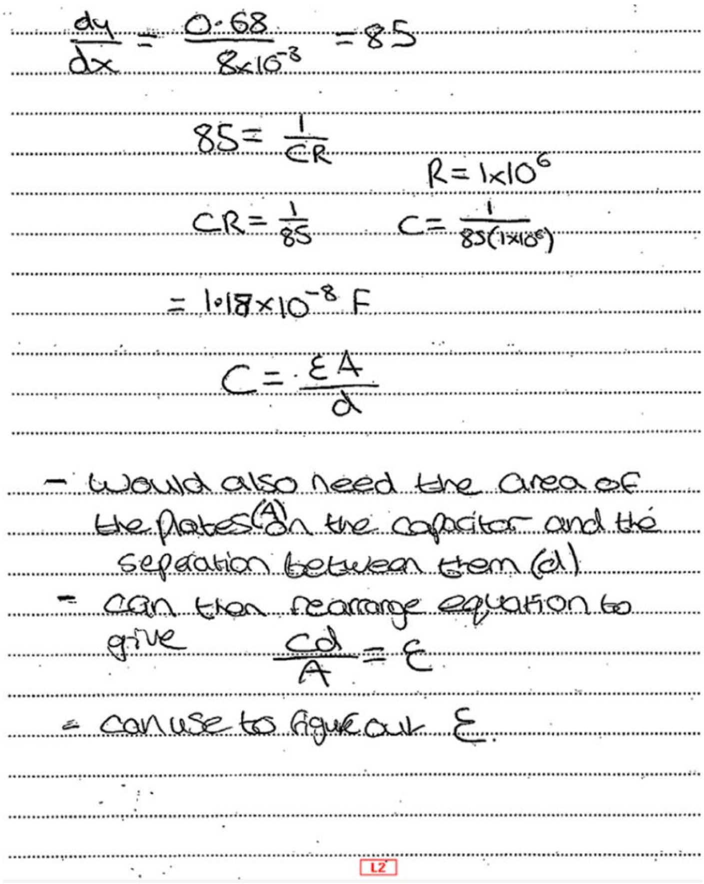
			direction **and** electrons are deposited on plate **B.**		
			(An equal number of) electrons are removed from plate **A** giving it a positive charge (of equal magnitude).	B1	
			Total	**2**	
17			Flemings left hand rule / the force on the electron is in the plane of the paper, right angles to the velocity and 'downwards'.	B1	
			Circular path within field in a clockwise direction.	B1	**Note**: If drawn on Fig. 22.1, then judge 'circular' path by eye.
			Total	**2**	
18			($V = V_0e^{-t/CR}$) $\ln(V/V_0) = -t/CR$ **or** $\ln V = \ln V_0 - t/CR$	**B1**	**Note** the minus sign is necessary **Examiner's Comments** This question was successfully tackled by the high-scoring candidates, many of whom effortlessly derived the correct expression $\ln V = \ln V_0 - t/CR$ and demonstrated clearly how the equation of a straight line made the gradient equal to $-1/CR$. The most common errors made by candidates were: • Using the wrong expression $V = V_0(1 - e^{-t/CR})$ • Writing the equation as $\ln(V/V_0) = -t/CR$ and comparing this with $y = mx$, with $y = \ln(V/V_0)$ and $x = t$. • Calculating the gradient of the line to be about -85; which proved to be helpful in the LoR question **22(b)**.
			$\ln V = \ln V_0 - t/CR$ **and** $y = mx + c$ / gradient = - 1/CR	**B1**	
			Total	**2**	
19			The charge on each plate remains the same.	B1	**Allow** other correct methods.
			$C = \varepsilon_0 A/d$, hence the capacitance is halved.	B1	
			$E = ½ Q^2/C$, $E \propto 1/C$ and hence energy stored doubles.	B1	

			Total	**3**	
20			Connect a voltmeter or data-logger or oscilloscope across the resistor (or capacitor) or an ammeter in series with the resistor.	B1	
			A stopwatch is started when the switch is opened and stopped when the p.d. or the current to decreases to 37% of its initial value.	B1	
			The time constant is the time taken for the p.d. or the current to decreases to 37% of its initial value.	B1	
			Total	**3**	
21	a		Line of best fit drawn through the data points Gradient = 38 ($Ck\ln2$ = gradient) $1.2 \times 10^{-3} \times k \times \ln2 = 38$ $k = 4.6 \times 10^4$ ($\Omega\ m^{-1}$)	B1 C1 C1 A1	Allow ± 2. Not calculated through use of a single point. Possible ECF from incorrect gradient **Note**: gradient of 40 gives 4.8×10^4 and gradient of 36 gives 4.3×10^4 **Examiner's Comments** This question is likely to be an unfamiliar scenario to many candidates and so required some careful reading. The first mark is for a single straight line of best fit; many candidates simply joined up the first and last point, which produced a line that did not produce an even distribution of points above and below. The gradient calculation was well done by most candidates, leading to a value within the tolerance. Although the given equation is likely to be unknown, most candidates were able to appreciate how to determine the value of *k* and did so successfully. Over half of the candidates were able to achieve full marks on this question.
	b		(CR =) $2000 \times 10^{-6} \times 120 \times 10^3$ $1.00 = 1.48 \times [1 - e^{-t/240}]$ **or** $0.48 = 1.48e^{-t/240}$ (t =) $- 240 \times \ln(0.48/1.48)$ t = 270 (s)	C1 C1 C1 A1	*CR* = 240 (s) Special case: 94 (s) for use of discharging equation. Max 2 marks **Examiner's Comments** This question comes from the learning outcome 6.1.3(c) in the use of an equation in a capacitor-resistor circuit. Candidates are required to determine the time at which a potential difference is met, which involves the use of logarithms. It was noted that many candidates were confident in their use of logarithms and were able to make some progress through their solution. Most candidates calculated the time constant correctly, taking into account the unit prefixes, and substituted this into an equation. However a large proportion used the discharging (rather than the charging) equation to calculate the time and some credit could be allowed for this. Less than one fifth of candidates scored all marks on this question.

					Misconception Many candidates seemed uncertain which equation to use, applying the simpler discharging equation. While the charging and discharging equations are given in the data booklet, it is not stated which is which, so candidates must make sure they know which to apply.
			Total	**8**	
22	a		$\varepsilon = 7.2 \times 10^{-12} \times 1.2 \times 10^{-3} / 4.0 \times 10^{-4}$ permittivity = 2.2×10^{-11} (F m^{-1})	C1 A1	**Allow** any subject **Allow** ε_o instead of ε **Note** answer to 3 sf is 2.16×10^{-11} (F m^{-1}) **Allow** 1 mark for bald 2.4; relative permittivity calculated **Examiner's Comment** Most candidates effortlessly used the equation $C = \varepsilon A / d$ to determine the permittivity *s* of the insulator between the capacitor plates. Once again, most answers were well-structured and showed good calculator skills. The most common errors were: • Taking the prefix pico (p) to be a factor of 10^{-9}. • Confusing permittivity ε and permittivity of free space ε_0. • Calculating relative permittivity (2.4).
	b	i	capacitance of two capacitors in series = 500 (πF) *C* = 1000 + 500 *C* = 1500 (μF)	C1 A1	**Examiner's Comment** The modal score here was two marks, with most scripts showing excellent understanding of capacitors in combination. Many candidates arrived at the final answer of 1500 μF without much calculation. A small number incorrect swapped the equations for series and parallel combinations and arrived at the incorrect answer of 670 μF.
		ii	$V = 1.5 \times e^{-12/15}$ *V* = 0.67 (V)	C1 A1	Possible ecf from **(i)** **Allow** 1 mark for 0.83 V, $V = 1.5[1 - e^{-12/15}]$ used **Examiner's Comment** Many candidates correctly calculated the time constant of the circuit and then either determined the p.d. across the capacitors (0.83 V) or the resistor (0.67 V) - the latter being the correct answer. The most common mistake was calculating e^{-12115} rather than $1.5 \times e^{-12/15}$. Weaker candidates got nowhere by attempting to use $V = IR$ and $Q = VC$.
			Total	**6**	

23			series capacitors: $C = (100^{-1} + 220^{-1})^{-1} = 68.75$ (μF)	C1	
			total capacitance = 500 + 68.75 = 568.75 (μF)	C1	
			$E = ½ \times 12^2 \times 568.75 \times 10^{-6}$	C1	
			$E = 4.1 \times 10^{-2}$ (J)	A1	
			Total	**4**	
24		i	*Qd* = constant At least **two** pairs of values substituted to show that *Qd* = constant	C1 A1	**Allow** straight-line graph of *Q* against 1/*d* passes through the origin **Allow** as *d* increases by a given factor (e.g. doubles) then *Q* decreases by the same factor (e.g. halves) **Allow** numbers that show when *d* doubles then *Q* halves **Ignore** prefixes and POT errors **Examiner's Comments** The question was not carefully examined by most candidates, because the reference to use **Fig. 22.2** was totally ignored. A significant number of candidates focused either on superfluous practical details or the proof of the relationship between *Q* and *d* – which was required in the next question. About a third of the candidates used at least two points on the graph to show that *Qd* = constant. The powers of ten were overlooked by examiners. A small number of candidates, mainly at the lower-end, calculated the gradient of the curve at arbitrary points to provide support for their incorrect reasoning.
		ii	$Q = VC$ **and** $C = \frac{\varepsilon_0 A}{d}$ Hence $Q = \frac{V\varepsilon_0 A}{d}$ (and $Q \propto \frac{1}{d}$)	C1 A1	**Allow** ε **Note** *Q*, or *Q/V* must be the subject here **Allow** $Q \propto C$ and $C \propto \frac{1}{d}$ **Examiner's Comments** Most candidates successfully, and elegantly, provided the proof for the relationship. Correct answers ranged from the whole space filled with algebra to a couple of succinct lines. A small number of candidates finished off their working by writing $Q = \frac{1}{d}$ instead $Q \propto \frac{1}{d}$ the 'equal' and the 'proportionality' symbols are not equivalent.
			Total	**4**	
25	a		Time constant of charging = 10 s	B1	**allow** alternative but equivalent statements
			maximum current = 10/100k = 100 μA	B1	**e.g.** current falls to 37 mA in 10 s

			statements about adequate sensitivity of meter and stopwatch	B1 B1	e.g. readings can be taken every 3 to 5 s so can collect at least 8 sets of values before approaching change of less than 2 μA; sensitivity of 0.5 s adequate
	b	i	1 the (total stored) charge is constant	B1	**max** 2 out of 3 marking points
		i	2 capacitors in parallel must come to the same voltage	B1	**allow** mathematical argument, e.g. initial Q = 1 mC final Q on each is 0.5 mC as identical Cs in parallel
		i	3 capacitors are identical so each stores half/same charge so final V is 5 V	A0	so $V = 0.5 \times 10^{-3} \times 1.0 \times 10^{-4} = 5.0$ V **or** total C × total Q gives 5 V
		ii	C_1 curve : exponential decay curve from 10 V to 5 V	B1	
		ii	C_2 curve: 10 − C_1 curve	B1	
		ii	time axis: curves to be horizontal at 5V about 25 s	B1	time constant of 5 s
			Total	**9**	
26			**Level 3 (5–6 marks)** Clear description **and** correct value of *C* *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear description **and** some correct working **OR** Some description **and** correct value for *C* *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Some description **OR** Some working *There is an attempt at a*	**B1 × 6**	**Indicative scientific points may include:** **Description** • $C = \varepsilon A/d$ • *A* = area (of overlap) and *d* = separation. • Use ruler to measure the side / radius / diameter (andhence the area *A*) • Ensure total overlap of plates. • Measure the thickness / *d* of paper using micrometer /(vernier) caliper. • Take several readings of thickness and determine anaverage value for *d* **Calculation of capacitance** • gradient ≈ 85 • $C \approx 1.2 \times 10^{-8}$ (F) **Examiner's Comments** This was the second of the two LoR questions in this paper. It required application of practical skills from module 1.1 (Development of practical skills), knowledge of parallel plate capacitor and permittivity. As with the other LoR question 17, examiners expect varied responses for the criteria for the three levels to be met. Unlike some of the analytical questions, there is no one perfect model answer for a specific question. For Level 3,

			logical structure with a line of reasoning. The information is in the most part relevant. **0 marks** No response or no response worthy of credit		correct value of the capacitance *C* was required together with a clear description of how to do the additional measurements that led to the determination of the permittivity of the paper. For Level 2, it was either clear description with some correct working or some description with the correct value for *C*. Level 1 required some description or some working. As expected, there were diverse answers which demonstrated adequate experimental and practical skills. The thickness of the paper was invariably measured using a micrometer, but some candidates decided to measure the total thickness of a large number of sheets using a ruler and then calculating the thickness of each sheet. This technique was as good as using a micrometer or using Vernier calipers. Diverse answers are the characteristic of LoR questions. The most common errors made were: • Confusing permittivity with either relative permittivity or the permittivity of free space ε_0. • Using $C = 4\pi\varepsilon R$ instead of $C = \varepsilon A/d$. • Issues with powers of ten when determining the gradient – mainly because of the milli prefix on the time axis. **Exemplar 10**  $\frac{dy}{dx} = \frac{0.68}{8\times10^{-3}} = 85$ $85 = \frac{1}{CR}$ $R = 1\times10^{6}$ $CR = \frac{1}{85}$ $C = \frac{1}{85(1\times10^{6})}$ $= 1.18\times10^{-8}$ F $C = \frac{\varepsilon A}{d}$ - Would also need the area of the plates (A) on the capacitor and the separation between them (d) - can then rearrange equation to give $\frac{Cd}{A} = \varepsilon$ - can use to figure out ε. L2 This exemplar illustrates a Level 2 performance from this top-end candidate. The analysis is perfect, but the description is basic and there are no details of the instruments needed to make the measurement. It would have taken a

					couple more lines to elevate this answer to Level 3. Compare and contrast this with the exemplar below for a Level 3 response. **Exemplar 11** $\lvert\Delta \ln(V)\rvert = 0.68$ $\lvert\Delta t\rvert = 8\times10^{-3}$ s $\lvert m\rvert = \frac{1}{CR} = \frac{0.68}{8\times10^{-3}}$ $= 85$ $85 = \frac{1}{C(10^6)}$ $C^{-1} = 8.5\times10^{7}$ $C = 1.176...\times10^{-8}$ F $= 12$ nF Via the equation $C = \frac{\varepsilon A}{d}$, to deduce ε, all the student must do is measure d (thickness of the paper) and A (Area of paper between aluminium plates) to give $\frac{Cd}{A} = \varepsilon$ To measure d, take 50 of the sheets of paper used and stack them ontop of eachother, using a micrometer screw gauge or a vernier caliper, measure this distance (ensuring not to crumple the paper) and divide by 50 for the d value. To calculate A, simply measure the width and height of both of the aluminium plates with a ruler (if small enough use a vernier caliper). Taking an average of height and width, multiply these together for the A value. Then $\varepsilon = \frac{Cd}{A}$ gives the permittivity of paper [6] 18 L3 Turn over This above is a typical Level 3 answer. Correct calculation and a description that has all the right ingredients. Notice how the appropriate measuring instruments are being used and how the uncertainty in the measurements is reduced.
			Total	**6**	
27		i	**1** A straight line of best-fit drawn passing through all error bars.	B1	
		i	**2** $V = V_0 e^{-t/CR}$, therefore $\frac{1}{2} = e^{-T/CR}$	M1	
		i	$\ln(0.5) = -T/CR$	M1	

		i	$T = -\ln(0.5)CR$	A0	
		i	**3** gradient = (−) ln(0.5)C	C1	
		i	gradient determined using a 'large triangle' and equal to (−) 7.7 × 10^{-4} (s Ω^{-1})	C1	**Allow** gradient in the range 7.5 to 8.0 × 10^{-4}
		i	C = gradient/ln(0.5) = (−) 7.7 × 10^{-4}/ln(0.5) C = 1.1 × 10^{-3} (F)	A1	Possible ECF from value of gradient
		ii	Draw a worst-fit straight line through the error bars.	M1	
		ii	Correct description of how to determine the % uncertainty in C.	A1	**Allow**: $\frac{\text{difference between worst and best - fit gradients}}{\text{value of best gradient from (i)3}} \times 100$
			Total	**8**	
2 8		i	Q = 9.0 x 10-3 x 2 x 80 = 1.44 (C) W = (Q^2/2C =) 1.44^2/2 x 0.12 W = 8.6(4) (J)	C1 C1 A1	**ECF** for incorrect Q e.g. 2/3 for use of Q = 0.72(C) giving W = 2.2(J) **Examiner's Comments** The strongest answers were those where candidates set out their response in steps; first calculating the total charge and then using a correct formula to calculate the total energy stored. Many candidates performed the steps of their calculation randomly across the answer space, making it hard to determine their method.
		ii	($W = Pt$ so 8.6 = 0.050t) t = 8.6/0.050 = 170 (s)	A1	**ECF (b)(i)** for incorrect W **Examiner's Comments** Almost all candidates gained the mark for 3(b)(ii), as any incorrect answer to 3(b)(i) was accepted with error carried forward (ECF).
			Total	**4**	