Marking Scheme

#1

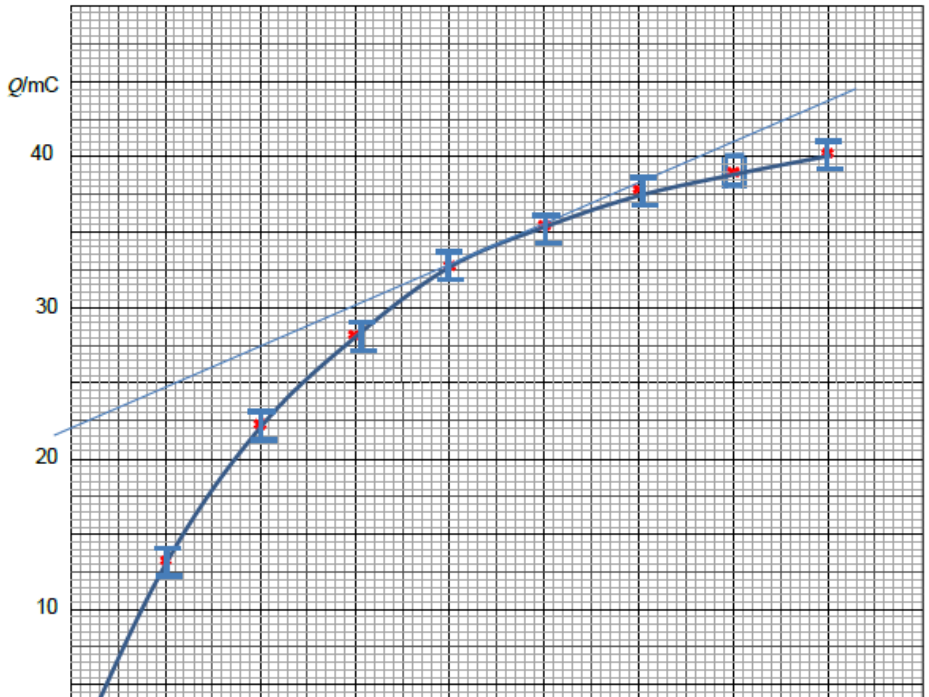
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)	Capacitor equation rearranged $\frac{Cd}{\varepsilon_0} = A$ (1) Area = x^2 used (1) Correct answer = 42.5 [cm] (1)	1	1 1		3	3	
		(ii)	Logical method employed e.g. eliminating 1, 2 etc.(can be implied by correct calculation for 4) (1) Evidence of a correct capacitor in series calculation (1) Evidence of a correct capacitor in parallel calculation (1) Number 4 chosen (1)			4	4	2	
		(iii)	Dielectric / increase the permittivity Accept a named dielectric	1			1		
		(iv)	Valid method e.g. $\frac{q^2}{2C} = U$ or 2 other valid equations (1) Accept use of 3 equations Rearrangement or algebra (1) Answer = 9.96×10^{-8} [C] (accept 1×10^{-7} C) (1)	1	1 1		3	3	
	(b)	(i)	RC used as the time constant (1) Answer = 1.94 M[Ω] (1)	1	1		2	2	
		(ii)	2 time constants interpreted or substitution into: $q = q_0 e^{-t/CR}$ (1) 0.37^2 or rearrangement of equation **ecf** (1) Answer = 0.135 or 13.5% or $\frac{27}{200}$ (1)		3		3	3	
	(c)	(i)	Correct shape (starting from 0,0 increasing with decreasing gradient (1) 50-75% charged at 15.5 ms or 8-15 ms half-life (1)	1	1		2	2	2
		(ii)	Correct shape (starting from I_0, 0 decreasing and decreasing negative gradient) (1) 50-75% discharged at 15.5 ms or 8-15 ms half-life (1)	1	1		2	2	2
			Question total	**6**	**10**	**4**	**20**	**17**	**4**

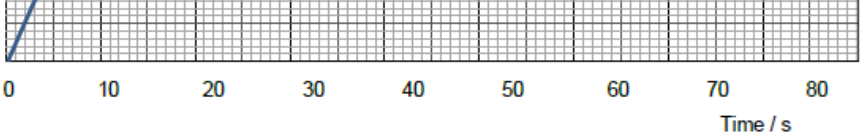
#2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)	Capacitor equation rearranged $d = \frac{\varepsilon_0 A}{C}$ (1) Substitution of values (1) Correct answer 1.43×10^{-4} m (0.143 mm) (1) [Accept 1.4×10^{-4} m, not 1×10^{-4}]	1	1 1		3	3	
		(ii)	Adding capacitors in parallel (4 nF) (1) Understanding of 6 nF in series with 4 nF i.e. correct application of physics (1) [even failure to invert to get answer, so 1/4 + 1/6 → 2 marks] Correct answer 2.4 n[F] or 12/5 n[F] (1) c.a.o.	1	1 1		3	2	
		(iii)	Any valid CV e.g. 2×9, 6×6, 2.4×15 (1) [Accept 2.4×15 or $\frac{1}{2} \times 2.4 \times 15$; **not** 1.2×15 or 2.4×7.5] ½-way explanation: charge split / divided between 2 nFs / 9 V across 2 nF / 6 V across 6 nF (1) Completed explanation: all charge on capacitors in series / justify 9 V or 6V [e.g. $V \propto 1/C$]	1	1 1		3	2	
		(iv)	Correct substitution (into valid equation) e.g. $0.5\ QV$ etc. (1) Correct answer (270 nJ or 2.7×10^{-7} J) (1)	1	1		2	2	
	(b)	(i)	Capacitor in series with resistor and cell/battery/psu (1) Properly placed ammeter and voltmeter (1)	2			2		2
		(ii)	Emf = 12 V stated [accept V_{max}] (1) Initial current = 2.7 mA (1) $R = \frac{V}{I} = 4444\ \Omega$ (1) [4.4 kΩ] [N.B. With incompatible V and I, 2nd and 3rd marks not accessible] RC ~ 8 s from 37% I_{max} value or 63% V_{max} value or intercept of gradient at the origin with $I = 0$ (or $V = 12$ V) OR taking logs and rearranging OR obtaining Q from total area under current graph around 2.0×10^{-2} C (1) $C = \frac{8.0}{4400} = 1.8$ [± 0.3] mF (1) [No ecf] **Unit** penalty (–1): all 3 units [V, Ω, F] needed **Alternative** Emf = 12 V (1) Find $\frac{dV}{dt}$ **and** I at given t, e.g. at 10 s, 0.411 V s^{-1}, 7.5 mA (1) Hence calculate C from $I = C\frac{dV}{dt} \rightarrow$ 1.8 mF ecf (1) RC ~ 8 s from 37% I_{max} value or 63% V_{max} value or intercept of gradient at $t = 0$ with $I = 0$ (or $V = 12$ V) (1) R from C and $RC \rightarrow$ 4.4 kΩ (1) **Unit** penalty (–1): all 3 units [V, Ω, F] needed		5		5	5	5
			Question 1 total	**6**	**12**	**0**	**18**	**14**	**7**

#3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)	Use of $C = \frac{\varepsilon_0 A}{d}$ [73.6 pF] [1]	1					
			Use of $E = \frac{1}{2}CV^2$ or combination of $E = \frac{1}{2}QV$ and $Q = CV$ [1]	1					
			Rearrangement $\left(\frac{2Ed}{\varepsilon_0 A}\right)$ OR substitution in both equations [1]		1				
			Correct answer = 833 [V] [1]		1		4	3	
		(ii)	[Pd supplies/leads to] charges on plates (1) accept electric field set-up [This set-up] can do work / [electrostatic] PE stored / energy stored in field (1) accept can provide current after pd removed	2			2		
		(iii)	Any 3 (× 1) valid points e.g. • Repeat experiment / more tests / repeatability • Repeats by other research groups / industry / reproducibility • Tests for safety [of dielectric] • Tests for lifetime [of dielectric] • Cost effectiveness / availability • Environmental impact • Check for charge leakage			3	3		
	(b)	(i)	2.2 mF × 0.5 V seen or clear % usage shown		1		1		1
		(ii)	28.2 (1) 37.6 (1)		2		2		2
		(iii)	Numbers on y-axis i.e. 10, 20, 30, 40 (1) Both points plotted correctly ecf < small square (1) y-error bars correct < small square (1) Good curve of best fit ecf (2) If flawed but valid attempt at best fit e.g. hairy line, not smooth, missing one of the bars award 1 mark only		5		5		5
		(iv)	Obtaining Q_0 = 19.1 × 2.2 mF = 42 ± 2 m[C] (1) Using 63 % of fully charged OR substituting values into $Q = Q_0\left(1 - e^{-\frac{t}{RC}}\right)$ OR taking logs correctly (1) T or RC = 27 ± 2 [s] (no marks for 26.4 s) OR Q value correct after substituting (1)		3		3	3	3
		(v)	Good tangent drawn at 45 s ecf (1) Gradient = 0.27 m[A] ecf (1)		2		2		2
	(c)		**Any 5 × (1) from:** - Shape of graph is good - Line of best fit goes through error bar(s) - RC = 26.4 s - RC in good agreement with 27 s (ecf available) - $I_0 = \frac{19.1}{12\,000} = 1.59$ m[A] - Gradient of graph decreases / gradient is the current - So current equation is in good agreement – only award mark if current decreasing implied - Substitution into either equation for confirmation			5	5	2	5
			Question 1 total	**4**	**15**	**8**	**27**	**8**	**18**




0
10
20
30
40
50
60
70
80
Time / s