

Question Number	Answer	Mark
16(a)	<p>When charging voltmeter is not across C, Or When switch at X, voltmeter is not across C, (1)</p> <p>When discharging the resistor isn't in the circuit, Or with switch at Y, the resistor isn't in the circuit (1)</p>	2
16(b)(i)	<p>Either</p> <p>Takes corresponding pairs values of V and t from graph (1) Use of $\ln V = \ln V_0 - t/RC$ Or Use of $V = V_0 e^{-\frac{t}{RC}}$ (1) $R = 1.1 \times 10^7 \Omega$ (1)</p> <p>Or</p> <p>Draws initial tangent to curve and determines t intercept (range 22 s - 26 s) (1) Use of $T = RC$ (1) $R = 1.1 \times 10^7 \Omega$ (1)</p> <p>Or (1) Read value of t at which $V = V_0 / e$ (2.3 V at 24 s) (1) Use of $T = RC$ (1) $R = 1.1 \times 10^7 \Omega$</p> <p><u>Example of calculation</u> eg $V = 4.1$ V and $t = 10$ s</p> $\ln 4.1 = \ln 6.2 - \frac{10\text{s}}{R \times 2.2 \times 10^{-6} \text{ F}}$ <p>$R = 1.1 \times 10^7 \Omega$</p>	3
16(b)(ii)	<p>Use of $Q = CV$ (1) Subtract charge at 30 s from charge at 0 s (1) Use of $I = Q/t$ (1) $I = 3.2 \times 10^{-7} \text{ A}$ (1)</p> <p><u>Example of calculation</u> $Q = 2.2 \times 10^{-6} \text{ F} \times 6.2 \text{ V} = 1.36 \times 10^{-5} \text{ C}$ $Q = 2.2 \times 10^{-6} \text{ F} \times 1.8 \text{ V} = 3.96 \times 10^{-6} \text{ C}$ $1.36 \times 10^{-5} \text{ C} - 3.96 \times 10^{-6} \text{ C} = 9.64 \times 10^{-6} \text{ C}$ $I = 9.64 \times 10^{-6} \text{ C} \div 30 \text{ s}$ $I = 3.2 \times 10^{-7} \text{ A}$</p>	4
16(b)(iii)	<p>Use of $W = \frac{1}{2} CV^2$ (1) Subtract energy at 30 s from energy at 0 s (1) Energy dissipated = $3.9 \times 10^{-5} \text{ J}$ (1)</p> <p><u>Example of calculation</u> $W = \frac{1}{2} \times 2.2 \times 10^{-6} \text{ F} \times (6.2 \text{ V})^2 = 4.23 \times 10^{-5} \text{ J}$ $W = \frac{1}{2} \times 2.2 \times 10^{-6} \text{ F} \times (1.8 \text{ V})^2 = 3.56 \times 10^{-6} \text{ J}$ $4.23 \times 10^{-5} \text{ J} - 3.56 \times 10^{-6} \text{ J} = 3.87 \times 10^{-5} \text{ J}$ Energy dissipated = $3.9 \times 10^{-5} \text{ J}$</p>	3
Total for question 16		12