Assessment Schedule

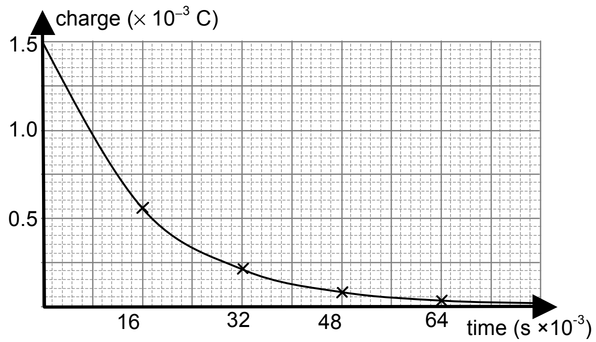
Physics: Demonstrate understanding of electrical systems (91526)

Evidence Statement

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding requires writing statements that typically show an awareness of how simple facets of phenomena, concepts or principles relate to a described situation. For mathematical solutions, relevant concepts will be transparent, methods will be straightforward.	*Demonstrate in-depth understanding* requires writing statements that will typically give reasons why phenomena, concepts or principles relate to given situations. For mathematical solutions the information may not be directly usable or immediately obvious.	*Demonstrate comprehensive understanding* requires writing statements that will typically give reasons why phenomena, concepts or principles relate to given situations. Statements will demonstrate understanding of connections between concepts.

Evidence Statement

NØ = No response; no relevant evidence.

Q1	Not Achieved	Achievement	Achievement with Merit	Excellence
(a)	$Q = VC = 12 \times 125 \times 10^{-6} = 1.5 \times 10^{-3}$ C	• Correct answer 1.5×10^{-3} C OR 0.0015 C.		
(b)	Resistance is very small, so current is very large. Resistance is small and the capacitance is also very small./ Time constant is very small 5τ is small.	• Correct explanation.	Some indication to tell that 5τ is small.	
(c)		Exponential decay (approx) ignore time axis labels + one of the following: • decay starts from the value 1.5×10^{-3}C. • The line shows 63% drop correctly. • Time constant = 0.016s calculated.	• Achievement plus at least 2 other plots shown from 0.555, 0.2, 0.08, 0.03. • Time axis should have correct values	

(d)	The lamp will be at or above its normal brightness if the voltage across it is at, or above, the voltage of the lamp. When $V = 9.0$ V, $Q = 9.0 \times 125 \times 10^{-6} = 1.125 \times 10^{-3}$ C Reading from the graph: when $Q = 1.125 \times 10^{-3}$ C $t = 16 \times 10^{-3} \times \frac{3.5}{10} = 0.0056$ s	• Correct charge calculated **1.125×10^{-3} C** OR • Correct time scale used for part (c)	TWO of: • Correct charge and • Correct time scale used for part (c) • If the time axis is incorrect, but time is consequently calculated correctly.	Correct Time Accept .0030 – .0064 s OR If the only error is the incorrect time constant used for *x*-axis scale, but time is consequently calculated correctly Accept range 0.00004 – 0.00009 s.
(e)	$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2} \Rightarrow C_{tot} = \frac{125 \times 10^{-6}}{2}$ $= 62.5 \times 10^{-6} = 63\ \mu$F	• Correct answer. • Working must be shown.		
/mj(f)	The time constant is reduced because the capacitance of the circuit is less ($\tau = RC$). Less charge is stored on the plates of each capacitor ($Q = CV$). Less charge can flow off the plates of the capacitors more quickly.	• $\tau = RC$ so lower τ because lower C.		

Q1	N1	N2	A3	A4	M5	M6	E7	E8

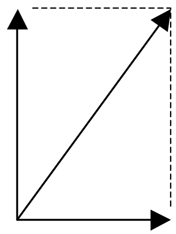
Q2	Not Achieved	Achievement	Achievement with Merit	Excellence
(a)	$E = \frac{1}{2}LI^2 = 0.5 \times 0.510 \times 1.70^2 = 0.73695 = 0.737$ J	• Correct answer **0.737 (J)**.		
(b)	$V = Ir \Rightarrow r = \frac{120}{1.70} = 70.588 = 70.6\ \Omega$ (*r* ishe internal resistance of the inductor). The maximum current is inversely proportional to *r*.	• Correct value **70.6 Ω.** Correct explanation.		
(c)	• When the switch is closed the current starts to increase from zero, and so there is **increasing flux** in the coil. • The **emf induced** by the changing flux will **oppose** the changing current making it take longer to build up to its maximum value.	• ONE correct statement. OR • Greater the inductance, the longer the time for the current to reach the max value. (T is directly proportional to L ($\tau = \frac{L}{R}$),	• Both correct statements.	
(d)	Nothing because the gap AB is effectively on open switch so nothing changes.	• Nothing.	• Nothing. • Because the gap acts as an open switch / circuit. Do not accept being in parallel as a reason.	

(e)	When switch 1 is opened. the current in the circuit will drop to zero and while it is changing a voltage is induced in the inductor. Because there is no longer a battery in the circuit, the induced voltage is no longer limited by the voltage of the battery so the rate of change of current, and hence induced voltage, depends on the time constant of the circuit. As the gap is effectively a huge resistance the time constant is very small so the rate of change of current and hence induced voltage is very high – high enough to produce a spark.	• Recognition that the **battery is no longer limiting** the size of the induced voltage. OR • Large induced voltage across inductor linked to **change in current** when switch 1 is opened. OR • Current dies very **quickly .** OR • Energy stored in the inductor is released.	• **Large induced voltage** across inductor linked to **rapid change in current** when switch 1 is opened. AND • Due to very short time (constant). OR • The Kirchoff's law does not apply due to swtich being open. OR • The Induced voltage can exceed the battery voltage due to the open switch.	• Explanation shows complete understanding that opening the switch will produce a very high induced voltage because the rate of change of current will be very high. • because the time constant will be very small. • because the resistance will be very big.

Q2	N1	N2	A3	A4	M5	M6	E7	E8
	ONE point	**TWO point**	**THREE points**	**FOUR points**	**1m + 3a**	**2m + 2a**	**1e + 1m + 2a**	**1e + 2m + 1a**

93 Ω

θ 55Ω

Q3	Not Achieved	Achievement	Achievement with Merit	Excellence
(a)	$X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 450 \times 15.0 \times 10^{-6}}$ $= 23.58 = 24\ \Omega$	• Correct answer.		
(b)	The current is in phase with the resistance and the supply voltage is in phase with the impedance.  $\theta = \cos^{-1}\frac{55}{93} = 53.74$ Current lags the supply voltage by 54° or 0.94 rad.	• Recognition that voltage phase difference is the same as impedance phase difference. OR • θ is labelled correctly in the diagram	• Correct answer. 54° or 0.89 rad	
(c)	$X_{tot} = X_L - X_C$ $Z^2 = X_{tot}^2 + R^2 \Rightarrow X_{tot} = \sqrt{Z^2 - R^2}$ $\Rightarrow X_{tot} = \sqrt{93^2 - 55^2} = 74.99\ \Omega$ $\Rightarrow X_L = 74.99 + 23.58 = 98.57 = 99\ \Omega$	• Correct X_{tot}. 75Ω OR • If the value of XL is substituted as 98.6 and then te Z is calculated as 93 Ω.	Correct answer 99 Ω.	
(d)	To bring the circuit to resonance, the frequency must be changed to make the two reactances equal in value. X_L is directly proportional to f and X_C is inversely proportional to f so changing the frequency will increase one but decrease the other. $X_L > X_C$ and so to decrease X_L and increase X_C, frequency must be **decreased**.	• Recognition that the frequency has to be **decreased** to make the $X_c = X_L$. OR • Recognition that the frequency has to be **decreased**, as by decreasing f, the X_L decreases and X_C increases.	Achievement + • By decreasing f, the X_L decreases and X_C increases.	

(e)	$220 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{L \times 15.0 \times 10^{-6}}}$ $L = 0.0350$ H		• Correct answer. 0.0350H.					
(f)	When the circuit is in resonance, the current is greatest because the reactance is zero and so the impedance is smallest. When the current is greatest the sound from the speaker is loudest. The current decreases rapidly either side of resonance because the reactance increases either side of resonance. So if the frequency is reduced quickly through the resonant frequency and down below it, there will be a brief surge of current and so a brief burst of sound.		• Recognition that the max sound happens at resonance. OR • Recognition that the frequency must be changed down through the resonant frequency. OR • Current-frequency diagram.		• Achievement. AND • Maximum current at resonance explained.		• Full explanation linking greatest sound to maximum current and zero reactance / impedance = *R* at resonance Rapid decline in current either side of resonance requires bringing the frequency quickly through the resonant frequency.	
Q3	**N1**	**N2**	**A3**	**A4**	**M5**	**M6**	**E7**	**E8**
	ONE point	**TWO points**	**THREE points**	**FOUR points**	**1m + 3a**	**2m + 2a**	**1e + 1m + 2a**	**1e + 2m + 1a**

Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 6	7 – 13	14 – 18	19 – 24