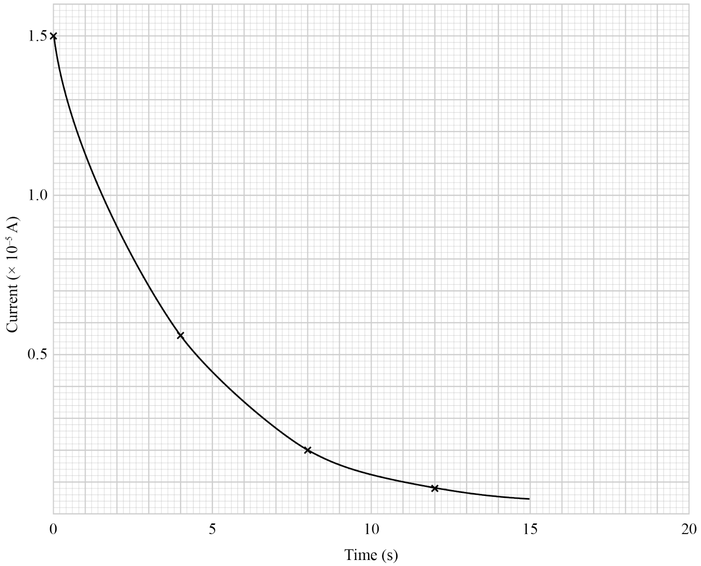
Assessment Schedule – 2017

Physics: Demonstrate understanding of electrical systems (91526)

Evidence Statement

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No evidence	1 a	2 a or 1 m	3 a	4 a or 2 a + 1m	1a + 2m	2a + 2 m	2 m + e	1a + 2m + 1e

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	The time constant is the time taken for the value of the current or voltage to change by 63%. OR It is also the time it would have taken had the rate of change stayed the same as at the start.	Correct explanation.		
(b)(i) (ii)	$E_p = \frac{1}{2}CV^2 \Rightarrow \frac{1}{2} \times 5.00 \times 10^{-6} \times 12.0^2 = 3.60 \times 10^{-4}$ J OR $E = \frac{7.2 \times 10^{-4}}{2}$ Only half the energy supplied by the cell is stored in the capacitor. The rest of the energy is changed to heat due to resistance.	Correct energy for either capacitor. OR Correct reasoning why less energy is stored in the capacitor.	Both energy correct AND explanation for difference.	

(c)(i)	$\tau = RC \Rightarrow 8.00\times10^{5}\times5.00\times10^{-6} \Rightarrow 4.00\ \text{s}$ $I_{\text{max}} = \dfrac{V}{R} = \dfrac{12.0}{8.00\times10^{5}} = 1.5\times10^{-5}\ \text{A}$ after one time constant, $I = I_{\text{max}} \times 0.37 = 0.56 \times 10^{-5}$ A 	• $\tau = 4.00$ s • $I = 0.56$ A • Graph correct shape starting at 1.5 A • V_c increases • Potential difference between cap and battery decreases • V_c opposes source voltage • Repulsion of charges • I decreases	• Correct time constant and correct shape of graph. • Indication that the rate of flow of charge is a maximum at the start of the charging process and that current falls to zero once the capacitor is fully charged.	Full explanation with links and reasoning and correct graph including correct time constant and two non-zero values on each axes. If graph touches zero, not extended to 15 s or curves up.
(ii)	Graph is a decay curve. The graph is a decay curve because as the capacitor begins to get charged, the current is a maximum at the start when the rate of flow of charge is a maximum. As more charges accumulate on the capacitor plates, the voltage across the capacitor increases, opposing the source voltage. It becomes harder for charges to accumulate on the plates, so the current decreases.			
(d)	The second capacitor is added parallel. This increases the capacitance $\tau = RC$, so the time constant increases. This causes the capacitor to charge up more slowly. OR Time taken to charge up increases.	Capacitance increases when another capacitor is added in parallel. OR Time constant increases, so charging time increases.	Correct explanation linking ideas.	

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	The voltage across the inductor will be zero once the current has reached a steady value.	Correct answer.		
(b)	When there is an inductor in a DC circuit, it takes a while for the current to reach the maximum because when the switch is switched on, the changing current results in changing flux. The changing flux creates an induced voltage across the inductor that opposes the source voltage and prevents the current from increasing rapidly.	One aspect correct.	Correct answer including reasoning and links.	
(c)	From the tangent line: $\frac{\Delta I}{\Delta t} = \frac{6}{0.10} = 60 \text{ A s}^{-1}$ $\varepsilon = L\frac{\Delta I}{\Delta t}$ $12 = L \times 60$ $L = \frac{12}{60} = 0.2 \text{ H}$	Correct rate of change of current. OR Correct use of EMF equation, but incorrect rate of change of current.	Correct answer with working.	
(d)	When the switch opens, the current in the first coil (primary) drops to zero very quickly. This causes a very rapid flux change in the primary. This flux change passes through the second coil (secondary). The rapid flux change causes a large induced EMF in the secondary. Because of the turns ratio, the secondary voltage is much greater than the primary voltage. This large secondary voltage is enough to cause a spark.	• The current in the first coil (primary) drops to zero very quickly. • This causes a very rapid flux change in the primary. • This flux change passes through the second coil (secondary). • The rapid flux change causes a large induced EMF in the secondary. • Because of the turns ratio, the secondary voltage is much greater than the primary voltage.	Describes effect of opening switch affecting flux. AND Explains how this produces secondary voltage. (Voltage proportional to rate of change of current.)	Merit plus • Large number of turns on secondary magnifies the voltage Large R results in small τ, so rate of change of current large therefore large voltage

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	$V_{max} = \sqrt{2}V_{rms} = \sqrt{2} \times 12.0 = 17.0$ V (or 17 V)	Correct answer.		
(b)	$Z = \sqrt{50^2 + 23.5^2} = 55.2\ \Omega$ $I = \frac{12.0}{55.2} = 0.217$ A (or 0.22 A)	One correct answer.	Both correct answers.	
(c)	The capacitance will increase because the dielectric constant will increase. Hence the reactance of the capacitor will decrease. $X_c = \frac{1}{2\pi fC}$. Hence the circuit current will increase.	Effect on capacitance or reactance of the circuit.	Links to the effect on circuit current.	
(d)(i) (ii)	$f = \frac{1}{2\pi\sqrt{LC}}$ $X_L = 2\pi fL \Rightarrow L = \frac{X_L}{2\pi f} \Rightarrow L = \frac{35.7}{2\pi \times 150} = 0.03762$ H $X_C = \frac{1}{2\pi fC} \Rightarrow C = \frac{1}{2\pi \times 150 \times 23.5} \Rightarrow C = 4.485 \times 10^{-5}$ F $f = \frac{1}{2\pi\sqrt{0.03787 \times 4.515 \times 10^{-5}}} \Rightarrow f = 122$ Hz At resonance, the reactance of the inductor is equal to the reactance of the capacitor and they are of opposite phase, cancelling each other. Hence the impedance of the circuit is a minimum and is equal to the resistance of the resistor. Hence the size of the circuit current at resonance is a maximum as current is inversely proportional to resistance.	• $L = 0.0376$ H • $C = 4.485 \times 10^{-5}$ F • X_c & X_L cancel out • Z is minimum • $Z = R$	• $f = 122$ Hz • Correct explanation	Correct answer for calculation and explanation.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 14	15 – 18	19 – 24