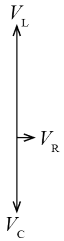
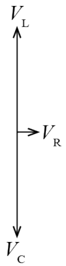
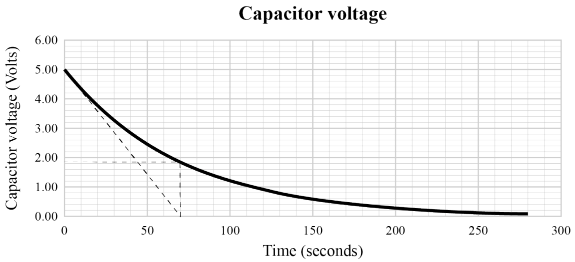
Assessment Schedule – 2015 Physics: Demonstrate understanding of electrical systems (91526)

Evidence

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	$\omega = 2\pi f$ $\omega = 2\pi \times 50 = 314$	• $\omega = 314\ \text{s}^{-1}$		
(b)	$X_L = \omega L = 2\pi f L$ $X_L = 2\pi \times 50 \times 0.150 = 47.1\ \Omega$	• Correct workings shown. **(SHOW THAT Q)**		
(c)	$V_L = IX_L = 0.656 \times 47.1 = 30.9$ V $V_R = IR = 0.656 \times 10.0 = 6.56$ V 	• Calculates values for V_L and V_R. OR • Draws phasors to represent V_C and V_L and V_R with correct phase shift.	• Calculates values for V_L and V_R. AND Draws phasors to represent V_C and V_L and V_R with correct phase shift.	• Calculates values for V_L and V_R. AND Draws phasors to represent V_C and V_L and V_R with correct phase shift and **correct sizes.**
(d)	In an AC circuit, V_L and V_C are 180° out of phase.  At resonance, $X_L = X_C$ so $X_L - X_C = 0$ $Z = R$ so $I = \frac{V}{R} = \frac{12}{10} = 1.20$ A	• V_L and V_C are 180° out of phase. • $X_L = X_C$ • $V_L = V_C$ • $I = 1.20$ A (no explanation)	• The impedance of the inductor and the capacitor cancel out, due to the opposite phase of the capacitor and the inductor therefore $Z = R$. OR • $X_L = X_C$, $Z = R$ OR • Excellence answer but no explanation that Z is minimum	Explains why the impedance of the circuit is a minimum ie it equals the resistance of the circuit at resonance, describing the equal reactance but opposite phase of the inductance and the capacitance so $I = \frac{V}{R} = \frac{12}{10} = 1.20$ A

Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	A	2 A	3 A 1 M	4 A 1 M & 1 A	1 M & 2 A 1 E	2 M 1 E & 3 A	E & M	2 E

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO (a)	Calculate voltage across cell 9.00 – 6.40 = 2.60 V Uses this to show that $\frac{2.60}{0.208} = 12.5\ \Omega$ OR $r = R_T - R_C$	• $V_r = 2.60$ V • $r = R_T - R_C$	• $r = 12.5\ \Omega$ **(Must clearly indicate how 2.6 is derived)** **(SHOW THAT Q)**	
(b)	$C = \frac{\varepsilon_0 \varepsilon_R A}{d}$ $A = \frac{Cd}{\varepsilon_0 \varepsilon_R}$ $A = \frac{2.75 \times 10^{-9} \times 2.26 \times 10^{-4}}{8.85 \times 10^{-12} \times 1}$ $A = 7.02 \times 10^{-2}\ \text{m}^2$	• A = 7.02×10^{-2} m^2		
(c)	 63% change interpolated on graph as 65 – 75 by either method. $\tau = RC$ so $R = \frac{\tau}{C} = \frac{68}{15} = 4.50\ \Omega$ $I = \frac{V}{R} = \frac{5.00}{4.50} = 1.11$ A	• Correct method used to estimate time constant. • Shows some understanding of a decrease in *V* leading to extrapolating Time constant. • Correct method used leading to incorrect *I* (used 33/37 or 63/67%)	• Correct method used to estimate time constant. AND Time constant used to calculate *R*. **(SHOW THAT Q)**	• Correct method used to estimate time constant. AND Time constant used to calculate *R*. AND Initial current calculated from τ and *R*.

(d)	$E = \frac{1}{2}CV^2 = \frac{1}{2} \times 400 \times 5.00^2 = 5000$ J This is about 1% of the 6×10^5 J of energy required. $\tau = RC = 4.5 \times 400 = 1800$ s The time to fully discharge, 5 time constants is 9000 s. The capacitor will take a long time (2.5 hours) to discharge and does not rapidly discharge.	• $E = \frac{1}{2}CV^2 = \frac{1}{2} \times 400 \times 5^2$ $= 5000$ J • $\tau = RC = 4.5 \times 400 = 1800$ s • Discharge will occur in 4 – 5 time constants.	No it won't charge because: • $E = \frac{1}{2}CV^2 = \frac{1}{2} \times 400 \times 5^2 =$ 5000 J. This is less than the energy required. **OR** • $\tau = RC = 4.5 \times 400 = 1800$ s The capacitor will take about 9000 s to discharge (5 time constants is 9000 s). This is too long.	No it won't charge because: • $E = 6 \times 10^5$, $Q = 2.6 \times 10^5$, so $C = 4800$ F, this is much larger than 400 F AND $\tau = RC = 4.5 \times 400 = 1800$ s The capacitor will take about 9000 s to discharge (5 time constants is 9000 s or reference to fact that its 63% discharged). This is too long. **OR** • $E = \frac{1}{2}CV^2 = \frac{1}{2} \times 400 \times 5^2$ $= 5000$ J. This is less than the energy required. AND $\tau = RC = 4.5 \times 400 = 1800$ s The capacitor will take about 9000 s to discharge (5 time constants is 9000 s or reference to fact that its 63% discharged). This is too long.

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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	A	2 A 1 M	3 A 1 M & 1 A	4 A 1 M & 2 A 2 M	2 M & 1A 1 E	3 M 1 E & 3 A	E & M	2 E

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE (a)	Inductors store energy as magnetic fields.	• Magnetic fields.		
(b)	$V_R = IR = 0.26 \times 12.5 = 3.25\ V$ $V_L = V_S - V_R = 9.00 - 3.25 = 5.75\ V$ $V_L = -L\dfrac{dI}{dt}$ So $\dfrac{dI}{dt} = \dfrac{V_L}{L} = \dfrac{5.75}{10 \times 10^{-3}} = 575\ \text{A s}^{-1}$	• V_R calculated. AND V_L calculated.	• V_R calculated. V_L calculated. $\dfrac{dI}{dt}$ calculated.	
(c)	When the switch is closed, the change in current, $\dfrac{dI}{dt}$, is very great so the reactive inductor opposes the change in current (producing a back emf), so most of the current goes through the bulb (as these two components are in parallel). As $\dfrac{dI}{dt}$ becomes smaller, the opposition of the inductor (its effective resistance) becomes smaller so more current flows through the inductor and less through the bulb.	• Explains why initially little current flows through the inductor. • Inductor produces a back emf / induced voltage • Less current in bulb, less Power	• Explains why initially little current flows through the inductor AND Explains why finally most of the current flows through the inductor and not the resistor.	• Explains why there is a change in I AND Less current in bulb, less Power

(d)	A changing (alternating) current inducing a changing (fluctuating) magnetic field around the coil of wire. The size of the field is determined by the frequency of the alternating current. Changing / fluctuating magnetic fields cause currents to flow in the bicycle wheels. By Lenz's law, a current creates a magnetic field that opposes the magnetic field that created it – the higher the frequency, the greater the eddy currents. The induced magnetic field always opposes or reduces the field that created it.	• Alternating currents have fluctuating magnetic fields/flux. • Changing flux will induce a voltage • Opposite direction due to Lenz's Law. • High frequency results in large induced voltage / (rate of) change in current.	• Changing flux results in an induced voltage / current / field (Faraday's Law). AND It will be large because rate of flux change is large due to high frequency. OR • Changing flux results in an induced voltage / current / field (Faraday's Law). AND It is in opposite direction to oppose change/ the current (Lenz's Law).	Changing flux results in an induced voltage / current / field (Faraday's Law). AND It will be large because rate of flux change is large due to high frequency. AND It is in opposite direction to oppose change / the current (Lenz's Law).

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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	A	2 A 1 M	3 A 1 M & 1 A	4 A 1 M & 2 A 2M	2 M & 1 A 1 E	3 M 1 E & 3 A	E & M	2 E

Cut Scores

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