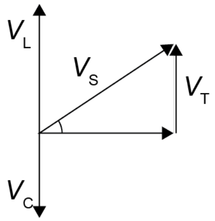
Assessment Schedule – 2021

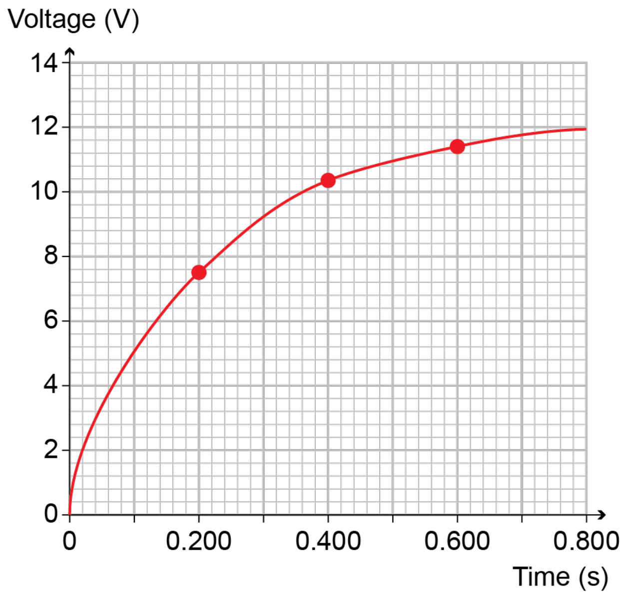
Physics: Demonstrate understanding of electrical systems (91526)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	When current is maximum. OR When inductor reactance is equal to capacitor reactance. OR Impedance is a minimum.	• ONE of: - $X_L = X_C$ - $V_L = V_C$ - $V_S = V_R$ - $Z = R$ - Z minimum - I maximum		
(b)	At resonance, $X_L = X_C$ $X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 210 \times 1.00 \times 10^{-4}} = 7.58\ \Omega$ $7.58 = 2\pi fL$ $L = \frac{7.58}{2\pi \times 210} = 5.74 \times 10^{-3}$ H	• Show calculation of reactance of capacitor. OR Calculated inductance of inductor without calculating reactance of capacitor.	• Correct value of inductance after showing value of capacitor reactance.	
(c)(i) (ii)	Inserting the iron rods into the core, increases the inductance of the inductor. So, the reactance of the inductor will increase as inductance is directly proportional to reactance. The reactance of the capacitor remains the same. Hence the circuit will no longer be at resonance since X_L is no longer equal to X_C. Since the impedance depends on the vector sum on X_L and X_C, the circuit impedance will increase ($Z = \frac{V}{I}$). Hence, current will decrease, causing the lamp to glow less brightly.	• ONE correct idea or statement: Inductance increases. - Circuit will no longer be at resonance. - Impedance will increase. - Lamp will no longer be at maximum brightness.	• TWO correct statements with reasoning: - Inductance increases, hence reactance of inductor increases, as inductance is directly proportional to reactance. - Hence ,the circuit will no longer be at resonance, since X_L is no longer equal to X_C. - Since the impedance depends on the vector sum on X_L and X_C, the circuit, impedance will increase ($Z = \frac{V}{I}$), causing current to decrease and lamp to glow less brightly.	• Inductance increases, hence reactance of inductor increases, as inductance is directly proportional to reactance. AND Reactance of capacitor remains the same (or the frequency has not changed). AND Hence, the circuit will no longer be at resonance, since X_L is no longer equal to X_C. AND Since the impedance depends on the vector sum on X_L and X_C, the circuit impedance will increase ($Z = \frac{V}{I}$), causing current to decrease and lamp to glow less brightly.

(d)	 $V_T = 12.0\sin 17.0 = 3.51\text{ V}$ Supply voltage leads circuit current.	• Correct vector diagram with V_S leading current or voltage across resistor and V_L greater than VC. • Evident in diagram or statement that supply voltage leads circuit current. • 3.51V.	• 3.51 V AND Supply voltage leads circuit current.	

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a or 1a + 1m	2a + 1m	1a + 2m	2a + 2m or 1a + 1m + 1e	2m + 1e or 2a + 1m + 1e	1a + 2m + 1e

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	$P = VI$ and $I = \dfrac{V}{R}$ $P = \dfrac{V^2}{R} \rightarrow R = \dfrac{V^2}{P}$ $R = \dfrac{12 \times 12}{18} = 8.00\ \Omega$ $\tau = \dfrac{L}{R} \rightarrow \tau = \dfrac{1.60}{8.00} = 0.200\text{ s}$	• Correct value for R showing working to calculate R. • $I = \dfrac{V}{R} = \dfrac{12}{8} = 1.5\ \Omega$	• Correct answer for time constant including correct working for R.	
(b)(i)		• Correct shape. • $V_{1T} = 12 - 0.37 \times 12 = 7.56\text{ V}$	• Correct shape and TWO correct points plotted for lamp. $V_0 = 0$ v, $V_{max} = 12$ V $V_{1T} = 12 - 0.37 \times 12 = 7.56$ V or 7.59 V (if using exponents) $V_{2T} = 12 - 0.37^2 \times 12 = 10.4$ V $V_{3T} = 12 - 0.37^3 \times 12 = 11.4$ V	• Correct shape and THREE correct points plotted for lamp. $V_0 = 0$ v, $V_{max} = 12$ V $V_{1T} = 12 - 0.37 \times 12 = 7.56$ V or 7.59 V (if using exponents) $V_{2T} = 12 - 0.37^2 \times 12 = 10.4$ V $V_{3T} = 12 - 0.37^3 \times 12 = 11.4$ V

(ii)	The lamp experiences a delay before reaching 12.0 V. (*Can take evidence for this from graph.)* At any instant, the total voltage is 12 V. This is equal to $V_L + V_R$. When the switch is closed, there is a changing current and hence a changing flux. This changing current induces a back emf in the inductor that opposes the build-up of current and so it takes time for the current to reach maximum value in the bottom branch. The voltage across the lamp depends on the resistance of the lamp and the current through the lamp. When the back emf is a maximum, the voltage across the lamp is a minimum. Once the current is steady and there is no longer a back emf across the inductor, the voltage across the lamp will reach 12 V. The gradient of the graph line is a maximum at the start as the current changes rapidly at the start, and hence the voltage across the lamp changes quickly at the start. The gradient of the graph line decreases as the voltage across the lamp gets closer to 12.0 V, as the rate of change in current decreases as the current approaches a maximum. So, the voltage across the inductor is tiny, while the graph line tends to approach 12.0 V for lamp B at infinity.	• ONE of: - Once switch is closed, there is a changing current and hence a changing magnetic flux. - This changing current induces a back emf that opposes the build-up of current. - The voltage across the lamp is a minimum at the start when current is a minimum. - Voltage across the lamp is a maximum once current is steady and it is equal to 12 V. - Gradient of graph line is a maximum at the start when current changes rapidly and gradient decreases as the voltage across the lamp approaches 12 V.	• TWO of: - Once switch is closed, there is a changing current and hence a changing magnetic flux. - This changing current induces a back emf that opposes the build-up of current. - The voltage across the lamp is a minimum at the start when current is a minimum. - Voltage across the lamp is a maximum once current is steady and it is equal to 12 V. - Gradient of graph line is a maximum at the start when current changes rapidly and gradient decreases as the voltage across the lamp approaches 12 V.	
(c)	$E=\frac{1}{2}LI^2$ $I=\frac{P}{V}=\frac{18.0}{12.0}=1.50\text{ A}$ $E=\frac{1}{2}\times 1.60\times 1.50^2=1.80\text{ J}$	• Correct answer. (Answer consistent with incorrect *I* calculation from Q2a.)		

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a or 1a + 1m	2a + 1m	1a + 2m	2a + 2m or 1a + 1m + 1e	2m + 1e or 2a + 1m + 1e	1a + 2m + 1e

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	The energy supplied / converted to each coulomb of charge as it enters the battery (before any of it is lost due to internal resistance). OR The voltage across the battery when no current is drawn.	• Correct answer		
(b)	*y*-axis intercept = emf = about 9.0 V Gradient of graph = internal resistance = 1.5 Ω (allow tolerance of 5%)	• One correct answer of: - 9 V from graph (**NOT** 8.5 V) - R = 1.5 Ω.	• Both correct.	
(c)	As more lamps are added in parallel, there are more pathways for the current to flow, (resistance decreases), so that current from the battery increases. Since there is more current passing through the battery, there will be a greater potential drop across the internal resistance, leaving less energy per coulomb of charge (voltage) available to the external circuit.	• Resistance decreases current increases. • Lost volts increases.	• Correct answer with links and reasoning.	
(d)	$I_1 + I_2 = I_3$ $-6.00 - 3.50I_1 + 2.90I_2 = 0$ $8.50 - 2.90I_2 = 0$ $I_2 = \frac{8.50}{2.90} = 2.93\text{ A}$ $-6.00 - 3.50I_1 + 2.90 \times 2.93 = 0$ $I_1 = \frac{2.50}{3.50} = 0.714\text{ A}$ $I_3 = 2.93 + 0.714 = 3.65\text{ A}$	• Correct current equation. • One correct current value.	• Correct current equation. AND One correct current value. OR One error in calculation.	• Correct values for all three currents.

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No response; no relevant evidence.	1a	2a	3a or 1a + 1m	2a + 1m	1a + 2m	2a + 2m or 1a + 1m + 1e	2m + 1e or 2a + 1m + 1e	1a + 2m + 1e

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 19	20 – 24