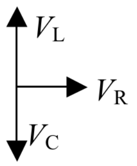
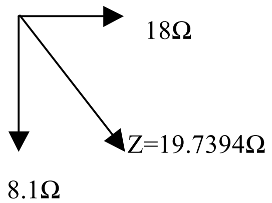
Assessment Schedule – 2007

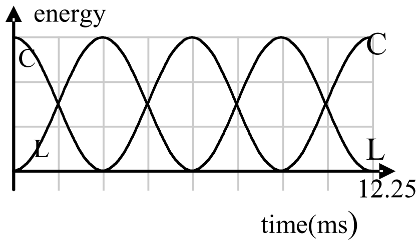
Physics: Demonstrate understanding of electrical systems (90523)

Evidence Statements

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
1(a)	$\tau = RC = (215 + 1.20) \times 7.7 \times 10^{-3}$ $= 216.5 \times 7.7 \times 10^{-3} = 1.665$ **= 1.7 s** **Note 1.20Ω resistor needed**	[2] Correct answer [1] Answer rounded to 2sf, plus correct unit.		
1(b)	$2.50 - 1.20I - 0 - 215I = 0$ $\Rightarrow I = \frac{2.50}{216.2} = 0.011563$ **= 0.0116 A** **Note 1.20Ω resistor needed**		[2] Correct answer	
1(c)	$V_C = 2.50$ V	[1] Correct voltage		
1(d)	When the capacitor is fully charged, the voltage across it equals the source voltage. The capacitor voltage opposes the source voltage and so the circuit voltage, and hence circuit current, is zero.	[1] Idea of capacitor voltage equalling the supply voltage **OR** Idea of charge building up (in cap) but must say **why** current reduces as cap charges	[1] Capacitor voltage is **opposing** the source voltage **OR** Zero circuit voltage	
1(e)	The capacitor discharges through the bulb. The bulb will glow when the power delivered to it is high enough. $P = IV$. As the capacitor discharges, both I and V decrease, so the power will quickly drop below the required value.	[1] They must explain **both** the **glow** and the bulb **going out**. eg Discharging of charge or current until insufficient current / charge to make the bulb go (be seen) **OR** something similar (perhaps involving voltage) and is correct eg V_{cap} reduces as charge reduces until the charges have insufficient voltage/energy to make the bulb go (be seen).	[1] Explanation links the initial glowing of the bulb to **sufficient power,** (and the power decrease as smaller I or V).	
1(f)	$I_1 = I_2 + I_3$	[1] Correct equation		
1(g)	**This is a SHOW question** $V = \varepsilon - Ir$ I_2 is zero $\Rightarrow I_1 = I_3 = I$ $\Rightarrow 2.50 - (112 + 215 + 1.20) \times I = 0$ $\Rightarrow I = \mathbf{7.6173 \times 10^{-3}}$ $\Rightarrow V = 2.50 - 7.6173 \times 10^{-3} \times 1.20$ $= 2.50 - 9.14076 \times 10^{-3}$ **OR** $V = 7.6173 \times 10^{-3} \times (112 + 215)$ = 2.4909V before rounding	Watch for **2.48608V** (if used I=.0116A) or current calculated in 1b (N) $V_T = 2.50 - \frac{1.64}{215} \times 1.20$ = 2.490846 V (N)		[2] Correct working. $V = 2.50 - 7.6173 \times 10^{-3} \times 1.20$ (= 2.4909V) **OR** $V = 7.6173 \times 10^{-3} \times (112+215)$ ($I = 7.6173 \times 10^{-3}$)

1(h)	$V_{terminal} - 1.64 - V_C = 0$ $2.4909 - 1.64 = V_C$ **= 0.85 V** $I = 7.6279 \times 10^{-3}$ $(= \frac{1.64}{215})$ gives $V_{bulb} = 7.6279 \times 10^{-3} \times 112 = 0.854$ V	[2] Correct answer. **Care with 0.86V (N)**		
1(i)	The bulb is designed to operate off a 2.5 V supply. The maximum voltage the capacitor can supply is 0.85 V, which will not give enough power to make the bulb glow.	[1] Idea of voltage (of capacitor) too low.		
1(j)	Switch 1 must be closed so that the capacitor can charge. Switch 2 must be open because if it is closed, the battery will always be supplying current to the outside loop, which means that the voltage drop across the resistances will reduce the fully-charged voltage across the capacitor.	[1] Correct switch 1 answer.	[1] Correct switch 2 answer. A voltage reason is needed to explain why the cap must be fully charged (not a current one).	[1] There must be some idea of the resistor's voltage having an effect on the voltage across the cap.
2(a)	While the current is changing, the flux in the coil is changing. This changing flux will link the turns of the coil, inducing a voltage across it.	[1] Idea of changing current causes a back EMF or an opposing voltage or correctly explains $\varepsilon = -L\frac{\Delta I}{\Delta t}$ Using voltage ideas not current)	[1] Idea of changing current AND Changing current linked to changing flux (or changing magnetic field) and hence induced voltage.	
2(b)	$\varepsilon = -L\frac{\Delta I}{\Delta t}$ $\Rightarrow$ $0.004 = L\left(\frac{1.62 - 0.13}{1.2}\right) = L\frac{1.49}{1.2}$ $L = \frac{4.0 \times 10^{-3} \times 1.2}{1.62 - 0.13}$ $= 3.2215 \times 10^{-3}$ **$= 3.2 \times 10^{-3}$ H**		[2] Correct answer.	
2(c)		[1] Correct diagram. V_L leading etc Accept L,C,R or Xc, X_L, R		
2(d)	Voltage phasors have a direct relationship with reactance vectors. If $X_C > X_L$, X_{tot} is capacitative and so, when combined with R, will give a vector ↘. The phasor for V_{supply} will therefore be in the same direction. As phasors rotate anticlockwise, and as I is in phase with V_R, I will lead V_{supply}. V_{supply} is the vector addition of the directions of Vr and (Vc-V_L).	[1] V_{supply}. lags.	[1] Must explain why V_{supply}. lags. Can use diagrams with explanation	[1] States (or proves) Vc or V_L in same direction as their reactances or V_{supply} in same direction as Z.
2(e)	$\omega = 2\pi f = 2 \times \pi \times 81.6$ $= 512.708$ **$= 513$ rad s^{-1}**	[2] Correct answer.		

2(f)	**This is a SHOW question** $X_C = \frac{1}{\omega C} = \frac{1}{512.708 \times 2.00 \times 10^{-4}}$ $= \frac{1}{0.1025415}$ $(= 9.75214\Omega)$	[2] Correct working.		
2(g)	$V = IZ$, $Z^2 = (X_C - X_L)^2 + R^2$ $\Rightarrow Z^2 = (9.75214 - 1.65)^2 + 18^2$ $\Rightarrow Z = 19.7394$ $\Rightarrow I = \frac{15}{19.7394} = 0.75990$ **= 0.76 A**  		[2] Consistent answer with incorrectly calculated Z. Must use a vector diagram for calculation of Z **OR** Correct formula but have incorrectly substituted or calculated Z	[2] Correct answer. $I = \frac{15}{19.7394}$ = 0.75990 A **= 0.76 A**
2(h)	The car becomes part of the core of the coil, which increases inductance.	[1] Idea of car becoming the part of the core.		
2(i)	Increasing the inductance of the coil increases its reactance and so brings its reactance closer to the capacitor reactance. This means the total reactance decreases. As the impedance is a combination of resistance and reactance, decreasing the reactance will also decrease the impedance. As the current is inversely proportional to the impedance, decreasing the impedance will increase the current.		[1] Current increases and either of X_L increases (as L increases) and $X_L \rightarrow X_C$ or $(X_L - X_C) \rightarrow 0$ OR Resonance occurs and states one of its conditions $X_L = X_C$, $V_L = V_C$, Z at min $V_R = V_S$	[1] Current increases and X_L increases (as L increases) and $X_L \rightarrow X_C$ and Z reduces
2(j)	$I = \frac{V}{Z}$, at resonance $Z = R$ $\Rightarrow I = \frac{15}{18} = 0.83333$ **= 0.83 A**		[2] Correct answer.	
2(k)	$X_L = \omega L = X_C = 9.75$ $\Rightarrow L = \frac{9.75}{512.708} = 0.01902$ **= 19 mH**		[2] Correct answer.	
2(l)	$E = ½QV$, $Q = VC \Rightarrow E = ½CV_C^2$ At resonance $V_C = I_{max}X_C$ $\Rightarrow E = ½ \times 200 \times 10^{-6} \times (0.83333 \times 9.75)^2$ $= 0.0066015$ **= 0.0066 J** **= 6.6mJ** **Or** $E = ½LI^2 = E = ½ \times 0.01902 \times 0.833^2$ =**0.006604J** **Watch consistency with 2j (I = 0.8333) and 2k (L = 19 mH).**	If use $V_C = 15\sqrt{2}$ (21.21V) E = 45mJ M2 V_C =15 E = 22.5mJ M2 $V_C = (0.833 \times 9.75) \times \sqrt{2}$ $= 8.1245 \times \sqrt{2}$ E = 13.2 mJ M2	[2] Correct answer consistent with incorrectly calculated V_C. or Uses formula $E = ½LI^2$	[2] Correct answer. or Uses formula $E = ½LI^2$ and (consistently) subs L and I to correclty calculate E

2(m)			[1] Graph shapes are correct except that only one half cycle shown (unless the time axis label shows this cycle is ½ period).	[1] Graph shapes are correct. Axis label correct. T = 12.25 s

Judgement Statement

	Achievement	Achievement with Merit	Achievement with Excellence	
Criterion 1	4 × A1	3 × A1 + 3 × M1	3 × A1 + 2 × M1 + 1 × E1	Plus one E from either criterion.
Criterion 2	3 × A2	2 × A2 + 2 × M2	2 × A2 +2 × M2 + 1 × E2	