Assessment Schedule – 2008

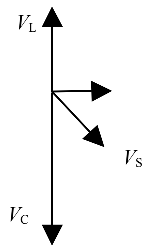
Physics: Demonstrate understanding of electrical systems (90523)

Evidence Statements

Judgements in italics indicate replacement evidence and so are not counted for sufficiency.

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	EMF/ Electro motive force / Open circuit voltage	[1]Correct.		
(b)	$R = \frac{V}{I} = \frac{5.87}{0.743}$	[2]Correct working.		
(c)	$r = \frac{(\varepsilon - V)}{I} = \frac{(6.12 - 5.87)}{0.743} = 0.336\ \Omega$ or $R_{\text{tot}} = \frac{V}{I} = \frac{6.12}{0.743} = 8.24$ $8.24 - 7.90 = 0.337\ \Omega$	[2] Correct R_{tot}.	[2]Correct working showing all steps (formula not required).	
(d)	If a battery with a higher internal resistance was used: There is a greater drop in pd across the internal resistance, so the pd is reduced across the lamp, so less current flows, so bulb is less bright / has less power. OR The circuit has a greater total resistance, so less current flows, so bulb is less bright / has less power.	[1]Dimmer lamp./lower voltmeter reading/lower terminal voltage/greater total resistance/lower current.	[1]Dimmer lamp due to less current / lower terminal pd.	[1] Complete explanation with voltage or current argument.
(e)	Two identical lamps in parallel have half the resistance, $R = \frac{7.90}{2} = 3.95\ \Omega$ $I = \frac{\varepsilon}{(R + r)}$ $= \frac{6.12}{(3.95 + 0.336)} = 1.43\ \text{A}$	[2]Correct calc of R for 2 bulbs.	[2]Correct answer (consistent with answer to 1(c)).	
(f)	$\tau = \frac{L}{R} \Rightarrow L = \tau R$ $L = 1.2 \times 10^{-3} \times 7.90 \quad = 9.48 \times 10^{-3}\ \text{H}$ $= 9.5 \times 10^{-3}\ \text{H}\ (= 9.5\ \text{mH})$	[2]Correct Value [1]2 sf + correct units (H) and in 3(a) (m^2).		
(g)	1. An inductor is a component that has significant inductance, L. 2. As the current changes $\frac{\Delta I}{\Delta t}$ an emf is produced which opposes the flow of the current. 3. Reduces the rate of change of current. 4. Back emf decreases over time 5. Hence current increase over time to a steady rate – bulb brightens gradually	[1] delay is because the inductor produces a magnetic field, which induces a back emf in the inductor. OR The inductor limits rate of change of current.	[1] Inductance related to back emf, hence limit on build up of current / brightness.	[1] Complete answer links equation to gradual build-up of current and decreasing rate of change of current/decreasing back emf

	6. This opposing emf cannot be bigger than the forward emf, putting a limit on $\frac{\Delta I}{\Delta t}$. 7. The bulb only glows when sufficient current (ΔI) flows which, due to 3, is after certain time.			
(h)	$\left(\frac{\Delta V}{\Delta t}\right) = \frac{200}{0.002} = 100 \times 10^3$	[2]Correct working. – any appropriate slope calculation with data from graph OR use dV/dt from sin function		
(i)	The 6 V is the rms value because the rms value of ac is the equivalent dc voltage that gives the same average power as the ac. As the lamp is about the same brightness the power output must be about the same.	[1]Rms.	[1]Rms with reason: same average power as dc, or same brightness / heating and light effect as dc.	
(j)	$\varepsilon = -M\frac{\Delta I}{\Delta t}$ $M = \frac{\varepsilon}{\left(\Delta I/\Delta t\right)} = \frac{\varepsilon_{max}}{\left(\Delta I/\Delta t\right)_{max}}$ $M = \frac{6 \times \sqrt{2}}{8.7} = 0.98\text{ H} = 1\text{ H}$	[2]Correct calc of peak voltage (8.48 V). OR use rms voltage gives M = 0.69/0.7 H		[2]Correct answer.
TWO (a)	1. The current in the coil produces a magnetic field. When there is an alternating current there is a changing magnetic field. 2. The field through the metal pan is changing, 3. so induces an emf (Faraday), 4. which will cause a current because the metal is a conductor. 5. This current will dissipate heat due to its resistance.	[1] Mentions induced current / voltage **in pan**	[1]Changing magnetic field induces (eddie) current(s) in the metal pan that result in heating.	[1] Full answer linking changing current in coil to heat with at three points linked clearly.
(b)	$X_L = 2\pi fL$ $= 2\pi \times 27 \times 10^3 \times 1.30 \times 10^{-3} = 221\ \Omega$	[2]Correct working. OR use X_L =221 to work backwards to f or L.		
(c)	$X_c = \frac{1}{2\ fC}$ $C = \frac{1}{2\ fX_c}$ $= \frac{1}{(2\pi \times 27 \times 10^3 \times 358)}$ $= 1.65 \times 10^{-8}$ F	[2]Correct working.		

(d)		[1]Correct orientation of capacitor and inductor voltage phasors.	[1]Capacitor voltage phasor is longest, inductor phasor longer than resistor voltage phasor and supply voltage phasor shows correct understanding of phasor addition.	
(e)	$V_S = IZ$ $I = \frac{V_s}{Z}$ $Z = \sqrt{((X_C - X_L)^2 + R^2)}$ $= \sqrt{((358 - 221)^2 + 70.0^2)}$ $= 153.8\ \Omega$ $I = \frac{200}{154} = 1.30\text{ A}$ With rounding $Z = 154.6$ so $I = 1.29$ A.		[2]Correct impedence (accept correctly worked solutions that have rounding errors).	[2]Correct answer (accept correctly worked solutions that have rounding errors).
(f)	The iron pan increases the magnetic field / flux around the coil (compared with a non magnetic pan). Thus the change in field is greater, so the inductance is greater.	[1]Links to increased field / fluxor change in field / flux. OR inductance increases	[1]Links to increased field and links change in field to inductance (eg Faraday's law, etc).	
(g)	Resonance occurs when supply (driving) frequency = natural frequency / $X_C = X_L$ / $V_C = V_L$ / when supply frequency causes maximum current.	[1]One correct statement.		
(h)	At resonance, impedance = resistance = 70.0 Ω. $I = \frac{V}{R} = \frac{200}{70.0} = 2.86\text{ A}$		[2]Correct answer.	
THREE (a)	$C = \frac{\varepsilon_r A}{d}$ $A = \frac{Cd}{\varepsilon_r}$ $= \frac{1.65\times10^{-8}\times1.00\times10^{-4}}{8.84\times10^{-12}}$ $= 0.187\text{ m}^2$	[2]Correct answer.		
(b)	Decrease separation. Use a dielectric (plastic/ paper). Roll the metal foil up.	[1]Two methods.		
(c)	$R = \frac{V}{I}$ – use the intercept value $= \frac{19.5}{0.00013}$ $=150\ 000\ \Omega$	[2]Correct use of intercept and working (allow intercept values 0.00013 – 0.000135).		

(d)	$\frac{1}{e}\times 0.000\,13 = 0.0478$ A Time constant works out, from graph at 0.0032 ± 0.0003 s $C = \frac{\tau}{R}$ $= \frac{0.032}{150\,000}$ $= 2.1 \times 10^{-8}$ F (range from time constant values 1.93 → 2.33×10^{-8} F)	[2]Correct method to find time constant	[2]Correct time constant within limits.	[2]Correct answer consistent with time constant measured from graph within limits.

Judgement Statement

Achievement	Merit	Excellence
$4 \times$ A1	$3 \times$ A1 + $2 \times$ M1	$2 \times$ A1 + $2 \times$ M1 + $1 \times$ E1
$3 \times$ A2	$3 \times$ A2 + $2 \times$ M2	$2 \times$ A2 + $2 \times$ M2 + $1 \times$ E2