Assessment Schedule – 2024

Physics: Demonstrate understanding of electrical systems (91526)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	EMF is the voltage across the terminals of the battery when no current flows. OR EMF is the energy gained by each coulomb of charge as it enters the cell.	• Correct explanation.		
(b)	When the switch is open, the voltmeter would read 12.0 V. When the switch is closed, a current flows through the circuit. The reading on the voltmeter would be less than 12.0 V due to the potential drop across the internal resistance.	• ONE of: - Switch open $V = 12.0$ V - Switch closed $V < 12.0$ V - Voltage / energy is lost due to the internal resistance. - Voltages are different.	• Complete answer including the reason why the voltmeter would read less than 12.0 V (ie heat/ energy / voltage drop or equation).	
(c)	$+24 - 15.5I - 12 - 0.5I = 0$ OR Effective EMF = 24 – 12 = 12 V Circuit current = $I = \frac{12\text{ V}}{16\,\Omega} = 0.75$ A Voltage across the 15.5 Ω resistor $= 0.75 \times 15.5 = 11.625$ V Terminal Voltage = 24 – 11.6 =12.4 V OR Terminal voltage = $12 + (0.75 \times 0.500)$ = 12.4 V	• ONE of: - Effective EMF = 12.0 V - Attempt at Kirchoff's Voltage equation.	• $I = 0.75$ A $V = 11.7$ V One error in calculation.	• $V = 12.4$ V

(d)	Once the switch is closed, lamp A glows brightly at the start as the capacitor plates gets charged. Once the capacitor is fully charged, current through lamp A stops, and so it stops glowing. The bottom branch has twice the resistance compared to the middle branch. So the current will be less / halved. As lamp B shares the voltage (equally) with the resistor the voltage across the resistor will be less / halved. As brightness depends on power ($P = IV$) and both I and V are reduced, the bulb will glow less brightly. Lamp B will continue to glow.	• ONE of: - Lamp A will glow initially. - Lamp A will stop glowing. - Lamp B will keep glowing. - Lamp B will be less bright.	• TWO of: - Once the switch is closed, lamp A glows brightly at the start as the capacitor plates get charged. - Once the capacitor is fully charged, current through lamp A stops, and so it stops glowing. - Lamp B will continue to glow. - Lamp A will be brighter than B because it has more current / voltage / power. OR Lamp B will glow less brightly as it shares its voltage with the resistor / has less current / power.	• ALL of: - Once the switch is closed, lamp A glows brightly at the start as the capacitor plates get charged. - Once the capacitor is fully charged, current through lamp A stops, and so it stops glowing. - Lamp B will continue to glow. AND - Lamp A will be brighter than B because it has more current / voltage / power. OR - Lamp B will glow less brightly because it has less voltage / current / power.

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

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	$\varepsilon = L\frac{\Delta I}{\Delta t} \rightarrow L = \frac{250\times10^{-6}\times0.400}{4.00} = 2.5\times10^{-5}$ H	• $L = 2.5 \times 10^{-5}$ H		
(b)	$\Delta\phi = BA$ for one turn $\Delta\phi = 1.80\times\left(1.6\times10^{-4}\right)$ $\Delta\phi = 2.88\times10^{-4}$ $V = -\frac{\Delta\phi}{\Delta t}$ $V = \frac{25\times2.88\times10^{-4}}{0.300}$ $V = 0.0240$ V	• ONE of: - $\Delta\phi = 2.88 \times 10^{-4}$ Wb - $\Delta\phi = 7.20 \times 10^{-3}$ Wb - $V = 9.6 \times 10^{-4}$ V - $V = 150$ V - $V = 240$ V - $V = 3.85 \times 10^{-5}$ V - One error in calculation.	• $V = 2.40 \times 10^{-2}$ V	
(c)	The acceleration of the magnet will be less than *g*. As the magnet falls, the amount of magnetic flux linked with the ring increases. This induces a voltage, which causes an eddy current to flow, this creates a magnetic field, which opposes the downward movement of the magnet. Once the magnet has crossed the metal ring, the amount of magnetic flux linking the ring decreases (changes). Hence a voltage is induced and causes an eddy current to flow within the ring, producing a magnetic field, which opposes the fall of the magnet. Hence the downward acceleration of the magnet will be less than 9.81 m s^{-2}.	• ONE correct statement of: - Downward acceleration < 9.81. - Changing magnetic flux. - Induced voltage / current. - Opposing magnetic field/flux is formed. - It slows down.	• Changing flux linking the ring will cause an induced current which opposes the movement of the magnet. • Acceleration < 9.81 because induced B / flux opposes the motion.	• Includes explanation of what happens when the magnet enters as well as leaves the ring.

(d)	$I_{max} = \frac{V}{R}$ $= \frac{12.0}{2.00}$ $= 6.00$ A $\tau = \frac{L}{R}$ $= \frac{0.600}{0.300}$ $= 0.300$ s so a time of 0.6 s is 2τ (two time constants) $I = I_{max}\left(1-\frac{1}{e^2}\right)$ $= 6.00\left(1-\frac{1}{e^2}\right)$ $= 5.187988$ $= 5.19$ A approximately $I = I_{max}\left(1-0.37^2\right)$ $= 6.00(0.8631)$ $= 5.1786$ A	• ONE of: - $I_{max} = 6.00$ A - $\tau = 0.300$ s - $1\tau = 63\%$ change	• ALL of: - $I_{max} = 6.00$ A - $\tau = 0.300$ s - At τ_1, $I = 3.38$ A Correct method with minor error.	• $I = 5.18$ A (May calculate 63% of I_{max}, then 63% of the remainder and add them.)

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Q	Evidence	Achievement	Merit	Excellence
THREE (a)	$V_{\text{peak}} = \sqrt{2} \times 110 = 156\text{ V}$	• $V = 156$ V		
(b)	$X_L = 2\pi fL = 2\pi \times 60 \times 0.070 = 26.4\ \Omega$ $Z = \sqrt{R^2 + X_L{}^2} = \sqrt{40^2 + 26.4^2} = 47.9\ \Omega$ $\theta = \tan^{-1}\left(\frac{26.4}{40}\right) = 33°$ $(= 0.5834\text{ rad})$ Source voltage leads circuit current.	• MUST SHOW THAT: $L = 0.070$ and $X_L = 26.4\ \Omega$ $\theta = 33°$ (0.583 rad). Source voltage leads current. Correct labelled vector diagram.	• $X_L = 26.4\ \Omega$, $\theta = 33°$ (0.583 rad) Indication that source voltage leads current.	
(c)	Removing the soft iron core will decrease the inductance of the inductor. Since the reactance of the inductor $X_L = \omega L$, the reactance of the inductor will decrease since $X_L \propto L$. Since the reactance of the inductor decreases, the overall impedance of the circuit decreases. Hence the circuit current will increase, causing the bulb to be brighter. Brightness depends on power output. As both the current through the lamp as well as the voltage across the lamp is increasing, the power and hence the brightness will increase.	• ONE of - L decreases - X_L decreases - Z decreases - I increases - Brightness depends on power output - Less back emf - Brighter - Smaller magnetic field / flux.	• L decreases therefore X_L will decrease. X_L decreases, Z decreases, so I will increase, causing the bulb to be brighter. Less back emf so greater voltage across bulb so its brighter.	• Less back emf so greater voltage across bulb so its brighter because brightness depends on Power Removing the iron core will decrease L, X_L decreases, Z decreases so I will increase. AND Brightness depends on Power, so the lamp will be brighter because the current through the lamp increases. OR The voltage across the lamp will increase (Accept any justification with relevant power formula.) $P = IV$ $P = I^2R$ $P = \frac{V^2}{R}$

(d)	At resonance, the circuit current is a maximum. This happens when the impedance is a minimum. This can happen when resistance = impedance as the reactance of the capacitor and the reactance of the inductor being 180° out of phase will cancel each other.	• One correct statement: - I is a maximum. - $Z = R$ - Z is a minimum. - Reactance of the capacitor cancels out reactance of the inductor.	• Any TWO achieved points.	• ALL of: - I is maximum - $Z = R$ or Z is minimum - Reactance of the capacitor cancels out. - Reactance of the inductor with reason (out of phase, equation or phasor diagram).

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 06	07 – 13	14 – 18	19 – 24