SAMPLE ASSESSMENT SCHEDULE

Physics 91526 (3.6): Demonstrate understanding of electrical systems

Assessment Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding requires writing statements that typically show an awareness of how simple facets of phenomena, concepts or principles relate to a described situation. For mathematical solutions, relevant concepts will be transparent and methods will be straightforward.	*Demonstrate in-depth understanding* requires writing statements that will typically give reasons why phenomena, concepts or principles relate to given situations. For mathematical solutions the information may not be directly usable or immediately obvious.	*Demonstrate comprehensive understanding* requires writing statements that will typically give reasons why phenomena, concepts or principles relate to given situations. Statements will demonstrate understanding of connections between concepts.

Evidence Statement

NØ = No response; no relevant evidence.

One	Not Achieved		Achievement		Merit		Excellence	
	N1	**N2**	**A3**	**A4**	**M5**	**M6**	**E7**	**E8**
	Any ONE of the following.	Any TWO of the following.	Any TWO of the following.	ALL of the following.	Any TWO of the following.	ALL of the following.	(b) PLUS (a) OR (c).	(b) PLUS (a) AND (c).
(a)	A current is induced OR current causing heating in any object		ONE point from: • Changing magnetic field / flux inducing current / voltage in pan. • Current in the pan causes heating due to resistance.		Links changing current / field in the wire to induced voltage / current in the pan OR links **induced** voltage / current to heating		Full answer linking changing current in coil to heat with THREE points linked clearly. • The current in the coil produces a magnetic field. • When there is an alternating current there is a changing magnetic field in the coil • The changing field induces an emf (Faraday) in the pan • The induced emf will cause a current because the metal is a	

				conductor. • This induced current will dissipate heat due to its resistance.
(b)	Uses correct equation but incorrect data for either ω, X_C or X_L.	$\omega = 2\pi f = 2\pi \times 27000$ $= 170 \times 10^2 \text{ s}^{-1}$ Or correct X_C or X_L	$X_C = \frac{1}{\omega C} = \frac{1}{170 \times 10^2 \times 1.65 \times 10^{-8}} = 357\ \Omega$ AND AND attempts $Z^2 = R^2 + (X_C - X_L)^2$	$Z^2 = R^2 + (X_C - X_L)^2$ $Z^2 = 70^2 + (357 - 221)^2$ $Z = 153\ \Omega$ $I = \frac{V}{Z} = \frac{200}{153} = 1.31\text{ A}$
(c)	Mentions magnetic field or flux.	ANY of the following: • The pan increased the field / flux. • The iron increases the inductance. • Circuit resonates / current becomes maximum.	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. Links ferromagnetic material (iron) / steel) to increased field and links change in field to inductance (eg, Faraday's law, etc). OR Pan changes the inductance so the circuit comes to resonance / reduces impedance and therefore increases the current.	Complete explanation of BOTH the effect of iron increasing the inductance, plus how changing inductance will make $X_C \approx\ = X_L$ and therefore bring the circuit to resonance – minimum resistance, maximum current. OR The iron pan increases the inductance of the coil so the inductive reactance increases and the impedance decreases, meaning that the current will increase OR Increasing the inductance will lower the resonant frequency of the circuit, bringing it equal with the supply frequency. When this occurs the only impedance in the circuit will be from the resistor so the current will be maximum.

<table>
<tr><th rowspan="3">Two</th><th colspan="2">Not Achieved</th><th colspan="2">Achievement</th><th colspan="2">Merit</th><th colspan="2">Excellence</th></tr>
<tr><th>N1</th><th>N2</th><th>A3</th><th>A4</th><th>M5</th><th>M6</th><th>E7</th><th>E8</th></tr>
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<tr><td>(a)</td><td colspan="2">Any of:
• Decrease the distance between the foil plates
• Roll up two foil sheets with the film in between
• Put the foil sheets very close together
• Length = Area / width
• $C = \frac{\varepsilon_0 \varepsilon_r A}{d}$</td><td colspan="2">OR
(i) Put plastic between the plates
OR
Minimise the distance between the plates
(ii) $C = \frac{\varepsilon_0 \varepsilon_r A}{d}$
$A = \frac{Cd}{\varepsilon_0 \varepsilon_r} = \frac{1.65 \times 10^{-8} \times 1.00 \times 10^{-4}}{8.85 \times 10^{-12} \times 2.3}$
$= 0.08106 \text{ m}^2$</td><td colspan="2">Correct length calculation but no explanation
OR
correct area with clear explanations:
Use one layer of plastic to make it thin as possible to put the plates as close as possible to each other.
OR
Avoid air pockets and make sure just one thickness of plastic separates the plates.</td><td colspan="2">$\text{Length} = \frac{\text{Area}}{\text{Width}} = \frac{0.08106}{0.10} = 0.81 \text{ m}$
Complete answer based on clear reasoning with Merit explanation clearly stated</td></tr>
<tr><td>(b)</td><td colspan="2">$R = \frac{V}{I}$
OR
$C = \frac{\tau}{R}$</td><td colspan="2">$R = \frac{V}{I} = \frac{19.5}{0.00013} = 150\ 000\ \Omega$
OR
Time constant is the time for the current to drop to 37% of its original value.(Calculation of τ
or clear construction lines on graph are shown)</td><td colspan="2">Time constant is the time for the current to drop to 37% of its original value. ie when $I = 4.8 \times 10^{-5}$ A
Concept correctly applied to finding τ
From graph, time constant = 0.003 s (allow discrepancy to $\pm\ 0.001$ s).
OR
Correct answer for C with no working for τ</td><td colspan="2">$R = \frac{V}{I} = \frac{19.5}{0.00013} = 150\ 000\ \Omega$
AND
Calculation of τ
or clear construction lines on graph are shown
AND
$C = \frac{\tau}{R} = \frac{0.003}{150\ 000} = 2 \times 10^{-8}$ F
(Complete answer.)
(Allow answers to 1 s.f.)</td></tr>
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<tr><td>(a)
(i)–(iii)</td><td colspan="2">Uses $V = IR$ but does not use all correct values.</td><td colspan="2">Switch 1 closed:
$I = \frac{V}{R} = \frac{12}{4.0 + 3.0} = 1.71\text{ A}$
Switch 2 closed:
$I = \frac{V}{R} = \frac{12}{3.0 + 0.1} = 3.87\text{ A}$
OR
Recognises that $I_c = I_N + I_B$.</td><td colspan="2">When both switches are closed – candidate writes a correct Kirchhoff's Voltage law equation (but does not reach final answer).
Nb Candidate must show recognition that the current drawn from each battery will change when both switches are closed</td><td colspan="2">Applies Kirchoff's voltage law eg:
$12 + 0.1I_N = 12 + 4I_B$
$\frac{I_N}{I_B} = 40$</td></tr>
<tr><td>(b)</td><td colspan="2">ONE of
• Recognises that the high resistance in the old battery will limit its power.
• The presence of the old battery will make the rechargeable battery last longer by an insignificant amount.
• The power of the lamp increases (an insignificant amount)</td><td colspan="2">Because of the high internal resistance the current from the old battery will be very low, so it will contribute little power (compared with the other battery).</td><td colspan="2">Because of the difference in resistances the current from the rechargeable battery is much greater than that from the old battery.
Because P = I^2R the power delivered by the rechargeable battery will be very much greater and the power from the old battery will be insignificant.
The current from the old battery does not affect the current from the rechargeable battery much, so its presence will not make it last significantly longer.</td><td colspan="2">The presence of the old battery does reduce the current from the rechargeable battery a little.
Power taken from the new battery is emf $\times$ I, so a reduction in current will make the battery last a little longer.
OR
$12 = 0.1I_N + 3(I_B + I_N)$
$12 = 3.1I_N + 3I_B$
$12 = (3.1 \times 40I_B) + 3I_B = 127I_B$
$I_B = 0.094\text{A};\ I_N = 40I_B = 3.78\text{ A}$
The current without the old battery is 3.87A, with the old battery it is 3.78A. Since power supply is VI, the power</td></tr>
</table>

				used will be 3.78/3.87 (98%) as much, and it will last 1.02 times longer. OR Merit answer plus internal resistance of the rechargeable battery will increase as it discharges, so the contribution of the old battery may become more significant.