

**Assessment Schedule – 2025****Physics: Demonstrate understanding of electrical systems (91526)****Evidence**

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$V_T = \varepsilon - Ir = 12.6 - 2.07 \times 0.100 = 12.393$ $= 12.4 \text{ V}$	<ul style="list-style-type: none"> <li>• ONE of:               <ul style="list-style-type: none"> <li>- 12.393 V</li> <li>- 12.42 V</li> </ul> </li> </ul>		
(b)	The emf supplied to the circuit remains the same, so, as the internal resistance increases, the more voltage will be lost across it, and the terminal voltage will decrease.	<ul style="list-style-type: none"> <li>• ONE of:               <ul style="list-style-type: none"> <li>- Terminal voltage decreases.</li> <li>- Lost volts increases.</li> <li>- Uses formula to show that <math>R_T</math> has <math>\uparrow</math>, <math>V_T \downarrow</math></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Terminal voltage decreases because there is more voltage lost across the internal resistance.</li> </ul>	

(c)  $\tau = RC$   
 $= 6.00(90.0)$   
 $= 540 \text{ s}$

$$I_{\max} = \frac{V}{R}$$

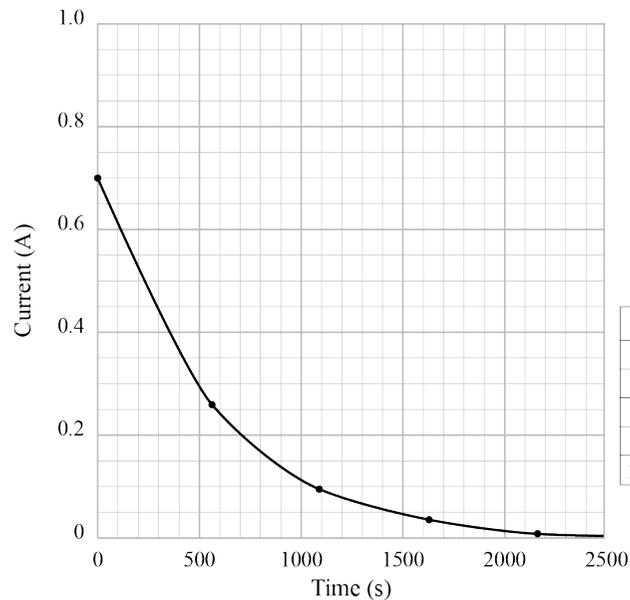
$$= \frac{4.20}{6.00}$$

$$= 0.700 \text{ A}$$

After one time constant:

$$I = I_{\max} \times 0.37$$

$$= 0.259$$



As the capacitor discharges, the charge ( $Q$ ) on its plates decreases. According to  $V = \frac{Q}{C}$ , a decrease in charge leads to a decrease in the voltage ( $V$ ) across the capacitor. Since the current is proportional to this voltage ( $I = \frac{V}{R}$ ), the current also decreases. The definition of current is the rate of flow of charge.

This creates a situation where there is now a lower current and that means a slower rate of charge loss, which in turn leads to an even slower decrease in voltage and current. This produces an exponentially decreasing curve.

- ONE of:
  - $\tau = 540 \text{ s}$
  - $I = 0.700 \text{ A}$
  - Graph correct shape starting at  $0.700 \text{ A}$ .
  - $V_c$  decreasing as  $Q$  decreasing.
  - $I$  decreases.

- Correct time constant and correct shape of graph showing  $I = 0.7 \text{ A}$  and  $I = 0.26 \text{ A}$ .  
 AND  
 $V_c$  decreases as  $Q$  decreases.  
 AND  
 $I$  decreases as  $Q$  decreases.

- Correct graph with values plotted for  $\tau$  ( $I = 0.26 \text{ A}$ ) and  $I$  decreases because  $Q$  (or  $V$ ) decreases.

<p>(d)</p>	<p>Adding two further capacitors in series will decrease the total capacitance. Since <math>\tau = RC</math>, this will decrease the time constant. The initial current will be greater as the voltage supplied by the capacitors is greater, but the exponential decrease will be quicker (i.e. it will decrease towards zero faster).</p> <p>Adding three capacitors in parallel will increase the total capacitance. This will increase the time constant. The initial current will be the same as one capacitor in series, as the voltage supplied is the same, but exponential decrease in current will be slower, as the time constant is larger.</p>	<ul style="list-style-type: none"> <li>• ONE of:             <ul style="list-style-type: none"> <li>- Total capacitance decreased in series / increased in parallel.</li> <li>- Time constant decreases in series / increases in parallel</li> <li>- Starting <math>I</math> is greater in series / same in parallel.</li> <li>- <math>I</math> will decrease faster in series / decrease slower in parallel.</li> <li>- Correctly links <math>\Delta C</math> to <math>\Delta \tau</math> or time taken for <math>I</math> to change.</li> </ul> </li> </ul> <p><math>C_T = 30 \text{ F}</math>, <math>C_T = 270 \text{ F}</math></p>	<ul style="list-style-type: none"> <li>• Total capacitance decreases in series increases in parallel.</li> </ul> <p>AND</p> <p>Time constant decreases in series increases in parallel.</p> <p>OR</p> <p>Starting <math>I</math> is greater in series same in parallel.</p> <p>OR</p> <p>But <math>I</math> will decrease faster in series / slower in parallel.</p> <ul style="list-style-type: none"> <li>• Explains that the initial current is higher for the series circuit because the initial voltage / charge is higher</li> </ul>	<ul style="list-style-type: none"> <li>• Total capacitance decreases for series and increases for parallel.</li> </ul> <p>AND</p> <p>Time constant decreases for series, increases for parallel.</p> <p>AND</p> <p>Starting <math>I</math> is greater for series, same for parallel.</p> <p>AND</p> <p>But <math>I</math> will decrease faster for series, slower for parallel.</p>
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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response, no relevant evidence.	1a	2a	3a or 1m + 1a or 1e	4a or 1m + 2a or 1e + 1a	2m + 1a or 1m + 3a	3m or 2m + 2a or 1e + 3a	2e + 1a or 1e + 2m	2e + 1m or 2e + 2a

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	12.6 V	<ul style="list-style-type: none"> <li>Correct answer.</li> </ul>		
(b)	$\tau = \frac{L}{R} = \frac{0.600}{2.50} = 0.240 \text{ s}$ $0.240 \text{ s} = 1\tau$ <p>So emf = <math>12.6 \times 0.37 = 4.662 = 4.66 \text{ V}</math></p>	<ul style="list-style-type: none"> <li>ONE of:                             <ul style="list-style-type: none"> <li><math>\tau = \frac{L}{R} = \frac{0.600}{2.50} = 0.240 \text{ s}</math></li> <li><math>V = v_{\max}^{-\frac{t}{\tau}} = 12.6^{-\frac{0.24}{0.25}} = 4.824 \text{ V}</math></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>4.66 V</li> </ul>	
(c)	<p>When the switch is opened, the magnetic field through the inductor collapses.</p> <p>As <math>\epsilon = -\frac{\Delta\phi}{\Delta t}</math>, as the flux decreases, a back emf is induced in the inductor.</p> <p>As <math>\tau = \frac{L}{R}</math>, the introduction of a large resistance from the air gap causes the time constant to drastically decrease, and so <math>\Delta t</math> is very small.</p> <p>This causes the induced voltage to be very large and able to produce a spark across the gap in the switch.</p> <p>Accept other suitable justification, e.g. using <math>\epsilon = -L\frac{\Delta I}{\Delta t}</math>.</p>	<ul style="list-style-type: none"> <li>An emf is induced across the inductor.</li> <li>Sudden decrease in current.</li> <li>The magnetic field to collapse / decrease.</li> <li>Time constant decreases.</li> <li>R is large.</li> </ul>	<ul style="list-style-type: none"> <li>Explains why an emf is induced across the inductor.</li> <li>OR</li> <li>Explains why the current decreases rapidly (<math>\tau = \frac{L}{R}</math>).</li> </ul>	<ul style="list-style-type: none"> <li>Explains why there is an induced emf</li> <li>AND</li> <li>t small because R</li> <li>OR</li> <li>reference to KL</li> </ul>
(d)	$I = \frac{V}{R} = \frac{12.6}{2.4 + 0.1} = 5.04 \text{ A}$ $E_L = \frac{1}{2}LI^2 = \frac{1}{2} \times 0.600 \times 5.04^2 = 7.62048 \text{ J}$ $E_c = \frac{1}{2}QV \quad Q = CV \text{ so } E_c = \frac{1}{2}CV^2$ $7.62048 = \frac{1}{2} \times C \times 12.6^2$ $C = 0.096 \text{ F}$	<ul style="list-style-type: none"> <li>ONE of:                             <ul style="list-style-type: none"> <li><math>I = 5.04 \text{ A}</math></li> <li><math>I = 5.25 \text{ A}</math></li> <li>Correct E stored in L with incorrect I</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>ONE of:                             <ul style="list-style-type: none"> <li><math>E = 7.62 \text{ J}</math></li> <li><math>E = 8.27 \text{ J}</math></li> <li>Correct method with incorrect energy stored</li> <li><math>C = \frac{L}{R^2}</math></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>ONE of:                             <ul style="list-style-type: none"> <li><math>C = 0.096 \text{ F}</math></li> <li><math>C = 0.104 \text{ F}</math></li> </ul> </li> </ul>

<b>NØ</b>	<b>N1</b>	<b>N2</b>	<b>A3</b>	<b>A4</b>	<b>M5</b>	<b>M6</b>	<b>E7</b>	<b>E8</b>
No response, no relevant evidence.	1a	2a	3a or 1m + 1a or 1e	4a or 1m + 2a or 1e + 1a	2m + 1a or 1m + 3a	3m or 2m + 2a or 1e + 3a	2e + 1a or 1e + 2m	2e + 1m or 2e + 2a

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	$X_L = \omega L = 2\pi \times 25 \times 0.6 = 94.24778$ $= 94.2 \Omega$	<ul style="list-style-type: none"> <li>• ONE of:                             <ul style="list-style-type: none"> <li>- <math>X_L = 2\pi \times 25 \times 0.6</math></li> <li>- <math>X_L = 50\pi \times 0.6</math></li> </ul> </li> </ul>		
(b)	Inserting the iron nail inside the coil will increase the inductance of the inductor, which in turn will increase the reactance of the inductor. This means the impedance of the circuit will increase, and since the size of the supply voltage is constant, the RMS current in the circuit will decrease, so the RMS voltage across the resistor will decrease.	<ul style="list-style-type: none"> <li>• ONE of:                             <ul style="list-style-type: none"> <li>- Flux / B / L <math>\uparrow</math></li> <li>- <math>X_L \uparrow</math></li> <li>- <math>V_L \uparrow</math></li> <li>- <math>Z \uparrow</math></li> <li>- <math>I \downarrow</math></li> <li>- <math>V_R \downarrow</math></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <math>X_L \uparrow, Z \uparrow, V_L \uparrow, I \downarrow, V_R \downarrow</math></li> </ul>	
(c)	In a resonant circuit, the voltages across each of the capacitor and the inductor are equal and opposite to each other. This means that the supply voltage becomes exactly in phase with the current in the circuit [phase angle = 0], giving a maximum amount of voltage (i.e. the supply voltage) across the resistor, causing the RMS current in the circuit to be at its maximum possible value.	<ul style="list-style-type: none"> <li>• ONE of:                             <ul style="list-style-type: none"> <li>- Resonance</li> <li>- <math>X_L = X_C</math></li> <li>- <math>V_L = V_C</math></li> <li>- <math>V_R = V_S</math></li> <li>- <math>Z = R</math></li> <li>- <math>Z \text{ min}</math></li> <li>- <math>I \text{ max}</math></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Resonance</li> <li>AND most of the following:                             <ul style="list-style-type: none"> <li><math>V_L = V_C</math> or <math>X_L = X_C</math></li> <li>explains why <math>X_L = X_C</math></li> <li><math>V_R = V_S</math></li> <li><math>Z = R</math></li> <li><math>Z \text{ min}</math></li> <li><math>I \text{ max}</math></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Explains resonance</li> <li>AND all the following:                             <ul style="list-style-type: none"> <li><math>X_L = X_C</math> opposite cancel out (formula)</li> <li><math>V_R = V_S</math></li> <li><math>Z = R</math></li> <li><math>Z \text{ min}</math></li> <li><math>I \text{ max}</math></li> </ul> </li> </ul>

(d)	$X_C = \frac{1}{\omega C} = \frac{1}{2\pi(16.0)(120 \times 10^{-6})}$ $= 82.8935 \Omega$ $X_L = \omega L = 2\pi(16.0)(0.6)$ $= 60.319 \Omega$ $Z^2 = R^2 + (X_L - X_C)^2$ $Z^2 = (68.0 + 2.4)^2 + (60.319 - 82.893)^2$ $= 73.9309 \Omega$ $I_{\text{RMS}} = \frac{V}{Z} = \frac{9.00}{73.9309}$ $= 0.121735 \text{ A}$	<ul style="list-style-type: none"> <li>• ONE of:             <ul style="list-style-type: none"> <li>- <math>X_L = 60.319 \Omega</math></li> <li>- <math>X_C = 82.8935 \Omega</math></li> <li>- Correct phasor diagram.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• ONE of:             <ul style="list-style-type: none"> <li>- <math>Z = 73.9 \Omega</math></li> <li>- <math>I = 0.126 \text{ A}</math></li> </ul> </li> <li>Correct method but incorrect impedance.</li> </ul>	<ul style="list-style-type: none"> <li>• <math>I = 0.122 \text{ A}</math></li> </ul>
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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response, no relevant evidence.	1a	2a	3a or 1m + 1a or 1e	4a or 1m + 2a or 1e + 1a	2m + 1a or 1m + 3a	3m or 2m + 2a or 1e + 3a	2e + 1a or 1e + 2m	2e + 1m or 2e + 2a

**Cut Scores**

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 18	19 – 24