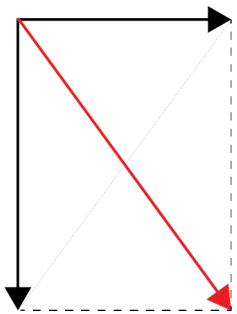
Assessment Schedule – 2022

Physics: Demonstrate understanding of electrical systems (91526)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$X_c = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 54.0 \times 10^{-6}}$ $= 58.946\ \Omega$	• Correct formula and substitution.		
(b)	$Z = \sqrt{R^2 + X_c^2}$ $= \sqrt{36.0^2 + 58.9^2} = 69.1\ \Omega$ Circuit current $= \frac{V_s}{Z} = \frac{25.0}{69.1} = 0.362$ A	• Correct answer for impedance. • Correct current with incorrect impedance.	• Correct answer for circuit current.	
(c)	Accept either an impedance phasor diagram or a voltage phasor diagram.  Current is in phase with resistor voltage: $\theta = \tan^{-1}\left(\frac{58.9}{36.0}\right) = 58.6°$ Current leads supply voltage by 58.6°.	• Correct phasor diagram. OR Recognition that the circuit current is in phase with the resistor voltage. OR Correct value for phase difference OR States that current leads supply voltage.	• Correct value for phase difference as an angle. AND States that current leads supply voltage.	

(d)	Resonance is when the current is a maximum. Current is a maximum when impedance is minimum. This happens when $X_c = X_L$ and $Z = R$ and $V_s = V_R$. So an inductor whose reactance is the same as that of the capacitor should be added to the circuit in order to bring this circuit to resonance.	• ONE condition for resonance.	• ONE error in answer.	• Correct answer.

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

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	$I_{max} = \frac{V_s}{R} = \frac{12.0}{22.0} = 0.545$ A Current after two time constants = $I = I_{max}\left(1 - e^{-2}\right)$ $I = 0.545\left(1 - e^{-2}\right) = 0.471$ A	• Correct value for maximum current. OR Identifies that current changes by 63%.	• Correct answer of 0.471 A.	
(b)	$V_L = 0$, $V_R = 12$ V	• BOTH correct.		
(c)	$V = \frac{L\Delta I}{t}$ $I = \frac{V}{R} = \frac{12.0}{22.0} = 0.545$ A $V = \frac{1.60 \times 0.545}{2.50 \times 10^{-2}} = 34.9$ V Since the induced voltage opposes the change in current, it will try to prevent the current from decreasing and so will act in the same direction as the source voltage.	• Correct value of induced voltage. OR Correct direction of induced voltage	• Correct value of induced voltage. AND Correct direction of induced voltage	
(d)	If the resistance was changed to 44.0 Ω, then the size of the maximum current once it was steady would halve, since $I = \frac{V}{R}$. The increased resistance will have an effect on the time constant as $\tau = \frac{L}{R}$, so time constant would halve. Hence it will take less time for the current to become steady. Since the energy stored in the inductor $E_p = \frac{1}{2}LI^2$, and the current has halved, the energy stored in the inductor once the current is steady would be ¼. Evidence can be taken from calculations to support explanation.	• Any ONE of: - current decreases - time constant decreases - less energy stored in the inductor.	• Any TWO statements with correct reasoning: - Current decrease since $I = \frac{V}{R}$, and R has doubled. - Time constant decreases because R has increased. - Less energy is stored in the inductor as current has decreased and energy stored $= \frac{1}{2}LI^2$.	• Current and time constant have halved with reasons including reasoning out the energy stored in the inductor has decreased by ¼ of its original value.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	1a + 2m	1a + 3m	2a + 1m + 1e	1a + 2m + 1e

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	$C = \frac{\varepsilon_0 \varepsilon_r A}{d} = \frac{8.85\times10^{-12}\times1.00\times0.16}{0.001} = 1.42\times10^{-9}$ F	• Correct working. *This is a SHOW THAT question.		
(b)	Energy stored $= \frac{1}{2}CV^2 = \frac{1}{2}\times1.42\times10^{-9}\times9.00^2$ $= 5.75\times10^{-8}$ J Introducing a dielectric will allow more charge to be stored on the plates, thereby increasing the capacitance 7 times. So, the energy stored will increase 7 times.	• Correct energy stored. OR Energy increases 7 times.	• Correct energy stored AND Capacitance increases 7 times, so energy stored increases 7 times.	
(c)	The charge on the plates remains the same. However, Capacitance, C, decreases as distance, d, between the plates increases $C = \frac{Q}{V}$. So, the voltage across the plates increases.	• One correct statement.	• Two statements with one correct reason.	
(d)	Total capacitance $= \frac{1}{C_T} = \frac{1}{470\,\mu F} + \frac{1}{800\,\mu F}$ $C_T = 296\,\mu F$ Total charge $= Q_T = C_T V = 296\times10^{-6}\times12$ $= 3.552\times10^{-3}$ C Voltage across 470 µF capacitor: $V = \frac{Q}{C} = \frac{3.552\times10^{-3}}{470\times10^{-6}} = 7.56$ V	• Total capacitance. OR Total charge with incorrect capacitance.	• Total charge. OR One error in calculation.	• Correct answer for voltage.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	1a + 2m	1a + 3m	2a + 1m + 1e	1a + 2m + 1e

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 18	19 – 24