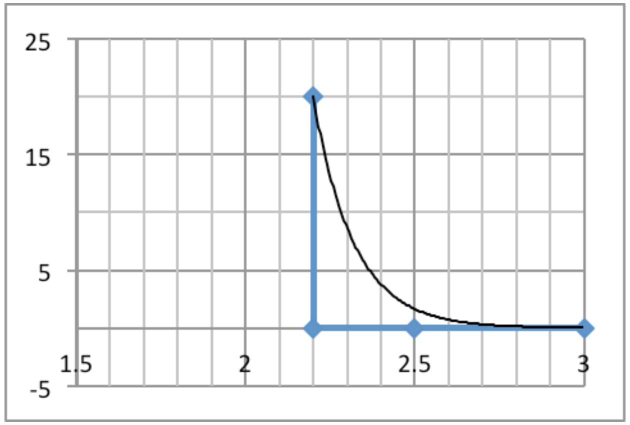
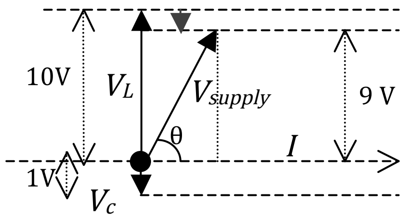
Assessment Schedule – 2011

Physics: Demonstrate understanding of electrical systems (90523)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	$\tau = RC = 1000 \times 0.12 \times 10^{-6} = 120 \times 10^{-6}$ s (or 0.12 ms, 0.12×10^{-3} s, 1.2×10^{-4} s, 0.00012s)	[2] Correct answer.		
(b)		[1] Sketch shows approx exponential decay shape. OR Demonstrates understanding of exponential decay shape with reference to exponential/constant percentage drop per time constant in written answer.	[1] Sketch shows exponential decay shape with roughly 37% of 20V (7.4 V) after 0.12 ms, or clear deliberate attempt to do this.	
(c)	$Q = CV = 0.12 \times 10^{-6} \times 20 = 2.4 \times 10^{-6}$ C 0.24 ms is 2 time constants, so the charge will drop to 37% of its full value, twice. Ie to $0.37 \times 0.37 = 0.137$ 2.4×10^{-5} C $\times 0.1360 = 3.29 \times 10^{-7}$ C/3.25×10^{-7} C	[2] Correct full charge. O TWO time constants calculated.	[2] Correct full charge and correct use of time constant. OR Voltage after TWO time constants found correctly.	[2] Correct working and answer.
(d)	• When the input voltage > V_c, the capacitor **charges**. • When the input voltage < V_c, the **capacitor discharges**. • Because it **takes time** to charge and discharge, the voltage across the capacitor remains more stable than the input. • Because V_c is proportional to Q. • This works if the **time constant** for the circuit is similar or larger than the time period of the signal.	[1] Links smoothing to **charge / discharge** of capacitor.	[1] Explanation includes **time taken** for capacitor to charge / discharge.	[1] Clear links between time constant, changing charge on the capacitor and output voltage.

TWO (a)	$Z = \frac{V}{I} = \frac{10}{0.3} = 33\ \Omega$	[2] Correct working and answer.		
(b)	Time period for the supply is 2.0 s. $\omega = \frac{2\pi}{T} = \frac{2\pi}{2.0} = 3.14\ \text{s}^{-1}$ $X_C = \frac{V}{I} = \frac{1}{0.3} = 3.3\ \Omega = \frac{1}{\omega C}$ $C = \frac{1}{\omega X_C} = \frac{1}{3.14 \times 3.3} = 0.096\ \text{F}$	[2] Correct calculation of ω, T, f or X_c.	[2] Correct calculation of ω and X_c.	[2] Complete correct answer.
(c)	 $\sin\theta = \frac{9}{10}\ \theta = 64°$ or 1.1 rad. 1.1Rad	[1] Shows $V_{L,}$ V_C V_S phasors in the correct directions.	[2] Complete diagram showing enough correct detail for calculation of phase angle.	[2] Complete correct answer.
(d)	$V_L > V_C$ resonance occurs when $V_L = V_C$ (and $X_L = X_C$) $X_L \propto f$ and $X_C \propto \frac{1}{f}$ Thus the frequency should be reduced, decreasing X_L and increasing X_C	[1] Demonstrates understanding of the condition for resonance. OR Demonstrates understanding of how capacitive and inductive reactance are related to frequency.	[1] Demonstrates understanding of the condition for resonance, AND Demonstrates understanding of how capacitive and inductive reactance are related to frequency.	
THREE (a)	Resistance of circuit: 2.0 + 4.0 + 300 = 306 Ω Current in circuit $I = \frac{V}{R} = \frac{1.48}{306} = 4.83 \times 10^{-3}$ A 4.84 mA	[2] Correct resistance.	[2] Correct answer.	

(b)	The voltage across the load will be **much lower** than in (a) because • The cell will drive a large current through the switch because it is a low resistance path • causing a larger voltage drop across the internal resistance and the inductor, • because the total voltage around the loop cannot exceed 1.48 V OR Assuming the switch has no resistance, there is no voltage drop across the switch, even with a high current. The load is in parallel with the switch so it too has no voltage – hence the voltage is **much lower** than in (a).	[1] Lower voltage with one bullet point reason. OR Zero / **much** lower voltage.	[1] Correct answer (much lower Voltage across load) with clear complete reasoning.	
(c)	When the switch turns off, there is rapid drop in current, so a large emf is induced in the forward direction to keep the current going (by Faraday's law). Because this emf is proportional to the rate of change of current, the rapid decrease in current produces an emf greater than the battery.	[1] Voltage induced in the coil / due to change in I / Φ / magnetic field.	[1] High Voltage induced in the coil / due to **rapid** change in I / Φ / magnetic field.	[1] Complete answer showing clear link between induced voltage, rapid drop that causes it: also states **or implies** that this **must only** be from the switch **opening** in order to add to the cell EMF (because Lenz's law applies).
(d)	Applying Kirchhoff's voltage law: $V = 1.48 + 15 = 16.48$ $R = 2 + 4 + 300 = 306$ $I = \frac{V}{R} = \frac{16.48}{306}$ $V = IR = \frac{16.48}{306} \times 300 = 16.16\ \text{V}$	[2] Adds resistors to find total resistance in circuit.	[2] Correctly writes equation using Kirchhoff's voltage law. OR correct current OR Correct ratio $V = 300 / 306 \times 16.48$	[2] Correct answer.

Judgement Statement

Achievement	Achievement with Merit	Achievement with Excellence
1 **A1** + 1 **A2**+ 2 **A**	1 **M1** + 1 **M2** + 1 **M** + 3 **A**	1 **E1** + 1 **E2** + 2 **M** + 2 **A**

Note: where the criterion is not specified, the required grade(s) can be from either.