# Marking Scheme

#1

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (a) | | Correct phasor diagram, labelled<br>Explanation of subtracting reactances<br>Pythagoras or similar for final step  | 3 | | | 3 | | |
| | (b) | (i) | Substitution into $X_L=\omega L$ (1)<br>Substitution into $X_C=(\omega C)^{-1}$ (1)<br>511-91 = 420 [Ω] (1) | 1<br>1 | <br><br>1 | | 3 | 1 | |
| | | (ii) | $420\sqrt{2}$ or similar seen for impedance e.g. $\sqrt{R+R}$ (1)<br>Use of $I=\frac{V}{Z}$ (1)<br>Answer = 7.58 m[A] (1) | | 3 | | 3 | 3 | |
| | | (iii) | 45° | | 1 | | 1 | 1 | |
| | | (iv) | Shape correct (1)<br>Max current = 10.7 m[A] (approx., by eye) (1)<br>Explanation or horizontal line right from 4 150 Hz point (1) | 1 | <br>1<br>1 | | 3 | 1 | |
| | | (v) | Either $X_L$ = 511 or $X_C$ = 91 used **OR** quadratic equation set up (1)<br>Answer = 23 250 [Hz] (1) | | 2 | | 2 | 1 | |
| | (c) | | Period = 0.333 m[s](1)<br>So 1 cycle is 3.33 [cm] (1)<br>Peak pd is 0.85 [V] (1)<br>i.e. 4 and a bit squares (1)<br>Conclusion: Time scale OK, volts/div not quite (1) | | | 5 | 5 | 3 | |
| | | | **Question total** | **6** | **9** | **5** | **20** | **10** | **0** |

#2

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 11 | (a) | (i) | 1.8 - 1.9 squares for peak (or 3.6 - 3.8 for double)<br>Or 0.002× and $I/\sqrt{2}$ (1)<br>Answer = 2.5 – 2.7 mV (1) | | 2 | | 2 | 2 | |
| | | (ii) | 7.9 - 8.3 squares for period<br>Or 0.05 × and $f = \frac{1}{T}$ (1)<br>Answer = 2.4 – 2.5 Hz (1) | | 2 | | 2 | 2 | |
| | (b) | (i) | Pd proportional to rate of change/cutting of flux (linkage) (1)<br>Rate of change/cutting is proportional (accept increases with) angular velocity (1) | 2 | | | 2 | | |
| | | (ii) | Vertical: no flux cut/flux does not change (1)<br>Horizontal: flux cut/changes at max rate (1)<br>**Alternative:** rate of change/cutting depends on angle (1)<br>Clarification e.g. vertical component of velocity does cutting<br>Or vertical/horizontal positions explained briefly (1) | 2 | | | 2 | | |
| | (c) | (i) | Pds across $C$ and $L$ cancel or equivalent (1)<br>$I = \frac{15}{120}$ (1) | 1 | 1 | | 2 | 1 | |
| | | (ii) | Valid method employed e.g. $X_C = X_L$ (1)<br>Answer = 15 850 Hz (1) | | 2 | | 2 | 1 | |
| | | (iii) | $X_C$ and $X_L$ calculated correctly (or implied, 2 229, 2 564) (1)<br>Impedance equation used (1)<br>$I = \frac{15}{355}$ seen or 42.3 mA (1) | 1 | 1<br>1 | | 3 | 2 | |
| | | (iv) | RMS values used – correct (1)<br>Current not in phase with pd or all pd not across R (1)<br>Actual power is $I_{rms}^2 R$ or equivalent (1)<br>Real value is 0.21 W (1)<br>Conclusion – invalid calculation (1)<br>Or<br>Current not in phase with pd so cannot use $\langle P \rangle = V_{rms} I_{rms}$ (1)<br>So Alistair is incorrect (1)<br>Only resistor dissipates power so $\langle P \rangle = I_{rms}^2 R$ is valid (1)<br>So real value is 0.21 W (1)<br>So Michonne is correct (1) | | | 5 | 5 | 2 | |
| | | | **Question 11 total** | **6** | **9** | **5** | **20** | **10** | **0** |

#3

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 11 | (a) | | $X_L = X_C$ or impedance cancel or $V_L = V_C$ [1]<br>$\omega L = \frac{1}{\omega C}$ [1]<br>$\omega = 2\pi f$ and reasonable algebra [1] | 3 | | | 3 | 1 | |
| | (b) | (i) | $I = \frac{V}{R} = \frac{15}{28} = 0.536$ [A] | | 1 | | 1 | 1 | |
| | | (ii) | Resonance frequency = 11.35 k[Hz] calculated or implied [1]<br>$X_L$ or $X_C$ calculated e.g. 3440 [Ω] or 851 [Ω] [1]<br>Total impedance calculated or implied [$Z$ = 2589 Ω] [1]<br>$I = \frac{V}{Z}$ giving answer = 5.8 m[A] [1] | | 4 | | 4 | 4 | |
| | | (iii) | $Q = \frac{\omega L}{R}$ or similar used [1]<br>Answer = 61.4 [1] | 1 | 1 | | 2 | 1 | |
| | | (iv) | Shape correct [1]<br>Asymptotes correct [1]<br>$I$ at $2f$ much smaller than $I$ at $f$ [1] | 1<br>1 | 1 | | 3 | | |
| | | (v) | Same shape & resonant frequency [1]<br>Peak is half height (by eye or labelled) [1] | | 2 | | 2 | | |
| | (c) | | Statement that $X_L$ increases with frequency or vice versa [1]<br>$\omega L$ obtained at 82.5 Hz giving 27.99 Ω or 28 Ω [1]<br>$Z$ obtained as 39.6 Ω or realising $\frac{V_0}{\sqrt{2}}$ or equivalent [1]<br>$V_{out}$ confirmed as 4.25 V [1]<br>Correct conclusion stated [1] | | | 5 | 5 | 3 | |
| | | | **Question 11 total** | **6** | **9** | **5** | **20** | **10** | **0** |

#4

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (a) | (i) | Converting peak to rms (1)<br>Answer = 3.9 [A] (1) | 1 | 1 | | 2 | 1 | |
| | | (ii) | Use of $P = I^2 R$ (1)<br>Answer = 64 [Ω] (1) | 1 | 1 | | 2 | 1 | |
| | (b) | | Use of $X_C = \frac{1}{\omega C}$ to explain frequency variation (1)<br>Realisation that $X_C$ is large at low freq or low at high freq (1)<br>Hence 68 Ω at high freq (1)<br>Infinite/high at zero freq/low freq (1)<br>Helen is wrong on both counts (1) | | | 5 | 5 | 2 | |
| | (c) | (i) | All pd across $R$ at resonance or reactances of capacitor and inductor cancel (accept $Z = R$ at resonance) (1)<br>$I = \frac{12}{18}$ or 667 m[A] or 0.67[A] etc. (1) | 2 | | | 2 | 1 | |
| | | (ii) | Use of valid equation e.g. $\omega^2 = \frac{1}{LC}$ (1)<br>$f = \sqrt{\frac{1}{4\pi^2 \times 0.0052 \times 13.5 \times 10^{-6}}}$ or 600.7 [Hz] (1) | 1 | 1 | | 2 | 1 | |
| | | (iii) | $X_L$ or $X_C$ calculated correctly (29.4 or 13.1) (1)<br>Calculation of $Z = \sqrt{(X_L - X_C)^2 + R^2}$ (= 24.3 Ω) (1)<br>Use of $I = \frac{V}{Z}$ (1)<br>Answer = 0.494 [A] (1) | 1 | 1<br>1<br>1 | | 4 | 1 | |
| | | (iv) | $X_L$ decreases by 1.5 or $X_C$ increases by 1.5 (accept 2.25) (1)<br>$X_L$ and $X_C$ swap values from part (iii) (1)<br>$\sqrt{(X_L - X_C)^2 + R^2}$ or $(X_L - X_C)^2$ is unaffected (1) | | 3 | | 3 | 3 | |
| | | | **Question total** | **6** | **9** | **5** | **20** | **10** | **0** |