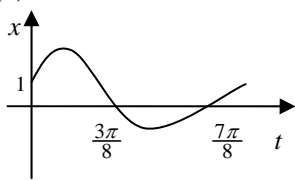


Question number	Scheme	Marks
1.	$\sum_{r=1}^n (r-1)(r+2) = \sum_{r=1}^n r^2 + \sum_{r=1}^n r - \left(\sum_{r=1}^n\right)^2$ $= \frac{1}{6}n(n+1)(2n+1) + \frac{1}{2}n(n+1), -2n$ $= \frac{1}{6}n(2n^2 + 6n - 8) \quad \text{M: Use factor } n \text{ and use common denom. (e.g.3, 6, 12)}$ $= \frac{1}{3}n(n^2 + 3n - 4) = \frac{1}{3}(n-1)n(n+4) \quad \text{M: Attempt complete factorisation (*)}$	<p>M1</p> <p>A1, A1</p> <p>M1</p> <p>M1 A1 cso (6)</p> <p>Total 6 marks</p>
2.	<p>2 is a 'critical value', e.g. used in solution, or $x = 2$ seen as an asymptote</p> $x^2 = 2x^2 - 4x \Rightarrow x^2 - 4x = 0$ <p>$x = 0, \quad x = 4$ M1: two other critical values</p> <p>$x < 0$</p> <p>$2 < x < 4$ M1: An inequality using the critical value 2</p>	<p>B1</p> <p>M1 A1</p> <p>B1</p> <p>M1 A1 (6)</p> <p>Total 6 marks</p>
3.	<p>(a) $z + 2i = iz + \lambda$ $(1-i)z = \lambda - 2i,$ $z = \frac{\lambda - 2i}{1-i}$</p> $z = \frac{\lambda - 2i}{1-i} \times \frac{1+i}{1+i}, = \frac{1}{2}(\dots\dots\dots)$ $= \left(\frac{\lambda}{2} + 1\right) + \left(\frac{\lambda}{2} - 1\right)i \quad (*)$ <p>(b) $\frac{\frac{\lambda}{2} - 1}{\frac{\lambda}{2} + 1} = \frac{1}{2}, \quad \lambda = 6$ 2^{nd} M: Solving $\frac{\frac{\lambda}{2} - 1}{\frac{\lambda}{2} + 1} = k$ (constant k)</p> <p>(c) $z = 4 + 2i, \quad z ^2 = 4^2 + 2^2 = 20$ M: Subs. λ value and attempt z or $z ^2$</p>	<p>M1, A1</p> <p>M1, A1</p> <p>A1 cso (5)</p> <p>M1, M1 A1 (3)</p> <p>M1 A1 (2)</p> <p>Total 10 marks</p>

Question number	Scheme	Marks
4.	<p>(a) $m^2 + 2m + 5 = 0 \Rightarrow m = -1 \pm 2i$</p> <p>$x = e^{-t} (A \cos 2t + B \sin 2t)$ M: Correct form (needs the two different constants)</p> <p>(b) $(1, 0) \Rightarrow A = 1$</p> <p>$\dot{x} = -e^{-t} (A \cos 2t + B \sin 2t) + e^{-t} (-2A \sin 2t + 2B \cos 2t)$ M: Product diff. attempt</p> <p>With $A = 1$, $e^{-t} \{ \cos 2t(-1 + 2B) + \sin 2t(-B - 2) \}$</p> <p>$\dot{x} = 1, t = 0 \Rightarrow 1 = -A + 2B$</p> <p>$B = 1$ ($x = e^{-t} (\cos 2t + \sin 2t)$) M: Use value of A to find B.</p> <p>(c)</p>  <p>'Single oscillation' between 0 and π</p> <p>Decreasing amplitude (dep. on a turning point)</p> <p>Initially increasing to maximum</p> <p>Any <u>one</u> correct intercept, whether in terms of π or not: 1 or $\frac{3\pi}{8}$ or $\frac{7\pi}{8}$</p> <p>(Allow degrees: 67.5° or 157.5°) (Allow awrt 0.32π or 1.18 or 2.75)</p>	<p>M1 A1</p> <p>M1 A1 (4)</p> <p>dB1</p> <p>dM1</p> <p>M1</p> <p>dM1 A1cso (5)</p> <p>B1</p> <p>B1ft</p> <p>B1ft</p> <p>B1 (4)</p> <p>Total 13 marks</p>

5.	<p>(a) $f(1.8) = 19.6686... - 20 = -0.3313...$ Allow awrt ± 0.33</p> <p>$f(2) = 20.6424... - 20 = 0.6424...$ Allow awrt ± 0.64</p> <p>$\frac{\alpha - 1.8}{\text{"0.33"}} = \frac{2 - \alpha}{\text{"0.64"}}, \left(\alpha = 1.8 + \frac{0.33}{0.33 + 0.64} \times 0.2 \right)$ 1.87</p> <p>(b) $f(1.9) \approx 0.1651795...$, or just $1.9 + 6 - 20e^{-0.5 \times 1.9}$ Allow awrt 0.165</p> <p>$f'(t) = 1 + 10e^{-0.5t}$ M1 A1</p> <p>$f'(1.9) = 4.8674...$, or just $1 + 10e^{-0.5 \times 1.9}$ Allow awrt 4.87</p> <p>$\alpha_2 = 1.9 - \frac{0.16518}{4.867410} \approx 1.866$ M1 A1 (6)</p> <p>(c) 112 (min) (1 h 52 m) B1 (1)</p>	<p>B1</p> <p>B1</p> <p>M1, A1 (4)</p> <p>B1</p> <p>M1 A1</p> <p>A1</p> <p>M1 A1 (6)</p> <p>B1 (1)</p> <p>Total 11 marks</p>
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Question number	Scheme	Marks
6.	<p>(a) $\frac{dy}{dx} = v + x \frac{dv}{dx}$</p> <p>$v + x \frac{dv}{dx} = \frac{3x - 4vx}{4x + 3vx}$ (All in terms of v and x)</p> <p>$x \frac{dv}{dx} = \frac{3 - 4v - v(4 + 3v)}{4 + 3v}$ (Requires $x \frac{dv}{dx} = f(v)$, 2 terms over common denom.)</p> <p>$x \frac{dv}{dx} = -\frac{3v^2 + 8v - 3}{3v + 4}$ (*)</p> <p>(b) $\frac{3v + 4}{3v^2 + 8v - 3} dv = -\frac{1}{x} dx$ Separating variables</p> <p>$\pm \ln x$</p> <p>$\frac{1}{2} \ln(3v^2 + 8v - 3)$ M: $k \ln(3v^2 + 8v - 3)$</p> <p>$\frac{1}{2} \ln\left(\frac{3y^2}{x^2} + \frac{8y}{x} - 3\right) = -\ln x + C$ Or any equivalent form</p> <p>(c) $\frac{3y^2}{x^2} + \frac{8y}{x} - 3 = \frac{A}{x^2}$ Removing \ln's correctly at any stage, dep. on having C.</p> <p>Using (1, 7) to form an equation in A (need not be $A = \dots$)</p> <p>(1, 7) $\Rightarrow 3 \times 49 + 56 - 3 = A \Rightarrow A = 200$ (or equiv., can still be \ln)</p> <p>$3y^2 + 8yx - 3x^2 = 200$</p> <p>$(3y - x)(y + 3x) = 200$ (M dependent on the 2 previous M's) (*)</p>	<p>B1</p> <p>M1</p> <p>M1</p> <p>A1 cso (4)</p> <p>M1</p> <p>B1</p> <p>M1 A1</p> <p>A1 (5)</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>M1 A1 cso (5)</p> <p>Total 14 marks</p>

Question number	Scheme	Marks
7.	<p>(a)(i) $r^2 \sin^2 \theta = a^2 \cos 2\theta \sin^2 \theta = a^2 (1 - 2 \sin^2 \theta) \sin^2 \theta$ $(= a^2 (\sin^2 \theta - 2 \sin^4 \theta))$</p> <p>(ii) $\frac{d}{d\theta} (a^2 (\sin^2 \theta - 2 \sin^4 \theta)) = a^2 (2 \sin \theta \cos \theta - 8 \sin^3 \theta \cos \theta), = 0$</p> <p>$2 = 8 \sin^2 \theta$ (Proceed to $a \sin^2 \theta = b$)</p> <p>$\sin \theta = \frac{1}{2} \Rightarrow \theta = \frac{\pi}{6}, r = \frac{a}{\sqrt{2}}$ (*)</p> <p>(b) $\frac{a^2}{2} \int \cos 2\theta d\theta = \frac{a^2}{4} \sin 2\theta$ M: Attempt $\frac{1}{2} \int r^2 d\theta$, to get $k \sin 2\theta$</p> <p>$\left[\dots \right]_{\pi/6}^{\pi/4} = \frac{a^2}{4} \left[1 - \frac{\sqrt{3}}{2} \right]$ M: Using correct limits</p> <p>$\Delta = \frac{1}{2} \left(\frac{a}{\sqrt{2}} \cdot \frac{1}{2} \right) \times \left(\frac{a}{\sqrt{2}} \cdot \frac{\sqrt{3}}{2} \right) = \frac{\sqrt{3}a^2}{16}$ M: Full method for rectangle or triangle</p> <p>$R = \frac{\sqrt{3}a^2}{16} - \frac{a^2}{4} \left[1 - \frac{\sqrt{3}}{2} \right] = \frac{a^2}{16} (3\sqrt{3} - 4)$ M: Subtracting, either way round (*)</p>	<p>B1 (1)</p> <p>M1 A1, M1</p> <p>M1</p> <p>A1, A1 cso (6)</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p>dM1 A1 cso (8)</p> <p>Total 15 marks</p>