Question Number	Scheme	Marks
1.	$\Sigma 6r^2 - \Sigma 6 = n(n+1)(2n+1)\ ,\ -6n$	M1, A1
	$= n(2n^2 + 3n - 5)$	M1
	$= n(n-1)(2n-5)$ (✱)	A1
		(4 marks)
2. (*a*)	$f'(x) = 2e^{2x} - 15$	M1
	$f'(x) = 2e^{3.2} - 15$ (= 34.065…)	A1
	$\alpha_2 = 1.6 - \dfrac{e^{3.2} - (15 \times 1.6) - 2}{f'(1.6)}$	M1, A1
	$= 1.6 - \left(\dfrac{-1.467...}{34.065...}\right) = 1.64$	A1 **(5)**
(*b*)	f(1.635) = …. f(1.645) = ….	M1
	= –0.213… = 0.167…	
	Sign change, ∴ Root is 1.64 to 3 s.f.	A1 **(2)**
		(7 marks)
3. (*a*)	$(2i)^4 - 6(2i)^3 + 17(2i)^2 - 24(2i) + 52$	
	$= 16 + 48i - 68 - 48i + 52 = 0$	B1 **(1)**
(*b*)	$-2i$ is also a root	B1
	$(x - 2i)(x + 2i) = x^2 + 4$	A1
	$(x^2 + 4)(x^2 - 6x + 13)$	M1, A1
	$x = \dfrac{6 \pm \sqrt{36 - 52}}{2} = 3 \pm 2i$	M1, A1 **(6)**
		(7 marks)

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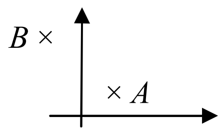
Question Number	Scheme	Marks
4.	$(x > 0)$ $2x^2 - 5x > 3$ or $2x^2 - 5x = 3$	M1
	$(2x + 1)(x - 3)$, critical values $-½$ and 3	A1, A1
	$x > 3$	A1 ft
	$x < 0$ $2x^2 - 5x < 3$	M1
	Using critical value 0: $-½ < x < 0$	M1, A1 ft
Alt.	$2x - 5 - \frac{3}{x} < 0$ or $(2x - 5)x^2 > 3x$	M1
	$\frac{(2x+1)(x-3)}{x} > 0$ or $x(2x + 1)(x - 3) > 0$	M1, A1
	Critical values $-½$ and 3, $x > 3$	A1, A1 ft
	Using critical value 0, $-½ < x < 0$	M1, A1 ft
		(7 marks)
5. (*a*)	$\lvert w \rvert = \sqrt{50}$ (or equivalent)	B1 **(1)**
(*b*)		B1 **(1)**
(*c*)	$\lvert \overrightarrow{OA} \rvert = 5$	B1
	$\overrightarrow{BA} = \begin{pmatrix} 4 \\ -3 \end{pmatrix}$ $\lvert \overrightarrow{BA} \rvert = 5$, $\therefore$ isosceles	M1, A1
	$5^2 + 5^2 = (\sqrt{50})^2$, $\therefore$ right-angled (or gradient method)	M1, A1 **(5)**
(*d*)	$\arg\left(\frac{z}{w}\right) = \arg z - \arg w$	M1
	$= (-)\angle AOB = \frac{\pi}{4}$	M1, A1 **(3)**
		(10 marks)

Question Number	Scheme	Marks
6. (*a*)	$\frac{\mathrm{d}y}{\mathrm{d}x} + y\left(\frac{\sin x}{\cos x}\right) = \cos^2 x$	M1
	Int. factor $\mathrm{e}^{\int \tan x \,\mathrm{d}x} = \mathrm{e}^{-\ln(\cos x)} = \sec x$	M1, A1
	Integrate: $y \sec x = \int \cos x \,\mathrm{d}x$	M1 , A1
	$y \sec x = \sin x + C$	A1
	$(y = \sin x \cos x + C \cos x)$	**(6)**
(*b*)	When $y = 0$, $\cos x(\sin x + C) = 0$, $\cos x = 0$	M1
	2 solutions for this $(x = {}^{\pi}/_{2}, {}^{3\pi}/_{2})$	A1 **(2)**
(*c*)	$y = 0$ at $x = 0$: $C = 0$: $y = \sin x \cos x$	M1
	$(y = ½ \sin 2x)$ Shape	A1
	Scales	A1 **(3)**
		(11 marks)

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Question Number	Scheme	Marks
7. (*a*)	$2m^2 + 7m + 3 = 0$ $\quad (2m+1)(m+3) = 0$	
	$m = -\tfrac{1}{2},\ -3$	
	C.F. is $y = Ae^{-\frac{1}{2}t} + Be^{-3t}$	M1, A1
	P.I. $y = at^2 + bt + c$	B1
	$y' = 2at + b, \quad y'' = 2a$	
	$2(2a) + 7(2at + b) + 3(at^2 + bt + c) \equiv 3t^2 + 11t$	M1
	$3a = 3, \quad a = 1 \qquad 14 + 3b = 11, \quad b = -1$	A1
	$4 - 7 + 3c = 0, \quad c = 1$	M1, A1
	General solution: $y = Ae^{-\frac{1}{2}t} + Be^{-3t} + (t^2 - t + 1)$	A1 ft **(8)**
(*b*)	$y' = -\tfrac{1}{2}Ae^{-\frac{1}{2}t} - 3Be^{-3t} + (2t - 1)$	M1
	$t = 0,\ y' = 1: \quad 1 = -1 - \tfrac{1}{2}A - 3B$	
	$t = 0, y = 1: \quad 1 = 1 + A + B$ one of these	M1, A1
	Solve: $A + B = 0, \quad A + 6B = -4$	
	$A = {}^4/_5,\ B = -{}^4/_5$	M1
	$y = (t^2 - t + 1) + \dfrac{4}{5}(e^{-\frac{1}{2}t} - e^{-3t})$	A1 **(5)**
(*c*)	$t = 1: \quad y = \dfrac{4}{5}(e^{-\frac{1}{2}} - e^{-3}) + 1 \qquad (= 1.445\ldots)$	B1 **(1)**
		(14 marks)

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Question Number	Scheme	Marks
8. (*a*)	$y = r\sin\theta = a(3\sin\theta + \sqrt{5}\sin\theta\cos\theta)$	
	$\dfrac{\mathrm{d}y}{\mathrm{d}\theta} = a(3\cos\theta + \sqrt{5}\cos 2\theta)$	M1, A1
	$2\sqrt{5}\cos^2\theta + 3\cos\theta - \sqrt{5} = 0$	
	$\cos\theta = \dfrac{-3 \pm \sqrt{9+40}}{4\sqrt{5}}$, $\cos\theta = \dfrac{1}{\sqrt{5}}$	M1, A1
	$\theta = \pm 1.107\ldots$	A1 ft
	$r = 4a$	A1 ft **(6)**
(*b*)	$2r\sin\theta = 20$	M1
	$8a\sin\theta = 20$, $a = \dfrac{20}{8\sin\theta} = 2.795\ldots$	M1, A1 **(3)**
(*c*)	$(3+\sqrt{5}\cos\theta)^2 = 9 + 6\sqrt{5}\cos\theta + 5\cos^2\theta$	B1
	Integrate: $9\theta + 6\sqrt{5}\sin\theta + 5\left(\dfrac{\sin 2\theta}{4} + \dfrac{\theta}{2}\right)$	M1, A1
	Limits used: $\left[\ldots\right]_0^{2\pi} = 18\pi + 5\pi$ (or upper limit: $9\pi + \dfrac{5\pi}{2}$)	A1
	$½\int_0^{2\pi} r^2 d\theta = a^2(23\pi) \approx 282\ \text{m}^2$	M1, A1 **(6)**
		(15 marks)

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