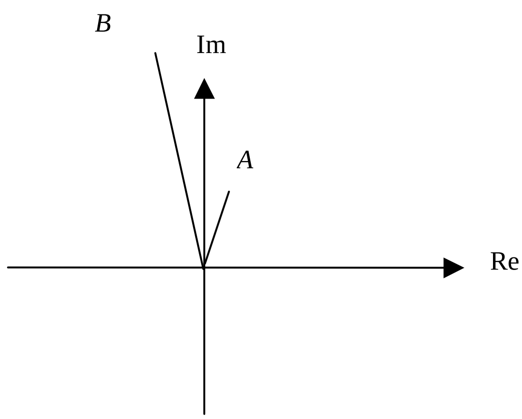
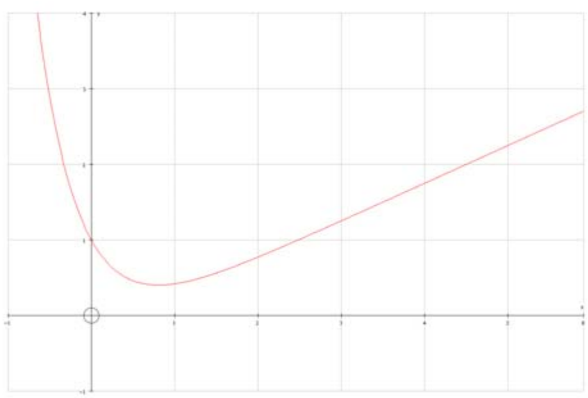
Question number	Scheme	Marks
1. (a)	Expand brackets and attempt to use appropriate formulae.	**M1**
	$\sum r^2 + 6r + 5 = \frac{n}{6}(n+1)(2n+1) + 6\frac{n}{2}(n+1) + 5n$	**A1**
	$= \frac{n}{6}[2n^2 + 3n + 1 + 18n + 18 + 30]$	**M1**
	$= \frac{n}{6}[2n^2 + 21n + 49] = \frac{n}{6}(n+7)(2n+7)$ *	**A1** **(4)**
(b)	Use S(40) – S(9) = $\frac{40}{6}\times 47\times 87 - \frac{9}{6}\times 16\times 25$	**M1**
	= 26660	**A1** **(2)**
2. (a)	f(1) = -1 and f(2) = 2	**B1**
	$\frac{2}{1} = \frac{2-\alpha}{\alpha - 1} \quad \rightarrow \quad \alpha = 1\tfrac{1}{3}$	**B1** **(2)**
(b)	$f'(x) = 2^x \ln 2 + 1$ Attempts $f'(x)$	**M1**
	$f'(1) = 2\ln 2 + 1$	**A1**
	$\therefore \alpha = 1 - \frac{(-1)}{2\ln 2 + 1}$ Uses Newton Raphson	**dM1**
	$= \frac{2\ln 2 + 2}{2\ln 2 + 1} = 1.419$ any correct answer	**A1** **(4)**

Question number	Scheme	Marks
3. (a)	$z = a + ib \rightarrow (a^2 - b^2) + 2abi = -16 + 30i$	**M1**
	Equating imaginary parts $2ab = 30$ and thus $ab = 15$ *	**A1** **(2)**
(b)	Also $(a^2 - b^2) = -16$	**B1**
	Attempt to solve by valid method involving elimination of unknown	**M1**
	$\therefore z = 3 + 5i$ or $z = -3 - 5i$	**A1 A1** **(4)**
4.	Solves $x^2 - 2 = 2x$ by valid method	**M1**
	Obtains $x = 1 \pm \sqrt{3}$ or equivalent (may only obtain relevant root if graph is used)	**A1**
	Solves $2 - x^2 = 2x$	**M1**
	Obtains $x = -1 \pm \sqrt{3}$	**A1**
	Rejects two of these roots and obtains (or uses graph and obtains)	**dM1**
	$x > 1 + \sqrt{3}$, $x < -1 + \sqrt{3}$	**A1, A1** **(7)**
	Special case:	
	Squares both sides to obtain quadratic in x^2 and solve to obtain $x^2 = 4 \pm 2\sqrt{3}$	***M1 A1***
	Obtains $x = 1 \pm \sqrt{3}$ or $x = -1 \pm \sqrt{3}$	***M1A1***
	Last three marks as before.	***dM1A1A1*** ***(7)***

Question number	Scheme	Marks
5. (a)	$w = (1+\sqrt{3}i)(2+2i)$	
	$= (2-2\sqrt{3}), +(2\sqrt{3}+2)\,\mathrm{i}$	M1 A1, A1 (3)
(b)	$\arg w = \arctan\left(\dfrac{2\sqrt{3}+2}{2-2\sqrt{3}}\right)$ or adds two args e.g. $60^{O}+45^{O}$	M1
	$= \dfrac{7\pi}{12}$ *or* 105^{o} or 1.83 radians	A1 (2)
(c)	$\lvert w\rvert = \sqrt{32} = 4\sqrt{2}$	M1 A1 (2)
(d)	 f.t. *w* in quadrant other than first	B1 B1 (2)
(e)	$\lvert AB\rvert^2 = 4+32-16\sqrt{2}\cos 45$ (=20), then square root	M1
	AB = $2\sqrt{5}$	A1 (2)
	Or $w-z = 1-2\sqrt{3}+i(2+\sqrt{3})$	M1
	$\therefore AB = \lvert w-z\rvert = \sqrt{(1-2\sqrt{3})^2+(2+\sqrt{3})^2}$ $=\sqrt{20} = 2\sqrt{5}$	A1c.a.o (2)

Question number	Scheme		Marks
6. **(a)**	Integrating Factor $= e^{2x}$	Min point and passing through (0,1)	**B1**
	$\frac{d}{dx}(ye^{2x}) = xe^{2x}$		**M1**
	$ye^{2x} = \frac{1}{2}xe^{2x} - \int \frac{1}{2}e^{2x}dx$		**M1**
	$= \frac{1}{2}xe^{2x} - \frac{1}{4}e^{2x} + c$	shape	**A1**
	$\therefore y = \frac{1}{2}x - \frac{1}{4} + ce^{-2x}$		**A1**
			(5)
(b)	$1 = c - \frac{1}{4} \to c = \frac{5}{4}$		**M1**
	$\therefore y = \frac{1}{2}x - \frac{1}{4} + \frac{5}{4}e^{-2x}$ and $\frac{dy}{dx} = \frac{1}{2} - \frac{5}{2}e^{-2x}$		**M1**
	When $y' = 0$, $e^{-2x} = \frac{1}{5}$ $\therefore 2x = \ln 5$		**M1**
	$x = \frac{1}{2}\ln 5$, $y = \frac{1}{4}\ln 5$ at minimum point.		**A1**
			(4)
(c)			**B1**
			B1
			(2)

Question number	Scheme	Marks
7. (a)	Auxiliary equation: $m^2+2m+2=0 \to m=-1\pm i$	M1
	Complementary Function is $y=e^{-t}(A\cos t+B\sin t)$	M1A1
	Particular Integral is $y=\lambda e^{-t}$, *with* $y'=-\lambda e^{-t}$, *and* $y''=\lambda e^{-t}$	M1
	$\therefore(\lambda-2\lambda+2\lambda)e^{-t}=2e^{-t}\to\lambda=2$	A1
	$\therefore y=e^{-t}(A\cos t+B\sin t+2)$	B1 (6)
(b)	Puts 1 = A+2 and solves to obtain A = -1	M1,
	$y'=e^{-t}(-A\sin t+B\cos t)-e^{-t}(A\cos t+B\sin t+2)$	M1 A1ft
	Puts 1 = B – A – 2 and uses value for A to obtain B	M1
	B=2	A1cso
	$\therefore y=e^{-t}(2\sin t-\cos t+2)$	A1cso
		(6)

Question number	Scheme	Marks
8. (a)	$3a(1-\cos\theta) = a(1+\cos\theta)$	**M1**
	$2a = 4a\cos\theta \to \cos\theta = \frac{1}{2}$ $\therefore \theta = \frac{\pi}{3}$ *or* $-\frac{\pi}{3}$	**M1**
	$r = \frac{3a}{2}$	**A1 A1**
	[Co-ordinates of points are $(\frac{3a}{2}, \frac{\pi}{3})$ and $(\frac{3a}{2}, -\frac{\pi}{3})$]	**(4)**
(b)	$AB = 2r\sin\theta = \dfrac{3a\sqrt{3}}{2}$	**M1A1**
		(2)
(c)	Area = $\int_{-\frac{\pi}{3}}^{\frac{\pi}{3}} \frac{1}{2} r^2 d\theta$	
	$= \frac{1}{2}\int [a^2(1+\cos\theta)^2 - 9a^2(1-\cos\theta)^2]d\theta$	**M1 M1**
	$= \frac{a^2}{2}\int [1+2\cos\theta+\cos^2\theta - 9(1-2\cos\theta+\cos^2\theta)]d\theta$	**A1**
	$= \frac{a^2}{2}\int [-8+20\cos\theta-8\cos^2\theta]d\theta$	
	$= \text{k}[-8\theta+20\sin\theta \ldots$	**B1**
	$\ldots\ldots -2\sin 2\theta - 4\theta]$	**B1**
	Uses limits $\frac{\pi}{3}$ and $-\frac{\pi}{3}$ correctly or uses twice smaller area and uses limits $\frac{\pi}{3}$ and 0 correctly.(Need not see 0 substituted)	**M1**
	$= a^2[-4\pi+10\sqrt{3}-\sqrt{3}]$ or $= a^2[-4\pi+9\sqrt{3}]$ or $3.022\,a^2$	**A1**
		(7)
(d)	$3a\dfrac{\sqrt{3}}{2} = 4.5 \to a = \sqrt{3}$	**B1**
	$\therefore$ Area = $3[9\sqrt{3}-4\pi]$, $= 9.07\,\text{cm}^2$	**M1, A1**
		(3)