Question Number	Scheme	Marks
4		
(a)	$\left\|18\sqrt{3}-18\text{i}\right\| = 18\sqrt{(3+1)} = 36$	B1
	$\tan\theta = \dfrac{-18}{18\sqrt{3}} \quad \theta = -\dfrac{\pi}{6}, \quad 18\sqrt{3}-18\text{i} = 36\left(\cos\left(-\dfrac{\pi}{6}\right)+\text{i}\sin\left(-\dfrac{\pi}{6}\right)\right)$	M1,A1cao (3)
(b)	$z^4 = 36\left(\cos-\dfrac{\pi}{6}+\text{i}\sin-\dfrac{\pi}{6}\right) = 36\left(\cos\left(2k\pi-\dfrac{\pi}{6}\right)+\text{i}\sin\left(2k\pi-\dfrac{\pi}{6}\right)\right)$	M1
	$z = \sqrt{6}\left(\cos\left(\dfrac{12k\pi-\pi}{24}\right)+\text{i}\sin\left(\dfrac{12k\pi-\pi}{24}\right)\right)$	M1
	$k=0 \quad z_0 = \sqrt{6}\left(\cos\left(\dfrac{-\pi}{24}\right)+\text{i}\sin\left(\dfrac{-\pi}{24}\right)\right) = \sqrt{6}\,\text{e}^{\text{i}\left(-\frac{\pi}{24}\right)}$	B1
	$k=1 \quad z_1 = \sqrt{6}\left(\cos\left(\dfrac{11\pi}{24}\right)+\text{i}\sin\left(\dfrac{11\pi}{24}\right)\right) = \sqrt{6}\text{e}^{\text{i}\frac{11\pi}{24}}$	A1ft
	$k=2 \quad z_2 = \sqrt{6}\left(\cos\left(\dfrac{23\pi}{24}\right)+\text{i}\sin\left(\dfrac{23\pi}{24}\right)\right) = \sqrt{6}\text{e}^{\text{i}\frac{23\pi}{24}}$	
	$k=-1 \quad z_3 = \sqrt{6}\left(\cos\left(-\dfrac{13\pi}{24}\right)+\text{i}\sin\left(-\dfrac{13\pi}{24}\right)\right) = \sqrt{6}\text{e}^{\text{i}\left(-\frac{13\pi}{24}\right)}$	A1ft (5)
		[8]

(a)	
B1	Correct modulus
M1	Attempt argument using $\tan\theta = \dfrac{\pm 18}{18\sqrt{3}}$ or other valid method. Can be implied by $\theta = \pm\dfrac{\pi}{6}$
A1cao	Correct answer in the required form.
(b)	
M1	Valid method for generating at least 2 roots, rotation through $\dfrac{\pi}{2}$ accepted
M1	Apply de Moivre or use the rotation method
B1	Any one correct root
A1ft	Second root in required form
A1ft	All 4 roots in the required form
	Follow through their $\sqrt[4]{36}$ but 36 not acceptable.
NB	Argument in degrees – M1M1B1A0A0 (ie treat as mis-read)
	Incorrect argument: B0A1ftA1ft available
	Answers in $r(\cos\theta+\text{i}\sin\theta)$ form – deduct final A marks