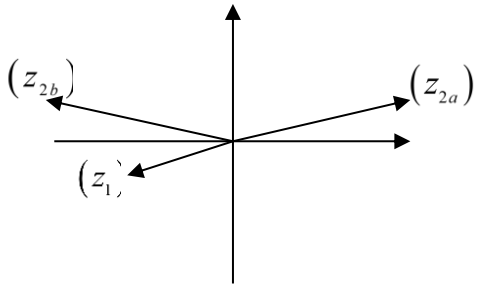
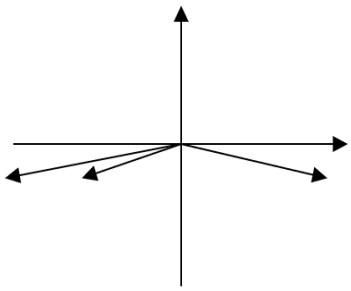
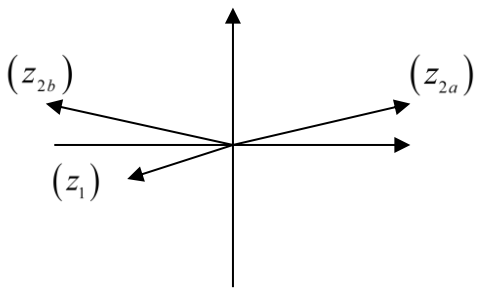
Question Number	Scheme	Notes	Marks
5	$z_1 = r\left(\cos\frac{7\pi}{6}+\text{i}\sin\frac{7\pi}{6}\right)$, $\quad\lvert z_1z_2\rvert=15\quad\lvert z_2\rvert=5\quad\left\{z_1=-\frac{3\sqrt{3}}{2}-\frac{3}{2}\text{i}=3\text{e}^{\frac{7\pi}{6}\text{i}}\right\}$		
(a)	$r=3$ Allow $z_1=3\left(\cos\frac{7\pi}{6}+\text{i}\sin\frac{7\pi}{6}\right)$	Correct value. No others and not ±3. Accept just "3" but $\lvert z_1\rvert=3$ is insufficient unless later work implies $r=3$	B1
			(1)
(b)	$z_2=a+b\text{i},\ z_1+z_2=c+0\text{i}\Rightarrow r\sin\frac{7\pi}{6}+b=0$ $\Rightarrow b=-3\sin\frac{7\pi}{6}\quad\left\{=-3\times-\frac{1}{2}=\frac{3}{2}\right\}$	Obtains $"b"=\pm"3"\sin\frac{7\pi}{6}$ or $\pm"3"\times\pm\frac{1}{2}$ with their real "3" from (a) which may have been negative or $\pm$. The "b" may be implied by e.g., $z_2=x+\frac{3}{2}\text{i}$ or later work	M1
	$a^2+b^2=25$ or e.g., $\sqrt{a^2+\left("\frac{3}{2}"\right)^2}=5$ Uses the modulus of z_2 to form a correct equation linking real and imaginary parts. Allow even if equation has no real solution. **See SC below if** $r=5$ Using $\lvert z_1z_2\rvert=15$ leads to $\sqrt{\left(-\frac{3\sqrt{3}}{2}a+\frac{3}{2}b\right)^2+\left(-\frac{3}{2}a-\frac{3\sqrt{3}}{2}b\right)^2}=15$ oe Must see a correct equation ft their r and value for b if necessary.		M1
	$a=\sqrt{25-\left("\frac{3}{2}"\right)^2}\quad\left\{=\ldots\pm\frac{\sqrt{91}}{2}\right\}$ Allow $a=(\pm)\sqrt{25-\left("3"\sin\frac{7\pi}{6}\right)^2}$	Substitutes b into a correct equation and finds at least one value or expression for a. Pythagoras must be used correctly and expression must be real.	M1
	SC: If $r=5$ in (a) we will allow access to the M marks (and the M only in (c)): $"b"=\pm5\sin\frac{7\pi}{6}$ or $\pm5\times\pm\frac{1}{2}\Rightarrow a^2+b^2=9$ or e.g., $\sqrt{a^2+\left("\frac{5}{2}"\right)^2}=3\Rightarrow a=\sqrt{9-\left("\frac{5}{2}"\right)^2}\quad\left\{=\ldots\pm\frac{\sqrt{11}}{2}\right\}$		
	$\{z_{2a}=\}\frac{\sqrt{91}}{2}+\frac{3}{2}\text{i},\ \{z_{2b}=\}-\frac{\sqrt{91}}{2}+\frac{3}{2}\text{i}$ or exact equivalents e.g., $\pm\sqrt{\frac{91}{4}}+\frac{3}{2}\text{i}$		
	A1: One correct answer: $(\pm\text{awrt }4.8)+1.5\text{i}$ and allow $-3\sin\frac{7\pi}{6}$ for 1.5 (but final A0 and a must be a **value** for any marks)		A1
	A1: Both correct **exact** answers. Accept e.g., $\frac{\pm\sqrt{91}+3\text{i}}{2}$ Allow both marks for e.g., $a=\pm\frac{\sqrt{91}}{2}$, $b=\frac{3}{2}$ (if $a+b\text{i}$ not seen there should be no subsequent evidence of a or b wrongly defined) or e.g., $z_2=x+\frac{3}{2}\text{i}$ seen and $x=\pm\frac{\sqrt{91}}{2}$ No additional answers. Ignore any labelling of the answers. Isw if necessary.		A1
			(5)
	A possible variation is: $z_1=3\left(\cos\frac{7\pi}{6}+\text{i}\sin\frac{7\pi}{6}\right)$, $z_2=5(\cos\theta+\text{i}\sin\theta)$, $z_1+z_2=c+0\text{i}\Rightarrow3\sin\frac{7\pi}{6}+5\sin\theta=0$ (M1) $\Rightarrow\sin\theta=\frac{3}{10}\Rightarrow\left(\frac{3}{10}\right)^2+\cos^2\theta=1$ (M1) $\Rightarrow\cos\theta=\pm\frac{\sqrt{91}}{10}$ (M1) $\Rightarrow z_2=5\left(\pm\frac{\sqrt{91}}{10}+\frac{3}{10}\text{i}\right)$ or $\pm\frac{\sqrt{91}}{2}+\frac{3}{2}\text{i}$ (A1A1)		

Question Number	Scheme	Notes	Marks
5(c)	**M1 Requires answers of form** $(\pm p)+q\text{i}\ \ p>0,\ q>0$ or $(\pm p)-q\text{i}\ \ p>0,\ q>0$ **from (b)** which could be inexact. Allow if still have trig expressions, e.g., $\pm\sqrt{25-\left(3\sin\frac{7\pi}{6}\right)^2}-3\sin\frac{7\pi}{6}\text{i}$ Ignore relative positions and complex number/axis labelling. May use points/lines. More than 3 complex numbers indicated is M0.		M1
	For $(\pm p)+q\text{i}$: Three complex numbers: 1 in each of quadrant 1, Q2 and Q3 (not on axes). **e.g.,**  	**For** $(\pm p)-q\text{i}$: Three complex numbers: 2 in Q3 and one in Q4 (not on axes). **e.g.,** 	
	A1 Requires correct answers from (b) but condone inexact equivalents $(\pm\text{awrt}\,4.8)+1.5\text{i}$ and allow if still have trig expressions, e.g., $\pm\sqrt{25-\left(3\sin\frac{7\pi}{6}\right)^2}-3\sin\frac{7\pi}{6}\text{i}$ and ignore attempts to write z_2 in trig form **AND** $r=3$ **from (a)** but and ignore miscalculation of z_1 $\left\{\text{i.e., if}\neq-\frac{3\sqrt{3}}{2}-\frac{3}{2}\text{i}\right\}$ provided complex number is placed in Q3 and is closest to O		A1
	 	Correct sketch with complex number in Q3 **clearly closest** of the three to the origin, otherwise ignore relative positions. Condone e.g., asymmetry of z_{2a} and z_{2b} May use points/lines. If real and imaginary axes have been labelled the wrong way round then A0 but ignore all other labelling	
			(2)
			Total 8