Question Number	Scheme	Notes	Marks
7.	$f(z)=z^4-6z^3+az^2-44z+b$; a, b are real constants. $z=-1-3i$ is given.		
(a)	$-1+3i$	$-1+3i$	B1
			(1)
(b)	$z^2+2z+10$	Attempt to expand $(z\pm(-1-3i))(z\pm"(-1+3i)")$ or any valid method ***to establish a quadratic factor*** e.g. $z=-1\pm3i\Rightarrow z+1=\pm3i\Rightarrow z^2+2z+1=-9$ or sum of roots $=-2$, product of roots $=10$ to give $z^2\pm$(their sum)$z\pm$(their product)	M1
		$z^2+2z+10$	A1
	$\{f(z)=\}$ $(z^2+2z+10)(z^2-8z+18)$	Attempts to find the other quadratic factor e.g. using long division to obtain $z^2+kz+...$, $k=$ value $\neq 0$ e.g. factorising/equating coefficients to obtain $f(z)=(z^2+2z+10)(z^2\pm kz\pm c)$, $k=$ value $\neq 0$, c can be 0	M1
		$z^2-8z+18$ seen in their working	A1
	$\{z^2-8z+18=0\Rightarrow\}$		
	• $z=\dfrac{--8\pm\sqrt{(-8)^2-4(1)(18)}}{2(1)}$ • $(z-4)^2-16+18=0\Rightarrow z=...$	**dependent on only the previous M mark** Correct method of applying the quadratic formula or completing the square **for solving their 3TQ** on their 2nd quadratic factor	dM1
	$\{z=\}$ $4\pm\sqrt{2}i$	$4+\sqrt{2}i$ **and** $4-\sqrt{2}i$	A1
			(6)
			7

Question 7 Notes

7. (a)	**Note**	Give B1 for either $4+\sqrt{2}i$ or $4-\sqrt{2}i$
(b)	**Note**	The values of the constants, i.e. $a=12$, $b=180$ do not have to be found explicitly.
	Note	You can assume $x\equiv z$ for solutions in this part
	Note	Give final dM1A1 for $z^2-8z+18=0\Rightarrow z=4+\sqrt{2}i,\ 4-\sqrt{2}i$ with no intermediate working.
	Note	They must be solving a 3TQ $"A"z^2+"B"z+"C"$ where A, B, C ***are all numerical values*** $\neq 0$ for the final dM1 mark.
	Note	**Special Case:** If ***their 2nd quadratic*** factor $z^2+"B"z+"C"$ **can** be factorised then give Special Case 3rd dM1 for correct factorisation leading to $z=...$ Otherwise, give 3rd dM0 for applying a method of factorisation to solve their 3TQ.
	Note	**Reminder: Method mark for solving a 3TQ** **Formula:** $Az^2+Bz+C=0\Rightarrow$ Attempt to use the correct formula (with values for A, B, C) **Completing the Square:** $z^2+Bz+C=0\Rightarrow\left(z\pm\dfrac{B}{2}\right)^2\pm q\pm C=0$, $q\neq 0$, leading to $z=...$
	Note:	**Comparing coefficients:** $f(z)=(z^2+2z+10)(z^2+\alpha z+\beta)\equiv z^4-6z^3+az^2-44z+b$ $z^3:\alpha+2=-6\Rightarrow\alpha=-8$; $z:2\beta+10\alpha=-44\Rightarrow2\beta-80=-44\Rightarrow\beta=18$ yielding 2nd quadratic factor = $z^2-8z+18$ Also, constant: $10\beta=b\Rightarrow b=180$; $z^2:\beta+2\alpha+10=a\Rightarrow a=18-16+10=12$

	Question 7 Notes Continued	
7. (b)	**Note:**	**<u>Long division:</u>** $$\begin{array}{r} z^2 - 8z + 18 \\ \hline z^2+2z+10 \,\big|\, z^4 - 6z^3 + az^2 - 44z + b \\ \underline{z^4 + 2z^3 + 10z^2} \\ -8z^3 + (a-10)z^2 - 44z \\ \underline{-8z^3 - 16z^2 - 80z} \\ (a+6)z^2 + 36z + b \\ \underline{18z^2 + 36z + 180} \\ 0 \end{array}$$ Also, note $a=12,\ b=180$
	Note	Ignore errors in long division for the 2nd A1 mark and/or the 3rd A1 mark.
	Note	Ignore errors in stating $a=12,\ b=180$ for the 2nd A1 mark and/or the 3rd A1 mark.
	Note	The solutions $4\pm\sqrt{2}\,\mathrm{i}$ need to follow on from a correct $z^2-8z+18$ in order to gain the final A mark.
	Note	Give final A0 for writing $\dfrac{8\pm2\sqrt{2}\,\mathrm{i}}{2}$ followed by either $4\pm2\sqrt{2}\,\mathrm{i}$ or $8\pm\sqrt{2}\,\mathrm{i}$