4(i)	$\sum \alpha_i = -\frac{5}{3}$ and $\sum \alpha_i\alpha_j = 0$ This mark can be awarded if seen in part (ii) or part (iii)	B1	3.1a
	So $\alpha^2+\beta^2+\gamma^2+\delta^2 = (\alpha+\beta+\gamma+\delta)^2 - 2\left(\sum \alpha_i\alpha_j\right) = \ldots$	M1	1.1b
	$= \frac{25}{9} - 2\times 0 = \frac{25}{9}$	A1	1.1b
		(3)	
(ii)	$\sum \alpha_i\alpha_j\alpha_k = \frac{7}{3}$ and $\prod \alpha_i = 2$ or for $x = \frac{2}{w}$ used in equation This mark can be awarded if seen in part (i) or part (iii)	B1	2.2a
	So $2\left(\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}+\frac{1}{\delta}\right) = 2\times\frac{\sum \alpha_i\alpha_j\alpha_k}{\alpha\beta\gamma\delta} = 2\times\frac{'\frac{7}{3}'}{'\frac{6}{3}'}$ or for $3\left(\frac{16}{w^4}\right)+5\left(\frac{8}{w^3}\right)-7\left(\frac{2}{w}\right)+6=0 \Rightarrow 6w^4-14w^3+\ldots=0$ leading to $\frac{14}{6}$	M1	1.1b
	$\left(=2\times\frac{7/3}{2}\right)\left(=\frac{14}{6}\right)=\frac{7}{3}$	A1	1.1b
		(3)	
(iii)	$(3-\alpha)(3-\beta)(3-\gamma)(3-\delta) = \ldots$ expands all four brackets Or equation with these roots is $3(3-x)^4+5(3-x)^3-7(3-x)+6=0$	M1	3.1a
	$=81-27\left(\sum \alpha_i\right)+9\left(\sum \alpha_i\alpha_j\right)-3\left(\sum \alpha_i\alpha_j\alpha_k\right)+\prod \alpha_i$ $=81-27\left(-\frac{5}{3}\right)+9(0)-3\left(\frac{7}{3}\right)+2$ Or expands to fourth power and constant terms and attempts product of roots $3x^4+\ldots+3\times3^4+5\times3^3-7\times3+6 \to \prod \alpha_i = \frac{"363"}{3}$	dM1	1.1b
	$=121$	A1	1.1b
		(3)	
			(9 marks)

Notes:

(i)

B1: Correct sum and pair sum of roots seen or implied. Must realise the pair sum is zero.

Note: These values can be seen anywhere in the candidate's solution

M1: Uses correct expression for the sum of squares.

A1: $\frac{25}{9}$. Allow this mark from incorrect sign on sum of squares (but they will score B0 if the sign is incorrect).

(ii)

B1: Correct triple sum and product of roots seen or implied. May be stated in (i). Alternatively, this may be scored for sight of $x = \frac{2}{w}$ used as a transformation in the equation.

Note: These values can be seen anywhere in the candidate's solution

M1: Substitutes their values into $2 \times \frac{\sum \alpha_i \alpha_j \alpha_k}{\alpha\beta\gamma\delta} = \ldots$ In the alternative it is for rearranging the equation to a quartic in *w* and uses to find the sum of the roots.

A1: $\frac{7}{3}$ Allow this mark from incorrect sign of both triple sum and product (but they will score B0 if the sign is incorrect).

(iii)

M1: A correct method to find the value used – may recognise structure as scheme, may expand the expression in stages, or may attempt to use a linear transformation $(3 - x)$ or e.g. $(3 - w)$ in original equation. Condone slips as long as the intention is clear.

dM1: Dependent on previous method mark**.** Uses at least 2 values of their sum of roots etc. in their expression. If using a linear shift this is for expanding to find the coefficient of x^4 and constant term and attempts product of roots by dividing the constant term by the coefficient of x^4.

A1: 121.