Question	Scheme	Marks	AOs
1	$\{w = x+2 \Rightarrow\}\ x = w-2$	B1	3.1a
	$(w-2)^3 - 7(w-2)^2 - 12(w-2) + 6\ (=0)$	M1	1.1b
	$(w^3 - 6w^2 + 12w - 8) - 7(w^2 - 4w + 4) - 12(w-2) + 6$ $w^3 - 6w^2 + 12w - 8 - 7w^2 + 28w - 28 - 12w + 24 + 6$ $= w^3 + \ldots w^2 + \ldots w + \ldots$	M1	3.1a
	$w^3 - 13w^2 + 28w - 6 = 0$	A1 A1	1.1b 1.1b
		(5)	
	Alternative using sum, pair sum and product of roots:		
	$\alpha + \beta + \gamma = 7,\ \alpha\beta + \beta\gamma + \alpha\gamma = -12,\ \alpha\beta\gamma = -6$	B1	3.1a
	New sum: $\alpha + 2 + \beta + 2 + \gamma + 2 = (\alpha + \beta + \gamma) + 6 = 7 + 6 = 13$ New pair sum: $(\alpha+2)(\beta+2) + (\alpha+2)(\gamma+2) + (\beta+2)(\gamma+2)$ $= (\alpha\beta + \alpha\gamma + \beta\gamma) + 4(\alpha+\beta+\gamma) + 12 = -12 + 4\times 7 + 12 = 28$ New product: $(\alpha+2)(\beta+2)(\gamma+2)$ $= \alpha\beta\gamma + 2(\alpha\beta + \alpha\gamma + \beta\gamma) + 4(\alpha+\beta+\gamma) + 8$ $= -6 + 2\times -12 + 4\times 7 + 8 = 6$	M1	3.1a
	$p = -\text{"}13\text{"},\ q = 28,\ r = -\text{"}6\text{"}$ **or** $w^3 - \text{"}13\text{"}w^2 + \text{"}28\text{"}w - \text{"}6\text{"}\ (=0)$	M1	1.1b
	$w^3 - 13w^2 + 28w - 6 = 0$	A1 A1	1.1b 1.1b
		(5 marks)	

Notes:

Allow a variable other than *w* to be used for the first 4 marks.

<u>The "= 0" is not required until the final mark.</u>

B1: Selects the method of making a connection between x and w by writing $x = w-2$

M1: Applies the process of substituting their $x = \text{"}w-2\text{"}$ into the equation for all occurrences of x.

M1: Depends on having attempted substituting either $x = w-2$ or $x = w+2$ into the equation. This mark is for manipulating their resulting equation into the required form so must have gathered terms. Condone poor squaring/cubing of brackets as long as a cubic expression is obtained.

A1: At least two of p, q and r correct.

A1: Correct final <u>equation</u> (including "= 0"). **Must be an equation in *w*.**

Note if they say e.g. $x = w - 2$ and then substitute $w + 2$, it is possible to score B1 M0 M1

Note if they say e.g. $x = w + 2$ and then substitute $w - 2$, allow recovery

Alternative:

B1: Selects the method of giving three correct equations for the sum, pair sum and product in terms of α, β and γ. Note that the correct values may be seen embedded when they attempt the new sum, pair sum and product e.g. $(\alpha+2)(\beta+2)(\gamma+2) = \alpha\beta\gamma + 2(\alpha\beta + \alpha\gamma + \beta\gamma) + 4(\alpha+\beta+\gamma) + 8$

$$= \underline{\mathbf{-6}} + 2(\underline{\mathbf{-12}}) + 4(\underline{\mathbf{7}}) + 8$$

M1: Applies the process of finding the new sum, pair sum and product. Mark positively here and allow slips provided they are attempting $\alpha + 2 + \beta + 2 + \gamma + 2$, $(\alpha+2)(\beta+2) + (\alpha+2)(\gamma+2) + (\beta+2)(\gamma+2)$ and $(\alpha+2)(\beta+2)(\gamma+2)$

M1: In this method, this mark is for choosing p = – (their new sum), q = their new pair sum, r = – (their new product) **or** forming $w^2 - (\text{new sum})w^2 + (\text{new pair sum})w - (\text{new product})$

A1: At least two of p, q and r correct. As values or seen in their equation.

A1: Correct final <u>equation</u> (including "= 0"). **Must be an equation in *w*.**

In all methods, the final A mark depends on all the previous marks.