Question	Scheme	Marks	AOs
3	$w=4x-1 \Rightarrow x=\dfrac{w+1}{4}$	B1	3.1a
	$a\left(\dfrac{w+1}{4}\right)^3+b\left(\dfrac{w+1}{4}\right)^2-19\left(\dfrac{w+1}{4}\right)-b\ (=0)$ or $(4x-1)^3-9(4x-1)^2-97(4x-1)+c\ (=0)$	M1	3.1a
	$aw^3+(3a+4b)w^2+(3a+8b-304)w+(a-60b-304)=0$ or $64x^3-192x^2-304x+87+c=0$	M1	1.1b
	Divides by a and equates the coefficients of w^2 and w $\dfrac{3a+4b}{a}=-9 \quad \dfrac{3a+8b-304}{a}=-97$ and solves simultaneously to find a value for a or a value for b **Note:** $12a+4b=0$ and $100a+8b=304$ or Divides through by '16' leading to values of a and b $4x^3-12x^2-19x+\dfrac{87+c}{19}=0$	M1	3.1a
	$c=\dfrac{a-60b-304}{a}=\ldots$ or $\dfrac{87+c}{19}=12 \Rightarrow c=\ldots$	M1	1.1b
	$a=4 \quad b=-12 \quad c=105$	A1	1.1b
		(6)	

(6 marks)

Notes:

B1: Selects the method of making a connection between x and w by writing $w=4x-1$ or $x=\dfrac{w+1}{4}$

M1: Applies the process of substituting their $x=\dfrac{w+1}{4}$ into $ax^3+bx^2-19x-b=0$ or $w=4x-1$ into $w^3-9w^2-97w+c=0$. Must be substitution of the correct variable into the opposing equation but may be scored if the initial linear equation is incorrect (e.g. $x=4w-1$ into the first equation). Note that the " = 0 " can be missing for this mark.

M1: Expands the brackets and collects terms in their equation (in x or w). Note that the " = 0 " can be missing for this mark.

M1: A complete method for finding a value for a or b. See scheme, it involves dividing through by an appropriate factor for their equation to balance the w^3 or $-19x$ terms, then equating other coefficients and solving equations if necessary.

M1: A complete method for finding a value for c. They must have divided through by an appropriate factor as per the previous M before attempting to compare the constant coefficient (and use their a and b if appropriate).

A1: $a=4 \quad b=-12 \quad c=105$

	Alternative At least two of $\alpha+\beta+\gamma=-\frac{b}{a}$ $\quad \alpha\beta+\alpha\gamma+\beta\gamma=-\frac{19}{a}$ $\quad \alpha\beta\gamma=\frac{b}{a}$	B1	3.1a
	New sum $=4(\alpha+\beta+\gamma)-3=9 \Rightarrow 4\left(-\frac{b}{a}\right)-3=9 \Rightarrow b=-3a$	M1	3.1a
	New pair sum$=16(\alpha\beta+\alpha\gamma+\beta\gamma)-8(\alpha+\beta+\gamma)+3=-97$ $\Rightarrow 16\left(-\frac{19}{a}\right)-8\left(-\frac{b}{a}\right)+3=-97$	M1	1.1b
	$\Rightarrow 16\left(-\frac{19}{a}\right)-8(3)+3=-97 \Rightarrow a=\ldots$	M1	3.1a
	New product $64(\alpha\beta\gamma)-16(\alpha\beta+\alpha\gamma+\beta\gamma)+4(\alpha+\beta+\gamma)-1=-c$ $\Rightarrow 64\left(\frac{b}{a}\right)-16\left(-\frac{19}{a}\right)+4(3)-1=-c \Rightarrow c=\ldots$	M1	1.1b
	$a=4 \quad b=-12 \quad c=105$	A1	1.1b
		(6)	

Alternative Notes

B1: Selects the method of giving at least two correct equations containing α, β and γ

M1: Applies the process of finding the new sum to generate an equation in *a* and *b*. Must be substituting in the correct places.

M1: Attempts the new pair sum to generate another equation connecting *a* and *b*. Must be substituting in the correct places.

M1: Solves their equations to find a value for *a* or *b*.

M1: Uses the new product with their values to find values for *a*, *b* and *c*

A1: $a=4 \quad b=-12 \quad c=105$