Question	Scheme	Marks	AOs
9(a)	$\alpha\beta\gamma=-\frac{1}{3}$ and $\alpha\beta+\alpha\gamma+\beta\gamma=-\frac{4}{3}$	B1	3.1a
	$\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}=\frac{\beta\gamma+\alpha\gamma+\alpha\beta}{\alpha\beta\gamma}=\frac{-4/3}{-1/3}$	M1	1.1b
	$=4$	A1	1.1b
		(3)	
(b)	$\left\{\alpha+\beta+\gamma=-\frac{1}{3}\right\}$ New product $=\frac{1}{\alpha}\times\frac{1}{\beta}\times\frac{1}{\gamma}=\frac{1}{\alpha\beta\gamma}=\frac{1}{-1/3}=...(-3)$ New pair sum $\frac{1}{\alpha\beta}+\frac{1}{\beta\gamma}+\frac{1}{\alpha\gamma}=\frac{\gamma+\alpha+\beta}{\alpha\beta\gamma}=\frac{-1/3}{-1/3}=...(1)$	M1	3.1a
	$x^3-(\text{part (a)})x^2+(\text{new pair sum})x-(\text{new product})(=0)$	M1	1.1b
	$x^3-4x^2+x+3=0$	A1	1.1b
		(3)	
	Alternative e.g. $z=\frac{1}{x}\Rightarrow\frac{3}{x^3}+\frac{1}{x^2}-\frac{4}{x}+1=0$	M1	3.1a
	$x^3-4x^2+x+3=0$	M1 A1	1.1b 1.1b
		(3)	
			(6 marks)

Notes:

(a)

B1: Correct values for the product and pair sum of the roots

M1: A complete method to find the sum of $\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}$. Must substitute in their values of the product and pair sum

A1: correct value 4

Note: If candidate does not divide by 3 so that $\alpha\beta\gamma=-1$ and $\alpha\beta+\alpha\gamma+\beta\gamma=-4$ the maximum they can score is B0 M1 A0

(b)

M1: A correct method to find the value of the new pair sum and the value of the new product

M1: Applies $x^3-(\text{part (a)})x^2+(\text{their new pair sum})x-(\text{their new product})(=0)$

A1: Fully correct equation, in any variable, including = 0

(b) Alternative

M1: Realises the connection between the roots and substitutes into the cubic equation

M1: Manipulates their equation into the form $x^3 + ax^2 + bx + c = 0$

A1: Fully correct equation in any variable, including = 0