Q	Marking instructions	AO	Marks	Typical solution
8(a)	Selects a method to verify the solution For example: Substitutes $x = -2$ and obtain at least two correct terms from the series $-2 + 1$, $4 + 2$ or $-8 + 3$ may be unevaluated PI by $-2 + 4 - 8 + 6$ Or Expands the series in terms of x and substitutes 1, 2 or 3 for r to obtain at least two correct terms from the series $x + 1$, $x^2 + 2$ or $x^3 + 3$ PI by $x^3 + x^2 + x + 6$	3.1a	M1	$\sum_{r=1}^{r=3}\left((-2)^r + r\right) = -2 + 1 + 4 + 2 - 8 + 3$ $= -1 + 6 - 5$ $= 0$
	Completes a reasoned argument to verify that $x = -2$ is a solution If written in the form $(-2)^3 + (-2)^2 + (-2)^1 + 6$ OE there must be one line of intermediate work before equating to zero	2.1	R1	
	Subtotal		**2**	

	Marking instructions	AO	Marks	Typical solution
8(b)	Uses the sum of the three terms, with at least two correct to form a cubic expression.	2.5	M1	$\sum_{r=1}^{r=3}\left(x^r + r\right) = x + 1 + x^2 + 2 + x^3 + 3$
	Obtains $x^3 + x^2 + x + 6$	1.1b	A1	$x^3 + x^2 + x + 6 = 0$
	Selects a suitable method to show that the cubic equation has exactly one real solution. For example: Divide their cubic by $(x + 2)$ to obtain a factor of the form $x^2 + Bx + C$ where B and $C \neq 0$ Condone a remainder Or Differentiates their cubic to obtain $3x^2 + Bx + C$ where B and $C \neq 0$	3.1a	M1	$(x+2)\left(x^2 - x + 3\right) = 0$ $x = -2$ or $x^2 - x + 3 = 0$ But $(-1)^2 - 4 \times 1 \times 3 = -11$ $-11 < 0$ So $x^2 - x + 3 \neq 0$ Hence $x = -2$ is the only solution.
	Obtains the quadratic factor $x^2 - x + 3$ Or Obtains the derivative $3x^2 + 2x + 1$	1.1b	A1	
	Selects one of the methods below to attempt to show that their quadratic has no [real] solution.	3.1a	M1	

	• Uses the quadratic formula • uses the discriminant • completes the square Condone sign errors Must come from differentiation or division of $(x + 2)$			
	Completes reasoned argument to: show that $x^2 - x + 3 = 0$ has no [real] solutions because: • -11 < 0 or -2.75 < 0 • the square root of a negative number is not real with -11 or -2.75 seen • The minimum has a y-value of 2.75, it's greater than zero **and** concludes that there is exactly one solution. Or Show that $x^3 + x^2 + x + 6$ is an increasing function because - $3x^2 + 2x + 1 > 0$ and • -8 < 0, $-\frac{2}{9} < 0$ or -2 < 0 • the square root of a negative number is not real with – 8 or $-\frac{2}{9}$ seen • The minimum y-value is $\frac{2}{3}$, which is greater than zero **and** concludes that there is exactly one solution. Accept $3x^2 + 2x + 1 \geq 0$	2.1	R1	
	Subtotal		**6**	

	Question 8 Total		**8**	