Question	Scheme	Marks
3(a) (i)	$d = u_2 - u_1 = -6 - 3 = -9$	**M1**
	Also, $u_4 - u_2 = -24 - (-6) = -18 = 2 \times -9$ Difference is consistent so could be arithmetic	**A1**
	$u_3 = -15$	**B1**
(ii)	$r = \dfrac{u_2}{u_1} = \dfrac{-6}{3} = -2$	**M1**
	Also, $\dfrac{u_4}{u_2} = \dfrac{-24}{-6} = 4 = (-2)^2$ Ratio is consistent so could be geometric	**A1**
	$u_3 = 12$	**B1**
		(6)
(b)	$u_1 = u_5 = u_9 = u_{13}$ etc $\Rightarrow \sum_{i=1}^{50} u_i = 12 \times (3 - 6 + u_3 - 24) + 3 - 6$	**M1**
	$\Rightarrow 12(u_3 - 27) - 3 = 141 \Rightarrow u_3 = ...$	**dM1**
	$u_3 = 39$	**A1**
		(3)
		(9 marks)

(a)(i)

M1: Attempts to find the common difference of the first two terms.

Implied by sight of ± 9 or $(-6)-(3)$ either way around

A1: Must be using a correct common difference of -9.

It requires a correct reason and minimal conclusion.

Acceptable reasons must include the first, second and fourth terms.

Examples of allowable reasons and conclusions are;

- if arithmetic $d = -9,\ u_4 = a + 3d = 3 + 3 \times -9 = -24$ ✓ (Calculation seen)
- $3,\ -6,\ -15,\ -24$ terms **all** decrease by 9 so (could be) arithmetic (explained in words)

B1: $u_3 = -15$

A minimal possible solution scoring 3 marks is;

$3,\ -6,\ u_3,\ -24$ (with -9, -9, -9) scores M1,

followed by $u_3 = -15$ scores B1 (which may be seen in the list), followed by appropriate wording

'Differences are constant, so (could be) arithmetic' which scores the A1

Or 'Common difference (in words, not just $d =$) is -9, so ✓ , which scores A1'

(a)(ii)

M1: Attempts to find the common ratio of two terms. Implied by sight of -2, $\frac{-6}{3}$ $-\frac{1}{2}$ or $\frac{3}{-6}$

A1: Must be using a correct common ratio of -2.

It requires a correct reason and minimal conclusion.

Acceptable reasons must include the first, second and fourth terms.

Examples of allowable reasons and conclusions are;

- if geometric $r=-2$, $u_4 = ar^3 = 3\times -2^3 = -24$ ✓ (Calculation seen)
- $3, \quad -6, \quad 12, \quad -24$ you multiply.by -2 **each time**, so geometric (explained in words)

B1: $u_3 = 12$

A minimal possible solution scoring 3 marks is;

$\times -2 \quad \times -2 \quad \times -2$

$3, \quad -6, \quad 12, \quad -24$ scores M1, B1

followed 'by multiplies by -2 each time, so (could be) geometric scores A1'

or 'common ratio (in words, not just r =) is -2 so ✓ scores A1'

(b)

M1: Attempts to write the summation as 12 sets of the sum of four consecutive terms plus the first two terms. Allow if there are sign slips in the two extra terms

Alternatively writes as a summation of 13 sets of the sum of four consecutive terms minus the last two terms. Allow if there are sign slips in the two extra terms.

E.g. Allow for $12\times(3-6+u_3-24)+3+6$

or $13\times(3-6+u_3-24)-24-u_3$ (both showing common sign slips)

dM1: Sets their sum equal to 141 (condoning slips e.g. 114) and solves to find u_3

Look for all of

- the award of the previous M1
- correct order of solving, condoning arithmetical slips only E.g.

  $12\times(3-6+u_3-24)+3+6=141$

  $12(u_3-21)+9=141 \Rightarrow 12(u_3-21)=132 \Rightarrow u_3-21=11 \Rightarrow u_3=32$

A1: Correct value.

Question	Scheme	Marks
4(i)	E.g. try [f (2) = −8, f (3) = 8, f (4) = 64] f (5) = ...	**M1**
	So, a counterexample is f (5) = 175	**A1**
	Since $5^3 = 125 < 175 < 216 = 6^3$ so f (5) cannot be a perfect cube.	**A1**
		(3)
(ii)	$(x+1)^2 - 6x + 4 = x^2 + 2x + 1 - 6x + 4$	**M1**
	$x^2 - 4x + 5 = (x-2)^2 - 4 + 5$	**M1**
	$(x-2)^2 + 1 > 0$ since $(x-2)^2 \geqslant 0$ for all x, hence $(x+1)^2 > 6x - 4$ *	**A1***
		(3)
		(6 marks)

(i)

M1: Shows evidence of searching for a counter example, e.g. attempts to use a positive integer greater than 1 in the expression. Note n = 1,2,3,4 all give perfect cubes, but this mark may be scored for the evidence of trying n = 2, 3 or 4 even if they think one is not a cube. Alternatively, attempting any greater integer is fine. If their answer is correct e.g. f (3) = 8, this is sufficient, but if it is incorrect you will need evidence such as sight of the 3 being substituted into f(n) condoning slips

n	f(n)	f(n)^(1/3)
2.00	-8.00	-2.00
3.00	8.00	2.00
4.00	64.00	4.00
5.00	175.00	5.59
6.00	356.00	7.09
7.00	622.00	8.54
8.00	988.00	9.96
9.00	1469.00	11.37
10.00	2080.00	12.77
11.00	2836.00	14.15

A1: For the correct result for a suitable counterexample.

A1: Demonstrates/shows that their example fails. They are likely to do this by taking the cube root of their value and showing it is not an integer. All work should be correct, values to at least 1 d.p. with a minimal conclusion. A brief solution for 3 marks would be f (6) = 356 and $\sqrt[3]{356} \approx 7.1$ so statement is not true

(ii)

M1: Gathers terms on one side and expands the brackets. May be done as part of steps with inequalities (using equivalences or not).

M1: Attempts to complete the square on the gathered quadratic. (See general principles)

A1*: Completes the proof with correct work, reason and conclusion given.

This requires all of

- $x^2 - 4x + 5 \equiv (x-2)^2 + 1$
- A reason for $(x-2)^2 + 1 > 0$ such as $(x-2)^2 \geqslant 0$
- A conclusion that refers back to the given statement

Example I: Scores M1, M1, A0 as it lacks both a reason and a reference back to the given statement

$(x+1)^2 > 6x - 4 \Rightarrow x^2 + 2x + 1 - 6x + 4 > 0 \Rightarrow x^2 - 4x + 5 > 0 \Rightarrow (x-2)^2 + 1 > 0$ which is true.

Example II: Scores M1, M1, A0 as the reason is incorrect. It does refer back due to use of $\Leftrightarrow$

$(x+1)^2 > 6x - 4 \Leftrightarrow x^2 + 2x + 1 - 6x + 4 > 0 \Leftrightarrow x^2 - 4x + 5 > 0 \Leftrightarrow (x-2)^2 + 1 > 0$ which is true as $(x-2)^2 > 0$.