Question Number	Scheme	Marks
2(a)	$u_1 = 7 \Rightarrow u_2 = k - 7$	B1
	$u_2 = k-7 \Rightarrow u_3 = k+k-7 \Rightarrow u_4 = k-(2k-7)$ $u_5 = k+(-k+7) = 7*$	M1A1*
		(3)
(b)	$\sum_{r=1}^{4} u_r = 30 \Rightarrow 7+k-7+2k-7-k+7 = 30 \Rightarrow k = ...$	M1
	$k = 15$	A1cso
		(2)
(c)	$\sum_{r=1}^{150} u_r = 37 \times 30 + 7 + "15" - 7$	M1
	$= 1125$	A1cso
		(2)
		Total 7

General Guidance

Note that it is possible to obtain correct answers in all parts of this question fortuitously. The A marks should only be awarded following correct work.

(a)

B1: Correct expression for u_2 e.g. $k-7$ with no incorrect work seen e.g.

$u_2 = (-1)^7 \times 7 + k = -7 + k$ scores B0. Must be seen in part (a).

Allow e.g. $u_2 = (-1)^1 \times 7 + k$ or e.g. $u_2 = (-1) \times 7 + k$ or e.g. $u_2 = -1 \times 7 + k$

M1: Attempts to use the recurrence formula **to reach the 5th term** but condone **consistent** use of $(n + 1)$ for n on the $(-1)^n$ term so e.g. $u_2 = (-1)^2 \times 7 + k$ is condoned but e.g. $u_2 = (-1)^7 \times 7 + k$ is M0

Allow even if any slips mean their sequence is not of order 4.

A1*: Obtains $u_5 = 7$ with no errors or omissions. The "$u_5 =$" must appear at some point but allow e.g. "$u_{4+1} =$"

For reference the terms are: $u_1 = 7,\ u_2 = k-7,\ u_3 = 2k-7,\ u_4 = 7-k,\ u_5 = 7$

(a) Alternatives:

1 $u_2 = -u_1 + k,\ u_3 = -u_1 + 2k,\ u_4 = u_1 - k,\ u_5 = u_1 = 7$

B1: Implied by $u_2 = -u_1 + k$

M1: Attempts to use the recurrence formula **to reach the 5th term** but condone use of $(n + 1)$ for n on the $(-1)^n$ term as above

A1*: Fully correct work to reach $u_5 = 7$

(Allow the above approach to be used with a made up k or a wrong k as the result is independent of k)

2 $u_5 = 7 \Rightarrow u_4 = 7-k \Rightarrow u_3 = 2k-7 \Rightarrow u_2 = k-7 \Rightarrow u_1 = 7$ Hence true.

B1: $u_4 = 7 - k$

M1: Attempts to use the recurrence formula correctly backwards **to reach the 1st term** but condone use of $(n + 1)$ for n on the $(-1)^n$ term as above.

A1*: Fully correct work to reach $u_1 = 7$ with a (minimal) conclusion.

(b)

M1: Adds their first 4 terms, sets = 30 and solves a linear equation for k
Condone slips in copying their 4 terms if the intention is clear.
Allow even if their sequence is of order 2 e.g. $7, k-7, 7, k-7, ...$

A1: Correct value **from correct work and a correct sequence**.

(c)

Marks in (c) are only available if their sequence is of order 4

M1: **Correct** numerical attempt for the required sum using their k. May be implied by the correct answer or the correct ft answer unless an incorrect method is seen e.g.
$37\times30+u_3+u_4$ or $38\times30-u_1-u_2$ score M0

Condone $\frac{150}{4}\times30$ or 75×15 or 37.5×30 following a **correct sequence** and the **correct value of *k*.**

Allow any equivalent **correct** method e.g. $38\times30-\left(2\times"15"-7+7-"15"\right)$

A1: For 1125 **from correct work and a correct sequence**.
Correct answer **only** scores both marks.

For reference the **correct** sequence is:

n	1	2	3	4
u_n	7	$k-7$	$2k-7$	$7-k$
Value (with $k=15$)	7	8	23	–8

<u>An unusual but correct method in (c) is:</u>

$$\sum_{r=1}^{150} u_r = 38\times7+38\left(15-7\right)+37\left(30-7\right)+37\left(7-15\right)=1125$$

<u>Example – Candidates who consistently use</u>

$$u_{n+1}=\left(-1\right)^{n+1}u_n+k$$

This gives:

(a) $u_1=7,\ u_2=k+7,\ u_3=-7,\ u_4=k-7,\ u_5=7$ which scores B0M1A0

(b) $\sum_{r=1}^{4} u_r = 30 \Rightarrow 7+k+7-7+k-7=30 \Rightarrow k=15$ which scores M1A0

(c) $\sum_{r=1}^{150} u_r = 37\times30+7+"15"+7=1139$ which scores M1A0

For reference this **incorrect** sequence is:

n	1	2	3	4
u_n	7	$k+7$	–7	$k-7$
Value (with $k=15$)	7	22	–7	8

Question Number	Scheme	Marks
3(a)	$2(-3)^3-(-3)^2+A(-3)+B=55$ or e.g. $-54-9-3A+B=55$	M1
	$-54-9-3A+B=55$ $\Rightarrow 3A-B=-118$*	A1*
		(2)

(a)

M1: Attempts $f(-3)=55$. The -3 embedded in the expression set = 55 is sufficient.

Condone missing brackets e.g. $2-3^3--3^2+A(-3)+B=55$

Note that $2(-3)^3-(3)^2+A(-3)+B=55$ is acceptable.

May be implied by further work. If -3 embedded in the expression is not seen, condone slips in their evaluation provided there is still evidence that the intention was to substitute in -3 and set = 55 but $f(3)=55$ is M0

A1*: Completes proof with at least one intermediate simplified and correct line that is not the final line such as $-54-9-3A+B=55$ or $118=-3A+B$. Any incorrect lines written after the start of their 'proof' should be scored A0*

Must be the given equation and not e.g. $B=3A+118$ unless the correct equation is seen previously but condone $-B+3A=-118$

$2(-3)^3-(-3)^2+A(-3)+B=55\Rightarrow 3A-B=-118$ scores M1A0

Tabular or division methods may be seen. The question does not demand use of the factor or remainder theorem so these methods should be rewarded.

The M1 would be scored for a full attempt and A1* for a correct proof.

If you cannot see what they are doing and find it hard to award, then use review.

e.g. long division:

$$\begin{array}{r} 2x^2-7x+A+21 \\ x+3\overline{)\,2x^3-x^2+Ax+B} \\ \underline{2x^3+6x^2} \\ -7x^2+Ax+B \\ \underline{-7x^2-21x} \\ (A+21)x+B \\ \underline{(A+21)x+3(A+21)} \\ B-3A-63=55 \end{array}$$

Score M1 for obtaining a quotient $...x^2\pm...x\pm...A+...$ and a remainder $...A\pm...B\pm...$ set = 55 where "…" are non-zero constants. Then A1* for a fully correct proof.

e.g. tabular method:

	$2x^2$	$-7x$	$21+A$
x	$2x^3$	$-7x^2$	$(21+A)x$
3	$6x^2$	$-21x$	$63+3A$

So $B-(63+3A)=55$ etc.

Score M1 for obtaining a constant $...A+...$ where … are non-zero constants and then sets B – their constant = 55. Then A1* for a fully correct proof.

(b)	$2\left(\frac{5}{2}\right)^3-\left(\frac{5}{2}\right)^2+A\left(\frac{5}{2}\right)+B=0$	M1
	$3A-B=-118,\ 5A+2B=-50$ $\Rightarrow A=...,$ **or** $B=...$	M1
	$A=-26,\ B=40$	A1
		(3)

(b) **Do not allow mis-reads of $(2x-5)$ in part (b).**

M1: Attempts $f\left(\frac{5}{2}\right)=0$. The $\frac{5}{2}$ embedded in the expression set = 0 is sufficient.

$f\left(-\frac{5}{2}\right)=0$ scores M0.

May be implied by further work. Again, tabular or division methods may be seen.
e.g. long division:

$$\begin{array}{r} x^2+2x+\frac{1}{2}A+5 \\ 2x-5\overline{)\,2x^3-x^2+Ax+B} \\ \underline{2x^3-5x^2} \\ 4x^2+Ax+B \\ \underline{4x^2-10x} \\ (A+10)x+B \\ \underline{(A+10)x-5\left(\frac{1}{2}A+5\right)} \\ B+\frac{5}{2}A+25=0 \end{array}$$

Score M1 for obtaining a quotient $...x^2\pm...x\pm...A+...$ and a remainder $...A\pm...B\pm...$ set = 0 where "…" are non-zero constants.
e.g. tabular method:

	x^2	$2x$	$5+\frac{A}{2}$
$2x$	$2x^3$	$4x^2$	$(10+A)x$
-5	$-5x^2$	$-10x$	$-25-\frac{5A}{2}$

So $B-\left(-25-\frac{5A}{2}\right)=0$. Score M1 for obtaining a constant $...A+...$ where "…" are non-zero constants, and then sets B – their constant = 0

M1: Solves $3A-B=-118$ simultaneously with their equation in A and B from having attempted $f\left(\pm\frac{5}{2}\right)=0$ or long division/tabular method using the correct factor of $(2x-5)$ and obtains a value for A or B.
May be via a calculator and may be implied by their values. You do not need to check but the above conditions must be satisfied.

For reference, use of $f\left(-\frac{5}{2}\right)=0$ gives $A=-161$, $B=-365$

A1: Both correct values

(c)	$f(x)=(x-7)(2x^2+...x+...)+...$	M1
	$2x^2+13x+65$	A1
		(2)
		Total 7

(c) Do not allow mis-reads of (x – 7) in part (c).

M1: Uses any appropriate method e.g. long division/inspection/table with numeric non-zero A and B to obtain $2x^2 + px + q$ where p and q are non-zero.
There is no requirement to find the remainder but assuming (x – 7) is a **factor** is M0 (see example below)

A1: Must follow correct values of *A* and *B*.
Correct expression $2x^2+13x+65$ **which is clearly identified** e.g. by circling/underlining or e.g. Quotient = $2x^2+13x+65$, $Q=2x^2+13x+65$
Any remainder, correct or incorrect, can be ignored. (NB correct remainder is 495)

Long division for reference:

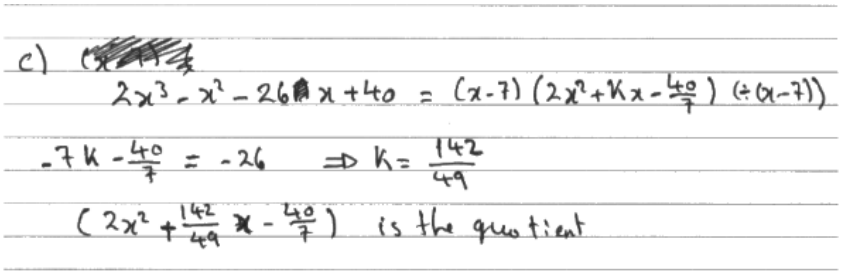
$$\begin{array}{r} 2x^2+13x+65 \\ x-7\overline{)\,2x^3-x^2-26x+40} \\ \underline{2x^3-14x^2} \\ 13x^2-26x+40 \\ \underline{13x^2-91x} \\ 65x+40 \\ \underline{65x-455} \\ 495 \end{array}$$

Tabular method for reference:

	$2x^2$	$13x$	65
x	$2x^3$	$13x^2$	$65x$
–7	$-14x^2$	$-91x$	–455

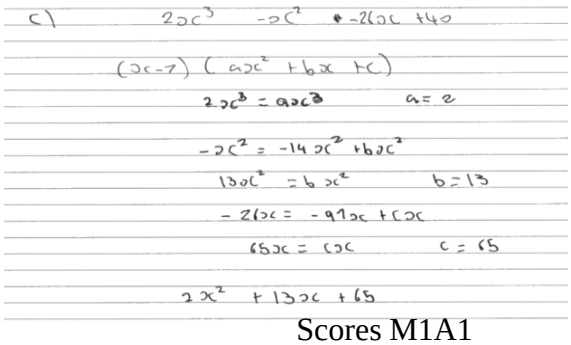
But note that **just** the above score M1A0 with no indication that the quotient is $2x^2+13x+65$

Some candidates assume that (x – 7) is a **factor** of f(x) and try to find the quadratic factor:



This scores M0 in part (c)

But work that doesn't assume (x – 7) is a factor is fine e.g.:



Scores M1A1