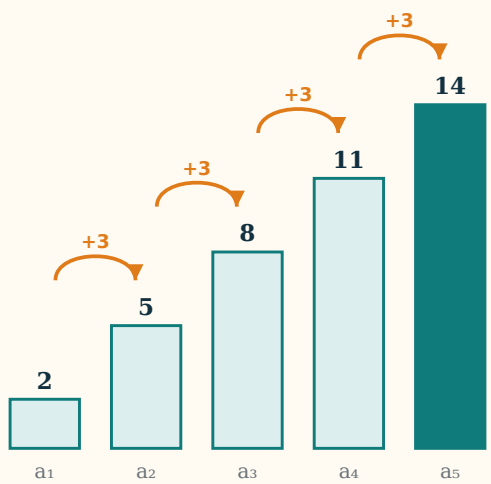
MATHS WITHOUT GUESSWORK

Arithmetic Progressions

Understand the Pattern.
Choose the Formula.
Solve Independently.

A step-by-step concept, problem-solving and board-exam practice workbook for Class 10 Mathematics

CBSE Class 10 Mathematics · Syllabus session 2026–27 · Volume 5



2, 5, 8, 11, 14, …

every step adds the same amount: d = 3

TWO SIGNATURE QUESTIONS

1 **Why does the** formula use (n − 1)?

2 **Nth term or** sum formula?

Core topics: pattern · common difference · nth term · sum of n terms · daily-life problems

Original explanations, examples and questions. Not a substitute for the NCERT textbook or your teacher.

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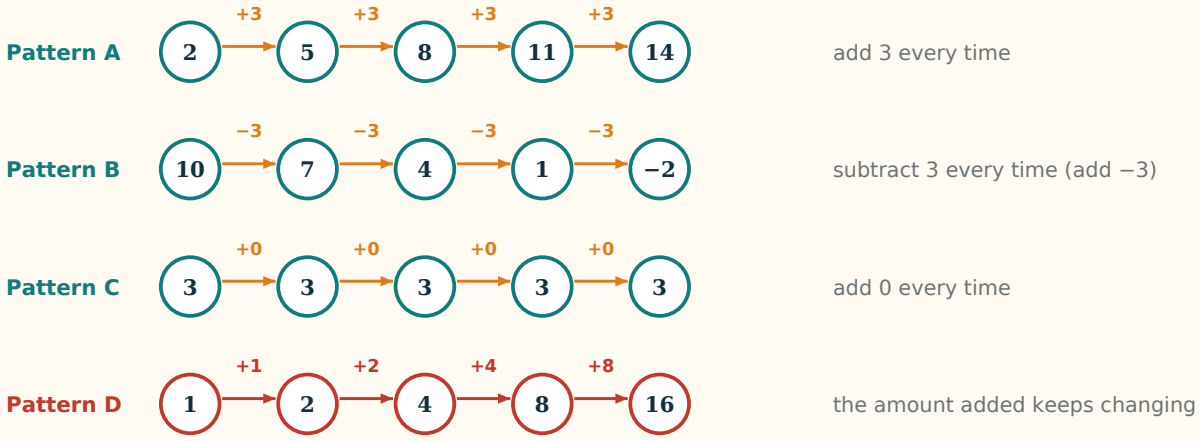
★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? CORE

Patterns before formulas

Learning objective: See what stays the same in a pattern, and what a “term” is, before any formula appears.

A list of numbers that follows a rule is called a **sequence**; each number in it is a **term**. Look at how each term is made from the one before it.

VISUAL 1 · THE NUMBER-PATTERN VISUAL: WHAT HAPPENS FROM ONE TERM TO THE NEXT?



List	Rule in words	Same amount added each time?
2, 5, 8, 11, 14, …	each term is 3 more than the one before	**Yes**: +3
10, 7, 4, 1, −2, …	each term is 3 less than the one before	**Yes**: −3
3, 3, 3, 3, 3, …	each term equals the one before	**Yes**: +0
1, 2, 4, 8, 16, …	each term is twice the one before (the gaps are 1, 2, 4, 8)	**No**: the gap changes

◆ UNDERSTAND

Arithmetic progression (AP): a list of numbers in which each term, except the first, is obtained by adding the **same fixed number** to the term before it. That fixed number is called the **common difference**, written **d**. Patterns A, B and C are APs; pattern D is not, because the amount added changes (1, 2, 4, 8).

★ SPOT THE CLUE

The key phrase is “the same each time”. A list can grow steadily, shrink steadily or stay put and still be an AP. What matters is that the *amount added* never changes, not that the numbers get bigger.

✎ YOUR TURN

C1 (guided) For each list say what is added (or subtracted) each time, or write “no fixed amount”: (a) 6, 11, 16, 21 (b) 50, 44, 38, 32 (c) −5, −5, −5, −5 (d) 2, 4, 7, 11 (e) 1/2, 1, 3/2, 2

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? CORE

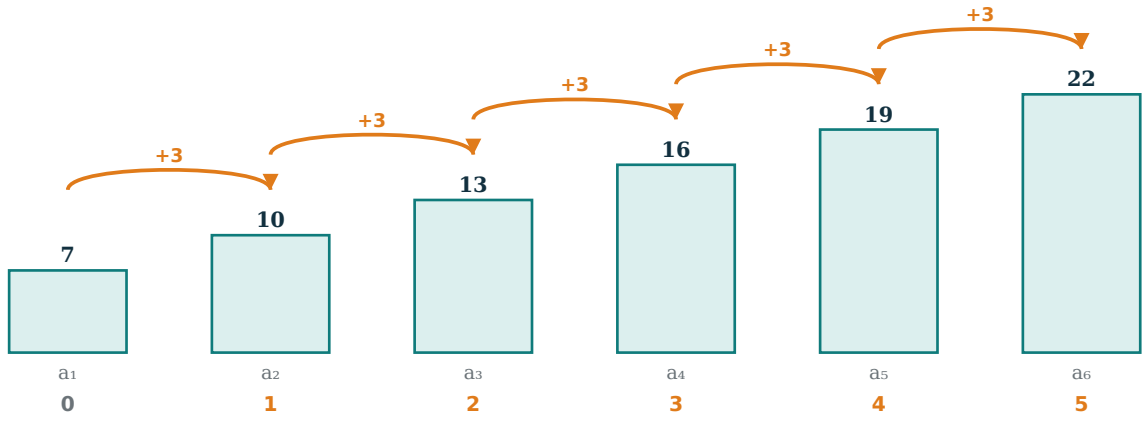
Why does the formula use (n − 1)?

Learning objective: Signature 1, part 1 of 3. Discover why the n-th term needs n − 1 jumps. No memorising yet.

Everyone is told "$a_n = a + (n - 1)d$". Hardly anyone is told **why**. Let us build it from the picture, using the AP 7, 10, 13, 16, 19, 22, ... (a = 7, d = 3).

VISUAL 5 · THE STAIRCASE: TO STAND ON STEP n YOU HAVE JUMPED n − 1 TIMES

You START on the first step. You have not jumped at all yet: 0 jumps.



position n: term name above, number of jumps from a_1 below (orange)

Term	Position n	Jumps from a_1	As an expression	Value
a_1	1	0	a	7
a_2	2	1	a + d	10
a_3	3	2	a + 2d	13
a_4	4	3	a + 3d	16
a_5	5	4	a + 4d	19
a_{10}	10	9	a + 9d	34
a_n	n	n − 1	a + (n − 1)d	?

FENCE POSTS



5 posts, 4 gaps

◆ UNDERSTAND

Read the table downwards. The number of jumps is always **one less** than the position: position 2 needs 1 jump, position 5 needs 4 jumps, position 10 needs 9. Each jump adds d. So reaching position n takes **n − 1** jumps, and the value is **a + (n − 1) × d**. It is the same reason a fence with 5 posts has only 4 gaps.

? WHY THIS STEP?

Why not a + n × d? Because you start *on* the first term. If the first term were called the "0th" term, then a + nd would be right. We number terms from 1, so the first term has taken 0 jumps, the second 1 jump, and so on: always one fewer.

✓ CHECK YOURSELF

Hold this question. How many jumps does it take to reach the 25th term of an AP? And the 100th? (Answers: 24 and 99. Now try W1–W6 on page 14 when you have seen the formula on page 13.)

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? CORE

Method 3: using the sum formulas

Learning objective: Use $S_n = n/2[2a + (n - 1)d]$ and $S_n = n/2(a + l)$, see why they agree, and know when each is convenient.

◆ UNDERSTAND

Form 1: $S_n = (n/2)[2a + (n - 1)d]$ (know a, d, n). **Form 2:** $S_n = (n/2)(a + l)$ where **$l = a_n$** is the last term (know a, l, n). They agree because $l = a + (n - 1)d$, so $a + l = 2a + (n - 1)d$: the same pair total.

Same AP: 4, 9, 14, 19, 24, 29, 34, 39 (n = 8)	Form 1: a, d, n	Form 2: a, l, n
Formula	$(n/2)[2a + (n - 1)d]$	$(n/2)(a + l)$
Substitute	$(8/2)[2(4) + 7 \times 5]$	$(8/2)(4 + 39)$
Pair total	$8 + 35 = 43$	$4 + 39 = 43$
Sum	$4 \times 43 = 172$	$4 \times 43 = 172$

Worked example 1 (form 1, negative d). Find the sum of the first 20 terms of 30, 26, 22, ... Predict the sign first.

Step	Working	Why this step?
READ	Asked: S_{20} (a total). Given: $a = 30$, $d = -4$, $n = 20$. *Predict:* terms go negative after the 8th: expect a negative total.	Predicting catches sign slips later.
CHOOSE	$S_n = (n/2)[2a + (n - 1)d]$	a, d and n are known, the last term is not.
SOLVE	$S_{20} = 20/2\ [2(30) + (20 - 1)(-4)] = 10 \times [60 - 76] = 10 \times (-16) = -160$	Put d in brackets: $19 \times (-4) = -76$.
CHECK	Form 2 with $l = a_{20} = -46$: $10 \times (30 - 46) = -160$ ✓, negative as predicted.	Use the other form as a check.

Worked example 2 (form 2, last term given). Find $5 + 8 + 11 + \ldots + 62$.

Step	Working	Why this step?
READ	Asked: the total. Given: $a = 5$, $d = 3$, $l = 62$; n is not given.	The list is given with its last term.
CHOOSE	Find n: $(62 - 5)/3 + 1 = 20$. Then $S_n = (n/2)(a + l)$.	Form 2 uses l directly; no need for d again.
SOLVE	$S_{20} = 20/2\ (a + l) = 20/2\ (5 + 62) = 10 \times 67 = 670$	The pair total is $5 + 62 = 67$.
CHECK	Form 1: $(20/2)[10 + 19 \times 3] = 10 \times 67 = 670$ ✓.	Both forms must match.

⚠ COMMON TRAP

Two slips. (1) Dropping the sign of d: $2(30) + 19 \times 4 = 136$ gives 1360, but S_{20} cannot exceed $20 \times 30 = 600$. (2) Using l as n: $l = 62$ is the last term; $n = 20$.

✎ YOUR TURN

C11 (guided) Find the sum of: (a) the first 15 terms of 6, 10, 14, ... (b) the first 12 terms of −5, −2, 1, ... **C12** Find $7 + 11 + 15 + \ldots + 63$. **T3** (transfer) Sum of all two-digit numbers divisible by 4.

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum?

Doubts 1 and 2: AP test, constant d

DOUBT 1 *"How do I know whether a list of numbers is an AP?"*

✗ WHY IT HAPPENS	I compare the first two numbers, see a pattern, and assume the rest follow it.
◆ SIMPLE EXPLANATION	Find **every** gap (next − previous). If all gaps are equal the list is an AP; one different gap means it is not.
★ SPOT THE CLUE	"Show that…", "Is this an AP?", or a list of four or more numbers: check all neighbouring pairs.
▦ WORKED EXAMPLE	Is $3, 8, 13, 18, 24$ an AP? Gaps: $8 - 3 = 5$, $13 - 8 = 5$, $18 - 13 = 5$, $24 - 18 = 6$. The last gap is 6, so it is **not** an AP.
? WHY THIS STEP?	A list of k numbers has k − 1 gaps; every one has to match.
⚠ COMMON TRAP	Thinking an AP must go up. $20, 14, 8, 2$ goes down, with $d = -6$, and is a perfectly good AP.
✎ YOUR TURN DB1	**DB1** Which are APs? (a) $2, 7, 12, 17, 23$ (b) $15, 11, 7, 3, -1$ (c) $1/2, 1, 3/2, 2, 5/2$ (d) $4, 4, 4, 4, 5$.
✓ QUICK CHECK	Count the gaps and write them in a row: they should all look the same.

DOUBT 2 *"Why does the difference have to be constant? What goes wrong if it is not?"*

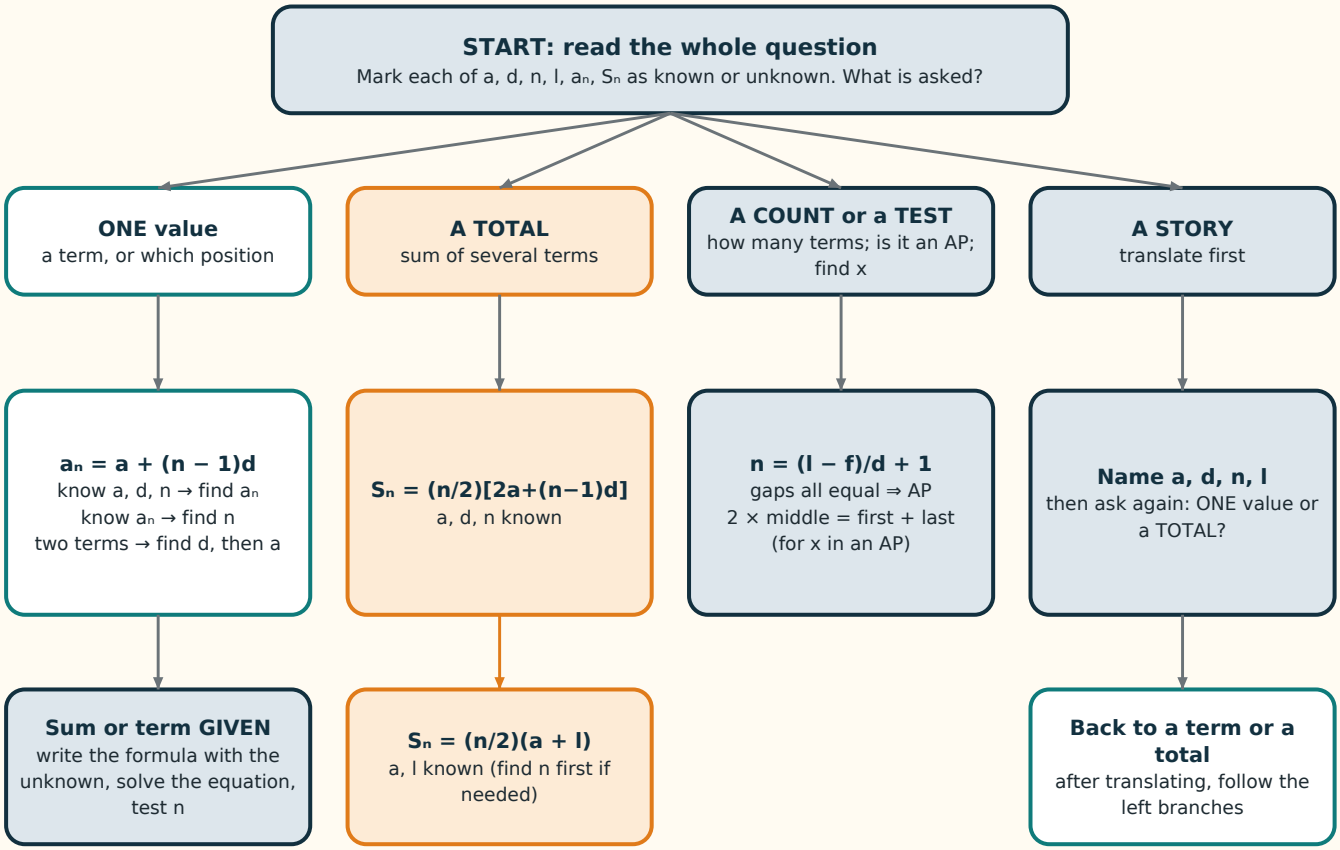
✗ WHY IT HAPPENS	"Constant" sounds like a fussy rule, not a reason.
◆ SIMPLE EXPLANATION	Every formula in this chapter counts **equal jumps**: the n-th term formula adds (n − 1) jumps of size d, and the pairing trick needs equal gaps. If the gaps change, those formulas give wrong answers.
★ SPOT THE CLUE	A question that uses a, d and a formula assumes the list really is an AP.
▦ WORKED EXAMPLE	The list $2, 5, 9, 14$ has gaps 3, 4, 5. Using $a = 2$, $d = 3$ the formula gives $a_4 = 2 + 3 \times 3 = 11$, but the list's 4th term is 14.
? WHY THIS STEP?	The formula assumed every jump was 3, but the real jumps grow.
⚠ COMMON TRAP	Taking d from the first gap only and trusting the formula without testing the other gaps.
✎ YOUR TURN DB2	**DB2** For $1, 4, 9, 16$ use $a = 1$, $d = 3$ to predict the 4th term, compare it with the actual 4th term, and explain the mismatch.
✓ QUICK CHECK	If a formula's predictions do not match the list, the list is not an AP.

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? CORE

The formula decision tree

Learning objective: Signature 2, part 2 of 4. Follow the branch that matches what the question asks.

VISUAL 8 · FORMULA-SELECTION DECISION TREE



ALWAYS: n is a positive whole number · check another way · answer in words, with units

Stuck between two branches? Ask: is the answer a single value from the list, or a total of values?

? WHY THIS STEP?

Why the tree starts with the question, not the numbers. The same list of numbers can lead to a term, a total, a position or a count. What the question asks decides the branch; the given numbers decide the form of the formula.

✎ YOUR TURN

C15 (guided) Walk each question through the tree and write the branch: (a) “Find the 14th term of 2, 9, 16, ...” (b) “Find the sum of the first 14 terms of 2, 9, 16, ...” (c) “How many terms has 2, 9, 16, ..., 100?” (d) “Which term of 2, 9, 16, ... is 93?”

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? CORE

Mistake clinic (1 of 3)

Learning objective: Read each student's work, find the exact line that fails, then fix the one in the box.

MISTAKE 1 — Subtracting in the wrong order

✗ STUDENT'S WORK	For $20, 17, 14, \ldots$ the student writes $d = 20 - 17 = 3$ and then $a_{10} = 20 + 9 \times 3 = 47$.
✗ WHERE IT FAILS	The list is going *down*, yet the answer 47 is far above 20. The true common difference is $17 - 20 = -3$.
? WHY IT TEMPTS	Subtracting the bigger number from the smaller feels backwards, so the student subtracts the first from the second reversed.
✓ CORRECTED	$d = 17 - 20 = -3$, so $a_{10} = 20 + 9 \times (-3) = 20 - 27 = -7$. A falling list gives a falling tenth term ✓.
★ PREVENTION RULE	d = next term − previous term. Falling list ⇒ d is negative. Check the direction of your answer.
✎ FIX IT MC1	**MC1** A student finds d for $50, 46, 42, \ldots$ as $50 - 46 = 4$. Correct it and find the 8th term.

MISTAKE 2 — Using n instead of (n − 1) SIGNATURE 1

✗ STUDENT'S WORK	Find the 12th term of $4, 9, 14, \ldots$. The student writes $a_{12} = 4 + 12 \times 5 = 64$.
✗ WHERE IT FAILS	Test the student's rule on the 2nd term: $4 + 2 \times 5 = 14$, but the 2nd term is 9 ✗. The rule always overshoots by one d.
? WHY IT TEMPTS	"The 12th term, so multiply by 12." Position and number of jumps feel like the same thing.
✓ CORRECTED	From term 1 to term 12 there are 11 jumps: $a_{12} = 4 + 11 \times 5 = 59$. Test: $a_2 = 4 + 1 \times 5 = 9$ ✓.
★ PREVENTION RULE	The first term has no jump. The nth term has (n − 1) jumps. Test the formula on n = 2.
✎ FIX IT MC2	**MC2** A student writes the 15th term of $6, 10, 14, \ldots$ as $6 + 15 \times 4 = 66$. Find the error, then the true value.

MISTAKE 3 — Finding a term when a sum is asked SIGNATURE 2

✗ STUDENT'S WORK	Find the sum of the first 10 terms of $5, 8, 11, \ldots$. The student finds $a_{10} = 5 + 9 \times 3 = 32$ and writes "sum = 32".
✗ WHERE IT FAILS	The sum has ten terms, each at least 5, so it must be at least 50. 32 is only the *last* term.
? WHY IT TEMPTS	The word "10" and the formula a_n are familiar, so the question is read as "find the 10th term".
✓ CORRECTED	$S_{10} = (10/2)[2(5) + 9 \times 3] = 5 \times 37 = 185$. Check with form 2: $5(5 + 32) = 185$ ✓.
★ PREVENTION RULE	"Sum", "total", "altogether" ⇒ S_n. Ask: is the answer one value or a total?
✎ FIX IT MC3	**MC3** Find the sum of the first 12 terms of $4, 7, 10, \ldots$. (A student wrote 37. Say what that number actually is.)

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? PRACTICE

Level 1: recognise an AP and find d

Learning objective: Decide whether a list is an AP, find d with its sign, and write terms from a and d.

1 Recognise | 2 Terms | 3 Sums | 4 Unknowns | 5 Mixed | Test

Take your time. Write d for each pair.

P1 Which of these are APs? Give d for each AP. (a) $4, 9, 14, 19$ (b) $2, 4, 8, 16$ (c) $10, 7, 4, 1$ (d) $1, 1, 1, 1$

Purpose: test the gaps

Hint (not the solution): next − previous, for every pair

Working space

P2 Find d. (a) $13, 19, 25, \ldots$ (b) $5, 1, -3, \ldots$ (c) $0.5, 1.0, 1.5, \ldots$ (d) $-8, -5, -2, \ldots$

Purpose: d with sign

Hint (not the solution): subtract in the same order each time

Working space

P3 Write the first four terms of the AP with $a = 12$ and $d = -5$.

Purpose: build from a and d

Working space

P4 A list has the rule $a_n = 3n + 2$. Write its first three terms and show that it is an AP.

Purpose: rule to list

Hint (not the solution): put n = 1, 2, 3, then check the gaps

Working space

P5 Find d and the next two terms of $2.5, 4, 5.5, \ldots$.

Purpose: decimal d

Working space

P6 Find x so that $x, 2x + 1, 5x - 2$ are in AP. Write the three terms.

Purpose: middle = average

Hint (not the solution): in an AP, 2 × middle = first + last

Working space

★ Signature 1 · Why (n − 1)? ★ Signature 2 · Term or sum? REVISION

Revision map

Learning objective: VISUAL 12. The whole chapter on one page: the pattern, the formulas, how to choose, and what to check.

VISUAL 12 · REVISION MAP

AP
list with the same d each time → **d**
next − previous (with sign) → **$a_n = a + (n - 1)d$**
ONE term; n − 1 jumps → **S_n**
a TOTAL of n terms

Symbol	Meaning	Symbol	Meaning
a	first term	l	last term (a_n for the final term)
d	common difference: $a_{n+1} - a_n$	a_n	the nth term (one value)
n	position or number of terms (a positive whole number)	S_n	sum of the first n terms (a total)

Formula	Use it when	Check
$a_n = a + (n - 1)d$	a term, a position n, d or a from known terms; n − 1 = number of jumps	test n = 1 and n = 2
$S_n = (n/2)[2a + (n - 1)d]$	a, d, n known (a total is asked)	compare with the other form
$S_n = (n/2)(a + l)$	first and last terms known; find n first if missing	estimate: average × n
$n = (l - a)/d + 1$	counting terms in a list or multiples	n must be a whole number
$a_n = S_n - S_{n-1}$	a term is wanted and S_n is given as a formula	$a_1 = S_1$

SIGNATURE 1 · Why (n − 1)?

- First term: 0 jumps. nth term: (n − 1) jumps of d.
- Position 12 means 11 jumps, so $a_{12} = a + 11d$.
- Test the rule on n = 1 and n = 2 (MC2).

SIGNATURE 2 · Term or sum?

- One value or a position → a_n. A total → S_n.
- Name what is asked, what is given, then choose.
- A given term can serve as l in the sum (MC3, MC7).

⚠ COMMON TRAP

Mistake checklist. ☐ d in the right order (MC1) ☐ n − 1, not n (MC2) ☐ term, not total, when one term is asked (MC3, MC7) ☐ a and d not swapped (MC4) ☐ negative d in brackets (MC5) ☐ n and l kept apart (MC6) ☐ arithmetic rechecked (MC8) ☐ n a whole number (MC9) ☐ roots tested against the story (MC10)

✓ CHECK YOURSELF

Checking routine. Re-read the question. Substitute n = 1. Compute the answer a second way (other sum form, or average × n). Does the sign and size make sense? Answer in words with units.

Progress: Section I ✓. Next: page 50, record where you stand and plan your practice.

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