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CHAPTER NOTES

Arithmetic Progressions Class 10 Notes | CBSE Maths Chapter 5

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Explain Arithmetic Progressions simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Arithmetic Progressions Class 10 Notes | CBSE Maths Chapter 5

Arithmetic Progressions is Chapter 5 of CBSE Class 10 Maths. It studies lists of numbers in which every term after the first is made by adding the same fixed number, called the common difference. The chapter shows how to recognise such a list, how to find any term with the formula $a_n = a + (n - 1)d$, and how to add the first n terms quickly with the sum formula that the young Gauss used to add 1 to 100.

For board exams the chapter is formula-driven, and most answers can be checked by writing out a few terms. Questions test finding a term, finding which term a number is, counting terms, working back to a and d from two conditions, finding sums, and daily-life problems on salaries, savings, instalments, rows of plants and stacked logs. Mastering the two formulas and setting up the AP correctly from the words is most of the work.

Quick Answer - Arithmetic Progression

An **arithmetic progression (AP)** is a list obtained by adding a fixed number d , the common difference, to the previous term. d can be positive, negative or zero, and $d = a_n - a_{n-1}$. The n th term is $a_n = a + (n - 1)d$. The sum of the first n terms is $S_n = \frac{n}{2}(a + l)$ when the last term l is known.



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All Key Formulas at a Glance

Idea	Formula or rule	Use it when
Common difference	$d = a_{k+1} - a_k = a_2 - a_1$	Finding d , or testing whether a list is an AP
General form	$a, a + d, a + 2d, a + 3d, \dots$	Writing an AP from a and d
n th (general) term	$a_n = a + (n - 1)d$	Finding a term, finding n , or finding a and d from two terms
Last term	$l = a + (n - 1)d$	Counting the terms of a finite AP
k th term from the end	$l - (k - 1)d$	Reading a finite AP backwards
Sum of first n terms	$S_n = n/2 [2a + (n - 1)d]$	
Sum using the last term	$S_n = n/2 (a + l)$	
Term from the sum	$a_n = S_n - S_{n-1}$	
Sum of first n positive integers	$1 + 2 + \dots + n = n(n + 1)/2$	
Arithmetic mean	If a, b, c are in AP, $b = (a + c)/2$	



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Key Concepts

1. Patterns in Lists of Numbers

Many lists of numbers in daily life follow a pattern. For example, Reena's monthly salary of ₹8000 with an annual increment of ₹500, or the rungs of a ladder that decrease uniformly.

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and Shakila's money box, which gets ₹100 at age one and ₹50 more every year (100, 150, 200, 250, ...). In each of these, the next term comes from **adding a fixed number**.

Other lists follow other rules. In a savings scheme where the amount becomes 5/4 times itself every 3 years, ₹8000 grows to 10000, 12500, 15625, 19531.25: each term is **multiplied** by a fixed number. The numbers of unit squares in squares of side 1, 2, 3, ... are $1^2, 2^2, 3^2, \dots$, and the rabbit pairs 1, 1, 2, 3, 5, 8 follow yet another rule. This chapter studies only the first kind of list.

2. Arithmetic Progression and Common Difference

Look at the lists 1, 2, 3, 4, ... (add 1), 100, 70, 40, 10, ... (add -30), 3, 3, 3, 3, ... (add 0) and -1.0, -1.5, -2.0, -2.5, ... (add -0.5).

Each number in a list is called a **term**. In each list, every term after the first is the previous term plus the same fixed number.

Definition: An arithmetic progression is a list of numbers starting from a fixed number and adding a fixed number to the preceding term. The fixed number is called the **common difference** of the AP, written d. If the first term is a, then the terms are a, a + d, a + 2d, a + 3d, ...

For terms $a_1, a_2, a_3, \dots, a_n$: $a_2 - a_1 = a_3 - a_2 = \dots = a_n - a_{n-1} = d$

In general, $d = a_{k+1} - a_k$, where a_{k+1} and a_k are consecutive terms. For example, in the list 1, 3, 5, 7, 9, ... from the term that **follows** it, even when the difference is negative, e.g., $5 - 8 = -3$, not $6 - 3 = 3$.

Sign of d	Behaviour of terms
$d > 0$	Terms increase
$d < 0$	Terms decrease
$d = 0$	All terms are equal

Illustration (NCERT Example 1): For the AP 1, -1, 1, -1, ... $1/2 - 3/2 = -1$.

3. General Form, Finite and Infinite Arithmetic Progressions

If the first term is a and the common difference is d, then the terms are a, a + d, a + 2d, a + 3d, ...



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$a, a + d, a + 2d, a + 3d, \dots$

This is the **general form of an AP**. To write an AP you need both the first term a and the common difference d . For example, $a = 6, d = 3$ gives 6, 9, 12, 15, ...; $a = 6, d = -3$ gives 6, 3, 0, -3, ...; $a = -7, d = -2$ gives -7, -9, -11, ...; and $a = 2, d = 0$ gives 2, 2, 2,

A **finite AP** has a limited number of terms and so has a last term. Example: cash prizes for toppers of Classes I to XII, 200, 250, 300, ..., 750. An **infinite AP** goes on without end and has no last term, like 1, 2, 3, 4,

The last term of a finite AP is written l . If the AP has m terms, then $a_m = l$.

4. Testing Whether a List Is an AP

A list is an AP only if the difference between each term and the one before it is the same all the way. The method:

1. Find $a_2 - a_1, a_3 - a_2, a_4 - a_3$, and so on
2. If all these differences are equal, the list is an AP.
3. If even one difference is different, the list is not an AP.

Illustration (NCERT Example 2):

- 4, 10, 16, 22, ...: differences 6, 6, 6. It is an AP.
- 1, -1, -3, -5, ...: differences $-1 - 1 = -2, -3 - (-1) = -4, -5 - (-3) = -2$. Next two terms: -7 and -9.
- -2, 2, -2, 2, -2, ...: $a_2 - a_1 = 4$ but $a_3 - a_2 = -4$. It is not an AP.
- 1, 1, 1, 2, 2, 2, 3, 3, 3, ...: differences 0, 0, 0, 1, 1, 1, 0, 0, 0. It is not an AP.

Lists like 2, 4, 8, 16, ... (differences 2, 4, 8) are not APs.

5. The n th Term of an AP

Reena's salary shows the idea. Her salary in the 1st year is ₹8000, and in the 5th year $8000 + 4 \times 500 = ₹15000$, and the 25th year salary is $8000 + 24 \times 500 = ₹16000$.

In general, $a_2 = a + d, a_3 = a + 2d, a_4 = a + 3d, \dots$

$$a_n = a + (n - 1)d$$



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a_n is also called the **general term** of the AP. The formula links four quantities: a_n , a , n and d . If any three are known, the fourth can be found.

Illustration (NCERT Example 3): 10th term of 2, 7, 12, ...: $a = 2$, $d = 5$, $n = 10$. $a_{10} = 2 + 9 \times 5 = 47$.

Illustration (NCERT Example 9): ₹1000 invested at 8% simple interest per year. The interest at the end of years 1, 2, 3, ... is $1000 \times 8 \times 1/100 = 80$, then 160, then 240, This is an AP with $a = 80$ and $d = 80$. Interest at the end of 30 years = $a_{30} = 80 + 29 \times 80 = ₹2400$.

6. Problems on the nth Term

Most nth-term questions are one of five types.

Type A: Which term is a given number? Put a_n equal to the number and solve for n . NCERT Example 4: in 21, 18, 15, ..., $a = 21$ and $d = -3$. For $a_n = -81$: $-81 = 21 + (n - 1)(-3) = 24 - 3n$, so $3n = 105$ and $n = 35$. For $a_n = 0$: $21 + (n - 1)(-3) = 0$ gives $3(n - 1) = 21$, so $n = 8$. The 8th term is 0.

Type B: Is a number a term at all? n must be a term. If solving gives a fraction or a negative number, so 301 is not a term.

Type C: Find the AP from two conditions. pair of linear equations. NCERT Example 5 Subtracting, $4d = 4$, so $d = 1$ and $a = 3$. The

Type D: Counting terms. Use the last term numbers divisible by 3 are 12, 15, 18, ..., 99

Type E: A term counted from the end. In a sequence, the $(n - k + 1)$ th term from the start. Or reverse difference becomes $-d$, so the k th term from the end is $a - (k - 1)d$, -62, there are 25 terms. The 11th term from the end is -32 .

A useful fact: $a_m - a_n = (m - n)d$. For example, $a_7 - a_1 = 6d = 7$ and $d = 1$.



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7. Sum of the First n Terms

Gauss's method. Asked at the age of 10 to add the positive integers from 1 to 100, Gauss wrote the sum forwards and backwards:

$$S = 1 + 2 + 3 + \dots + 99 + 100$$

$$S = 100 + 99 + \dots + 3 + 2 + 1$$

Adding the two lines pair by pair gives $2S = 101 + 101 + \dots + 101$ (100 times) $= 100 \times 101$, so $S = 5050$.

The general formula. Apply the same idea to the AP $a, a + d, a + 2d, \dots, a + (n - 1)d$:

$$S = a + (a + d) + \dots + [a + (n - 1)d] \quad (1)$$

$$S = [a + (n - 1)d] + [a + (n - 2)d] + \dots + a \quad (2)$$

Adding (1) and (2) term by term, every pair adds up to $2a + (n - 1)d$. So $2S = n[2a + (n - 1)d]$, which gives

$$S_n = \frac{n}{2} [2a + (n - 1)d]$$

Since $a + (n - 1)d = a_n$, this can also be written as $S_n = \frac{n}{2} (a + a_n)$, where a_n is the last term l , so

$$S_n = \frac{n}{2} (a + l)$$

Illustration (Shakila's money box): $a = 1000$, $d = 1200$. Total amount = ₹12600 in the box on her daughter's birthday.

Sum of the first n positive integers (NCERT Example 10): For the first 1000 positive integers, $S = \frac{1000}{2} (1 + 1000) = 500 \times 1001 = 500500$.

8. Problems on the Sum and the Last Term

Finding n from a sum. This gives a quadratic equation. NCERT Example 13: how many terms of $24, 21, 18, \dots$ must be taken so that their sum is 78? $a = 24$, $d = -3$. $78 = \frac{n}{2} (2 \times 24 + (n - 1)(-3)) = \frac{n}{2} (51 - 3n)$. So $3n^2 - 51n + 156 = 0$. $n = 4$ and $n = 13$ work. Two answers are possible because the sum is zero: a is positive and d is negative, so the terms cross zero.

Finding d or a from a sum. NCERT Example 14: Find the sum of all the multiples of 3 between 1 and 100. $a = 3$, $d = 3$. $100 = 3 + (n - 1) \times 3$, so $d = 10$. Then $a_{20} = 10 + 19 \times 10 = 200$.



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Sum of a list given by its nth term. NCERT Example 15: $a_n = 3 + 2n$ gives 5, 7, 9, 11, ..., an AP with $a = 5$ and $d = 2$. $S_{24} = 12 [10 + 46] = 672$. Any a_n that is linear in n (of the form $pn + q$) gives an AP with $d = p$.

The term from the sum. The n th term is the sum of the first n terms minus the sum of the first $(n - 1)$ terms:

$$a_n = S_n - S_{n-1}, \text{ and } a_1 = S_1.$$

For $S_n = n^2 + n$: $a_1 = S_1 = 2$ and $a_2 = S_2 - S_1 = 6 - 2 = 4$.

Arithmetic mean. If a, b, c are in AP, then $b - a = c - b$, so **$b = (a + c)/2$** . b is called the arithmetic mean of a and c . This gives a quick way to find an unknown: if $2k + 1, 13, 5k - 3$ are in AP, then $2 \times 13 = (2k + 1) + (5k - 3)$, so $26 = 7k - 2$ and $k = 4$.



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Formula and Theorem Sheet

Result	Formula	Notes
Common difference	$d = a_{k+1} - a_k$	Later term minus earlier term; can be positive, negative or zero
nth term	$a_n = a + (n - 1)d$	n must be a positive integer
Last term of n terms	$l = a_n = a + (n - 1)d$	Used to count terms
Difference of two terms	$a_m - a_n = (m - n)d$	Quick route to d
kth term from the end	$l - (k - 1)d$, or the $(n - k + 1)$ th term	
Sum of first n terms	$S_n = n/2 [2a + (n - 1)d]$	
Sum with last term	$S_n = n/2 (a + l)$	
Term from sums	$a_n = S_n - S_{n-1}$; a_1	
First n positive integers	$1 + 2 + \dots + n = n(n + 1)/2$	
Arithmetic mean	$b = (a + c)/2$ when a, b, c are in AP	

Important Definitions

- Arithmetic progression (AP):** a list of numbers where each term is obtained by adding a fixed number to the preceding term, except the first term.
- Common difference (d):** the fixed number added to each term to get the next term, a_k . It can be positive, negative or zero.

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- **General form of an AP:** $a, a + d, a + 2d, a + 3d, \dots$, where a is the first term and d the common difference.
- **n th term or general term (a_n):** the term in position n , given by $a_n = a + (n - 1)d$.
- **Finite AP:** an AP with a limited number of terms. It has a last term.
- **Infinite AP:** an AP whose terms go on without end. It has no last term.
- **Last term (l):** the final term of a finite AP. If the AP has m terms, $l = a_m$.
- **Sum of first n terms (S_n):** $a_1 + a_2 + \dots + a_n = n/2 [2a + (n - 1)d]$.
- **Arithmetic mean:** if a, b, c are in AP, then $b = (a + c)/2$ is called the arithmetic mean of a and c .

Solved Examples (NCERT-Based)

Example 1: Which situations make an AP?

In which of the following situations, does this form an AP, and why? (i) The taxi fare after each additional km. (ii) The amount of air remaining in the cylinder at a rate of digging, when it costs ₹150 for the first 100 m. (iii) The amount of money in the account every year at 8% per annum.

Solution:

(i) Fares: 15, 23, 31, 39, Each difference is 8. It is an AP.

(ii) Let the air be x at the start. After each 100 m, the amount of air remaining is $27x/64, \dots$. Differences: $3x/4 - x = -x/4$ and $27x/64 - 3x/4 = -x/4$. It is an AP.

(iii) Costs: 150, 200, 250, 300, Each difference is 50. It is an AP.

(iv) Amounts: $10000(1.08), 10000(1.08)^2, 10000(1.08)^3, \dots$. Differences 864 and 933.12 are unequal. It is not an AP.



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Example 2: Which term is 78? (NCERT Exercise 5.2)

Which term of the AP : 3, 8, 13, 18, ... ,is 78?

Solution: $a = 3$, $d = 8 - 3 = 5$, $a_n = 78$.

$$78 = 3 + (n - 1) \times 5$$

$$75 = (n - 1) \times 5$$

$$n - 1 = 15, \text{ so } n = 16.$$

78 is the 16th term.

Example 3: Is -150 a term? (NCERT Exercise 5.2)

Check whether -150 is a term of the AP : 11, 8, 5, 2 ...

Solution: $a = 11$, $d = 8 - 11 = -3$. Suppose -150 is the n th term

$$-150 = 11 + (n - 1)(-3)$$

$$-161 = -3(n - 1)$$

$$n - 1 = 161/3, \text{ so } n = 164/3.$$

n is not a positive integer. **So -150 is not a term of the AP.**

Example 4: The 31st term from two

Find the 31st term of an AP whose 11th term

Solution:

$$a_{11} = a + 10d = 38 \quad (1)$$

$$a_{16} = a + 15d = 73 \quad (2)$$

$$(2) - (1): 5d = 35, \text{ so } d = 7. \text{ From (1): } a = 38 - 10 \times 7 = -32$$

$$a_{31} = a + 30d = -32 + 210 = \mathbf{178}.$$

Example 5: Three-digit numbers d

How many three-digit numbers are divisib



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Solution: The first three-digit multiple of 7 is 105 (7×15) and the last is 994 (7×142). The list 105, 112, 119, ..., 994 is an AP with $a = 105$, $d = 7$, $l = 994$.

$$994 = 105 + (n - 1) \times 7$$

$$889 = 7(n - 1)$$

$$n - 1 = 127, \text{ so } n = 128.$$

There are 128 three-digit numbers divisible by 7.

Example 6: 20th term from the last (NCERT Exercise 5.2)

Find the 20th term from the last term of the AP : 3, 8, 13, ..., 253.

Solution: Reverse the AP: 253, 248, 243, ..., 3. Now the first term is 253 and $d = -5$.

$$20\text{th term} = 253 + (20 - 1)(-5) = 253 - 95 = \mathbf{158}.$$

Example 7: First three terms from

The sum of the 4th and 8th terms of an AP is 24. Find the first three terms of the AP.

Solution:

$$a_4 + a_8 = (a + 3d) + (a + 7d) = 2a + 10d = 24 \quad (1)$$

$$a_6 + a_{10} = (a + 5d) + (a + 9d) = 2a + 14d = 28 \quad (2)$$

$$(2) - (1): 2d = 10, \text{ so } d = 5. \text{ From (1): } a = 12$$

First three terms: -13, -8, -3.

Example 8: Subba Rao's salary (NCERT Exercise 5.2)

Subba Rao started work in 1995 at an annual salary of ₹5000 and received an increment of ₹200 each year. In which year did his income reach ₹7000?

Solution: Salaries in 1995, 1996, 1997, ...: 5000, 5200, 5400, ...

$$7000 = 5000 + (n - 1) \times 200$$

$$2000 = 200(n - 1)$$

$$n - 1 = 10, \text{ so } n = 11.$$



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The 11th year counted from 1995 is $1995 + 10 = 2005$. His income reached ₹7000 in 2005.

Example 9: How many terms give 636? (NCERT Exercise 5.3)

How many terms of the AP : 9, 17, 25, ... must be taken to give a sum of 636?

Solution: $a = 9$, $d = 8$, $S_n = 636$.

$$636 = \frac{n}{2} [18 + (n - 1) \times 8] = \frac{n}{2} (8n + 10) = n(4n + 5)$$

$$4n^2 + 5n - 636 = 0$$

$$\text{Discriminant} = 25 + 4 \times 4 \times 636 = 25 + 10176 = 10201 = 101^2.$$

$n = (-5 \pm 101)/8$ gives $n = 12$ or $n = -106/8$, which is rejected. **12 terms must be taken.**

Example 10: Sum of first n terms from two sums (NCERT Exercise 5.3)

If the sum of first 7 terms of an AP is 49 and the sum of first 17 terms is 289, find the sum of first n terms.

Solution:

$$S_7 = \frac{7}{2} (2a + 6d) = 7(a + 3d) = 49, \text{ so } a + 3d = 7$$

$$S_{17} = \frac{17}{2} (2a + 16d) = 17(a + 8d) = 289, \text{ so } a + 8d = 17$$

$$(2) - (1): 5d = 10, \text{ so } d = 2 \text{ and } a = 7 - 6 = 1$$

$$S_n = \frac{n}{2} [2 \times 1 + (n - 1) \times 2] = \frac{n}{2} \times 2n = n^2$$

Example 11: Terms from a given S_n

If the sum of the first n terms of an AP is $4n^2 - 3n$, find the sum of first two terms? What is the second term?

Solution:

- $S_1 = 4 - 1 = 3$, so the first term is **3**.
- $S_2 = 8 - 6 = 2$ (sum of first two terms).
- $a_2 = S_2 - S_1 = 2 - 3 = -1$.
- $S_3 = 12 - 9 = 3$, so $a_3 = S_3 - S_2 = 3 - 2 = 1$.



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- $S_{10} = 40 - 100 = -60$ and $S_9 = 36 - 81 = -45$, so $a_{10} = -60 - (-45) = -15$.
- $a_n = S_n - S_{n-1} = (4n - n^2) - [4(n-1) - (n-1)^2] = 4n - n^2 - 4n + 4 + n^2 - 2n + 1 = 5 - 2n$.

Example 12: Seven cash prizes (NCERT Exercise 5.3)

A sum of ₹700 is to be used to give seven cash prizes to students of a school for their overall academic performance. If each prize is ₹20 less than its preceding prize, find the value of each of the prizes.

Solution: Let the first prize be ₹ a . Then $d = -20$, $n = 7$, $S_7 = 700$.

$$700 = \frac{7}{2} [2a + 6(-20)] = 7(a - 60)$$

$$a - 60 = 100, \text{ so } a = 160.$$

The prizes are ₹160, ₹140, ₹120, ₹100, ₹80, ₹60 and ₹40. Check: $160 + 140 + 120 + 100 + 80 + 60 + 40 = 700$.

Example 13: Stack of 200 logs (NCERT Exercise 5.3)

200 logs are stacked in the following manner: 10 logs in the bottom row, 9 logs in the row next to it and so on. In how many rows are the logs stacked?

Solution: Logs per row from the bottom: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1. So $S_n = 200$.

$$200 = \frac{n}{2} [40 + (n-1)(-1)] = \frac{n(41-n)}{2}$$

$$400 = 41n - n^2$$

$$n^2 - 41n + 400 = 0$$

$$(n-16)(n-25) = 0, \text{ so } n = 16 \text{ or } n = 25.$$

$n = 25$ would make the top row $a_{25} = 20 - 24 = -4$, which is not possible. So $n = 16$, the top row has $a_{16} = 20 - 15 = 5$ logs.

The logs are placed in 16 rows, with 5 logs in the top row.



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Competency-Based Questions (with answers)

1. Case-based: The school auditorium

A school auditorium has 20 seats in the first row, 22 in the second row, 24 in the third row, and so on, with each row having 2 more seats than the row in front of it. There are 30 rows.

(i) How many seats are in the 15th row? (ii) Which row has 50 seats? (iii) How many seats are there in the auditorium?

Answer: The seats form an AP with $a = 20$, $d = 2$, $n = 30$.

(i) $a_{15} = 20 + 14 \times 2 = \mathbf{48 \text{ seats}}$.

(ii) $50 = 20 + (n - 1) \times 2$ gives $n - 1 = 15$, so the **16th row**.

(iii) Last row: $a_{30} = 20 + 29 \times 2 = 78$. $S_{30} =$

2. Case-based: The ladder

The lengths of the rungs of a ladder decrease in an AP. The top rung is 45 cm long and the ladder has 8 rungs.

(i) Write the lengths as an AP and state a general term formula. (iii) Find the total length of all rungs.

Answer: (i) 45, 43, 41, 39, 37, 35, 33, 31 with $d = -2$

(ii) $a_8 = 45 + 7(-2) = \mathbf{31 \text{ cm}}$.

(iii) $S_8 = \frac{8}{2} (45 + 31) = 4 \times 76 = \mathbf{304 \text{ cm}}$.

3. Source-based: Gauss and the sum of the first 100 natural numbers

Read the source: "He was asked to find the sum of the first 100 natural numbers. He immediately replied that the sum is 5050." Gauss then wrote it again in reverse order, $S = 100 + 99 + \dots + 1$.

(i) What does each pair add up to when the numbers are written in reverse order? (ii) Hence find $1 + 2 + \dots + 50$. (iii) Hence find $51 + 52 + \dots + 100$.



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Answer: (i) Each pair adds to 101, and there are 100 pairs, so $2S = 10100$ and $S = 5050$.

(ii) Pairs add to 51, and there are 50 of them: $2S = 50 \times 51$, so $S = \mathbf{1275}$.

(iii) $5050 - 1275 = 3775$.

4. Assertion-Reason

Assertion (A): 301 is not a term of the list 5, 11, 17, 23,

Reason (R): The position n of a term in an AP must be a positive integer.

Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (a) $301 = 5 + (n - 1) \times 6$ gives $n = 151/3$, which is not a positive integer. R is exactly why A holds.

5. Assertion-Reason

Assertion (A): The list 1, 1, 2, 3, 5, 8 is an

Reason (R): In an AP, $a_{k+1} - a_k$ is the same

Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (d) The differences are 0, 1, 1, 2, test for an AP.

6. Assertion-Reason

Assertion (A): If the sum of the first n term

Reason (R): The n th term of an AP is $a_n =$

Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (a) $S_2 = 12 + 4 = 16$ and $S_1 = 3 +$

7. Assertion-Reason

Assertion (A): 0 is a term of the AP 21, 18,

Reason (R): Every AP with a negative common difference has 0 as one of its terms.

A screenshot of a chat application. At the top, there is a dark blue header bar. On the left of this bar is a circular profile picture of a woman with long brown hair, smiling. To the right of the profile picture, the name 'Ira' is written in white, bold font. Below the name, the text 'Your teacher for Arithmetic Progress...' is written in a smaller white font. The main area of the chat is white. On the left side of this area, there is a smaller circular profile picture of the same woman. To the right of this picture, there is a white speech bubble with a thin grey border. Inside the speech bubble, the text reads: 'Hi, I am Ira. I teach this syllabus all day, so Arithmetic Progressions is very much my home ground. Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:'. At the bottom of the screen, there is a light grey bar. In the center of this bar, the text 'Free questions, no login needed' is written in a dark grey font. Below this text, in a smaller dark grey font, it says 'AI generated, can make mistakes. Cross-check with NCERT.'

Choose: (a) Both A and R are true and R is the correct explanation of A. (b) Both A and R are true but R is not the correct explanation of A. (c) A is true but R is false. (d) A is false but R is true.

Answer: (c) $21 + (n - 1)(-3) = 0$ gives $n = 8$, so A is true. R is false: in 10, 7, 4, 1, -2, ..., solving $10 - 3(n - 1) = 0$ gives $n = 13/3$, so 0 is not a term.

8. Error analysis: The 11th term from the end

For the AP 10, 7, 4, ..., -62, a student found 25 terms and wrote: "The 11th term from the end is the $25 - 11 = 14$ th term, so it is $10 + 13(-3) = -29$." Find the error and give the correct answer.

Answer: Counting back from the 25th term, the 1st term from the end is the 25th, the 2nd is the 24th, and so on. The kth term from the end is the $(n - k + 1)$ th term. The 11th from the end is the $25 - 11 + 1 = 15$ th term: $10 + 14(-3) = -32$. The student forgot the "+ 1".

Important Questions for

1-Mark Questions

- 30th term of the AP: 10, 7, 4, ..., is (A) 9
 $a = 10, d = -3. a_{30} = 10 + 29(-3) = 10 - 87 = -77$
- Find the common difference of the AP
 $d = (1 - p)/p - 1/p = -p/p = -1$.
- If $2k + 1, 13, 5k - 3$ are three consecutive terms of an AP, find k.
 $2 \times 13 = (2k + 1) + (5k - 3)$, so $26 = 7k$
- Find the sum of the first 20 positive integers.
 $n(n + 1)/2 = 20 \times 21/2 = 210$.

2-Mark Questions

- The 17th term of an AP exceeds its 10th term by 7.
 $a_{17} - a_{10} = (a + 16d) - (a + 9d) = 7d = 7$
- How many multiples of 4 lie between 10 and 200?
First multiple after 10 is 12; last before 200 is 196.
 $(196 - 12)/4 + 1 = 48$
= 60.
- For what value of n, are the nth terms of the two APs equal?
 $63 + (n - 1) \times 2 = 3 + (n - 1) \times 7$ gives $60 + 2n - 2 = 7n - 7$
 $65 = 5n$
equal 87.)



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4. Find the sum of the odd numbers between 0 and 50.

1, 3, 5, ..., 49: $49 = 1 + (n - 1) \times 2$ gives $n = 25$. $S = 25/2 (1 + 49) = 625$.

3-Mark Questions

1. If the 3rd and the 9th terms of an AP are 4 and -8 respectively, which term of this AP is zero?

$a + 2d = 4$ and $a + 8d = -8$. Subtracting, $6d = -12$, so $d = -2$ and $a = 8$. $0 = 8 + (n - 1)(-2)$ gives $n - 1 = 4$, so the 5th term is zero.

2. The first and the last terms of an AP are 17 and 350 respectively. If the common difference is 9, how many terms are there and what is their sum?

$350 = 17 + (n - 1) \times 9$ gives $n - 1 = 37$, so $n = 38$. $S = 38/2 (17 + 350) = 19 \times 367 = 6973$.

3. Find the sum of first 51 terms of an AP whose second and third terms are 14 and 18 respectively.

$d = 18 - 14 = 4$ and $a = 14 - 4 = 10$. $S_{51} = 51/2 [20 + 50 \times 4] = 51/2 \times 220 = 51 \times 110 = 5610$.

4. A contract on construction job specifies a penalty for delay in completion of work to be ₹200 for the first day, ₹250 for the second day, ₹300 for the third day, and so on, up to ₹1100 for the thirtieth day. What is the total penalty for the delay in completion of work over the 30 days?

$a = 200$, $d = 50$, $n = 30$. $S_{30} = 15 [400 + 29 \times 50] = 15 [400 + 1450] = 15 \times 1850 = 27750$.



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5-Mark Questions

1. A spiral is made up of successive semicircles, starting with centre at A, of radii 0.5 cm, 1.0 cm, 1.5 cm, ... and so on. Find the total length of the spiral made up of thirteen consecutive semicircles.

The length of a semicircle of radius r is πr . The radii form an AP with first term 0.5π , $d = 0.5\pi$, $n = 13$.
Total length = $13/2 [0.5\pi + 6.5\pi] = 13/2 \times 7\pi = 45.5\pi$ cm.

2. In a potato race, a bucket is placed at the starting point, which is 5 m from the first potato, and the other potatoes are placed 3 m apart in a straight line. A competitor starts from the bucket, picks up the nearest potato, runs back to the bucket, drops it in the bucket, runs back to pick up the next potato, and she continues in the same way until all the potatoes are picked up. What is the total distance the competitor has to run?

The potatoes are 5, 8, 11, ... m from the starting point. The distances are 2×5 , 2×8 , 2×11 , ...
 $S_{10} = 10/2 [20 + 9 \times 6] = 5 \times 74 = 370$ m.

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3. In an AP: (i) given $a_{12} = 37$, $d = 3$, find a and S_{12} . (ii) given $a_3 = 15$, $S_{10} = 125$, find d and a_{10} .
- (i) $37 = a + 11 \times 3$, so $a = 4$. $S_{12} = 12/2 (4 + 37) = 6 \times 41 = 246$.
- (ii) $a + 2d = 15$, so $2a + 4d = 30$. $S_{10} = 5(2a + 9d) = 125$, so $2a + 9d = 25$. Subtracting, $5d = -5$, so $d = -1$ and $a = 17$. $a_{10} = 17 + 9(-1) = 8$.

Common Mistakes and Examiner Tips

- Subtracting in the wrong order to find d .** In 6, 3, 0, -3, ..., $d = 3 - 6 = -3$. Always take the later term minus the earlier term.
- Checking only one difference.** 1, 1, 1, 2, 2, 2, ... has $a_2 - a_1 = a_3 - a_2 = 0$, yet $a_4 - a_3 = 1$. Check every consecutive difference you can form from the given terms before calling a list an AP, and show them.
- Writing $a + nd$ instead of $a + (n - 1)d$.** The first term has no d added. The 10th term of 2, 7, 12, ... is $2 + 9 \times 5 = 47$, not $2 + 10 \times 5 = 52$.
- Accepting a fractional or negative n .** If n is not a positive integer, it is not a term of the AP. Say so in words.
- Off-by-one error for terms from the end.** The k th term from the end is $a_n - (k - 1)d$. The safer route is to reverse the sequence.
- Wrong first or last term when counting terms.** For "three-digit numbers between 12 and 248", start at 12 and stop at 248. For "three-digit numbers", start at 100 and stop at 999. Divide the end points by the number of terms.
- Confusing a_n and S_n .** "How much is saved in 12 weeks" asks for S_{12} . Underline the word "how much".
- Treating a given S_n expression as a_n .** If $S_n = 2n^2 - 3n$, then $a_n = S_n - S_{n-1} = 2n^2 - 3n - (2(n-1)^2 - 3(n-1)) = 4n - 5$.
- Keeping both roots of the quadratic in n .** For $n^2 - 17n + 68 = 0$, roots are $n = 4$ and $n = 13$. Both are valid. Test each.
- Stopping at a number in word problems.** "Income reached ₹7000 in 2005", and asked for the year when income was ₹10000. Do not stop at 2005.



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Quick Revision Points

- An AP is a list in which each term after the first is the previous term plus a fixed number d .
- $d = a_{k+1} - a_k$, the later term minus the earlier term.
- d can be positive (increasing AP), negative (decreasing AP) or zero (constant AP).
- General form: $a, a + d, a + 2d, a + 3d, \dots$
- A list is an AP only if all consecutive differences are equal.
- Lists made by multiplying by a fixed number, such as 2, 4, 8, 16, ..., are not APs.
- n th term: $a_n = a + (n - 1)d$.
- If solving for n gives a non-integer or a negative value, the number is not a term.
- $a_m - a_n = (m - n)d$.
- k th term from the end $= l - (k - 1)d =$ the $(n - k + 1)$ th term.
- $S_n = n/2 [2a + (n - 1)d] = n/2 (a + l)$.
- $1 + 2 + 3 + \dots + n = n(n + 1)/2$; for $n = 10$
- $a_n = S_n - S_{n-1}$, and $a_1 = S_1$.
- If a_n is linear in n , like $3 + 2n$, the list is an AP.
- Finding n from a sum gives a quadratic; solve for n .
- If a, b, c are in AP, $2b = a + c$ and b is the arithmetic mean of a and c .



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Weightage in Board Exams

Arithmetic Progressions is Chapter 5 of the course structure for the marks given to the predictable way.

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Question type	What is usually asked
MCQ and Assertion-Reason	Finding d , a given term, whether a list is an AP, the value of k for three terms in AP, a_n from S_n
Short answers	Which term is a number, is a number a term, counting multiples in a range, term from the end, sum of a simple AP
Long answers	Finding a and d from two conditions, then a term or a sum; finding n from a sum by solving a quadratic; word problems on salaries, savings, prizes, penalties and stacks
Case-based	A daily-life pattern (seats, savings, rungs) split into parts on a_n , n and S_n

The textbook marks Exercise 5.4 as optional from the examination point of view. For every word problem, write a formula, and finish with a sentence answer.



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