GENERAL

arithmetic sequence problems and solutions

Published: September 19, 2026 | Index ID: #-

Introduction

Arithmetic sequences—often called arithmetic progressions (AP)—are one of the most fundamental concepts in algebra and number theory. Whether you're a high school student tackling textbook problems, a teacher preparing lesson plans, or a lifelong learner curious about patterns in numbers, understanding how to work with arithmetic sequences is essential. This guide dives deep into the world of arithmetic sequence problems and solutions, offering clear explanations, step by step solutions, and practical tips to help you master the subject.

Understanding Arithmetic Sequences

What Is an Arithmetic Sequence?

An arithmetic sequence is a list of numbers in which the difference between consecutive terms is constant. This constant difference is called the **common difference**. For example, the sequence 3, 7, 11, 15, … has a common difference of 4 because each term is obtained by adding 4 to the previous one.

Key Properties

- Linear Growth: Each term increases (or decreases) by the same amount.
- Predictability: Knowing the first term and the common difference lets you calculate any term in the sequence.
- Closed Form Expressions: Arithmetic sequences can be expressed using simple algebraic formulas.

Common Notation and Terms

When writing an arithmetic sequence, we usually use the following symbols:

- a • – the first term.
- d – the common difference.
- a ™ – the nth term.
- S ™ – the sum of the first n terms.

Formulas for Arithmetic Sequences

nth Term Formula

The nth term of an arithmetic sequence can be found using the formula:

a ™ = a • + (n - 1)·d

This formula states that to get the nth term, start with the first term and add the common difference multiplied by (n /– /1).

Sum of the First n Terms

To calculate the sum of the first n terms, use:

S ™ = n/2 · (a • + a ™)

or equivalently,

S ™ = n/2 · [2a • + (n - 1)d]

Both expressions yield the same result and are useful depending on which values are known.

Finding the Common Difference

If you know two terms of the sequence, say a – and a — (where k), the common difference is:

d = (a — - a –) / (l - k)

This formula is handy when you're given non adjacent terms.

Common Arithmetic Sequence Problems

Problem 1: Find the 15th Term

Given the arithmetic sequence 5, 9, 13, 17, …, determine the 15th term.

Problem 2: Determine the Common Difference

In the sequence 12, ?, 24, 36, …, find the missing term and the common difference.

Problem 3: Sum of First 20 Terms

Calculate the sum of the first 20 terms of the sequence 2, 5, 8, 11, ….

Problem 4: Solving for Unknown Terms

Given that the 7th term of an arithmetic sequence is 37 and the 12th term is 57, find the first term and the common difference.

Problem 5: Real World Application

A savings account offers a fixed monthly deposit that increases by a constant amount each month. If the first deposit is $200 and the 12th deposit is $500, find the monthly increase and the total amount deposited over the year.

Step by Step Solutions

Solution to Problem 1

1. Identify the first term: a • = 5.
2. Find the common difference: d = 9 - 5 = 4.
3. Apply the nth term formula for n /= /15: a • … = 5 + (15 - 1)·4 = 5 + 56 = 61.

The 15th term is **61**.

Solution to Problem 2

1. Let the missing term be a ,. The sequence is 12, a ,, 24, 36.
2. Since the common difference is constant, a , = 12 + d and 24 = a , + d = 12 + d + d = 12 + 2d.
3. Set up the equation: 12 + 2d = 24 !' 2d = 12 !' d = 6.
4. Find a ,: a , = 12 + 6 = 18.

The missing term is **18** and the common difference is **6**.

Solution to Problem 3

1. First term: a • = 2.
2. Common difference: d = 5 - 2 = 3.

3. Find the 20th term: a , € = 2 + (20 - 1)·3 = 2 + 57 = 59.
4. Compute the sum: S , € = 20/2 · (2 + 59) = 10 · 61 = 610.

The sum of the first 20 terms is **610**.

Solution to Problem 4

1. Let a • be the first term and d the common difference.
2. Using the nth term formula:\\n \\n a ‡ = a • + 6d = 37
3. a • , = a • + 11d = 57

(a • + 11d) - (a • + 6d) = 57 - 37 !’ 5d = 20 !’ d = 4.

a • + 6·4 = 37 !’ a • + 24 = 37 !’ a • = 13.

The first term is **13** and the common difference is **4**.

Solution to Problem 5

1. Let the monthly increase be d. The first deposit: a • = 200.
2. 12th deposit: a • , = 200 + 11d = 500.

S • , = 12/2 · (200 + 500) = 6 · 700 = 4,200.

The monthly increase is approximately **$27.27**, and the total deposited over the year is **$4,200**.

Advanced Arithmetic Sequence Challenges

Problem 6: Two Sequences Intersection

Sequence A: 3, 7, 11, 15, … (common difference 4). \\nSequence B: 2, 9, 16, 23, … (common difference 7). \ \nFind the term number where both sequences have the same value.

Problem 7: Quadratic Relationship

Given that the nth term of an arithmetic sequence is equal to $n^2 + 3n$ for n "e 1, determine the first term and common difference.

Problem 8: AP with Variable Common Difference

Consider a sequence where the common difference changes by a constant amount each step: the first difference is 2, and each subsequent difference increases by 1. Write a general formula for the nth term.

Tips and Tricks for Mastering Arithmetic Sequences

Visualizing the Sequence

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