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Mathematics

Quarter 1 – Module 4:
Sum of Arithmetic Sequence

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Alternative Delivery Mode
Quarter 1 – Module 4: Sum of Arithmetic Sequence
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Mathematics

Quarter 1 – Module 4:
Sum of Arithmetic Sequence

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

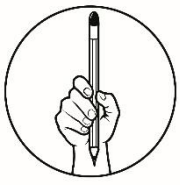
Thank you.

What I Need To Know

This module was designed and written with you in mind. It is here to help you find the sum of the terms of an arithmetic sequence. The scope of this module permits it to be used in many different learning situations. The lessons are arranged to follow the standard sequence of the course but the pacing in which you read and answer this module will depend on your ability.

After going through this module, you are expected to be able to demonstrate knowledge and skill related to sequences and apply these in solving problems. Specifically, you should be able to:

a) define arithmetic series,
b) find the sum of the first n terms of a given arithmetic sequence, and
c) solve word problems involving arithmetic series.



What I Know

Find out how much you already know about the topics in this module. Choose the letter of your answer from the given choices. Write your answer on your answer sheet. Take note of the items that you were not able to answer correctly and find the right answer as you go through this module.

1. It is the sum of the terms of a sequence.

   A) mean B) sequence C) n^{th} term D) series

2. Find the sum of the first ten terms of the arithmetic sequence 4, 10, 16, 22, 28, …

   A) 310 B) 430 C) 410 D) 390

3. Find the sum of the first 25 terms of the arithmetic sequence 17, 22, 27,32, …

   A) 1925 B) 1195 C) 1655 D) 1895

4. The sum of the first 10 terms of an arithmetic sequence is 530. What is the first term if the last term is 80?

   A) 40 B) 36 C) 30 D) 26

5. The third term of an arithmetic sequence is −12 and the seventh term is 8. What is the sum of the first 10 terms?

   A) 5 B) 8 C) 11 D) 15

6. Find the sum of the first 50 terms of the arithmetic sequence if the first term is 21 and the twentieth term is 154.

A) 9635 B) 9765 C) 9265 D) 9625

7. Find the sum of the first eighteen terms of the arithmetic sequence whose nth term is $a_n = 15 + 8n$.

A) 1438 B) 1638 C) 1836 D) 1783

8. The first term of an arithmetic sequence is 5, the last term is 45 and the sum is 275. Find the number of terms.

A) 13 B) 10 C) 12 D) 11

9. If the first n terms of the arithmetic sequence 20, 18, 16,... are added, how many of these terms will be added to get a sum of -100?

A) 35 B) 25 C) 15 D) 30

10. A worker saves Php 36,000 from his salary this year. If he increases his savings yearly by Php 3,000, how much will be his total savings for 8 years?

A) Php 315,000 B) Php 372,000 C) Php 432,000 D) Php 495,000

11. Jane was saving for a pair of shoes. From her weekly allowance, she was able to save Php 10 on the first week, Php 13 on the second, Php 16 on the third week, and so on. If she continued saving in this pattern and made 52 deposits, how much did Jane save?

A) Php 3984 B) Php 4568 C) Php 4498 D) Php 5678

12. Mary gets a starting monthly salary of Php 6,000 and an increase of Php 600 annually. How much income did she receive for the first three years?

A) Php 276,300
B) Php 237, 600
C) Php 637, 300
D) Php 673, 200

13. Mirasol saved 10 pesos on the first day of January, 12 pesos on the second day, 14 pesos on the third day, and so on, up to the last day of the month. How much did Mirasol save at the end of January?

A) Php 2 710 B) Php 2 170 C) Php 1 240 D) Php 1 420

14. Mrs. De la Cruz started her business with an income of Php 125,000 for the first year and an increase of Php 5,000 yearly. How much is the total income of Mrs. De la Cruz for 8 years since she started her business?

A) Php 1,104,000
B) Php 1,410,000
C) Php 1,140,000
D) Php 2,140,000

15. A hall has 30 rows. Each successive row contains one additional seat. If the first row has 25 seats, how many seats are in the hall?

A) 1 185 B) 1 815 C) 1 970 D) 1 780

Lesson Finding the Sum of the First *n* Terms of an Arithmetic Sequence.

What's In

In the previous module, it was discussed that to find the n^{th} term of a given arithmetic sequence, the formula

$a_n = a_1 + d(n - 1)$ can be used.

For this module, we will be discussing how to find the sum of the first n terms in an arithmetic sequence.

For example, how do we compute the sum of all the terms of each of the following sequences?

a) 1, 2, 3, . . . , 100
b) 5, 10, 15, 20, . . . , 50
c) −5, −2, 1, 4, . . . , 31

Adding manually the terms of a sequence is manageable when there are only few terms in the sequence. However, if the sequence involves numerous terms, then it is no longer practical to be adding the terms manually. It is a tedious work to do. Thus, this module will present to you a formula that will make the computation easier and faster.

What's New

To let you experience getting the sum of the terms in a sequence manually, do the following.

1. Find the sum of the first 20 natural numbers.

   Solution:

   a. By listing all the natural numbers from 1 to 20 and adding them, we have:

$$1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12 + 13 + 14 + 15 + 16 + 17 + 18 + 19 + 20 = 210$$

b. Thus, the sum of the first 20 natural numbers is 210.

2. Find the sum of all the terms of the sequence: 5, 10, 15, 20, …, 50.

Solution:

a. By listing all the terms of the sequence and adding them, we have:

$$5 + 10 + 15 + 20 + 25 + 30 + 35 + 40 + 45 + 50 = 275$$

b. Thus, the sum of the terms of the sequence is 275.

3. Find the sum −5, −2 , 1, 4,…, 31.

Solution:

a. By listing all the terms of the sequence and adding them, we have:

$$-5 + (-2) + 1 + 4 + 7 + 10 + 13 + 16 + 19 + 22 + 25 + 28 + 31 = 169$$

b. Thus, the sum of the terms of the sequence is 169.

In doing this kind of solution, it is very challenging specially if you are dealing with a sequence that has many terms. For example, finding the sum of the terms of the sequence: 1, 2, 3, . . . , 10,000. There are 10,000 terms to be added one by one to get their sum.

To derive a formula to be used in finding the sum of the terms of an arithmetic sequence, consider the following illustration:

The terms of an arithmetic sequence with common difference, d, are

First term	a_1
Second term	$a_1 + d$
Third term	$a_1 + 2d$
Fourth term	$a_1 + 3d$
⋮	⋮
n^{th} term	$a_1 + (n-1)d$

Thus, the sum of the terms, S_n, is:

$$S_n = \underset{1^{\text{st}}}{a_1} + \underset{2^{\text{nd}}}{(a_1 + d)} + \underset{3^{\text{rd}}}{(a_1 + 2d)} + \underset{4^{\text{th}}}{(a_1 + 3d)} + \cdots + \underset{n^{\text{th}}}{[a_1 + (n-1)d]} \quad \rightarrow \textit{equation 1}$$

The terms of an arithmetic sequence can also be written starting from the n^{th} term and successively subtracting the common difference, d. Hence,

$$S_n = a_n + (a_n - d) + (a_n - 2d) + (a_n - 3d) + \cdots + [a_n - (n-1)d] \rightarrow \textit{equation 2}$$

To find the rule for S_n, add the two equations:

$$\begin{array}{rl} S_n = & a_1 + (a_1 + d) + (a_1 + 2d) + (a_1 + 3d) + \cdots + [a_1 + (n-1)d] \\ + \; S_n = & a_n + (a_n - d) + (a_n - 2d) + (a_n - 3d) + \cdots + [a_n - (n-1)d] \\ \hline 2S_n = & (a_1 + a_n) + (a_1 + a_n) + (a_1 + a_n) + (a_1 + a_n) + \cdots + (a_1 + a_n) \end{array}$$

Notice that all the terms containing d added out. So,

$$2S_n = n(a_1 + a_n)$$

Divide both sides of the equation by two,

$$S_n = \frac{n(a_1 + a_n)}{2}$$

Substituting $a_n = a_1 + (n-1)d$ to a_n, will lead to the following formula:

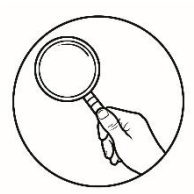
$$S_n = \frac{n[a_1 + a_1 + (n-1)d]}{2}$$

$$S_n = \frac{n[2a_1 + (n-1)d]}{2}$$

Thus, the sum of the terms of an arithmetic sequence is

$$S_n = \frac{n}{2}[2a_1 + d(n-1)]$$

where: S_n is the sum of the first n terms
a_1 is the first term
d is the common difference



What Is It

In getting the sum of the terms of an arithmetic sequence. We will be using any of the following the formula:

1) $S_n = \frac{n}{2}(a_1 + a_n)$ if the first and last term are given

2) $S_n = \frac{n}{2}[2a_1 + (n-1)d]$ if the last term is not given

Example 1. Find the sum of the first 20 natural numbers.

Given:

$a_1 = 1\, a_n = 20 \qquad n = 20 S_n = ?$

Solution:

Since the last term is given, we used the following formula:

$$S_n = \frac{n}{2}(a_1 + a_n)$$

Substituting the given values in the formula:

$$S_{20} = \frac{20}{2}(1 + 20)$$

$$S_{20} = 10(21)$$

$$S_{20} = 210$$

∴ The sum of the first 20 natural numbers is 210.

Example 2. Find the sum of the first 16 terms of the arithmetic sequence:

8, 11, 14, 17, 20, …

Given:

$a_1 = 8\, n = 16 \qquad d = 3 \qquad S_{16} = ?$

Solution:

The last term is not given, so we use the formula

$$S_n = \frac{n}{2}[2a_1 + (n-1)d]$$

Substitute the given values in the formula:

$$S_{16} = \frac{16}{2}[2(8) + (16-1)3]$$

$$= 8[16 + (15)3]$$

$$= 8(16 + 45)$$

$$= 8\,(\,61\,)$$

$$S_{16} = 488$$

∴ The sum of the first 16 terms of the series is 488.

Example 3. If the first n terms of the sequence: 9, 12, 15, 18, … are added, how many terms give a sum of 126?

Given: $a_1 = 9\, S_n = 126 \quad d = 3 \quad n = ?$

Solution:

The last term is not given so we use the following formula

$$S_n = \frac{n}{2}\,[\,2a_1 + (n-1)d\,]$$

Substituting the given:

$$126 = \frac{n}{2}[2(9) + (n-1)3]$$

$$126 = \frac{n}{2}[\,18 + (3n-3)]$$

$$252 = n\,[18 + 3n - 3]$$

$$252 = n\,[3n + 15]$$

$$252 = 3n^2 + 15n$$

$$\frac{0}{3} = \frac{3n^2 + 15n - 252}{3}$$

$$0 = n^2 + 5n - 84 \quad \text{by factoring}$$

$$(n+12)(n-7) = 0$$

$$(n+12) = 0 \qquad (n-7) = 0$$

$$n = -12 \qquad n = 7$$

Since the domain of a sequence is the set of positive integers, we reject $n = -12$. Hence, we only accept $n = 7$.

∴ The number of terms that will add up to 126 is 7.

Example 4. Find the sum of the integers between 1 and 70 that are divisible by 3.

Given: $a_1 = 3 \quad a_n = 69 \quad d = 3 \quad n = ? \quad S_n = ?$

Solution:

a) To solve for n, use the formula:

$$a_n = a_1 + (n-1)d$$

Substitute the given values:

$$69 = 3 + (n-1)3$$

$$69 = 3 + 3n - 3$$

$$69 = 3n$$

$$n = 23$$

b) Since we already solved n, we can now solve for S_n.

$$S_n = \frac{n}{2}\,[\,2a_1 + (n-1)d\,]$$

$$S_{23} = \frac{23}{2}[\,2\,(\,3)\; +\; (\,23-1\,)\,3\,]$$

$$S_{23} = \frac{23}{2}\,[\,6\; +\; (\,22)\,3\,]$$

$$S_{23}\; = \frac{23}{2}\,(\,6\; +\; 66\,)$$

$$S_{23} = \frac{23}{2}\,(\,72\,)$$

$$S_{23} = 828$$

∴ The sum of the integers from 1 to 70 that are divisible by 3 is 828.

Example 5. The sum of the first 15 terms of an arithmetic sequence is 765. If the first term is 23, what is the common difference?

Given: $a_1 = 23$ $n = 15$ $S_{15} = 765$ d =?

Solution:

$$S_n = \frac{n}{2}\,[\,2a_1 + (n-1)d\,]$$

$$S_{15} = \frac{15}{2}[2\,(23) + (15-1)d\,]$$

$$765 = \frac{15}{2}\,[46\; +\; (\,14)\,d\,]$$

$$1530\; =\; 15\,(46\; +\; 14d\,)$$

$$1530 =\; 690 + 210d$$

$$210d = 1530 - 690$$

$$210d = 840$$

$$d = 4$$

∴ The common difference is 4.

What's More

After knowing all the needed concept in finding the sum of an arithmetic sequence. You are now ready to answer the following exercises:

A. Find the indicated partial sum of each arithmetic series.
   1) The first 9 terms of $5 + 8 + 11 + \cdots$
   2) The first 30 terms of $1 + 3 + 5 + \cdots$
   3) The first 14 terms of $6 + 9 + 12 + \cdots$
   4) The first 25 terms of $5 + 8 + 11 + \cdots$
   5) The first 15 terms of $-12 + (-6) + 0 + \cdots$

B. Solve for the value of n.

1) $S_n = -80,$	$a_1 = 10,$	$a_n = -26,$	$n = ?$
2) $S_n = 50,$	$a_1 = 4,$	$a_n = 16,$	$n = ?$
3) $S_n = -15,$	$a_1 = 12,$	$d = -3,$	$n = ?$
4) $S_n = 180,$	$a_1 = 5,$	$d = 5,$	$n = ?$

C) Answer what is asked.
   1) Find the sum of the first 13 terms of the sequence: $-3, -1, 1, 3, \ldots$
   2) Find the sum of the first 15 terms of the arithmetic sequence: $10, 15, 20, 25, \ldots ?$
   3) Find the sum of the first 11 terms of the arithmetic sequence: $-4, 3, 10, 17, \ldots ?$
   4) Find the sum of the first 19 terms of the arithmetic sequence: $9, 14, 19, 24, \ldots ?$
   5) Find the sum of the integers from 8 and 35.
   6) Find the sum of all even integers from 10 to 70.
   7) Find the sum of all odd integers from 1 to 50.
   8) Find the sum of the integers from 20 to 130 and are divisible by 5.
   9) If the sum of the first 8 terms of an arithmetic sequence is 172 and its common difference is 3, what is the first term?
   10) If the sum of the first 9 terms of an arithmetic sequence is 216 and its first term is 4, what is the common difference?

What I Have Learned

To find the sum of the terms of an arithmetic sequence, you can use the following formulae:

A. If the first and last terms are given:

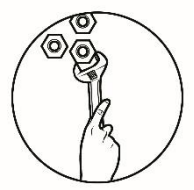
$$S_n = \frac{n}{2}(a_1 + a_n)$$

where: S_n is the sum of the first n terms
a_1 is the first term
a_n is the last term

B. If the last term is not given:

$$S_n = \frac{n}{2}[2a_1 + d(n-1)]$$

where: S_n is the sum of the first n terms
a_1 is the first term
d is the common difference



What I Can Do

Read and understand the problems and answer what is asked.

1. Suppose a cinema has 42 rows of seats and there are 20 seats in the first row. Each row after the first row has two more seats than the row that it precedes. How many seats are in the cinema?

2. A 25-layer of logs is being piled to be used on a construction. The uppermost layer is composed of 25 logs, the second upper layer contains 27 logs, and the third upper layer contains 29 logs, and so on. If the pattern continues up to the lowest layer, what is the total number of logs piled for construction?

Assessment

Read and analyze each item carefully. Write the letter of the correct answer in a separate paper.

1. Which of the following is a formula for arithmetic series?

   A) $S_n = \frac{1}{2}(a_1 + a_n)$ C) $S_n = \frac{1}{2}(a_1 + d)$

   B) $S_n = \frac{n}{2}(a_1 + a_n)$ D) $S_n = \frac{n}{2}(a_1 + da_n)$

2. Find the sum of the first 12 terms of the arithmetic sequence 4, 11, 18, 25, 32, …

   A) 610 B) 530 C) 510 D) 410

3. Find the sum of the first 15 terms of the arithmetic sequence 17, 12, 7, 2, …

   A) 270 B) 287 C) −287 D) −270

4. The sum of the first 12 terms of an arithmetic sequence is 606. What is the first term if the last term is 67?

   A) 64 B) 54 C) 34 D) 44

5. The second term of an arithmetic sequence is −16 and the eighth term is 8. What is the sum of the first 10 terms?

   A) −15 B) −20 C) 15 D) 20

6. Find the sum of the first 40 terms of the arithmetic sequence if the first term is 16 and the tenth term is 70.

   A) 5320 B) 1720 C) 2200 D) 6320

7. Find the sum of the first 15th terms of the arithmetic sequence whose *n*th term is $a_n = 5 + 3n$.

   A) 870 B) 860 C) 435 D) 430

8. The first term of an arithmetic sequence is 8, the last term is 56 and the sum is 416. Find the number of terms.

   A) 13 B) 12 C) 11 D) 10

9. If the first n terms of the arithmetic sequence 24, 20, 16,... are added, how many of these terms will be added to get a sum of −60?

A) 35 B) 30 C) 25 D) 15

10. A yaya receives a starting annual salary of Php 60,000 with a yearly increase of Php 3600. What is her total income for 5 years?

A) Php 672,000 B) Php 552,000 C) Php 276,000 D) Php 336,000

11. Jane was saving for a pair of shoes. From her weekly allowance, she was able to save Php 5 on the first week, Php 9 on the second, Php 13 on the third week, and so on. If she continued saving in this pattern and made 43 deposits, how much did Jane save?

A) Php 3822 B) Php 3827 C) Php 7644 D) Php 6574

12. Mary gets a starting monthly salary of Php 8,000 and an increase of Php 800 annually. How much income did she receive for the first four years?

A) Php 441,600 B) Php 388,800 C) Php 40,000 D) Php 36,800

13. Mirasol saved 8 pesos on the first day of January, 11 pesos on the second day, 14 pesos on the third day, and so on, up to the last day of the month. How much did Mirasol save at the end of January?

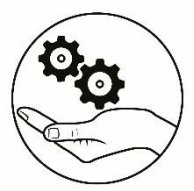
A) Php 4282 B) Php 4290 C) Php 1643 D) Php 1 590

14. Mrs. De la Cruz started her business with an income of Php 250,000 for the first year and an increase of Php 6,000 yearly. How much is the total income of Mrs. De la Cruz for 6 years since she started her business?

A) Php 530,000
B) Php 3,180,000
C) Php 1,590,000
D) Php 1,608,000

15. A hall has 35 rows. Each successive row contains two additional seats. If the first row has 20 seats, how many seats are in the hall?

A) 1 080 B) 1 100 C) 1 925 D) 1 890



Additional Activity

Let us sing the song titled "Twelve Days of Christmas." Afterwards, answer the question that follows.

Verse 1:

On the first day of Christmas my true love sent to me

A partridge in a pear tree

Verse 2:

On the second day of Christmas my true love sent to me

Two turtle doves, and a partridge in a pear tree

Verse 3:

On the third day of Christmas my true love sent to me

Three French hens

Two turtle doves, and a partridge in a pear tree

Verse 4:

On the fourth day of Christmas my true love sent to me

Four calling birds

Three French hens

Two turtle doves, and a partridge in a pear tree

Verse 5:

On the fifth day of Christmas my true love sent to me

Five golden rings

Four calling birds

Three French hens

Two turtle doves, and a partridge in a pear tree

Verse 6:

On the six day of Christmas my true love sent to me

Six geese a – laying

Five golden rings

Four calling birds

Three French hens

Two turtle doves, and a partridge in a pear tree

Verse 7:

On the seventh day of Christmas my true love sent to me

Seven swans a - swimming

Six geese a - laying

Five golden rings

Four calling birds

Three French hens

Two turtle doves, and a partridge in a pear tree

Verse 8:

On the eighth day of Christmas my true love sent to me

Eight maids a-milking

Seven swans a - swimming

Six geese a - laying

Five golden rings

Four calling birds

Three French hens

Two turtle doves, and a partridge in a pear tree

Verse 9:	**Verse 11:**
On the ninth day of Christmas my true love sent to me	On the 11th day of Christmas my true love sent to me
Nine ladies dancing	11 pipers piping
Eight maids a-milking	10 lords a-leaping
Seven swans a - swimming	Nine ladies dancing
Six geese a - laying	Eight maids a-milking
Five golden rings	Seven swans a - swimming
Four calling birds	Six geese a - laying Five golden rings
Three French hens	Four calling birds
Two turtle doves, and a partridge in a pear tree	Three French hens
	Two turtle doves, and a partridge in a pear tree
Verse 10:	**Verse 12:**
On the tenth day of Christmas my true love sent to me	On the 12th day of Christmas my true love sent to me
10 lords a-leaping	12 drummers drumming
Nine ladies dancing	11 pipers piping
Eight maids a-milking	10 lords a-leaping
Seven swans a - swimming	Nine ladies dancing
Six geese a - laying	Eight maids a-milking
Five golden rings	Seven swans a - swimming
Four calling birds	Six geese a - laying
Three French hens	Five golden rings
Two turtle doves, and a partridge in a pear tree	Four calling birds
	Three French hens
	Two turtle doves, and a partridge in a pear tree

Summarizing, we have the following:

12 drummers drumming	6 geese – a – laying
11 pipers piping	5 golden rings
10 lords-a-leaping	4 calling birds
9 ladies dancing	3 French hens
8 maids- a – milking	2 turtles doves, and
7 swans-a-swimming	A partridge in a pear tree.

Question:

How many gifts are given after the 12th day of Christmas?

Answer Key

What I Know	What's More	What I Can Do
1. D 2. A 3. A 4. D 5. A 6. D 7. B 8. D 9. B 10. B 11. C 12. B 13. C 14. C 15. A	A. 1) 153 2) 900 3) 357 4) 1 025 5) 450 B. 1) 10 2) 5 3) 10 4) 8 C) 1. 117 2. 675 3. 341 4. 1 026 5. 602 6. 1 240 7. 625 8. 1 725 9. 11 10. 5	1. 2562 seats 2. 1225 logs. **Assessment** 1) B 2) C 3) D 4) C 5) B 6) A 7) C 8) A 9) D 10) D 11) B 12) A 13) C 14) C 15) D
Additional Activity • 78 gifts		

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