

Mathematics

Quarter 1 – Module 6: Finding the n^{th} Term of a Geometric Sequence and Geometric Means



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Mathematics – Grade 10
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Quarter 1 – Module 6. Finding the n^{th} Term of a Geometric Sequence and Geometric Means
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Mathematics

Quarter 1 – Module 6: Finding the n^{th} Term of a Geometric Sequence and Geometric Means

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.

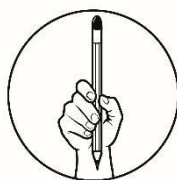


What I Need to Know

This module aims to provide the material necessary to introduce the mathematical concept of geometric sequences to Grade – 10 students. This module will discuss the procedures in finding the n^{th} term of geometric sequences and identifying geometric means. It also includes interesting activities which will help learners understand well the derivation of formulas for n^{th} term of geometric sequences and geometric means.

After going through this module, the learner should be able to:

- familiarize the formulas in finding terms of geometric sequence,
- find the n^{th} term of a geometric sequence, and
- determine the geometric mean/s of a geometric sequence.



What I Know

A. Multiple Choice. Read and analyze the following items and determine the letter of the correct answer from the given choices. Write your answer on a separate sheet of paper.

- What expression is same as $(a \cdot a \cdot a \cdot a)(b \cdot b)$?
A. $(4a)(2b)$
B. $a^2 b^2$
C. $a^4 b^2$
D. $8ab$
- What is the common ratio of the sequence 36, 12, 4, ...?
A. 3
B. -3
C. $\frac{1}{3}$
D. $-\frac{1}{3}$
- The first term of a geometric sequence is 5, and the second term is 10, what is the sixth term?
A. 160
B. 80
C. 320
D. 640
- The common ratio of a geometric sequence is $\frac{1}{2}$, and the fourth term is $\frac{1}{4}$. What is the third term of the sequence?
A. 1
B. $\frac{1}{2}$
C. $\frac{1}{4}$
D. $\frac{1}{8}$
- The common ratio of a geometric sequence is $\frac{3}{2}$. Find the first three terms if the fifth term is 1.
A. $\frac{16}{81}, \frac{8}{27}, \frac{4}{9}$
B. $\frac{8}{27}, \frac{4}{9}, \frac{2}{3}$
C. $\frac{32}{243}, \frac{16}{81}, \frac{8}{27}$
D. $2, 1, \frac{1}{2}$

For items 6 – 10, find the specified term of the following geometric sequences.

6.) 3, 6, 12, ... find a_7

7.) 10, 5, $\frac{5}{2}$, ... find a_6

8.) 1, 3, 9, ... find a_9

9.) 2, -1, $\frac{1}{2}$, ... find a_{10}

10.) 100, 20, 4, ... find a_8

For items 11 – 15, insert geometric means in each geometric sequence.

11.) 3, ____, 8

12.) $\frac{3}{2}$, ____, $\frac{3}{8}$

13.) 7, ____, ____, 56

14.) 36, ____, ____, ____, $\frac{9}{64}$

15.) -1, ____, -9, ____, -81

Lesson

1

Finding the n^{th} term of a Geometric Sequence



What's In

In the previous modules, you learned about geometric sequences and how to find the next terms of geometric sequences.

Look at the sequences below.

5, 10, 20,...

36, 12, 4,...

If you are asked to find the next three terms of the geometric sequences, what method are you going to use?

Basically, you are going to multiply the common ratio to obtain the next terms as taught in the previous modules.

The sequence 5, 10, 20... is a geometric sequence with a common ratio of 2. Therefore, the next three terms are 40, 80 and 160.

The same through as the sequence 36, 12, 4, ...with a common ratio of $\frac{1}{3}$. Therefore, the next three terms are $\frac{4}{3}$, $\frac{4}{9}$, and $\frac{4}{27}$.

Essential Question:

What if I am going to ask for the 10th term, 20th term and 100th respectively? Are you going to use the same method?

Using the same method (multiplying the common ratio) to identify the 10th term, 20th term and 100th is such a waste of time. Don't worry! This module will solve this problem.



What's New

THE RIGHT TERM

Use any method to find the n th term of the given geometric sequences.

1. What is the 7th term of the sequence 5, 10, 20, ...? _____

Since you obtained already the common ratio of this sequence which is 2 and the next three terms are 40, 80, and 160, you can easily identify the 7th term. By multiplying 160 by 2, you will obtain the 7th term which is 320.

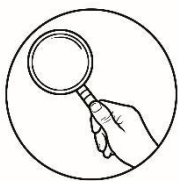
Now, what is the 10th term? 20th term?

Here is another representation:

First term:	5
Second term:	$5 \times 2 = 10$
Third term:	$10 \times 2 = 20$
Fourth term:	$20 \times 2 = 40$
Fifth term:	$40 \times 2 = 80$
Sixth term:	$80 \times 2 = 160$
Seventh term:	$160 \times 2 = 320$
Eighth term:	$320 \times 2 = 640$
Ninth term:	$640 \times 2 = 1\,280$
Tenth term:	$1\,280 \times 2 = 2\,560$

This method seems to be time – consuming and impractical, so, let us try to derive a shorter and a more accurate formula.

Therefore, the 10th term is 2 560.



What Is It

Using the geometric sequence: 5, 10, 20, ... you are asked to find for the 10th term.

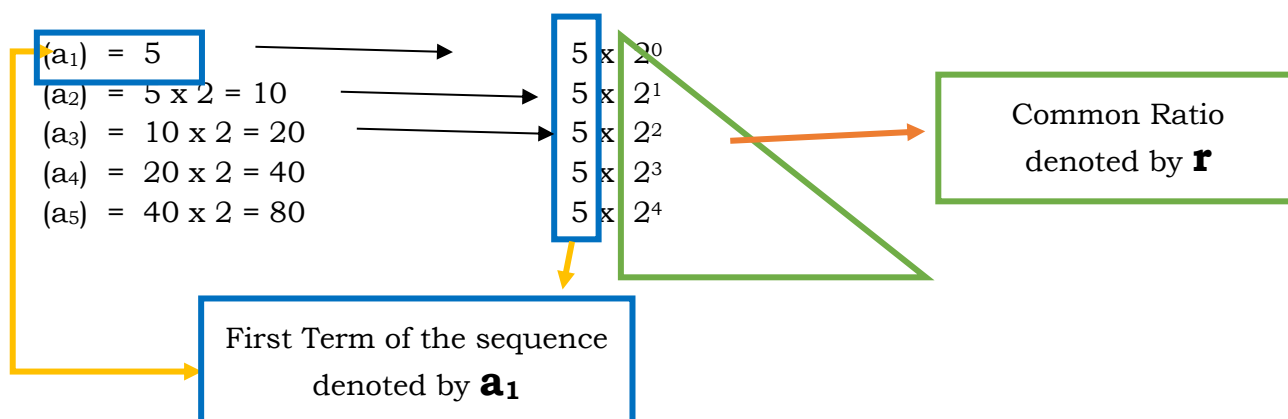
Let us now derive a formula which may help us find an unknown term of a geometric sequence.

We obtained the 10th term of the sequence by using the representation.

it can be written as

1 st term (a_1)	5	→	5
2 nd term (a_2)	$5 \times 2 = 10$	→	5×2
3 rd Term (a_3)	$10 \times 2 = 20$	→	$5 \times 2 \times 2$
4 th Term (a_4)	$20 \times 2 = 40$		$5 \times 2 \times 2 \times 2$
5 th Term (a_5)	$40 \times 2 = 80$		$5 \times 2 \times 2 \times 2 \times 2$
6 th Term (a_6)	$80 \times 2 = 160$		$5 \times 2 \times 2 \times 2 \times 2 \times 2$
7 th Term (a_7)	$160 \times 2 = 320$		$5 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$
8 th Term (a_8)	$320 \times 2 = 640$		$5 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$
9 th Term (a_9)	$640 \times 2 = 1\,280$		$5 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$
10 th Term (a_{10})	$1\,280 \times 2 = 2\,560$		$5 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$

Looking at the illustration, we can derive a pattern that is being followed by the sequence. Let us consider the first five terms.



Let's try to **change the numbers to variables**.

$$a_1 = a_1 \cdot 1 = a_1 \cdot r^0$$

$$a_2 = a_1 \cdot r = a_1 \cdot r^1$$

$$a_3 = a_1 \cdot r \cdot r = a_1 \cdot r^2$$

$$a_4 = a_1 \cdot r \cdot r \cdot r = a_1 \cdot r^3$$

Recall: In the laws of exponents can be written as a^3 , and any non-zero number raised to zero (0) is always equal to 1. Hence, $a^0 = 1$.

$$a_5 = a_1 \cdot r \cdot r \cdot r \cdot r = a_1 \cdot r^4$$

What can you observe from the exponent of **r** and the subscript of **a**?

The exponent of **r** is less than one of the subscript of **a**. The subscript of **a** refers to the placement of the term which is denoted by **n**. Therefore, using these variables, we derived the formula

GENERAL IDEA. The formula in finding the n^{th} term of a geometric sequence is

$$a_n = a_1 r^{n-1}$$

Wherein:

a_n - n^{th} term

a_1 - first term

r - common ratio

n - number of terms

Using the sequence: 5, 10, 20, ..., we identified the 7th term and the 10th term, which are **320** and **2,560** respectively. Now, let us use the derived formula to check if we are on the right track.

For the 7th term (a_7)

Given: $a_1 = 5, r = 2, n = 7$

$$a_n = a_1 r^{n-1}$$

$$a_7 = (5)(2^{7-1})$$

$$a_7 = (5)(2^6)$$

$$a_7 = (5)(64)$$

$$a_7 = 320 \checkmark$$

For the 10th term (a_{10})

Given: $a_1 = 5, r = 2, n = 10$

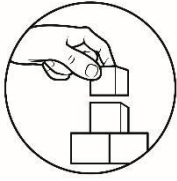
$$a_n = a_1 r^{n-1}$$

$$a_{10} = (5)(2^{10-1})$$

$$a_{10} = (5)(2^9)$$

$$a_{10} = (5)(512)$$

$$a_{10} = 2,560 \checkmark$$



What's More

ACTIVITY 1. THE n^{th} TIME

Find the specified term of the given geometric sequence.

1. $\frac{1}{2}, 2, 8, \dots$; find a_6

To solve for the unknown term, identify first the given values. The first term is $\frac{1}{2}$, and the unknown term is the sixth term, so, the value of n is equal to 6. To find common ratio:

$$r = \frac{a_n}{a_{n-1}} \longrightarrow \frac{a_2}{a_1} = \frac{2}{\frac{1}{2}} = 4$$

The given values will then be substituted to the formula in finding the n^{th} term of a geometric sequence.

Given: $a_1 = \frac{1}{2}$; $r = 4$; $n = 6$ Unknown = a_6

$$a_n = a_1 r^{n-1}$$

$$a_6 = \left(\frac{1}{2}\right)(4)^{6-1}$$

$$a_6 = \left(\frac{1}{2}\right)(4)^5$$

$$a_6 = \left(\frac{1}{2}\right)(1\,024)$$

$$a_6 = 512$$

ASSESSMENT 1. FIND OUT!

Find the specified term of each of the given geometric sequences. Show your complete solutions.

1.) $3, 6, 12, \dots$ a_7

2.) $18, 6, 2, \dots$ a_9

3.) $1, \frac{1}{2}, \frac{1}{4}, \dots$ a_7

ACTIVITY 2. FIND ME!

1. What is the seventh term of a geometric sequence whose fourth term is 128 and common ratio equal to 4?

To begin with the problem, you must have to analyze carefully what does it ask for. The problem is asking for the 7th term but the first term was not given.

First, identify the given values and the unknown variable/s.

Given: Fourth Term (a_4) = 128

Common Ratio (r) = 4

There are two unknowns, we have a_1 and a_7 .

Let's have the formula $a_n = a_1 r^{n-1}$

There are two unknowns in the problem and to solve a_7 , we need to solve a_1 first.

Since the given term is the fourth term, which is 128, we can use it to solve for the value of a_1 . **Substitute the value of a_4 , which is 128, n which is 4, and r , which is 4 in the formula $a_n = a_1 r^{n-1}$.**

$$a_n = a_1 r^{n-1}$$

$$128 = a_1 (4)^{4-1}$$

$$128 = a_1 (4)^3$$

$$\frac{128}{64} = \frac{64a_1}{64}$$

$$a_1 = 2$$

Afterwards, identify the unknown term which is a_7 .

$$a_n = a_1 r^{n-1}$$

$$a_7 = (2)(4)^{7-1}$$

$$a_7 = (2)(4)^6$$

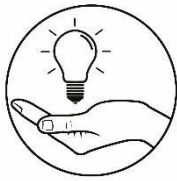
$$a_7 = 2(4\,096)$$

$$\mathbf{a_7 = 8,192}$$

ASSESSMENT 2: FIND OUT!

Answer the problem completely.

1. The third and eighth term of a geometric sequence are 8 and $\frac{1}{4}$ respectively.
What is the first term and the common ratio of the sequence?

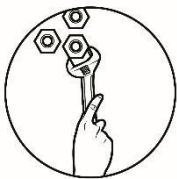


What I Have Learned

FILL IN THE TABLE

Directions. Find the specified term of the geometric sequences given the first term and the common ratio.

Given	a_5	a_7	a_9
1. $a_1 = 3$ $r = 3$			
2. $a_1 = 2$ $r = 2$			
3. $a_1 = -\frac{1}{2}$ $r = -6$			



What I Can Do

Solve for what is asked in the problem. Show your solutions.

Warren deposited his P12, 000. 00 in a local bank in 2019.

1. If the bank offers 5% interest rate compounded annually, how much will be in his bank account in 2028?
2. Suppose he will withdraw the principal in 2028 and will leave the interest in his account, how much will the interest earn after 5 years?

Note:

A - final amount

P - initial principal balance

r - interest rate

n - number of times interest

applied per time period

t - number of time periods

elapsed

Lesson

2

Geometric Means



What's In

In the previous lesson in this module, you were able to derive the formula in finding the n^{th} term of geometric sequences.

To review what you have already learned in finding the n^{th} term of a geometric sequence, accomplish the following activity.

WHAT'S THAT TERM?

Find the specified term in each of the following geometric sequence.

_____ 1. 3, 9, 27, ... **6th term**

_____ 2. 1, 2, 4, ... **7th term**

_____ 3. 12, a_2 , 3

_____ 4. 2, a_2 , a_3 , 54

Were you able to answer items 3 and 4? How did you come up with your answers?

Using the formula in finding the n^{th} term of a geometric sequence to supply the unknown term in Items 3 and 4, will really let you experience difficulties.

Through this module, let us discover a shorter way to identify the unknown term/s in between terms of geometric sequences.



What's New

Look at the problem below:

What must be placed in the blank to form a geometric sequence?

12, _____, 3

You might use the formula in finding the n^{th} term of geometric sequence to supply the middle term.

$$a_n = a_1 r^{n-1}$$

We're stuck in here!

$$a_2 = 12r^{2-1}$$

$$a_2 = 12r$$

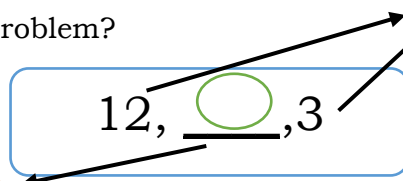
Let's discover how to answer his problem.



What is It

How can we solve this problem?

Geometric mean



extremes

The given terms are the first and last terms. These terms are called the **extremes**, and the term/s in between the extremes are called **geometric mean/s**. In the geometric sequence, 2, 4, 8, 16, the numbers 4 and 8 are the geometric means of the extremes, 2 and 16.

Let us derive the formula:

The **common ratio** refers to the ratio of two consecutive terms,

$$r = \frac{a_n}{a_{n-1}} \text{ same through as } \frac{a_3}{a_2} \text{ and } \frac{a_2}{a_1}, \text{ therefore we can equate } \frac{a_3}{a_2} = \frac{a_2}{a_1},$$

This can be our basis in finding geometric means.

$$\frac{a_3}{a_2} = \frac{a_2}{a_1},$$

Let's go back to the problem, 12, ____, 3. The first term is 12 and the last term is 3. Now, let us substitute.

$$\frac{a_3}{a_2} = \frac{a_2}{a_1},$$

$$\frac{3}{a_2} = \frac{a_2}{12},$$

$$(a_2)^2 = 36$$

$$\sqrt{a_2} = \pm\sqrt{36}$$

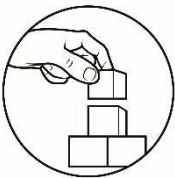
$$a_2 = 6 \text{ or } -6$$



To insert terms, let us identify first the common ratio by using the formula:

$$r = \sqrt[n-k]{\frac{a_n}{a_k}}$$

Where: n = number of terms
 $k = 1$, since it is the first term placement
 r = common ratio



What's More

ACTIVITY 1. MEET ME HALFWAY

Find the missing term/s in the following geometric sequences.

1) 3, _____, 45

To insert a geometric mean, let us first identify the extremes and number of terms. By substitution,

$$\frac{a_3}{a_2} = \frac{a_2}{a_1},$$

$$\frac{45}{a_2} = \frac{a_2}{3}$$

$$(a_2)^2 = 135$$

$$\sqrt{a_2} = \pm\sqrt{135} \text{ or } \pm 3\sqrt{15}$$

$$\text{Therefore, } a_2 = 3\sqrt{15} \text{ or } -3\sqrt{15}$$

2) 2, _____, _____, 250

There are two geometric means needed in this problem. Let us identify first the extremes and the number of terms. The extremes are 2 and 250, and there are 4 terms in the sequence.

$$r = \sqrt[n-k]{\frac{a_n}{a_k}}$$

$$r = \sqrt[4-1]{\frac{a_4}{a_1}}$$

$$r = \sqrt[3]{\frac{250}{2}}$$

$$r = \sqrt[3]{125}$$

$$r = 5$$

Therefore, the sequence is 2, 10, 50, 250...

ASSESSMENT 1: HALFWAY

Find the geometric mean of the given extremes.

Given	Geometric Mean
1. 3 and 8	
2. 100 and 25	
3. $\frac{1}{2}$ and $\frac{1}{8}$	
4. 3 and $\frac{1}{3}$	
5. x and x^7	

ASSESSMENT 2. IN BETWEEN

Insert geometric means in each geometric sequence.

- 1.) 2, _____, _____, 686
- 2.) _____, 24, _____, _____, $\frac{3}{64}$
- 3.) _____, _____, _____, 4, 8
- 4.) _____, $\frac{1}{4}$, $\frac{1}{2}$, _____
- 5.) 81, _____, _____, _____, _____, $\frac{1}{3}$

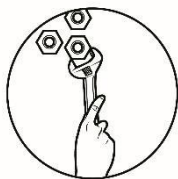


What I Have Learned

SHADE THAT TERM OF MINE

The table contains terms of a geometric sequence. Identify whether the terms in the right columns are geometric means or term of the sequence. Use any shade to color the geometric means or terms

Geometric Sequence	Terms			
1.) 1, ____, ____, ____, 81	30	9	27	3
2.) ____, 3, ____, ____, $\frac{1}{9}$	1	6	9	$\frac{1}{3}$
3.) 24, ____, ____, ____, $\frac{3}{2}$	1	2	3	4
4.) 2, ____, $\frac{1}{2}$, ____, $\frac{1}{8}$	1	4	$\frac{1}{4}$	2
5.) ____, $\frac{1}{2}$, 1	2	4	$\frac{1}{4}$	$\frac{1}{3}$



What I Can Do

SALARY SCHEME

Angelie is working for a year as a clerk in a certain department. Her employer promised her that she will be having a salary increase every after 3 months. Assume that her basic salary is P10,000.00 and there is a constant rate of increase in her salary every after 3 months.

Your task is to construct/write a salary scheme for Angelie that determines her salary in the first up to the last quarter of the year.

Cycle of Salary Increase	1	2	3	4
Salary Received				



Assessment

A. Multiple Choice. Read and analyze the following items and determine the letter of the correct answer from the given choices. Write your answer on a separate sheet of paper.

- _____ 1. What expression is same as $(a \cdot a \cdot a \cdot a \cdot a)(b \cdot b \cdot b)$?
A. $15ab$ C. $a^3 b$
B. $a^5 b^3$ D. $5a^3b$
- _____ 2. What is the common ratio of the sequence $\frac{1}{7}, 1, 7, \dots$?
A. 7 C. $\frac{1}{7}$
B. -7 D. $-\frac{1}{7}$
- _____ 3. The first term of a geometric sequence is 2, and the second term is 10, what is the fifth term?
A. 250 C. 500
B. 100 D. 1 250
- _____ 4. The common ratio of a geometric sequence is $\frac{1}{4}$, and the fourth term is $\frac{1}{2}$. What is the third term of the sequence?
A. 1 C. $\frac{1}{4}$
B. $\frac{1}{2}$ D. 2
- _____ 5. Find the 12th term of the geometric sequence 1, 2, 4, ...
A. 512 C. 2 048
B. 1 024 D. 1 112

For items 6 – 10, find the specified term of the following geometric sequences.

- _____ 6.) 6, 12, 24, ... find a_7
- _____ 7.) 20, 10, 5, ... find a_6
- _____ 8.) 7, - 14, 28, ... find a_8
- _____ 9.) $a_1 = 2, r = 3$ find a_{10}
- _____ 10.) $a_1 = 0, r = \frac{1}{2}$ find a_8

For items 11 – 15, insert geometric means in each geometric sequence.

11.) 3, _____, 27

12.) $\frac{1}{2}$, _____, $\frac{1}{8}$

13.) $\frac{5}{2}$, _____, _____, $\frac{625}{16}$

14.) 3, _____, _____, _____, 3

15.) - 1, _____, - 25, _____, - 625



Answer Key

ASSESSMENT

1. B
2. A
3. D
4. D
5. C
6. 384
7. $\frac{8}{5}$
8. -896
9. 39,366
10. 0
11. 9 or -9
12. $\frac{1}{1}$ or $-\frac{4}{1}$
13. $\frac{4}{25}$, $\frac{8}{125}$
14. -3, 3, -3 or 3, 3, 3
15. 5, 125

What I Know

1. C
2. C
3. A
4. B
5. A
6. 192
7. $\frac{16}{5}$
8. 6 561
9. $-\frac{1}{256}$
10. $\frac{3}{125}$
11. $2\sqrt{6}$ or $-2\sqrt{6}$
12. $\frac{4}{3}$ or $-\frac{4}{3}$
13. 14, 28
14. $9, \frac{4}{9}$, $\frac{16}{9}$ or $-9, \frac{4}{9}$, $-\frac{16}{9}$
15. 3, 27 or -3, -27

What I have Learned (Lesson 1)

1. 243, 2 187, 19,683
2. 32, 128, 512
3. -648, -23 328, -839 808

What's More.
Lesson 2
Assessment 1
 1. $2\sqrt{6}$ or $5 - 2\sqrt{6}$
 2. 50 or -50
 3. $\frac{1}{4}$ or $-\frac{1}{4}$
 4. 1 or -1
 5. x^4

What's In
Lesson 2
 1. 729
 2. 64
 3. 6 or -6
 4. 6, 18

What's More.
Lesson 1
Assessment 1
 1. 192
 2. $\frac{2}{729}$
 3. $\frac{1}{64}$

What's More.
Lesson 2
Assessment 2
 1. 2, 14, 98, 686
 2. 192, 24, $3\frac{8}{3}$, $\frac{64}{3}$
 3. $\frac{1}{2}$, 1, 2, 4, 8
 4. $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1

What's More.
Lesson 1
Assessment 2
 $r = \frac{1}{2}$
 $a_1 = 32$

Geometric Sequence				TERMS	
1.) 1, —, —, —, 81	30	9	27	3	3
2.) —, 3, —, —, $\frac{1}{9}$	1	6	9	$\frac{1}{3}$	1
3.) 24, —, —, —, $\frac{3}{2}$	1	2	3	4	4
4.) 2, —, $\frac{1}{2}$, —, $\frac{1}{8}$	1	4	$\frac{1}{4}$	2	2
5.) —, $\frac{1}{2}$, 1	2	4	$\frac{1}{4}$	$\frac{1}{1}$	$\frac{3}{3}$

What I Have Learned (Lesson 2)

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