SECTION Ready To Go On? Skills Intervention **12A** 12-1 Introduction to Sequences

Find these vocabulary words in Lesson 12-1 and the Multilingual Glossary.

Vocabulary		
sequence	infinite sequence	finite sequence

Finding Terms of a Sequence by Using a Recursive Formula Find the first five terms of each sequence.

A.
$$a_n = a_{n-1} + 1$$
, where $n \ge 2$ and $a_1 = 1$



$a_3 = 3(__) - 1 = __$	Repeat to find a_3 .
a_ = 3() - 1 =	Repeat to find the next term.
$a_5 = 3(14) - __= __$	Repeat to find the fifth term.

Finding Terms of a Sequence by Using the Explicit Formula Find the first three terms of each sequence.

A.
$$a_n = 2n - 1$$
, where $n \ge 1$

	$a_1 = 2 \cdot 1 - 1 = $	Let $n = 1$. Substitute this value into the formula $a_n = 2n - 1$ to find a_1 .
	a ₂ = 2() - 1 =	Let $n = 2$. Substitute this value into the formula $a_n = 2n - 1$ to find a_2 .
	a ₃ = 2() - 1 =	Let $n = 3$. Substitute this value into the formula $a_n = 2n - 1$ to find a_3 .
В.	$a_n = 3^n - n$, where $n \ge 1$	
	$a_1 = 3^1 - 1 = $	Let $n = 1$. Substitute this value into the formula to find a_1 .

Repeat to find the remaining terms: $a_2 = 3 - 2 =$; $a_3 = 3 - 2 =$

SECTION Ready To Go On? Problem Solving Intervention 12A 12-1 Introduction to Sequences

A recursive formula is a rule to describe a sequence where one or more previous terms are used to generate the next term.

Grace has an action figure from a popular science fiction movie still in its original packaging. It is currently worth \$75. Action figures from this movie typically increase in value by about 7% a year.

a. Write a recursive rule predicting the value of the figure each year.

b. Use the recursive formula to predict the value of the figure in 10 years.

Understand the Problem

- 1. What is the initial value of the figure?
- 2. Will the value of the figure increase or decrease?
- 3. By how much will the value increase each year?

Make a Plan

Name

- 4. What do you need to determine?
- 5. Let a_n represent the value of the figure in year *n*. What symbol represents the value in the previous year?

6. By how much did the value of the figure increase in year n - 1?

7. Write a recursive rule to model the value of the figure.

Solve

8. Use the recursive rule to predict the value of the figure in 10 years.

Look Back

9. You can check your solution by using an explicit formula. The explicit rule for this pattern is the same as the formula for compound interest.

 $a_n = a_0(1 + r)^t = 75(1 + ___)^{--} = __$

Does your answer check?

SECTION Ready To Go On? Skills Intervention **12A** 12-2 Series and Summation Notation

Find these vocabulary words in Lesson 12-2 and the Multilingual Glossary.

Vocabulary

series

summation notation

infinite series

Using Summation Notation

Write this series using summation notation. $2 + \frac{2}{5} + \frac{2}{25} + \frac{2}{125} + \frac{2}{625}$

Find a rule for the *k*th term of the sequence.

Look at the numerators:

Each numerator is _____.

Look at the denominators:

Each denominator is the base _____ to a power of 0, 1, 2, 3, and _____.

Write the rule for the sequence: $a_k = \frac{1}{5}$

Write the notation for the first five terms: $\sum_{k=0}^{\square} \frac{\prod}{5^k}$

Evaluating a Series

The value of π can be approximated by a partial sum of an infinite series.

Expand the series
$$\pi \approx 4 \sum_{k=0}^{\infty} \frac{(-1)^k}{2k+1}$$
 and evaluate.

Write out the first five terms.

$$\pi \approx 4 \left(\frac{\left(\boxed{} \right)^{0}}{2 \cdot 0 + 1} + \frac{\left(-1 \right)^{\Box}}{2 \cdot \Box + 1} + \frac{\left(-1 \right)^{\Box}}{\Box \cdot 2 + 1} + \frac{\left(\boxed{} \right)^{3}}{2 \cdot \Box + 1} + \frac{\left(\boxed{} \right)^{\Box}}{2 \cdot 4 + \Box} \right)$$

Simplify each term.

$$\pi \approx 4\left(\frac{1}{2} + \frac{1}{3} + \frac{1}{5} + \frac{-1}{2} + \frac{1}{9}\right)$$

Simplify.

 $\pi pprox$ _____

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Ready To Go On? Problem Solving Intervention 12A *12-2 Series and Summation Notation*

A series can be represented by summation notation, indicated by Σ , and then evaluated to find the sum of the series.

A hot air balloon rises 30 m in the first minute. In each minute thereafter, the balloon rises 70% as far as it did the previous minute. How far does the balloon rise in 5 minutes?

Understand the Problem

1. What is the initial height?	_
--------------------------------	---

2. What is the height gain during the second minute?

3. What is the total height after the second minute?

4. What is the height gain during the third minute?

5. What is the total height after the third minute?

Make a Plan

Name _____

- 6. Write a rule that represents the height gain during the *k*th minute.
- 7. Write a summation that represents the total height after *n* minutes

Solve

8. Use the summation to calculate the total height of the balloon after 5 minutes.

Look Back

9. You can check your solution by using the formula for the sum of an infinite geometric series. For this series, |r| = 0.70, which is less than, so it is a convergent series. The sum is: $S_n = \frac{a_1}{1-r} = \frac{1}{1-0.70} = \frac{1}{1-r}$

Since the result in Exercise 8 is less than the sum of the series, is your answer reasonable?

SECTION Ready To Go On? Skills Intervention

12A 12-3 Arithmetic Sequences and Series

Find this vocabulary word in Lesson 12-3 and the Multilingual Glossary.

Identifying Arithmetic Sequences

Determine whether the sequence, 5, 9, 13, 17, \dots , is arithmetic. If so, determine the common difference and the next term.

Find the difference of the first two terms: $9 - __= 4$

Find the difference of the next two terms: 13 – ____ = ____

Find the difference of the next two terms: _____ = ___

Is the difference constant? _____; If so, what is the common difference? _____

Find the next term: $17 + ___$

Finding the *n*th Term Given an Arithmetic Sequence

Find the ninth term of the sequence: $\frac{7}{2}$, 4, $\frac{9}{2}$, 5, ...

The formula for the *n*th term in a sequence is $a_n = a_1 + (n - 1)d$, where a_1 is the first term.

What is a_1 ? ____ What is n? ____

Find the common difference: _____ $-\frac{7}{2} =$ _____

Substitute $d = \underline{\qquad}; a_1 = \frac{7}{\square};$ and $n = \underline{\qquad}$ into the formula and solve.

 $a_9 = \frac{7}{2} + (2 - 1)\frac{1}{2} = \frac{7}{2} + (8)\frac{1}{2} = \frac{7}{2} + \frac{1}{2} = \frac{1}{2}$

Finding the Sum of an Arithmetic Sequence

Find the sum of the first 10 terms of the sequence: $\frac{7}{2}$, 4, $\frac{9}{2}$, 5, ... First find the 10th term of the sequence.

What is a_1 ? ____ What is n? ____ What is the common difference: _____ $-\frac{7}{2}$ = _____ Substitute known values into the formula to find the 10th term: $a_{10} = \frac{7}{2} + (____ - 1)\frac{1}{2}$ = _____ The formula for the sum of the first *n* terms in an arithmetic sequence is $S_n = n\left(\frac{a_1 + a_n}{2}\right)$.

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Find S_{10} : $S_n = n\left(\frac{a_1 + a_n}{2}\right) = \left[\left(\frac{\frac{7}{2} + \frac{1}{2}}{2}\right) = \right]$

, 17, ... , is arithmetic. If so, determine

Vocabulary

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Ready To Go On? Problem Solving Intervention 12A *12-3 Arithmetic Sequences and Series*

Thanh has a college fund of \$1200. He withdraws \$10 from this fund the first week of college and increases the withdrawal amount by \$10 each week as his expenses increase. If Thanh then withdraws \$150 from his account and his statement shows an account balance of \$0, how many weeks have passed?

Understand the Problem

1. Is this an arithmetic series? Explain.	

2. What is the formula for the sum of an arithmetic series?

3. What is the unknown in this problem?

Make a Plan

4. What is the first term in the series?

5. What is the arithmetic difference?

6. What is the last term in the series?

7. Solve the formula for the sum of an arithmetic series for *n*.

Solve

8. Substitute the known values into the formula and solve for *n*.

$n = \frac{2S_n}{2S_n}$	2	
$a_{1} + a_{n}^{-}$	+	

9. How many weeks have passed for Thanh to now have an account balance of \$0? _____

Look Back

- **10.** Use another method to check your solution: Write out the first 15 terms of the series, then find the sum of all 15 terms.
- 11. Is your solution the same using both methods: the series formula in Exercise 8 and adding up the terms of the series in Exercise 11? _____

2.	$a_n = -n - 5$
2.	$a_n = -n - 5$
2.	$a_n = -n - 5$
4.	$a_n = a_{n-1} + 1, a_1 = 1$
in two The p	o equal pieces and stacked. process is repeated 5 times.
seq	uence.
7.	1, 6, 13, 22, 33,
9.	$\frac{3}{16}, \frac{4}{25}, \frac{5}{36}, \frac{6}{49}, \dots$
	4. In two The p seq 7. 9.

Holt Algebra 2

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12A 		
xpand and evaluate each series	c	
$2. \sum_{n=1}^{3} \left(\frac{n}{2n+3} \right)$	13. $\sum_{n=3}^{6} \left(-\frac{1}{2}\right)^n$	
I. Bowling pins are set up so that the first row has one more pin than the previous. notion to write an expression for the numl expression.	ow has one pin and ea There are four rows. I ber of bowling pins. E	ach subsequent Use summation valuate the
2–3 Arithmetic Sequences and Ser ind the eighth term of each arithmetic sec 5. 13, 21.5, 30, 38.5, 47,	ies quence. 16. −5, 7, 19, 31,	,
nd the missing terms in each arithmetic	sequence.	
7. –11, –6,,, 14, 19,	18. 9, 18, 27,	_,, 54, 63,
ind the indicated sum for each series.	5	
9. 5, 9, 13, 17,	20. $\sum_{n=1}^{\infty} (5n + 2)$	
S ₅₀ =		
 Honus loves to collect baseball cards. His him baseball cards for his birthday. As a s two cards today, but then give four cards 	s younger brother Ty o surprise, Ty plans to g tomorrow, six cards tl	decides to give jive Honus only he day after, and

to Honus?

continue the sequence for one week. What is the total number of cards Ty gives

Ready To Go On? Enrichment SECTION 12A

Physics and Sequences

It is easy to make a simple device that will demonstrate Galileo's rule for falling objects. If small weights are tied to a cord so that the distances between the weights has the following pattern, 1, 3, 5, 7, 9, then when the string is dropped, the time interval between when the weights hit the ground will be the same for all weights. To see why, complete this table.

Column 1	Column 2	Column 3
Weight Number	Distance to Next Weight	Total Distance
1	1 unit	1 unit
2	3 units	4 units
3	5 units	
4	7 units	
5	9 units	

Use the table to answer each question.

- 1. Are the numbers in Column 2 an arithmetic series? If so, calculate d.
- 2. Are the numbers in Column 3 an arithmetic series? If so, calculate d.
- 3. Write an explicit rule for the numbers in Column 2.
- 4. Write an explicit rule for the numbers in Column 3.
- 5. The formula for distance traveled as a function of time, according to Galileo (using modern notation), is $d = \frac{1}{2}at^2$, where *a* is a constant quantity called acceleration and t is time. In the table, which column of numbers represents time?

SECTION Ready To Go	On? Skills In	tervention
12B 12-4 Geometric	Sequences and	Series
Find these vocabulary words	in Lesson 12-4 and the	e Multilingual Glossary.
Vocabulary		
geometric sequence	geometric series	geometric means
Identifying Geometric Seq Determine if each sequence is the common difference. If it is	uences arithmetic or geomet geometric, find the co	ric. If it is arithmetic, find ommon ratio.
A. -7, -3, 1, 5, 9, 13, 17		
5 - 1 =, 9 =	_ Find the difference b	between two pairs of successive terms.
5 = , 9 =	Find the ratio of two	pairs of successive terms.
Is the sequence arithmetic or ge	ometric?	-
Is there a common difference or	common ratio?	
What is it?		
B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{12} = -\frac{1}{12}, \frac{1}{12} - \frac{1}{12} =$	- <u>1</u> Find the differe	ence between two pairs of ms.
$\frac{1}{1} = \frac{1}{1}, \frac{1}{1} = \frac{1}{1}$	Find the ratio	of two pairs of successive terms.
Is the sequence arithmetic or ge	ometric?	-
Is there a common difference or	common ratio?	
What is it?		
Finding the <i>n</i>th term Give Find the 8th term of a geomet	n a Geometric Sequ ric sequence if $a_1 = 16$	ence 6 and <i>r</i> = 0.5.
$a_n = a_1 r^{n-1}$	Write the formula	for geometric sequence.
$a_n = \(0.5)^{\square}$	Substitute known	values and evaluate.
$= \underline{\qquad}$ $= \frac{1}{\underline{\qquad}}$ The 8 th term in the sequence is	<u>1</u> .	

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SECTION Ready To Go On? Problem Solving Intervention **12B** 12-4 Geometric Sequences and Series

Each term in a geometric sequence is the product of the previous term and the common ratio.

Carlos planted three tomato plants. He exposed the plants to artificial light for 12 hours per day and measured their height each week. His measurements showed that the plants increased in height by an average of 8% per week. The average initial height of the three plants was 22 cm. Predict the average height of the plants at the end of 10 weeks.

Understand the Problem

- 1. Does the measured height of the plants form a geometric series? Explain.
- **2.** What formula gives the *n*th term of a geometric sequence?
- **3.** What is the first term of the sequence?
- 4. What is the second term of the sequence?
- 5. What is the common ratio?

Make a Plan

- 6. In the expression for the *n*th term of a geometric sequence, what are the known values?
- 7. In the expression for the *n*th term of a geometric sequence, what is the unknown value? _____

Solve

- 8. Substitute the appropriate values into the geometric sequence formula.
- **9.** Evaluate the formula.

10. What is the average height of the plants after 10 weeks?

Look Back

11. Use estimation to determine if your answer is reasonable. 8% can be rounded

up to 10%. What is 10% of 22 cm? _____Multiply this value by 10. ____

Add this value to 22. ____ Does your answer in Exercise 10 make sense? ____

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SECTION Ready To Go On? Skills Intervention

123 12-5 Mathematical Induction and Infinite Geometric Series

Find these vocabulary words in Lesson 12-5 and the Multilingual Glossary.

Vocabulary infinite geometric series converge limit

Finding the Sums of Infinite Geometric Series Determine if the following infinite series converges. If so, find its sum.

 $2 + \frac{2}{5} + \frac{2}{25} + \frac{2}{125} + \frac{2}{625} + \dots$

For an infinite geometric series, if r < 1, the series _____. If $r \ge$ _____, the series does not converge and does not have a sum.

Calculate the ratio between successive terms:



Since r < 1, the series _____



Writing Repeating Decimals as Fractions

Write 0.09090909... as a fraction in simplest form.

Repeating decimals are ______ numbers. Infinite geometric series can be used to convert a repeating decimal to a fraction.

0.090909 = + 0.0009 +	Write the repeating decimal as an infinite series.
$\frac{0.0009}{0.09} = $	Calculate the common ratio.
<i>a</i> ₁ =	Identify the first term.
$S = \frac{a_1}{1 - \square}$	Write the formula.
=	Substitute known values and evaluate.
=	
So 0.09090909 = $\frac{1}{10000000000000000000000000000000000$	

You can find the sum of an infinite geometric series, if it converges.

Bacteria reproduce by fission results in one cell dividing into two cells. One particular species of bacteria reproduces about once every hour. A researcher swabs a plate of growth medium leaving 100 bacteria. Assuming inexhaustible space and unlimited food, how many bacteria would there be in 12 hours?

Understand the Problem

- **1.** Is this a geometric series? Explain how you know.
- **2.** What is the common ratio?
- 3. What is the first term?
- 4. What is the formula for a partial sum of an infinite series?

Make a Plan

- 5. In the formula for the partial sum of an infinite series, what are the known values?
- 6. In the formula for the partial sum of an infinite series, what is the unknown value?

Solve

7. Substitute the known values into the formula and evaluate.



=

8. How many bacteria were there in 12 hours?

Look Back

9. Graph the function $y = \underline{\left(\frac{1-2}{1-1}\right)}$ on your graphing calculator. Does your graph support your answer to Exercise 8?

e the first six terms of each see	nd Series quence.
27, 135, 675, 3375,	2. 1, $\frac{1}{3}$, $\frac{1}{9}$, $\frac{1}{27}$,
the 10th term of each sequend	ce.
$\frac{2}{2}, 1, \frac{1}{2}, \frac{1}{4}, \ldots$	4. $\sqrt{2}$, 2, 2 $\sqrt{2}$, 4,
$a_1 = 0.625, r = 2$	6. $a_4 = 4, r = 2$
A piece of paper is 0.03 mm thick The stack is torn in again into two our pieces of paper. This proces sheets of paper doubling each tin stack after <i>n</i> times. Assuming it is	K. It is torn in two equal pieces and stacked. o equal pieces and stacked again, so it has s is repeated many times, with the number of ne. Write a formula for the height of the paper s possible, calculate the height of the stack
A piece of paper is 0.03 mm thick The stack is torn in again into two four pieces of paper. This proces sheets of paper doubling each tin stack after <i>n</i> times. Assuming it is after 11 tears.	k. It is torn in two equal pieces and stacked. o equal pieces and stacked again, so it has s is repeated many times, with the number of ne. Write a formula for the height of the paper s possible, calculate the height of the stack

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18.
$$\sum_{k=1}^{\infty} 2\left(\frac{1}{3}\right)^{k-1}$$
 19. $\sum_{k=1}^{\infty} 4(3)^{k-1}$

20. Prove by mathematical induction that the *n*th partial sum of the series

 $1 + 3 + 5 + 7 + \ldots + (2n - 1)$ is equal to n^2 .

12B

Ready To Go On? Enrichment SECTION

Mathematical Induction

Mathematical Induction is a powerful means of proving many mathematical conjectures. Graph the two functions $f(x) = x^2$ and

Math for ir valu

- 2.
- 3.
- 4.

Alte

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- S3 = ____ S1 = _____
- S2 = S4 =

It is clear that these terms do not converge to a limit, so this series does not have a sum. To further test the idea, apply the rule for the sum of a convergent series,

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 $S = \frac{a_1}{1-r} = \frac{||}{1-(-1)} = \frac{1}{||}$. This answer makes no sense.

Many alternating series do converge.

5. Suggest an example of an alternating series that converges.

Holt Algebra 2

nematical conjectures. Graph the two functions $f(x) = x^{-1}$ $g(x) = 2^{x}$ on the same axes.
What is the relationship between $f(x)$ and $g(x)$ for large values of x ?
nematical Induction can be used to prove the conjecture in Exercise 1 ntegers. Let the variable be n , where $n > 4$ and can have only integer es.
Rewrite this conjecture using the new variable.
Prove the conjecture for the first case.
Assume the statement is true for for $n = k$ and show that it is true for $n = k + 1$.
rnating Series s the series $1 - 1 + 1 - 1 + 1 - 1 +$ have a sum? nd out, calculate the first few partial sums.

11B	n? Enrichment		SECTION Ready To Go 12A 12-1 Introducti	o On? Skills Intervention fon to Sequences	on
Z-scores			Find these vocabulary words	s in Lesson 12-1 and the Multilingual	Glossary.
Standard scores, also known as z-s more easily. A z-score is the numbe above or below the mean. It is foun- particular data value, \overline{x} is the mean	scores enable statisticians to compare values or of standard deviations that a given value x is d by using the formula: $z = \frac{x - \bar{x}}{s}$ where x is n and s is the standard deviation. The use of	s s a	Vocabulary sequence infinite	sequence finite sequence	ula
z-scores in statistics is extremely im differentiate between ordinary and u greater than 2.00 is considered to b	nportant because they can be used to unusual values. A <i>z</i> -score less than -2.00 or be unusual.		Find the first five terms of a sequence A. $a_n = a_{n-1} + 1$, where $n \ge 1$	ach sequence. 2 and $a_1 = 1$	uia
Example: Heights of all adult male deviation of 2.8 inches. What is the $-X - \overline{X}$ 78 - 69	es have a mean of 69 inches and a standard <i>z</i> -score for a male that is 78 inches tall?		$a_1 = 1$ $a_2 = 1 + 1 = 2$	The first term is given. Substitute $a_1 = 1$ into the rule $a_n = a_n$	$a_{n-1} + 1$ to find a_2 .
$Z = \frac{1}{S} = \frac{1}{2.8} = 3.21$ You can interpret this result by statil standard deviations above the mean	ng that an individual 78 inches tall is 3.21 n. This would be an unusual height.		$a_3 = 2^{+} + 1 = 3^{+} + 1 = 4^{-}$	Repeat to find a_3 . Repeat to find the next term,	
Solve			$a_5 = 4 + 1 = 5$	Repeat to find the fifth term.	
 A mathematics teacher gives tw Algebra classes. The statistics a on the section 1 test or a 46 or 	vo different tests to two different sections of are shown below. Which score is better: an 82 n the section 2 test?	2	B. $a_n = 3a_{n-1} - 1$, where $n = a_{n-1} - 1$	≥ 2 and $a_1 = 1$	
Section 1: mean = 75 and stan	ndard deviation = 14		$a_1 = 1$ $a_2 = 3(1) - 1 = 2$	Substitute $a_1 = 1$ into the rule $a_n = 3$	$3a_{n-1} - 1$ to find a_2 .
Section 2: mean = 40 and stan	indexideviation = 8 $= 0.75$		$a_3 = 3(\underline{2}) - 1 = \underline{5}$	Repeat to find a ₃ .	
A 46 on the section 2 test	is a better score. $2 = 0.75$,		$a_4 = 3(5) - 1 = 14$	_ Repeat to find the next term.	
2. The Bean Pole club is open to height requirement for women i	men and women who are very tall. The minim is 70 in. If women's heights have a mean of	ium	$a_5 = 3(14) - 1 = 41$	_ Repeat to find the fifth term.	
corresponding to a height of ex z-score is 2.56, the height	actly 70 inches. Is this height unusual? t would be considered unusual.		Finding Terms of a Seque Find the first three terms of	ence by Using the Explicit Formu each sequence.	ula
3. Three potential employees take different areas are tested. Which	e a required mathematics test in which three ch of the following scores has the highest relat	tive	A. $a_n = 2n - 1$, where $n \ge 1$ $a_1 = 2 \cdot 1 - 1 = \underline{1}$	Let $n = 1$. Substitute this value into t $a_n = 2n - 1$ to find a_1 .	the formula
Test 1: Score of 37 on a test wi	ith a mean of 28 and standard deviation of 6		$a_2 = 2(\underline{2}) - 1 = \underline{3}$	Let $n = 2$. Substitute this value into t $a_n = 2n - 1$ to find a_2 .	he formula
Test 2: Score of 398 on a test v Test 3: Score of 4.10 on a test v	with a mean of 312 and standard deviation of a with a mean of 2.75 and standard deviation of	56 f	$a_3 = 2(3) - 1 = 5$	Let $n = 3$. Substitute this value into t $a_n = 2n - 1$ to find a_3 .	he formula
z-scores of 1.5, 1.54 and highest relative position.	1.47; the score of 398 has the		B. $a_n = 3^m - n$, where $n \ge 1$ $a_1 = 3^1 - 1 = 2$	Let $n = 1$. Substitute this value into t	the formula to find a_1 .
Copyright © by Holt, Rinehart and Winston.	190	Holt Algebra 2	Copyright © by Holt, Rinehart and Winston.	ng terms: $a_2 = 3 = -2 = -2 = -2$; $a_3 = 3$	Holt Algebra 2
	n? Problem Solving Interv	vention		o On? Skills Interventio	on
12A 12-1 Introduction	to Sequences		12A 12-2 Series and	d Summation Notation	
A recursive formula is a rule to deso terms are used to generate the next	cribe a sequence where one or more previous tt term.	5	Find these vocabulary words	s in Lesson 12-2 and the Multilingual	Glossary.
Grace has an action figure from a p	anular agiange fiction movie still in its original		Vocabulary		
in value by about 7% a year	. Action figures from this movie typically increa	ise	series summation	notation infinite series	
a. Write a recursive rule predicting	Action figures from this movie typically increase the value of the figure each year.	150	series summation Using Summation Notation	notation infinite series	2
packaging. It is currently worth \$75. in value by about 7% a year. a. Write a recursive rule predicting i b. Use the recursive formula to pred	Action figures from this movie typically increa the value of the figure each year. dict the value of the figure in 10 years.	150	series summation Using Summation Notation Write this series using summ Find a rule for the <i>k</i> th term of the	notation infinite series on nation notation. $2 + \frac{2}{5} + \frac{2}{25} + \frac{2}{125} + \frac{2}{1}$ the sequence.	2 625
ackaging. It is currently worth \$75. in value by about 7% a year. a. Write a recursive rule predicting i b. Use the recursive formula to pred Understand the Problem	Action figures from this movie typically increate the value of the figure each year. dict the value of the figure in 10 years.	126	series summation Using Summation Notation Write this series using summ Find a rule for the <i>k</i> th term of the Look at the numerators?	notation infinite series on nation notation. $2 + \frac{2}{5} + \frac{2}{25} + \frac{2}{125} + \frac{2}{125}$ the sequence.	2 625
 packaging. It is currently worth \$75. in value by about 7% a year. a. Write a recursive rule predicting i b. Use the recursive formula to pred Understand the Problem 1. What is the initial value of the first 2. Will the value of the first increases 	Action figures from this movie typically increased the value of the figure each year. dict the value of the figure in 10 years.		series summation Notation Write this series using summation Notation Write this series using summarian Find a rule for the <i>k</i> th term of the Look at the numerators: Each numerator is <u>2</u> .	notation infinite series on nation notation. $2 + \frac{2}{5} + \frac{2}{25} + \frac{2}{125} + \frac{2}{125} + \frac{2}{125}$ the sequence.	2 625
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SECTION Ready To Go On? Problem Solving Intervention	SECTION Ready To Go On? Skills Intervention	
124 12-2 Series and Summation Notation	12A 12-3 Arithmetic Sequences and Series	
A series can be represented by summation notation, indicated by Σ , and then evaluated to find the sum of the series.	Find this vocabulary word in Lesson 12-3 and the Multilingual Glossary. Vocabulary arithmetic series	
A hot air balloon rises 30 m in the tirst minute. In each minute thereafter, the balloon rises 70% as far as it did the previous minute. How far does the balloon rise in 5 minutes?	Identifying Arithmetic Sequences Determine whether the sequence, 5, 9, 13, 17,, is arithmetic. If so, determine the common difference and the next term	
Understand the Problem	Find the difference of the first two terms: $9 - 5 = 4$	
1. What is the initial height? 30 m	Find the difference of the next two terms: $13 - \frac{9}{2} = \frac{4}{2}$	
2. What is the height gain during the second minute? $0.70 \times 30 \text{ m} = 21 \text{ m}$	Find the difference of the next two terms: $17 - 13 = 4$	
3. What is the total height after the second minute? $30 \text{ m} + 21 \text{ m} = 51 \text{ m}$	Is the difference constant? Yes; If so, what is the common difference? 4	
4. What is the height gain during the third minute? $0.70 \times 0.70 \times 20 = 0.70 \times 21 m = 14.7 m$	Find the next term: $17 + \underline{4} = \underline{21}$	
$\frac{0.70 \times 0.70 \times 30 = 0.70 \times 21 \text{ m} = 14.7 \text{ m}}{30 \text{ m} + 21 \text{ m} + 14.7 \text{ m} = 65.7 \text{ m}}$	Finding the <i>n</i> th Term Given an Arithmetic Sequence	
5. What is the total height after the third minute?	Find the ninth term of the sequence: $\frac{7}{2}$, 4, $\frac{9}{2}$, 5,	
Make a Plan	The formula for the <i>n</i> th term in a sequence is $a_n = a_1 + (n - 1)d$, where	
6. Write a rule that represents the height gain during the <i>k</i> th minute. $(0, 70)^{k-1}$ (30)	a_1 is the first term. $\frac{7}{2}$	
(0.70) (30)	What is $a_1?$ 2 What is $n?$ 9	
7. Write a summation that represents the total height after <i>n</i> minutes $\prod_{n=1}^{n} n = n + 1$	Find the common difference: $4 - \frac{7}{2} = \frac{1}{2}$	
$\sum_{k=1}^{k} (0.70)^{k-1} (30)$	$\frac{1}{2} = \frac{1}{2}$	
Solve	Substitute $a = \underline{2}$; $a_1 = \underline{2}$; and $h = \underline{3}$ into the formula and solve.	
 Use the summation to calculate the total height of the balloon after 5 minutes. 	$a_{g} = \frac{7}{2} + (9 - 1)\frac{1}{2} = \frac{7}{2} + (8)\frac{1}{2} = \frac{7}{2} + \frac{1}{2} = \frac{1}{2}$	
$h = \sum_{k=1}^{\infty} (0.70)^{k-1}$ (30) m	Finding the Sum of an Arithmetic Sequence	
$\frac{k=1}{(k-1)^{2}(2k-1)^{$	Find the sum of the first 10 terms of the sequence: $\frac{7}{2}$, 4, $\frac{9}{2}$, 5,	
$\frac{n = (0.70)^{\circ}(30) + (0.70)^{\circ}(30) + (0.70)^{\circ}(30) + (0.70)^{\circ}(30) + (0.70)^{\circ}(30)}{20 \text{ m} + 21 \text{ m} + 147 \text{ m} + 10.2 \text{ m} + 7.2 \text{ m} - 92.2 \text{ m}}$	First find the 10th term of the sequence.	1
<u> </u>	What is $a_1?$ $\frac{1}{2}$ What is $n?$ $\frac{10}{2}$ What is the common difference: $\frac{4}{2} - \frac{7}{2} = \frac{2}{2}$	2
Look Back	Substitute known values into the formula to find the 10 th term: $a_{10} = \frac{7}{2} + (\frac{10}{2} - 1)\frac{1}{2} = -$	8
9. You can check your solution by using the formula for the sum of an infinite	The formula for the sum of the first <i>n</i> terms in an arithmetic sequence is $S = n \begin{pmatrix} a_1 + a_n \\ a_1 + a_n \end{pmatrix}$	
geometric series. For this series, $ r = 0.70$, which is less than, so it is a	The formula for the solution are metric than an antimetric sequence is $\mathcal{O}_n = \mathcal{O}(\frac{7}{2})$.	
convergent series. The sum is: $S_n = \frac{a_1}{1 - r} = \frac{100}{1 - 0.70} = \frac{100}{0.3} = 100$	Find S_{10} : $S_n = n\left(\frac{a_1 + a_n}{2}\right) = 10\left(\frac{2 + b_1}{2}\right) = 57.5$	
Since the result in Exercise 8 is less than the sum of the series, is your		
answer reasonable?	Conscible Buy Mark Market and Market	
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SECTION Ready To Go On? Problem Solving Intervention	SECTION Ready To Go On? Quiz	
SECTION Ready To Go On? Problem Solving Intervention 12A 12-3 Arithmetic Sequences and Series	SECTION Ready To Go On? Quiz	
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SECTION Ready To Go On? Quiz continued	SECTION Ready	/ To Go On? Eni	richment	
Expand and evaluate each series 12. $\sum_{n=1}^{5} \left(\frac{n}{2n+3}\right)$ 13. $\sum_{n=3}^{6} \left(-\frac{1}{2}\right)^{n}$ $\frac{1}{5} + \frac{2}{7} + \frac{3}{9} + \frac{4}{11} + \frac{5}{13} = 1.567$ $-\frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \frac{1}{64} = -\frac{5}{64}$	Physics and Sequ It is easy to make a objects. If small we has the following pa interval between wi see why, complete	ences a simple device that will den ights are tied to a cord so th attern, 1, 3, 5, 7, 9, then wh nen the weights hit the grou this table.	nonstrate Galileo's hat the distances I en the string is dri nd will be the sam	rule for falling between the weights opped, the time e for all weights. To
14. Bowling pins are set up so that the first row has one pin and each subsequent	Column 1 Weight Number	Column 2	Column 3	
notion to write an expression for the number of bowling pins. Evaluate the expression	1	1 unit	1 unit	
$\sum_{i=1}^{4} n; 1+2+3+4=10$	2	3 units	4 units	
	3	5 units	9 units	
12-3 Arithmetic Sequences and Series	5	7 units	25 units	
15. 13, 21.5, 30, 38.5, 47, 16. -5, 7, 19, 31,	5	9 units	20 units	
72.5 79	1. Are the numbe	nswer each question. rs in Column 2 an arithmeti Yes, because <i>d</i> is c	c series? If so, cal onstant, <i>d</i> = 2	culate <i>d</i> .
Find the missing terms in each arithmetic sequence. 17. -116	2. Are the numbe	rs in Column 3 an arithmeti	c series? If so, cal	culate <i>d</i> .
, 4, 9, 36, 45	3. Write an explic	it rule for the numbers in Co $a_n = 2n$	blumn 2. — 1	
Find the indicated sum for each series.	4. Write an explic	it rule for the numbers in Co	blumn 3.	
19. 5, 9, 13, 17, 20. $\sum_{n=1}^{\infty} (5n+2)$		$a_n =$	n²	
S ₅₀ = 5150 85	5. The formula for	r distance traveled as a fun	ction of time, acco	rding to Galileo
21. Honus loves to collect baseball cards. His younger brother Ty decides to give him baseball cards for his birthday. As a surprise, Ty plans to give Honus only two cards today, but then give four cards tomorrow, six cards the day after, and	acceleration ar time?	notation), is $a = \frac{1}{2}at$, when t is time. In the table, which t is time.	ch column of num	duantity called bers represents
continue the sequence for one week. What is the total number of cards Ty gives to Honus?		Column 1, wei	ght number	
$\sum^{T} 2n$; 56 cards				
<i>n</i> =1				
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SECTION Ready To Go On? Skills Intervention 128 12-4 Geometric Sequences and Series Find the Multiple of Section of the Multiple of Section	SECTION Ready	/ To Go On? Pro eometric Sequence	blem Solves and Series	ing Intervention
Vocabulary	common ratio.	metric sequence is the proc	luct of the previou	s term and the
geometric series geometric means	Carlos planted three per day and measur plants increased in h	e tomato plants. He exposed red their height each week. H height by an average of 8% p	the plants to artifici lis measurements per week. The aver	al light for 12 hours showed that the age initial height
Determine if each sequence is arithmetic or geometric. If it is arithmetic, find the common difference. If it is geometric, find the common ratio.	of the three plants w 10 weeks.	as 22 cm. Predict the average	ge height of the pla	nts at the end of
A. -7 , -3 , 1, 5, 9, 13, 17 5-1 = 4, $9-5 = 4$ Find the difference between two pairs of successive terms.	1. Does the meas	Problem sured height of the plants fo	rm a geometric se	ries? Explain.
5 = 5 $9 = 1.8$ Find the ratio of two pairs of successive terms.		Yes, because there	is a common i	atio.
I Is the sequence arithmetic or geometric? Arithmetic	 What formula g What is the first 	jives the nth term of a geor	netric sequence?	n-1
Is there a common difference or common ratio? Common difference		t term of the sequence? Z	2 cm	$a_n = a_1 r^{n-1}$
4	4. What is the sec	t term of the sequence? 2 cond term of the sequence?	$\frac{2 \text{ cm}}{22 + 0.0}$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$
What is it? <u>4</u>	 What is the set What is the contained on the set 	t term of the sequence? cond term of the sequence? mmon ratio?	$\frac{2 \text{ cm}}{22 + 0.03}$ $\frac{23.76}{22} = 1$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$.08
What is it? $\frac{4}{3}$ B. $\frac{1}{3}$, $\frac{1}{12}$, $\frac{1}{48}$, $\frac{1}{192}$	 What is the set What is the cor Make a Plan 	t term of the sequence? cond term of the sequence? mmon ratio?	$\frac{2 \text{ cm}}{22 + 0.00}$ $\frac{23.76}{22} = 1$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$.08
What is it? <u>4</u> B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms.	 What is the set What is the cor What is the cor Make a Plan In the expressivation of the set of the	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{23.76}{22} = 1$ metric sequence, $r = 1.08$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$.08 what are the known
What is it? <u>4</u> B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} = \frac{1}{4}, \frac{1}{48} = \frac{1}{4}$ Find the ratio of two pairs of successive terms.	 What is the sec What is the cor Make a Plan In the expressivalues? In the expressivalues and the expressival unknown value 	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ?	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{23.76}{22} = 1$ metric sequence, e, r = 1.08 metric sequence, a_n	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$.08 what are the known what is the
What is it? <u>4</u> B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = \frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u>	 What is the set What is the correlation of the expression of the expression	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ?	$\frac{2 \text{ cm}}{\frac{22 + 0.0}{22} = 1}$ metric sequence, $\frac{23.76}{22} = 1$ metric sequence, $\frac{2}{a_n}$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$.08 what are the known what is the
What is it? <u>4</u> B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u>	 What is the set What is the con Make a Plan In the expressivalues? In the expressivalues? In the expressival unknown value Solve Substitute the answer 	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the <i>t</i>	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{22 + 0.0}{23.76} = 1$ metric sequence, $\frac{2}{2} = 1.08$ metric sequence, $\frac{a_n}{2}$ geometric sequence, $\frac{a_n}{2} = 1.08$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$ $.08$ what are the known what is the ce formula.
What is it? $\underline{4}$ B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48}, -\frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12}, \frac{1}{3} = \frac{1}{4}, \frac{1}{12}, \frac{1}{48} = \frac{1}{4}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u> What is it? $\frac{1}{4}$	 What is the set What is the cor Make a Plan In the expressivalues? In the expressivalues? In the expressival expression of the expressio	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the $a_n = a_1 r^{n-1} =$	$\frac{2 \text{ cm}}{\frac{22 + 0.0}{22} = 1}$ metric sequence, $r = 1.08$ metric sequence, a_n geometric sequence, a_n	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$ $.08$ what are the known what is the ce formula.
What is it? $\underline{4}$ B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48}, -\frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. $\frac{1}{3}, -\frac{1}{4}, \frac{1}{12}, \frac{1}{12} = \frac{1}{4}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u> What is it? $\frac{1}{4}$ Find the ratio Sequence Find the Ath term Given a Geometric Sequence Find the Ath term Given a Geome	 What is the set What is the correlation of the expression of the expression	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the $a_n = a_1 r^{n-1} =$ mrula. $a_n = a_n r^{n-1} = 2$?	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{22 + 0.0}{23.76} = 1$ metric sequence, $r = 1.08$ metric sequence, a_n geometric sequence, $2n$ $2(1.08)^9 \approx 44$	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$.08 what are the known what is the e formula.
What is it? $\underline{4}$ B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. $\frac{1}{13} = \frac{1}{4}, \frac{1}{12}, \frac{1}{148} = \frac{1}{4}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u> What is it? $\frac{1}{4}$ Finding the <i>n</i> th term Given a Geometric Sequence Find the 8th term of a geometric sequence if $a_1 = 16$ and $r = 0.5$. $a_n = a_1 r_n^{n-1}$ Write the formula for geometric sequence.	What is the set What is the set What is the con Make a Plan In the expressi values? In the expressi unknown value Solve Substitute the a Unit of the set In the set	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the g $a_n = a_1 r^{n-1} =$ mula. $a_n = a_1 r^{n-1} = 22$ erage height of the plants at	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{22 + 0.0}{23.76} = 1$ metric sequence, $\frac{a_n}{22}$ geometric sequence, $\frac{a_n}{2}$ $\frac{22(1.08)^9}{22(1.08)^9} \approx 44$ ther 10 weeks?	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$ $.08$ what are the known what is the e formula. About 44 cm
What is it? $\frac{4}{3}$. B. $\frac{1}{3}$, $\frac{1}{12}$, $\frac{1}{48}$, $\frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}$, $\frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}$, $\frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. $\frac{1}{12} - \frac{1}{4}$, $\frac{1}{12} - \frac{1}{48} = \frac{1}{4}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u> What is it? $\frac{1}{4}$ Finding the rth term Given a Geometric Sequence Find the 8th term of a geometric sequence if $a_1 = 16$ and $r = 0.5$. $a_n = a_1 r^{n-1}$ Write the formula for geometric sequence. $a_n = \frac{16}{(0.5)^{[1]}}$ Substitute known values and evaluate. = 0.125	What is the sec What is the sec What is the con Make a Plan In the expressi values? T. In the expressi unknown value Solve S. Substitute the a Evaluate the fo Io. What is the ave Look Back	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the end $a_n = a_1 r^{n-1} = 22$ mrula. $a_n = a_1 r^{n-1} = 22$ erage height of the plants at	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{22.76}{22} = 1$ metric sequence, a_n metric sequence, a_n $\frac{a_n}{22(1.08)^9} \approx 44$ ter 10 weeks?	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$ $.08$ what are the known what is the e formula. About 44 cm
What is it? $\frac{4}{3}$. B. $\frac{1}{3}$, $\frac{1}{12}$, $\frac{1}{48}$, $\frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}$, $\frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}$, $\frac{1}{48} - \frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. $\frac{1}{3} - \frac{1}{4}$, $\frac{1}{12} = \frac{1}{4}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u> What is it? $\frac{1}{4}$ Finding the nth term Given a Geometric Sequence Find the sth term of a geometric sequence if $a_1 = 16$ and $r = 0.5$. $a_n = a_1r^{n-1}$ Write the formula for geometric sequence. $a_n = \frac{16}{0.5}(0.5)^{[2]}$ Substitute known values and evaluate. $= \frac{0.125}{10}$	What is the sec What is the sec What is the cou Make a Plan In the expressi values?	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the $a_n = a_1 r^{n-1} = 22$ mrula. $a_n = a_1 r^{n-1} = 22$ errage height of the plants at to determine if your answer	$\frac{2 \text{ cm}}{\frac{22 + 0.0}{22} = 1}$ metric sequence, $p_{r} = 1.08$ metric sequence, a_{n} geometric sequence, a_{n} $\frac{22(1.08)^{9}}{2(1.08)^{9}} \approx 44$ ter 10 weeks?	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$ $.08$ what are the known what is the e formula. About 44 cm % can be rounded
What is it? $\underline{4}$ B. $\frac{1}{3}, \frac{1}{12}, \frac{1}{48}, \frac{1}{192}$ $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48}, -\frac{1}{12} = -\frac{1}{16}$ Find the difference between two pairs of successive terms. $\frac{1}{12} - \frac{1}{3} = -\frac{1}{4}, \frac{1}{48}, -\frac{1}{12} = -\frac{1}{16}$ Find the ratio of two pairs of successive terms. $\frac{1}{13} - \frac{1}{4}, \frac{1}{12}, \frac{1}{142} = \frac{1}{4}$ Find the ratio of two pairs of successive terms. Is the sequence arithmetic or geometric? <u>Geometric</u> Is there a common difference or common ratio? <u>Common ratio</u> What is it? $\frac{1}{4}$ Find the term Given a Geometric Sequence Find the stherm of a geometric sequence if $a_1 = 16$ and $r = 0.5$. $a_n = a_1r^{n-1}$ Write the formula for geometric sequence. $a_n = \frac{16}{0.125}$ Substitute known values and evaluate. $= \frac{1}{125}$ The 3^{th} term in the sequence is $\frac{1}{8}$.	What is the set What is the set What is the con Make a Plan In the expressi values?	t term of the sequence? $\frac{2}{2}$ cond term of the sequence? mmon ratio? on for the <i>n</i> th term of a geo $a_1 = 22$ on for the <i>n</i> th term of a geo ? appropriate values into the g $a_n = a_1 r^{n-1} =$ mrula. $a_n = a_1 r^{n-1} = 22$ arage height of the plants at to determine if your answe at is 10% of 22 cm? <u>2.2.1</u> to 22. <u>44</u> Does your answe	$\frac{2 \text{ cm}}{22 + 0.0}$ $\frac{23.76}{22} = 1$ metric sequence, a_n geometric sequence, a_n $\frac{a_n}{22}$ geometric sequence, a_n $\frac{a_n}{22}$ $\frac{22(1.08)^9}{22(1.08)^9} \approx 44$ ther 10 weeks?	$a_n = a_1 r^{n-1}$ $3 \times 22 = 23.76$ $.08$ what are the known what is the e formula. $About 44 \text{ cm}$ % can be rounded alue by 10. <u>22</u> make sense? <u>Yes</u>

SECTION Ready To Go On? Skills Intervention 128 12-5 Mathematical Induction and Infinite Geometric Series Find these vocabulary words in Lesson 12-5 and the Multilingual Glossary.	Ready To Go On? Problem Solving Intervention 128 12-5 Mathematical Induction and Infinite Geometric Series You can find the sum of an infinite geometric series, if it converges.
Vocabulary infinite geometric series converge limit	Bacteria reproduce by fission results in one cell dividing into two cells. One particular species of bacteria reproduces about once every hour. A researcher swabs a plate of growth medium leaving 100 bacteria. Assuming inexhaustible crace and uninitied ford, bow many bacteria would there be in 12 hours?
Finding the Sums of Infinite Geometric Series Determine if the following infinite series converges. If so, find its sum. $2 + \frac{2}{5} + \frac{2}{25} + \frac{2}{125} + \frac{2}{625} + \dots$ For an infinite geometric series, if $r < 1$, the series <u>CONVERGES</u> . If $r \ge 1$, the series does not converge and does not have a sum. Calculate the ratio between successive terms: $r = \frac{\frac{2}{5}}{\frac{5}{2}} = \frac{1}{5}r = \frac{\frac{7}{25}}{\frac{12}{5}} = \frac{1}{5}$ Since $r < 1$, the series <u>CONVERGES</u> . Calculate the sum of the series: $S = \frac{a_1}{1-r} = \frac{\frac{2}{2}}{1-\frac{1}{5}} = \frac{\frac{10}{4}}{\frac{4}{5}} = \frac{\frac{10}{4}}{\frac{4}{5}} = \frac{2.5}{\frac{5}{4}}$ Writing Repeating Decimals as Fractions Write 0.09090909 as a fraction in simplest form. Repeating decimals are <u>rational</u> numbers. Infinite geometric series can be used to convert a repeating decimal to a fraction. 0.090909 = <u>0.09</u> + 0.0009 + <u>0.000009</u> Write the repeating decimal as an infinite $\frac{0.0009}{0.09} = \frac{0.01}{1}$ Calculate the common ratio. $a_1 = \frac{0.09}{1-\frac{1}{1-\frac{1}{1}}}$ Write the formula. $= \frac{10.09}{1-\frac{0.01}{1-\frac{1}{1-\frac{1}{1}}}}$ Substitute known values and evaluate. $= \frac{10.09}{0.99}$ 1.1	Understand the Problem 1. Is this a geometric series? Explain how you know. Yes, because the ratio is constant. 2. What is the common ratio? 2 3. What is the first term? 100 4. What is the formula for a partial sum of an infinite series? $S_n = a_1 \left(\frac{1 - r^n}{1 - r}\right)$ Make a Plan 5. In the formula for the partial sum of an infinite series, what are the known values? $a_1 = 100, r = 2, n = 12$ 6. In the formula for the partial sum of an infinite series, what is the unknown value? S_n Solve 7. Substitute the known values into the formula and evaluate. $S_n = a_1 \left(\frac{1 - r^n}{1 - r}\right)$ $= \frac{100}{\left(\frac{1 - 2^{\frac{100}{2}}}{-1}\right)}$ $= 100 \left(\frac{-\frac{100}{2}}{-1}\right)$ $= \frac{409,500}{-1}$ 8. How many bacteria were there in 12 hours? $\frac{409,500}{1 - \frac{100}{2}}$
= 1 So, 0.09090909 = (1) 1 All right reserved. 202 Holt Algebra 2	Copyright Day Holt, Rinebast and Winston. 203 Holt Algebra 2
Ready To Go On? Quiz 124 Geometric Sequences and Series Write the first six terms of each sequence. 1. 27, 135, 675, 3375, 2. 1, $\frac{1}{3}$, $\frac{1}{9}$, $\frac{1}{27}$, $\frac{1}{81}$, $\frac{1}{243}$ Find the 10th term of each sequence. 3. 2, 1, $\frac{1}{2}$, $\frac{1}{4}$, 4. $\sqrt{2}$, 2, 2/2, 4, $\frac{1}{256}$ 32 5. $a_1 = 0.625$, $r = 2$ 6. $a_4 = 4$, $r = 2$ 320 256 7. A piece of paper is 0.03 mm thick. It is torn in two equal pieces and stacked. The stack is torm in again into two equal pieces and stacked again, so it has four pieces of paper. This process is repeated many times, with the number of sheets of paper doubling each time. Write a formula for the height of the paper stack after n times. Assuming it is possible, calculate the height of the stack after n times. Assuming it is possible, calculate the height of the stack after n times. Assuming it is possible, calculate the height of the stack after 11 tears. 10.03(2) ⁿ⁻¹ = 0.03(2) ¹⁰ = 30.72 mm Find the geometric mean of each pair of numbers. 8. $\frac{1}{4}$ and 4 9. 4 and 64 1 16 Find the geometric means to complete each sequence. 10. 8, arg 27, 112, arg 54, 12, 18 6, -18	Perform Perform Perform Find the indicated sums. 12. S_6 for $1 + 5 + 25 + 125 +$ $S_n = a_1 \left(\frac{1 - r^n}{1 - r}\right) = 3906$ 13. S_6 for $\frac{2}{3} + \frac{1}{3} + \frac{1}{6} + \frac{1}{12} +$ $S_n = a_1 \left(\frac{1 - r^n}{1 - r}\right) \approx 1.33$ 12-5 Mathematical Induction and Infinite Geometric Series Determine if the series converges. If it does, find the sum. 14. $\frac{1}{25} + \frac{1}{250} + \frac{1}{2500} +$ 15. $5 + \frac{5}{2} + \frac{5}{4} + \frac{5}{8} +$ $r = 0.1 < 1; S = \frac{a_1}{1 - r} = 0.0\overline{4}$ 16. $\sum_{k=1}^{\infty} \left(\frac{1}{3}\right)^{k-1}$ 17. $\frac{2}{7} + \frac{4}{7} + \frac{8}{7} + \frac{16}{7} +$ $r = \frac{1}{9} < 1; S = \frac{1}{1 - \frac{1}{9}} = 1.125$ 18. $\sum_{k=1}^{\infty} 2\left(\frac{1}{3}\right)^{k-1}$ 19. $\sum_{k=1}^{\infty} 4(3)^{k-1}$ $r = \frac{1}{3} < 1; S = \frac{2}{1 - \frac{1}{3}}$ 20. Prove by mathematical induction that the <i>n</i> th partial sum of the series $1 + 3 + 5 + 7 + + (2n - 1)$ is equal to n^2 . If $n = 1, S_1 = 1^2 = 1$. Assume that for $n = k, S_k = k^2$ Given $S_k = k^2; \sum_{k=1}^{k} (2n - 1) = k^2$ $\frac{k+1}{2(2n - 1)} = \sum_{k=1}^{k} (2n - 1) + (2(k + 1) - 1)$ $= \sum_{n=1}^{k} (2n - 1) + 2k + 1$ $= k^2 + 2k + 1 = (k + 1)^2$

SECTION Ready To Go On? Enrichment	SECTION	Ready To Go	On? Skills Interver	ntion		
12B	13A	13-1 Right-Angle	e Trigonometry			
Mathematical Induction	Find th	ese vocabulary words i	n Lesson 13-1 and the Multiling	jual Glossary.		
Mathematical Induction is a powerful means of proving many mathematical conjectures. Graph the two functions $f(x) = x^2$	Vocab	ulary				
and $g(x) = 2$ on the same axes. 1. What is the relationship between $f(x)$ and $g(x)$ for large values of x ?	i trigono	ant	sine cosine secant cotangent	tangent		
For $x > 4$, $x^2 < 2^2$. Mathematical induction can be used to prove the conjecture in Exercise 1	Findin	g Values of Trigonom	netric Functions	8 cm 17 cm		
for integers. Let the variable be n , where $n > 4$ and can have only integer values.	In a righ	It triangle, $\sin \theta = \frac{\text{opp}}{\text{hyp}}$, co	$\cos \theta = \frac{\mathrm{adj}}{\mathrm{hyp}}, \tan \theta = \frac{\mathrm{opp}}{\mathrm{adj}}$	θ cm 15 cm		
2. Rewrite this conjecture using the new variable. $n^2 < 2^n, n > 4$	sin	$\theta = \frac{\text{opp}}{\text{hyp}} = \frac{8}{\text{hyp}}$ The	side opposite is the side that doe	es not touch the angle.		
3. Prove the conjecture for the first case. $n^2 < 2^n$; $5^2 < 2^5$; $25 < 32$	sin	$\theta = \frac{\text{opp}}{\text{hyp}} = \frac{8}{17}$ The	hypotenuse is the side opposite f	from the right angle.		
4. Assume the statement is true for for $n = k$ and show that it is true for $n = k + 1$.	sin	$\theta = \frac{\text{opp}}{\text{hyp}} = \boxed{0.47}$ Solv	e.			
$\frac{(k+1) = k + 2k + 1, (k+1) < k + (k-1)k + 1 \text{ since}}{2 < k - 1; (k+1)^2 < 2k^2 - k + 1; (k+1)^2 < 2(2^k) \text{ since}}$	D. FIN	$\theta = \frac{\text{adj}}{\text{hum}} = \frac{15}{\text{hum}}$ The	side adjacent is the side that touc	ches the angle.		
$k^2 < 2^k$; $(k+1)^2 < 2^{k+1}$	cos	$\theta = \frac{\text{adj}}{\text{hum}} = \frac{15}{15}$ The	hypotenuse is the side opposite f	from the right angle.		
Alternating Series Does the series $1 - 1 + 1 - 1 + 1 - 1 +$ have a sum? To find out, calculate the first few partial sums.	cos	$\theta = \frac{\text{adj}}{\text{hyp}} = \boxed{\textbf{0.88}} \text{Solv}$	e.			
$S1 = \underline{1}$ $S3 = \underline{1}$	C. Fin	d the value of the tange	ent function for the triangle sho	wn.		
S2 = 0 $S4 = 0It is clear that these terms do not converge to a limit, so this series does not have a$	tan	$\theta = \frac{opp}{adj} = \frac{15}{15}$ The	opposite and the adjacent are the	e two shortest sides.		
sum. To further test the idea, apply the rule for the sum of a convergent series, $S = -\frac{a_1}{a_1} = -\frac{1}{a_1}$. This answer makes no sense	tan	$\theta = \frac{opp}{adj} = \boxed{0.53} x$ The	hypotenuse is the side opposite f	from the right angle.		
1 - r 1 - (-1) 2. This area is the initial of the context o	D. Fin	d the value of the cosec $\theta = \frac{1}{\sin \theta}$	cant function for the triangle sh	iown.		
5. Suggest an example of an alternating series that converges.	csc	$\theta = \frac{1}{0.47}$				
Sample answer. $1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{16} + \dots$	csc	$\theta = 2.13$				
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Ready To Go On? Problem Solving Interven ISETTON 13-1 Right-Angle Trigonometry	section 13A	Ready To Go 13-2 Angles of F	On? Skills Interver	ntion		
Ready To Go On? Problem Solving Interven Item 13-1 Right-Angle Trigonometry A trigonometric ratio compares the length of two sides of right triangles.	tion 13A Find th	Ready To Go 13-2 Angles of F ese vocabulary words in	On? Skills Interver Rotation n Lesson 13-2 and the Multiling	ntion Jual Glossary.		
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