7-6 Exploring the Number e
John Napier, the inventor of logarithms in 1614, based his work on a number the Swiss mathematician Leonard Euler later called <i>e</i> . The value of <i>e</i> is the irrational number 2.71828
As you have seen, one way to approximate the value of <i>e</i> is to let the value of <i>n</i> become very large in the sequence of numbers obtained from
the expression $1\left(1 + \frac{1}{n}\right)^n$. You can explore some other methods for evaluating <i>e</i> .
Consider the sequence 1, $\frac{1}{1}$, $\frac{1}{2 \cdot 1}$, $\frac{1}{3 \cdot 2 \cdot 1}$,

- 1. Write the 9th term of the sequence.
- 2. Using a calculator, determine
 - a. the sum of the first 5 terms of the sequence.

Name

- **b.** the sum of the first 7 terms of the sequence.
- **c.** the sum of the first 10 terms of the sequence.
- **3.** Use what you know about the value of *e* and the results of Exercise 2 to write an expression for *e* in terms of the given sequence of numbers.

A continued fraction is formed by a number added to a fraction whose denominator is a fraction added to a fraction whose denominator is a fraction, and so on, forming a pattern.

Example To evaluate, start with the last denominator.

$$-\frac{1}{2 + \frac{1}{3 + \frac{1}{4}}} = 1 + \frac{1}{2 + \frac{1}{\frac{13}{4}}} = 1 + \frac{1}{2 + \frac{4}{13}} = 1 + \frac{1}{\frac{30}{13}} = 1 + \frac{13}{30} = \frac{43}{30}$$
Start.

Date Class

Complete the continued fraction by finding the missing denominator. Then evaluate.

4.
$$2 + \frac{1}{1 + \frac{1}{2 + \frac{2}{3 + \frac{3}{4 + \frac{4}{2}}}}}$$

5. $1 + \frac{2}{1 + \frac{1}{6 + \frac{1}{10 + \frac{1}{14 + \frac{1}{2}}}}$

6. Continue the pattern further in the fractions above and make an observation.

	Reteach									
	The Natur		. e (con	tinued)				7-6 Exploring the N	umber e	
	natural base, e, a			-	compound	ed continu	ously.	John Napier, the inventor of loga	arithms in 1614, based h	
	$A = Pe^{rt}$							number the Swiss mathematician of e is the irrational number 2.71		lied <i>e</i> . The value
	A = total among B = principal		mount					As you have seen, one way to approximate the value of e is to let the		
	P = principal, or initial amount r = annual interest rate							value of <i>n</i> become very large in the sequence of numbers obtained from the expression $1(1 + \frac{1}{n})^n$. You can explore some other methods for		
	t = time in y	ears						the expression $1(1 + \frac{1}{n})$. You conclusion evaluating <i>e</i> .	an explore some other n	nethods for
	at is the total amou tinuously for 5 year		vestment o	of \$2000 inv	rested at 39	% and com	pounded	Consider the sequence $1, \frac{1}{1}, \frac{1}{2}$	<u>1_1</u>	
	p 1 Identify the va		orrespond	to the varia	ables in the	formula.		1. Write the 9th term of the sec		1
	P = initial inv							2. Using a calculator, determin	-	$\underline{8\cdot 7\cdot 6\cdot 5\cdot 4\cdot 3\cdot 2\cdot 1}$
	r = 3% = 0.0	3						a. the sum of the first 5 term	ms of the sequence.	2.7083
	t = 5 Step 2 Substitute the known values into the formula.							b. the sum of the first 7 tern	ms of the sequence.	2.718055556
Ste	p 2 Substitute the $A = Pe^{rt}$	e known val	lues into the	e formula.				c. the sum of the first 10 ter	rms of the sequence.	2.718281526
	$A = Pe^{A}$ $A = 2000e^{0.0}$	13(5)						3. Use what you know about th		$e = 1 + \frac{1}{1_1} + \frac{1}{2 \cdot 1}$
Ste	p 3 Use a calcula		o for A, the	total amou	nt.			results of Exercise 2 to write in terms of the given sequer		$+\frac{1}{3\cdot 2\cdot 1}+\cdots$
	$A = 2000e^{0.0}$						_			art with the last denominator.
	$A\approx 2323.67$	-		Use 2000	the <i>e</i> * key De ^(.03*5) =	on a calcu 2323.6684	lator: 85	formed by a number added to a fraction whose 1+-	$\frac{1}{2} = 1 + \frac{1}{2}$	$= 1 + \frac{1}{2 + \frac{4}{13}} = 1 + \frac{1}{\frac{30}{13}} = 1 + \frac{13}{30} = \frac{4}{3}$
The	total amount is \$2	323.67.						denominator is a fraction added to a fraction whose	$2 + \frac{1}{3 + \frac{1}{4}}$ $2 + \frac{1}{\frac{13}{4}}$	$2 + \frac{1}{13}$ $\frac{1}{13}$
Use	the formula $A = F$	Pe ^{rt} to solv	e.					denominator is a fraction, S	Start.	
	What is the total an			nt of \$500 i	nvested at	4.5% and		and so on, forming a pattern.		
	compounded contir P = 500	uously for		0.045		+_	10	Complete the continued fraction Then evaluate.		
		_	·		_	<i>i</i> –		4. 2 ± <u>1</u>	5.1+	2
-				\$784.16				4. $2 + \frac{1}{1 + \frac{1}{2 + \frac{2}{3 + \frac{3}{4 + \frac{4}{4}}}}}$		$+\frac{2}{1+\frac{1}{6+\frac{1}{10+\frac{1}{14+\frac{1}{10}}}}}$
	Randy deposited \$ 2.8% with continuo							$2 + \frac{-}{3 + \frac{-}{3}}$		$6 + \frac{1}{10 + \frac{1}{10}}$
ł	balance after 6 yea	rs?				\$118	2.94	4 + 4		14 + —
9. i	 Martin borrows continuous comp 							$5+\frac{5}{6},\frac{5760}{2119}\approx 2.71$	18263332 18	$+\frac{1}{22};\frac{1,084,483}{398,959}\approx 2.71828182$
	owe at the end of					\$620	1.23			
I	 Martin found a b of 5.5%. How m 							6. Continue the pattern further Possible answer: Bo	th of the given conti	nued fractions can be used to
	end of 2 years?			at the		\$61	.70		determine the value	ue of <i>e</i> .
Copyrigh All rights	t © by Holt, Rinehart and Winston reserved.			47			Holt Algebra 2	Copyright © by Holt, Rinehart and Winston. All rights reserved.	48	Holt Algebra
7-(Irene	Problem The Natur reads that the 20	al Base	, e s of whoop					Reading Stra		
7-8 Irene 213 I	The Natur	al Base 04 census fe refuge i	, <i>E</i> s of whoop n Texas. Th	nis numbe	r exceeded			7-6 Use a Graphic C	Drganizer Facts	
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