CHAPTER 1
5

Patterns and Spreadsheets

STUDENT BOOK PAGES 20–21
Exploration

Goal **Create patterns using spreadsheets and compare the growth.**

Prerequisite Skills/Concepts

- Create, identify, and extend patterns using a variety of tools.
- Use a spreadsheet.

Expectations

- determine the term number of a given term in a growing pattern that is represented by a pattern rule in words, a table of values, or a graph

Assessment for Feedback	What You Will See Students Doing…	
Students will	**When Students Understand**	**If Students Misunderstand**
• use computer applications to explore patterns	• Students will use a spreadsheet to extend and explore a pattern.	• Students enter data into the spreadsheet by typing into each cell. Provide direct instruction on how to enter and apply formulas across cells into a spreadsheet.
• analyze number patterns and state the rule for any relationships	• Students will correctly write a formula to extend a pattern using a spreadsheet.	• Students have difficulty stating a pattern rule as a spreadsheet formula. Have students describe the pattern by referring to what was done with the values in each cell (add C1 to B2) then rewrite using symbols (C1 + B2).

Preparation and Planning

Pacing	**15–20 min** Introduction **20–30 min** Teaching and Learning **5–10 min** Consolidation
Materials	• spreadsheet software • *Optional (if computers are not available):* calculator (1/student)
Masters	• *Optional:* Chapter 1 Mental Math p. 70 • *Assessment:* Problem Solving/ Thinking Rubric, Masters Booklet p. 8
Workbook	p. 5
Vocabulary/ Symbols	*(multiplication in a spreadsheet)
Key Assessment of Learning Question	Entire Exploration, Problem Solving/Thinking
Mathematical Processes	Reflecting, Connecting, Selecting Tools and Computational Strategies, Representing, Problem Solving

Meeting Individual Needs

Extra Challenge

- Have students complete the pattern to find out how many grains of rice are on each square of a chessboard. Find the total number of grains of rice altogether (*final number is 18 446 744 073 999 998 976*).
- Have students write each of the amounts of rice using multiplication ($2 \times 2 \times 2$) and as a numeral (8). Challenge students to read the very large numbers.

Extra Support

- Provide students with other spreadsheet data and have them express the relationship of one column to the other using a formula.
- Have students represent the power of doubling numbers by showing the growth on a graph, e.g., (1, 2), (2, 4), (3, 8), and so on.

CHAPTER 1

5 Patterns and Spreadsheets

You will need
- spreadsheet software

Goal **Create patterns using spreadsheets and compare the growth.**

Chandra saved the local rajah's elephants, so the mean rajah offered her a reward. He gave her a choice of beautiful jewels, but she noticed a chessboard. "All I ask for is rice," she said with a smile. "Please put two grains of rice on the first square of the chessboard. Put four grains on the second square, put eight on the next, and so on, doubling each pile until the last square."

The rajah thought Chandra was foolish.

? How did Chandra trick the rajah? When will she have gathered more than 1 000 000 grains of rice?

Chandra's Spreadsheet

B3 = =2*B2

	A	B	C
1	Square on number of grains of rice		
2	1	2	
3	2	4	
4	3	8	
5	4	16	
6	5	32	

* A symbol used to represent multiplication in a spreadsheet

A. Cell B3 has the formula "=2*B2". Why does it make sense to use this formula here?

B. What would the formula for cell B6 be?

C. Predict the number of grains of rice on square 8. Calculate the number of grains on square 8. How close was your prediction?

D. Add a third column to the spreadsheet with the title Total grains of rice. What is the total for two squares? three squares? What formula can you use for the cells in this column?

Entire Exploration is for Assessment of Learning. **(See chart on p. 43.)**

1. Introduction (Whole Class) ▸ 15–20 min

Read *The Rajah's Rice* by David Barry and stop at an appropriate place to allow students to work with the pattern that is beginning to emerge. Alternatively, tell the story about the young girl who heals the rajah's favourite elephant and is told, "Name your reward, Elephant Bather." Once students know what reward Chandra has asked for, have them discuss if Chandra is foolish, wise, or if she is trying to trick the rajah.

Sample Discourse

"How many squares are there on a chessboard?"
- *There are 64 squares.*

"How many grains of rice do you think Chandra would get using this method?
- *I think she would get several thousand because 2 + 4 + 8 + 16 + 32 + 64 + 128 + 256 gives her 510 just in the first row.*
- *I think she would get a lot more than that. She would get many million grains of rice.*

"If you used a table to record the pattern, how many headings would you have and what headings would you use for these columns?"
- *I would use two. The first column would be the square number, the second column would be the grains of rice.*
- *I would add another column that would keep track of the total amount of rice that Chandra was given.*

Tell students that, in this lesson, they will use a computer spreadsheet to record a pattern and find out how many grains of rice Chandra got from the rajah.

2. Teaching and Learning (Individual) ▸ 20–30 min

Read and discuss the central question on Student Book page 20 and ask students to look at the picture of the spreadsheet. Have students read prompt A and ask them to find where the formula is shown on the spreadsheet (*formula bar*). Be sure students know that 2*B2 can be read "2 multiplied by the value of cell B2." Pair students and provide access to a computer with a spreadsheet program. Instruct students to enter headings for columns A and B and the numbers 1 to 5 in column A. Allow students some time to discuss with their partner how they will enter the formula for cell B3, and then have them complete prompts A to C. After students have made their prediction in prompt D, encourage students to discuss with their partner their strategy for extending the pattern to 64 squares.

A. to C. Watch that students write their predictions before calculating the data.

D. to F. Have student pairs show you the formulas before they apply it to the spreadsheet. Remind students that each formula must start with an equal sign. Students should realize that they may use 2*B2 or B2*2 to double the value in cell B2. Watch that students know that the formula can be entered into the first cell (e.g., B2) and then applied to the rest of the column by right-clicking and dragging the cursor down the column.

If students complete the exploration using a hard copy of a spreadsheet, calculators should be distributed.

Reflecting

Here students reflect on the surprising effect of doubling. Students should come to understand that every time the cell position in column B increases by 1, the number represented by 2*B2 doubles (24th number is twice as large as the 23rd). Students are asked to apply their understanding of the effects of doubling in a new context.

Answers

A. For example, for each new square on the chessboard, the number of grains of rice is doubled. Multiplying by 2 is the same as doubling and the asterisk means multiply on spreadsheets. So the formula "=2*B2" makes sense.

B. The number that goes in this cell is twice the number in the cell above it, cell B5. So the formula for cell B6 would be "=2*B5."

C. For example, about 200. For example, I can see from the spreadsheet that there are 32 grains of rice on the 5th square. On the 6th, there will be $2 \times 32 = 64$. On the 7th, there will be $2 \times 64 = 128$, and on the 8th square, there will be $2 \times 128 = 256$.
There will be 256 grains on the 8th square.

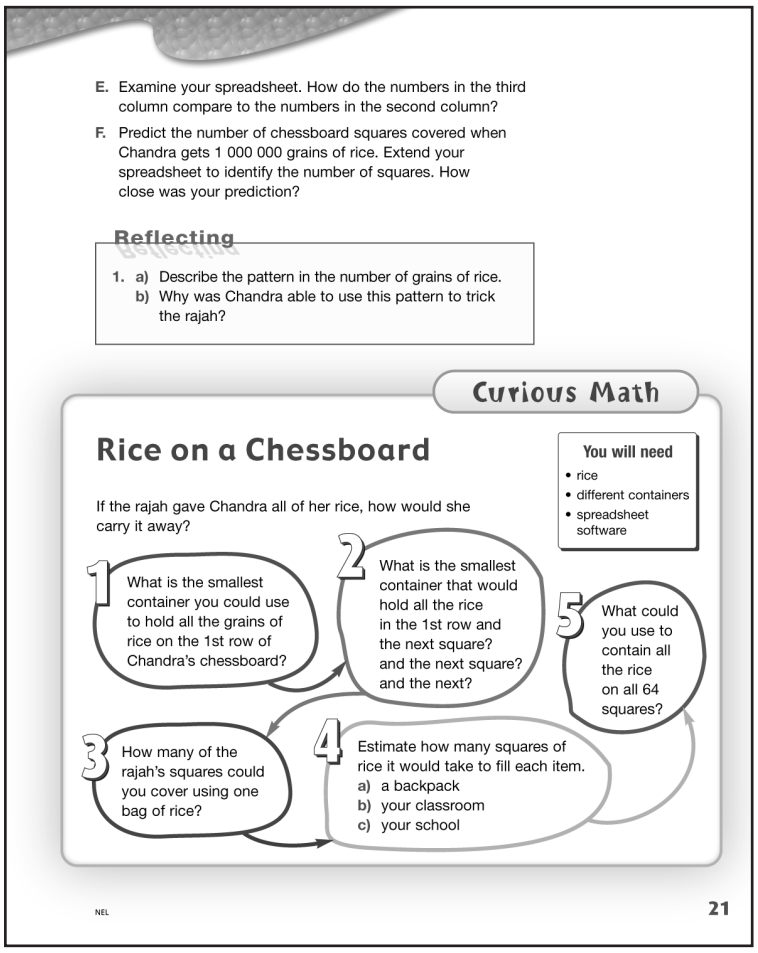
D. The total grains of rice for two squares is 6, and for three squares is 14.
The rule is to add the number of grains from all the previous squares to the number of grains on the current square to get the total grains of rice so far. The formula you can use for the third square is "=C3+B4."

E. For example, the numbers in column C are 2 less than the number in the next row of column B.

F. For example, about 50.

Square on	Number of grains of rice	Total grains of rice
1	2	2
2	4	6
3	8	14
4	16	30
5	32	62
6	64	126
7	128	254
8	256	510
9	512	1022
10	1024	2046
11	2048	4094
12	4096	8190
13	8192	16 382
14	16 384	32 766
15	32 768	65 534
16	65 536	131 070
17	131 072	262 142
18	262 144	524 286
19	524 288	1 048 574
20	1 048 576	2 097 150

For example, Chandra will have more than 1 000 000 grains of rice on the 19th square. I predicted 50. My prediction was very low.



E. Examine your spreadsheet. How do the numbers in the third column compare to the numbers in the second column?

F. Predict the number of chessboard squares covered when Chandra gets 1 000 000 grains of rice. Extend your spreadsheet to identify the number of squares. How close was your prediction?

Reflecting

1. a) Describe the pattern in the number of grains of rice.
   b) Why was Chandra able to use this pattern to trick the rajah?

Curious Math

Rice on a Chessboard

You will need
- rice
- different containers
- spreadsheet software

If the rajah gave Chandra all of her rice, how would she carry it away?

1. What is the smallest container you could use to hold all the grains of rice on the 1st row of Chandra's chessboard?
2. What is the smallest container that would hold all the rice in the 1st row and the next square? and the next square? and the next?
3. How many of the rajah's squares could you cover using one bag of rice?
4. Estimate how many squares of rice it would take to fill each item.
   a) a backpack
   b) your classroom
   c) your school
5. What could you use to contain all the rice on all 64 squares?

NEL 21

1. a) For example, this pattern has numbers that start at 2 and increase by doubling or multiplying by 2 each time. They start out growing slowly and then they start getting bigger very quickly.

b) For example, because when you say "start at 2 and double that and then double again," the pattern seems to grow slowly and you think it will always stay that way. It surprises you after you get into the thousands because it starts to grow very quickly.

3. Consolidation ▸ 5–10 min

For intervention strategies, refer to Meeting Individual Needs or the Assessment for Feedback chart.

Closing (Whole Class)

Have students summarize their learning by explaining what formula would be used if Chandra had asked for 3 grains of rice on the first square and triple the number of grains of rice on each subsequent square. Have students explain what might be the same and what might be different between this pattern and the pattern in the Student Book.

*The pattern would be 3, 9, 27, 81, 243, …. The formula would be "=3*B2."*

This pattern increases like Chandra's pattern, but it seems to increase a lot faster. I think that tripling would give numbers that are much bigger than doubling. I think this because the 5th square in the story had only 32 grains of rice and 5th in this pattern has 243 grains already.

Assessment of Learning—What to Look for in Student Work…

Assessment Strategy: investigation
Problem Solving/Thinking

Assessment Opportunity
In this lesson, the entire exploration is an opportunity for assessment. You will see students using a spreadsheet to examine patterns relating to doubling. Students will use formulas in cells to determine the entries and make observations and predictions based on the patterns.

To gather evidence about a student's ability to problem solve, use informal observation, questioning, and written work. Use Problem Solving/Thinking Rubric, Masters Booklet p. 8, to help you focus on the problem-solving process. You may want to focus on the Carry Out the Plan, Look Back, and Communicate rows in the rubric.

Extra Practice and Extension

- You might assign any of the questions related to this lesson, which are cross-referenced in the chart below.

Curious Math	Student Book p. 21, Questions 1–5
Problem Bank	Student Book p. 31, Questions 7 & 8
Chapter Review	Student Book p. 33, Question 5
Workbook	p. 5, all questions
Nelson Web Site	Visit **www.mathK8.nelson.com** and follow the links to *Nelson Mathematics 6*, Chapter 1.

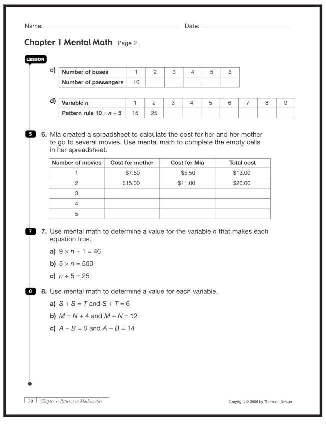
Math Background

The power of multiplying by 2, or doubling, creates an amazing pattern. Most people are quite surprised to discover how quickly the numbers grow. The last page of *The Rajah's Rice* provides the reader with visual clues to help understand the numbers, and tells the reader that all the grains of rice altogether would cover India knee-deep in rice. You will find the name of other books with this same Indian folktale on Teacher's Resource page 3. There are many interesting problems that can extend students' understanding of this powerful pattern.

At Home

If students have computers at home, have them complete the pattern to the 64th square. Other students could share the story with family members by asking them how many grains of rice they think would be on the 64th square.

Optional: Chapter 1 Mental Math p. 70



Name: ____________ Date: ____________

Chapter 1 Mental Math Page 2

LESSON

c)

Number of buses	1	2	3	4	5	6
Number of passengers	16					

d)

Variable n	1	2	3	4	5	6	7	8	9
Pattern rule $10 \times n + 5$	15	25							

5 6. Mia created a spreadsheet to calculate the cost for her and her mother to go to several movies. Use mental math to complete the empty cells in her spreadsheet.

Number of movies	Cost for mother	Cost for Mia	Total cost
1	$7.50	$5.50	$13.00
2	$15.00	$11.00	$26.00
3			
4			
5			

7 7. Use mental math to determine a value for the variable n that makes each equation true.

a) $9 \times n + 1 = 46$

b) $5 \times n = 500$

c) $n \div 5 = 25$

8 8. Use mental math to determine a value for each variable.

a) $S + S = T$ and $S + T = 6$

b) $M = N + 4$ and $M + N = 12$

c) $A - B = 0$ and $A + B = 14$

70 Chapter 1: Patterns in Mathematics

Copyright © 2006 by Thomson Nelson

Assessment: Problem Solving/Thinking Rubric, Masters Booklet p. 8