Student Guide

Square Number Patterns (SG pp. 438–441) Question 1–13

1.* Sqare Shell Turtle

A Age in Years	*G* New Growth in Squares	*S* Size in Squares
1	1	1
2	3	4
3	5	9
4	7	16
5	9	25
6	11	36
7	13	49
8	15	64

2. **A.*** See Figure 2 in the lesson.
   B.* See Figure 3 in the lesson.
   C.* See Figures 2 and 3 in the lesson.

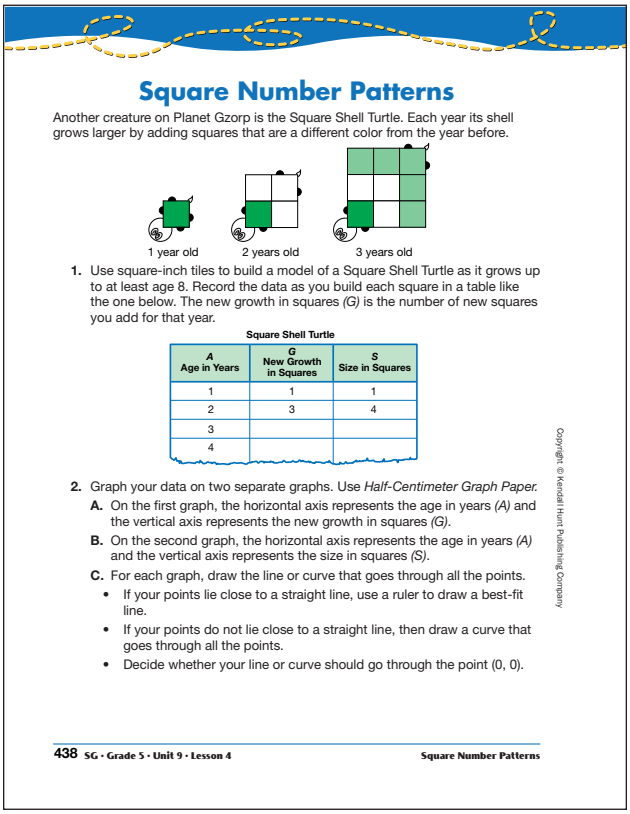
3.* Answers will vary. Responses may include: Age multiplied by itself will equal Size. New Growth goes up by 2 as Age goes up by 1. Age times 2 minus 1 equals New Growth.

4.* Answers will vary. Possible response. You can add 2 to New Growth in any row to find the next value in the next row. Or, you can multiply Age by 2 and subtract 1.

5.* Answers will vary. Possible responses: Pick a row. To find the size of the turtle in that row, add the value for growth in the row you picked to the size in the row before it. Or, multiplying the age by itself will give you the size of the turtle in squares.

6.* $G = A \times 2 - 1$

7.* $S = A \times A$ or $S = A^2$



Square Number Patterns

Another creature on Planet Gzorp is the Square Shell Turtle. Each year its shell grows larger by adding squares that are a different color from the year before.

1 year old 2 years old 3 years old

1. Use square-inch tiles to build a model of a Square Shell Turtle as it grows up to at least age 8. Record the data as you build each square in a table like the one below. The new growth in squares *(G)* is the number of new squares you add for that year.

Square Shell Turtle

A Age in Years	*G* New Growth in Squares	*S* Size in Squares
1	1	1
2	3	4
3		
4		

2. Graph your data on two separate graphs. Use *Half-Centimeter Graph Paper.*
   - **A.** On the first graph, the horizontal axis represents the age in years *(A)* and the vertical axis represents the new growth in squares *(G)*.
   - **B.** On the second graph, the horizontal axis represents the age in years *(A)* and the vertical axis represents the size in squares *(S)*.
   - **C.** For each graph, draw the line or curve that goes through all the points.
     - If your points lie close to a straight line, use a ruler to draw a best-fit line.
     - If your points do not lie close to a straight line, then draw a curve that goes through all the points.
     - Decide whether your line or curve should go through the point (0, 0).

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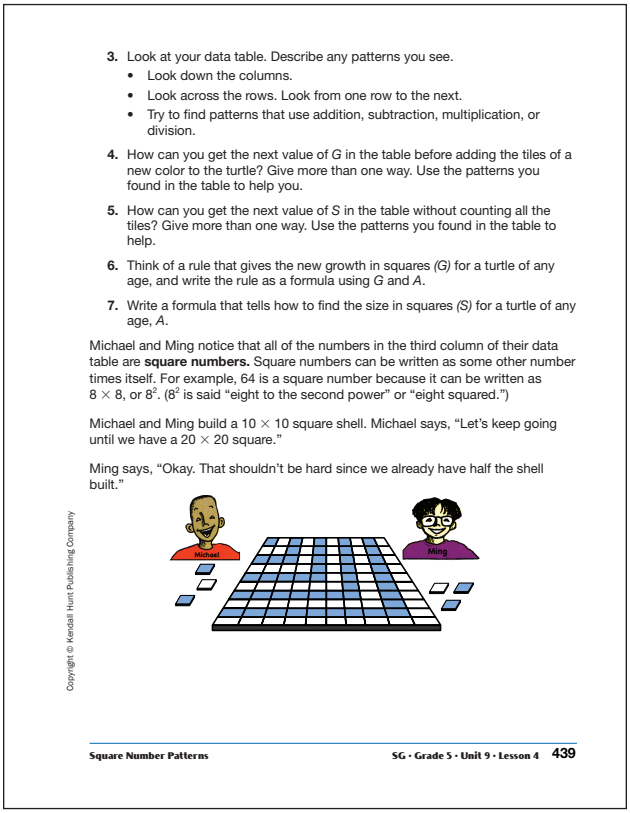

3. Look at your data table. Describe any patterns you see.
   - Look down the columns.
   - Look across the rows. Look from one row to the next.
   - Try to find patterns that use addition, subtraction, multiplication, or division.
4. How can you get the next value of *G* in the table before adding the tiles of a new color to the turtle? Give more than one way. Use the patterns you found in the table to help you.
5. How can you get the next value of *S* in the table without counting all the tiles? Give more than one way. Use the patterns you found in the table to help.
6. Think of a rule that gives the new growth in squares *(G)* for a turtle of any age, and write the rule as a formula using *G* and *A*.
7. Write a formula that tells how to find the size in squares *(S)* for a turtle of any age, *A*.

Michael and Ming notice that all of the numbers in the third column of their data table are **square numbers.** Square numbers can be written as some other number times itself. For example, 64 is a square number because it can be written as 8×8, or 8^2. (8^2 is said "eight to the second power" or "eight squared.")

Michael and Ming build a 10×10 square shell. Michael says, "Let's keep going until we have a 20×20 square."

Ming says, "Okay. That shouldn't be hard since we already have half the shell built."

Michael Ming

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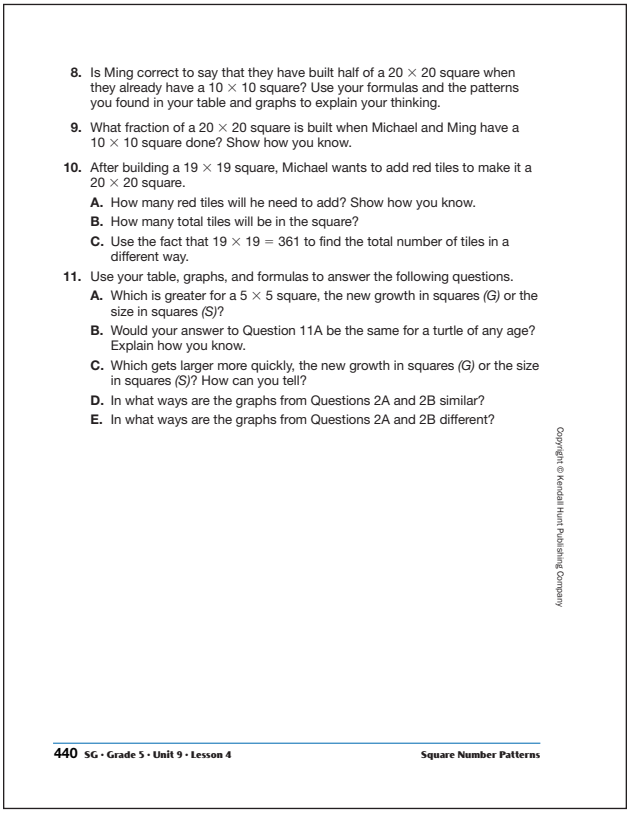
***Answers and/or discussion are included in the lesson.**



8. Is Ming correct to say that they have built half of a 20 × 20 square when they already have a 10 × 10 square? Use your formulas and the patterns you found in your table and graphs to explain your thinking.

9. What fraction of a 20 × 20 square is built when Michael and Ming have a 10 × 10 square done? Show how you know.

10. After building a 19 × 19 square, Michael wants to add red tiles to make it a 20 × 20 square.
    - **A.** How many red tiles will he need to add? Show how you know.
    - **B.** How many total tiles will be in the square?
    - **C.** Use the fact that 19 × 19 = 361 to find the total number of tiles in a different way.

11. Use your table, graphs, and formulas to answer the following questions.
    - **A.** Which is greater for a 5 × 5 square, the new growth in squares *(G)* or the size in squares *(S)*?
    - **B.** Would your answer to Question 11A be the same for a turtle of any age? Explain how you know.
    - **C.** Which gets larger more quickly, the new growth in squares *(G)* or the size in squares *(S)*? How can you tell?
    - **D.** In what ways are the graphs from Questions 2A and 2B similar?
    - **E.** In what ways are the graphs from Questions 2A and 2B different?

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8.* Ming is not correct. A 20 × 20 square will have 400 tiles, but a 10 × 10 square will have 100 tiles. 100 is not half of 400.

9.* They will have one fourth ($\frac{1}{4}$) of it done because 100 times 4 is 400.

10. A. He will need to add 39 red tiles. My formula says that $G = A \times 2 - 1$, and A is equal to the length of a side. So for a 20 × 20 square, A is equal to 20, and $20 \times 2 - 1 = 39$

B. There will be 400 tiles in the square because $20 \times 20 = 400$.

C. If a 19 × 19 square has 361 tiles, and a 20 × 20 square have 39 new tiles, then I can add 361 and 39 to find the total number of tiles in a 20 × 20 square: $361 + 39 = 400$ tiles.

11. A.* The new growth will be 9 squares because $5 \times 2 - 1 = 9$. The size will be 25 squares, because $5 \times 5 = 25$. So the size in squares will be larger.

B.* Yes, except for when the turtle is 1 year old, when G and S are the same. I saw this on my chart. $A \times A$ is always larger than $A \times 2 - 1$ when A is larger than 1.

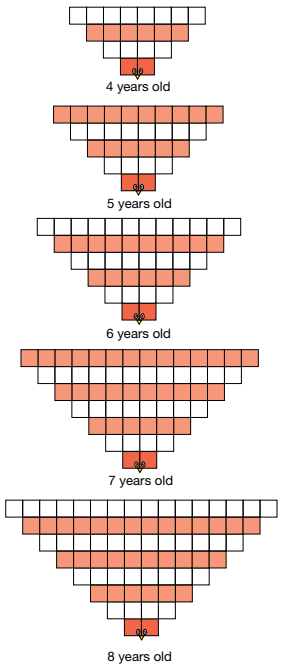
C.* The size in squares gets larger more quickly. New growth goes up by 2 squares but size goes up by a larger number of squares each time.

D. Both G and S get larger as A goes up.

E. The graph for Question 2A goes up in a straight line, but the graph for Question 2B has a curved line. The graph for Question 2B also gets much higher in the same amount of years.

*Answers and/or discussion are included in the lesson.

12. A.



B.

Even Number Eagle

A Age in Years	*G* New Growth in Squares	*S* Size in Squares
1	2	2
2	4	6
3	6	12
4	8	20
5	10	30
6	12	42
7	14	56
8	16	72

C. Answers will vary. Possible responses:

The numbers in the second column are the even numbers. They go up by 2 each year.

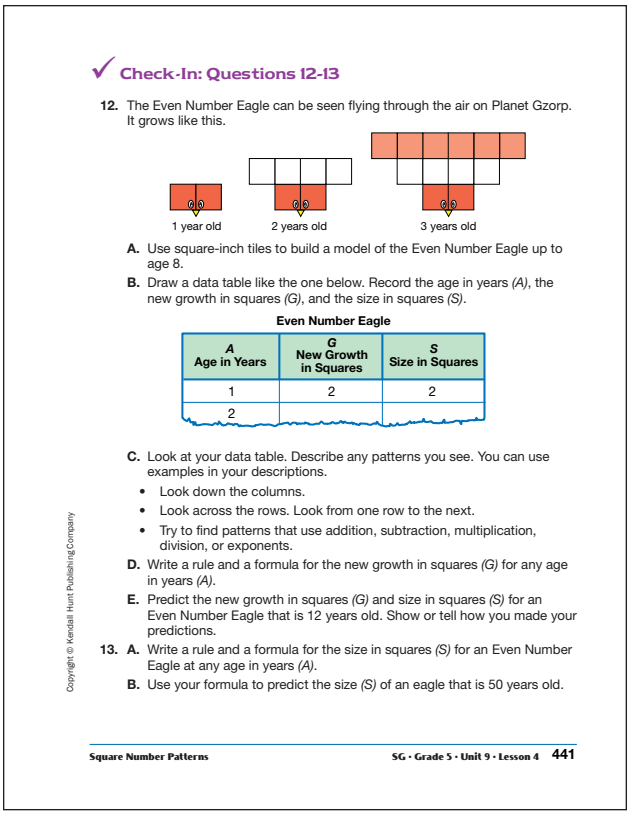
For every time the age goes up by 1, the new growth goes up by 2.

The size goes up by a higher amount each time. It goes up by 4 first, then 6, then 8, and it keeps adding 2 to the amount it goes up by.

Multiply age times 2 to get the new growth *(G)*.

To get the size in a row, add the growth in that row to the size in the row before that.

The size of an eagle equals the age of the eagle times the age of an eagle that is 1 year older. For example, the size for an eagle that is 7 years old equals 7 times 8 or 56 squares.



✓ Check-In: Questions 12-13

12. The Even Number Eagle can be seen flying through the air on Planet Gzorp. It grows like this.

A. Use square-inch tiles to build a model of the Even Number Eagle up to age 8.

B. Draw a data table like the one below. Record the age in years *(A)*, the new growth in squares *(G)*, and the size in squares *(S)*.

Even Number Eagle

A Age in Years	*G* New Growth in Squares	*S* Size in Squares
1	2	2
2		

C. Look at your data table. Describe any patterns you see. You can use examples in your descriptions.

- Look down the columns.
- Look across the rows. Look from one row to the next.
- Try to find patterns that use addition, subtraction, multiplication, division, or exponents.

D. Write a rule and a formula for the new growth in squares *(G)* for any age in years *(A)*.

E. Predict the new growth in squares *(G)* and size in squares *(S)* for an Even Number Eagle that is 12 years old. Show or tell how you made your predictions.

13. A. Write a rule and a formula for the size in squares *(S)* for an Even Number Eagle at any age in years *(A)*.

B. Use your formula to predict the size *(S)* of an eagle that is 50 years old.

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D. $G = A \times 2$

E. $G = 24$ squares and $S = 156$ squares. Strategies will vary. Possible explanations include extending the data table to $A = 12$. Students may use their rules. For example $G = 2 \times 12 = 24$ squares and the size of a 12-year old eagle will be 12×13 or 156 squares.

13. A. $S = A \times A + A$, or
$S = A^2 + A$, or
$S = A \times (A + 1)$

B. Possible response: $50 \times 51 = 2550$ squares