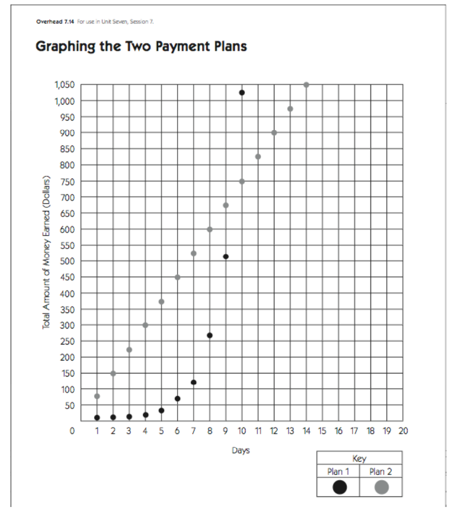
Grade 5, Unit Seven: Algebraic Thinking

In this unit your child will:

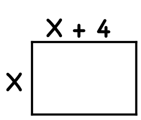
- apply the standard order of operations to complete a series of calculations
- find the missing value in an equation
- make generalizations and conclusions about patterns
- write equations with variables and make graphs to represent linear and non-linear functions
- use models and sketches to find the values of unknown numbers based upon the relationships between them



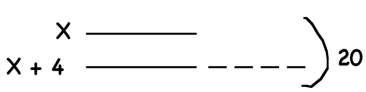
Your child will learn and practice these skills by solving problems like those shown below. Keep this sheet for reference when you're helping with homework.

<table>
<tr><th>Problem</th><th>Comments</th></tr>
<tr><td>Use the standard order of operations to solve this problem. Show all your work.

(9 x 3 – 2) ÷ 5 + 90 x 2
(27 – 2) ÷ 5 + 90 x 2
25 ÷ 5 + 90 x 2
5 + 180 = 185</td><td>The order of operations tells what sequence to follow when doing more than one calculation, as in the example at left.
1. First do anything inside parentheses, following the order below as needed.
2. Multiply or divide from left to right.
3. Add or subtract from left to right.</td></tr>
<tr><td>Mr. Jackson has a small rectangular yard. The perimeter of his yard is 40 meters. One side of the yard is 4 meters longer than the other. What are the dimensions of Mr. Jackson's yard?



If the perimeter is 40, then the two sides add up to 20 (half of the perimeter).



20 – 4 = 16
2x = 16
so x is 8.

The short side is 8 meters and the long side is 8 + 4 = 12 meters.
Double check: 8 + 12 + 8 + 12 = 20 + 20
= 40</td><td>Students draw pictures to show unknown values in story problems like this one. The pictures help them solve the problems using information provided about the relationships between the unknown values. Solving problems this way lays a strong foundation for using variables and substitution, as shown below, which students will do in later grades.

$x + 4 = y$
$2x + 2y = 40$

$2x + 2(x+4) = 40$
$2x + 2x + 8 = 40$
$4x + 8 = 40$
$4x = 32$
$x = 8$
$x + 4 = y$ and $x = 8$, so $8 + 4 = y$, which means $12 = y$.
The two sides are 8 meters and 12 meters.</td></tr>
</table>

Find the values of A, B, and C. Show all your work.

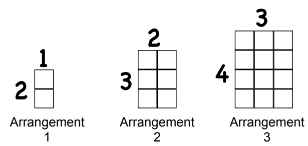
$$A - 30 = 70$$
$$A \div B = 25$$
$$(A + B) \div C = 13$$

A = 100 B = 4 C = 8

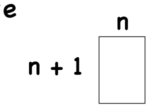
A – 30 = 70   100 – 30 = 70 so A = 100
100 ÷ B = 25   25 x 4 = 100 so B = 4
(A + B) ÷ C = 13   100 + 4 = 104
104 ÷ C = 13   so 13 x C = 104   C = 8

To find the missing values in each equation, students apply what they know about inverse operations (e.g., if 100 ÷ B = 25, then B x 25 = 100), their knowledge of basic facts, and their ability to calculate with larger numbers.

Write an expression to show how many tile would be in any arrangement of this sequence.



I labeled the arrangements above and made this sketch to show it's always the arrangement number times 1 more than the arrangement number. → n x (n + 1)

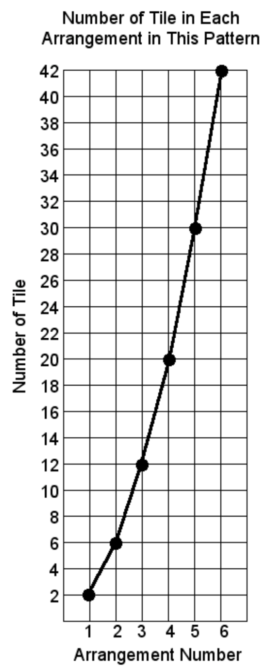


If you made a graph of the number of tile in each arrangement, would it be linear or non-linear? Explain how you know.

I made this table to show how the number of tile grows. The difference between the number of tile in each arrangement and the next one gets bigger and bigger every time, so it would be non-linear. If the difference were always the same, it would be linear.

Arrangement	**1**	**2**	**3**	**4**	**5**	**6**
Tile	**2**	**6**	**12**	**20**	**30**	**42**

When graphed, a linear equation or function produces a straight line. The student was correct that a constant difference between successive values would signify that the pattern is linear (the difference would be the slope in the case of this tile sequence). The number of tile in each arrangement increases by an ever greater amount, however, and when graphed produces a curve as shown here. You might recall that when the variable is raised to a power greater than 1, as it is here ($n \times (n + 1) = n^2 + n$), the function is non-linear.



Frequently Asked Questions about Unit Seven

Q: I remember doing problems like these in high school. Can fifth graders really understand and solve problems about linear and non-linear equations, as well as equations with two or more variables?

A: You may have recognized ideas and methods from high school algebra in the comments for the second and fourth problems above. It's true that these kinds of problems are often addressed in middle- and high-school algebra. The wonderful thing about visual models, including tile patterns and sketches, is that they provide elementary students with the tools to solve complex problems like these with understanding. When Bridges students graduate to middle- and high-school mathematics, they approach algebra with a much greater understanding fostered by these kinds of models and experiences.

