## “The Expanding Space Station”
### and Other Expanding Function Patterns

Unit 3: Linear Equations

### Grade Level
Grade 8

### Overview

In this task, students will write and explain linear equations.

**Part 1:** Using toothpick manipulatives, students will work in groups to determine the function for toothpick design patterns. Part 1 is designed to be a warm up activity. Student posters are set up with probing questions that scaffold their discovery of this particular function rule.

**Part 2:** Students create house designs with pattern block pieces (triangles and squares only). They use these designs to create a rule for the “growing house.” Then groups must design a graphic representation of their data. Examples of such a representation are circle graphs, pictographs, or bar graphs. This activity is scaffolded with teacher questions during different parts of the activity in order to guide the groups towards the correct answers.

**Part 3:** Now that students have an understanding of the linear functions in this activity, no manipulatives are needed for the “Expanding Space Station” portion of this task. Students draw pictures to represent the growing pattern, create a T-chart to organize their data, and create a rule for the function.

### Key Standards

**M8A1. Students will use algebra to represent, analyze, and solve problems.**
- Represent a given situation using algebraic expressions or equations in one variable.
- Simplify and evaluate algebraic expressions.
- Solve algebraic equations or inequalities in one variable, including those involving absolute values.
- Solve equations involving several variables for one variable in terms of the others.
- Interpret solutions in problem context.

### Possible Materials
- poster handout for each group
- markers
- pencils and paper
- pattern blocks (triangle and square pieces only)
- toothpicks
Task

**Expanding Space Station**  
*Adapted from Texas Instruments Activity Exchange*

NASA launched an orbiting space station. Soon NASA officials decided to add two auxiliary modules to provide room for additional experiments. These modules must be added in pairs to maintain the stability of the orbit for the overall station. If the pattern shown below is continued, how many total units (the base station plus the modules) would be needed for the eighth version? For the \(n\)th version?

Color the diagram above to help explain your rule.

Explain your rule, using both words and symbols.

**Sample Questions**

1. Can there be more than one way to correctly write a function rule?
2. In what ways can picture representations of functions help a mathematician develop a function rule?
3. Why is it important to organize the data from a growing pattern in a chart (T-chart, bar graph, pictograph)?
4. When trying to find the \(n\)th figure in a pattern, why must we first find the pattern for smaller numbers such as the first, second, and third toothpick, house, or space station designs? How do those smaller examples relate to the \(n\)th figure?

**Sample Question Solutions**

1. Yes, there is more than one way to write a function rule. Just as there is usually more than one way to solve a math problem, the multiplication in a function rule can often be broken down into addition rules and often the use of a variable can vary from solution to solution.
2. Picture representations visually represent the same thing as a math equation. However, these pictures often allow the eye to catch a pattern that does not look the same in a number pattern. For this reason, it may be helpful to draw pictures and use manipulatives when finding the \(n\)th rule of a linear function.
3. This is similar to the answer in question two. Organizing data in a chart of some kind shows the common differences in the pattern more clearly.
4. When finding the $n$th rule for a function, using smaller numbers in the first, second, and third part of the pattern will be identical to the 100th, 200th, and $n$th version of the pattern. Using smaller numbers in the pattern will help you identify the rule more quickly.

Assessment Ideas

- final written poster project
- oral responses
- white board explanations and chart drawings