EXPLORATIONS

Activity 3

# Expanding Space Station

## Teacher Notes

### Concept

- Patterns and Functions

### Skill

- Evaluating expressions

### Applicable Calculator Functions

- [▸OP1], [OP1], [▸OP2], [OP2]

### Materials

- Student Activity Sheets (page 22)
- TI-30X IIS/TI-34 II calculator
- Plastic Disks
- Blank Transparencies/Chart Paper

### Objective

- Students will find and compare function rules for a given pattern

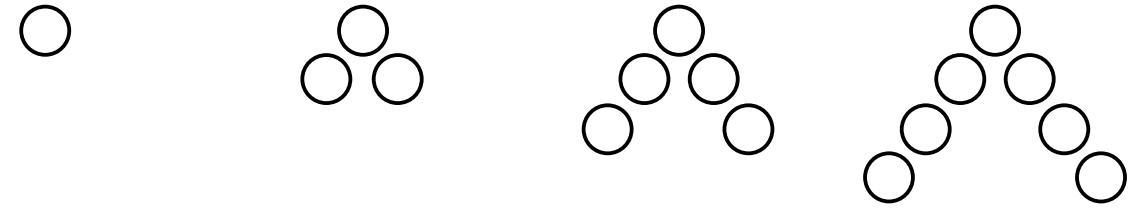
*Prerequisites*

Prior to this activity, students should have had some experience finding the function rule for patterns and evaluating variable expressions. They should be familiar with the [OP1] and [OP2] keys on the calculator.

*Problem*

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?

Stage 1 Stage 2 Stage 3 Stage 4



## *Activity*

Have students work in pairs using plastic disks (if needed) to build the various stages and record their answers on the Student Activity page. When they write their function rule, it is important that they record their rule in words that reflect the way the students interpreted the pattern. Thus, students may offer the following interpretations, among others:

| Statement of Rule | Rule Applied to Stage 4 | Rule for *n*th Stage |
|---|---|---|
| 2(length of one side) - 1(disk that overlaps) | 2(4)−1 | 2n−1 |
| number of disks on left side in the figure + one less than the number of disks on left side | 4 + 3 | n +(n−1) |
| 2(number of disks on one side without center) + 1(center) | 2(3)+1 | 2(n−1)+1 |
| (number of disks on one side)$^2$ - (one less than the number of disks in one side)$^2$ | $4^2-3^2$ | n2−(n−1)$^2$ |
| (length of one side) [1 + (one less than the length of a side ÷ length of one side)] | 4 (1 ¾) | $n(1 \frac{n-1}{n})$ |

This notation makes it easier for students to generate a rule for the pattern, using *n* as the figure number. Circulate to be sure students understand the task, to check the table of function values, and to answer any questions.

Next, each pair of students should enter their rule in the calculator and verify it by comparing results the calculator indicates with those in their table.

Comparing the different versions of the function rule and their outputs is the heart of this activity. You may want students to make transparencies which show their rule and keystrokes or have them write their rules on the board and explain their thinking to the entire class. In either case, class discussion should show that there are several correct ways to write the function rule, all of which produce the same values for each stage. This realization is an important step towards developing algebraic thinking.

According to the skill level of the students, you may want to show how to simplify the various versions of the function rule to demonstrate symbolically that they are all the same.

### *Wrap-Up*

Have students share their paragraphs about what they found and learned. Be sure these questions are answered:

- *Can there be more than one way to correctly write a function rule?*
- *Are all the function rules mathematically equivalent?*

### *Assessment*

Use a related problem to have students repeat this process.

*Example:*

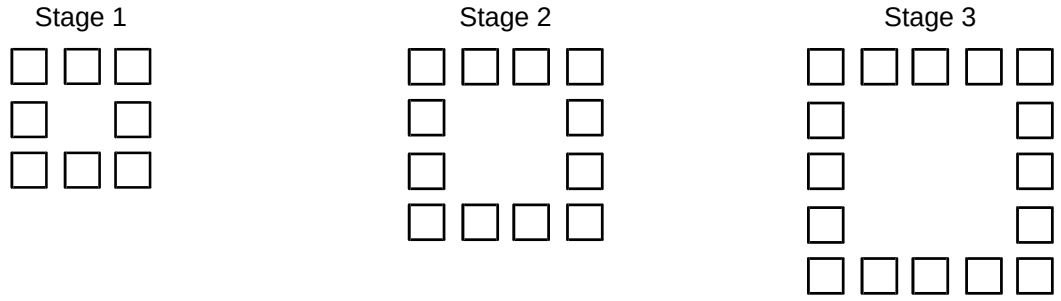
If NASA added four auxiliary modules at the time, find the rule for how many total units would be needed for the nth stage. (4n – 3)

### *Extensions*

- Use a similar problem to have students repeat this process.

  *Example:*

  If the pattern shown below is continued, how many total tiles would be needed for the tenth figure? For the hundredth figure? For the nth figure?




- Have students make up their own problem situations similar to this one and present them to classmates. Remind them that it will be more interesting if there is more than one reasonable way to write the function rule for their problem situation.

Student Activity

Name _____

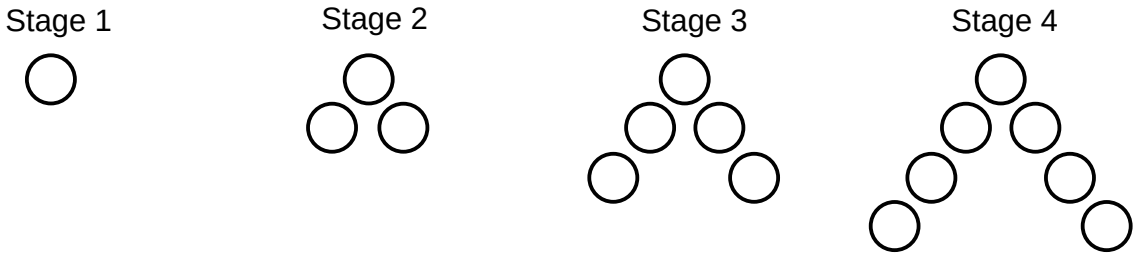
Date _____

Activity 3

# Expanding Space Station

***Objective:*** *You will find and compare function rules for a given pattern*

***Problem:*** *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 nth version?*




**1.** Complete the table below to help you find the function rule for this pattern.

| Stage Number | Total Number of Units Needed |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 8 | |
| n | |

**2.** List and explain your rule below, using symbols and words.

**3.** Work with a partner to enter your rule in the calculator. Write the sequence of keystrokes below. Be sure the calculator gives the same results you listed in your table.

**4.** Compare your rule with those of your classmates to see whether they are equivalent. Then write two paragraphs below.

**a.** What we found:

**b.** What I Learned:

# Expanding Space Station Keystrokes for the TI-34 II

To enter 2n – 1 in the calculator:

| PRESS | DISPLAY |
|---|---|
| [2nd] [▸OP1] | OP1 =<br>(Press [CLEAR] if needed) |
| [×] 2 [ENTER] | OP1 = X2 |
| [2nd] [▸OP2] | OP2 =<br>(Press [CLEAR] if needed) |
| [–] 1 [ENTER] | OP2 = – 1 |

***Example:*** *To evaluate 2n – 1 if n = 3.*

| | |
|---|---|
| 3 [OP1] | 3 X 2<br>1 6 |
| [OP2] | 6 – 1<br>1 5 |

To enter n + (n – 1) in the calculator:

| | |
|---|---|
| [2nd] [▸OP1] | OP1 =<br>(Press [CLEAR] if needed) |
| [–] 1 [ENTER] | OP1 = –1 |

***Example:*** *To evaluate n + (n + 1) if n = 3*

| | |
|---|---|
| 3 [+] 3 [OP1] | 3 + (3 – 1)<br>1 5 |

# Expanding Space Station Keystrokes for the TI-30X IIS

To enter 2n – 1 in the calculator:

| PRESS | DISPLAY |
|---|---|
| 2nd [K] | K =<br>(Press CLEAR if needed) |
| × 2 – 1 ENTER | K = ∗ 2 – 1<br>DEG K |

***Example:*** *To evaluate 2n – 1 if n = 3.*

| | |
|---|---|
| 1 ENTER | 1 ∗ 2 – 1<br>1<br>DEG K |

To enter n + (n + 1) in the calculator:

| | |
|---|---|
| 2nd [K] | K =<br>(Press CLEAR if needed) |
| + 1 ENTER | K = +1<br>DEG K |

***Example:*** *To evaluate n + (n + 1) if n = 3*

| | |
|---|---|
| 3 + 3 ENTER | 3 + 3 + 1<br>7<br>DEG K |

Note: You must clear the constant [K] key when you are finished.