LESSON 2

# Functions

# Linear Functions

## Objective

Graph functions based on input/output coordinate pairs and determine if the function is linear or not.

## Common Core State Standards

- **8.F.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two ($x$, $y$) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

As the mathematics experiences at the middle school level become increasingly algebraic, students begin working with the concept of linearity as part of their study of patterns and relationships. Students' ability to determine whether a function is linear or not paves the way for an understanding of more complex concepts, such as rate of change, slope, and $y$-intercept, that will ensue.

**Try It!** *Perform the Try It! activity on the next page.*

## Talk About It

Discuss the Try It! activity.

- **Ask:** *What did you plot along the x-axis? What did you plot along the y-axis? What does each peg represent? Why do we start with (0, 3)?*
- **Ask:** *How do you have to "move" in order to get from one peg to the next? (What is the pattern?)*
- **Ask:** *How long will it take Sam to save $5? $9?* **Say:** *Continue the graph to find out how much he will save over time.*
- **Ask:** *What does the word* linear *mean? Why do you think this function is called a linear function?*
- **Ask:** *How would the graph be different if Sam did not have any money when he started saving?*

## Solve It

Reread the problem with students. Ask them to write the definition of a linear function and sketch an example.

## More Ideas

For other ways to teach about linear equations—

- Have students create an input/output table of values for the expression $2x + 5$. Have them plot the coordinate values on a pegboard and compare the resulting graph to the expression $2x + 3$. Encourage students to talk about how the constant affects the values in each expression.
- Have students create an input/output table of values for the expression $x + 3$. Have students plot the coordinate values on a pegboard, including some negative values. Have students talk about real-life situations in which negative values could apply and situations in which they could not.

## Formative Assessment

Have students try the following problem.

*Which of the following functions is not linear?*

**A.**

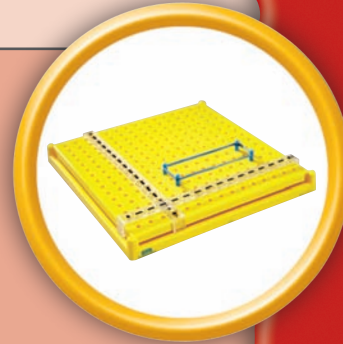
| $x$ | $y$ |
|---|---|
| 0 | 2 |
| 1 | 1 |
| 2 | 0 |

**B.**

| $x$ | $y$ |
|---|---|
| -2 | 2 |
| -1 | 5 |
| 0 | 8 |

**C.** $y = 3 + x^2$

**D.** $y = 4x + 1$



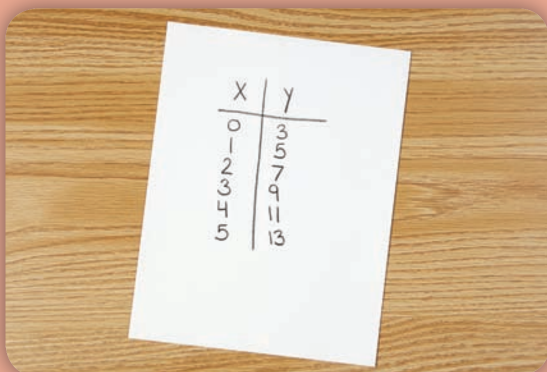
## Try It! 30 minutes | Groups of 4

Here is a problem about linear functions.

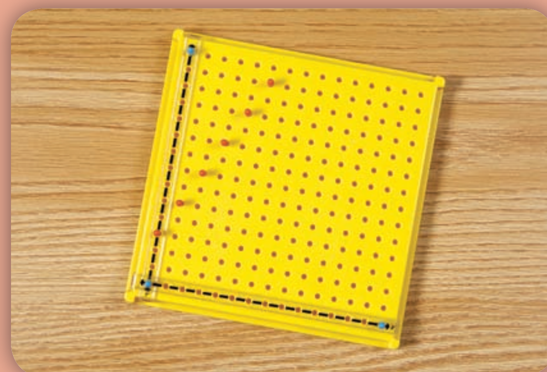
*Sam is saving his money to buy a DVD of one of his favorite movies. He already has $3 saved. If he saves $2 each week, at the end of what week will he have saved enough money to buy the DVD for $11.99?*

Introduce the problem. Then have students do the activity to solve the problem. Distribute the materials.

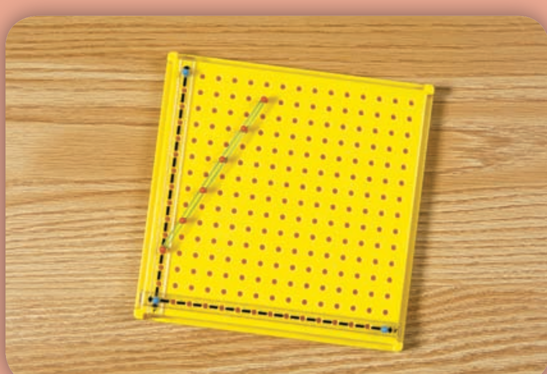
### Materials
- XY Coordinate Pegboard
- paper (1 sheet per group)
- pencils (1 per group)




**1.** Have students create an input/output table, beginning with the coordinate pair (0, 3). Have students discover that as each *x*-coordinate increases by 1, the *y*-coordinate should increase by 2, representing the $2 increase for each week.



**2.** Have students set up their pegboards for Quadrant I graphing. Have them peg (0, 3) to represent the $3 Sam already has saved. Have students use the pattern of "up two, right one" to match the coordinate pairs in their input/output table.



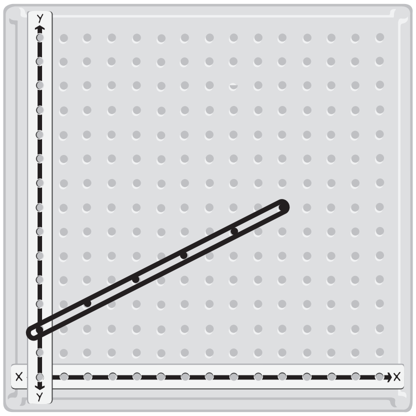
**3.** Continue to plot the coordinates until the students are able to answer the question: At the end of which week will Sam have enough money to buy the DVD for $11.99?

### Look Out!

Some students may need help understanding what the new coordinate pairs mean with respect to the original problem. They may get caught up in the graphing and forget that each *x*-coordinate represents the number of weeks Sam saves his money toward the DVD purchase, and that each *y*-coordinate represents the total amount of money he has saved to date.

**Use an XY Coordinate Pegboard to model the graph of the function. Make a table of the ordered pairs. Is the function linear? Write yes or no.**

**1.**



(Check students' work.)

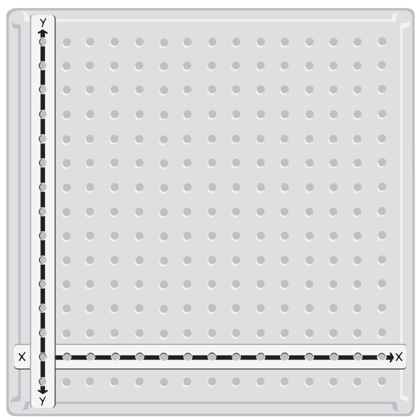
| *x* | *y* |
|---|---|
| 0 | 2 |
| 2 | 3 |
| 4 | 4 |
| 6 | 5 |
| 8 | 6 |
| 10 | 7 |

yes

**Using an XY Coordinate Pegboard, graph the function. Sketch the graph of the function. Is the function linear? Write yes or no.** (Check students' models.)

**2.**

| *x* | *y* |
|---|---|
| 0 | 4 |
| 1 | 5 |
| 2 | 7 |
| 3 | 9 |
| 2 | 1 |
| 4 | 5 |



no

**Determine if each function is linear. Write yes or no.**

**3.**

| *x* | *y* |
|---|---|
| 1 | 2 |
| 3 | 4 |
| 5 | 6 |
| 7 | 8 |
| 9 | 11 |
| 11 | 13 |

no

**4.**

| *x* | *y* |
|---|---|
| 4 | 1 |
| 1 | 4 |
| 5 | 2 |
| 2 | 5 |
| 6 | 3 |
| 3 | 6 |

no

**5.**

| *x* | *y* |
|---|---|
| 0 | 3 |
| 1 | 3 |
| 2 | 3 |
| 3 | 3 |
| 2 | 3 |
| 4 | 3 |

yes

## *Answer Key*

**Challenge!** How can you determine without graphing a set of ordered pairs if the set of ordered pairs models a linear function? Show an example.

Challenge: (Sample) Choose two ordered pairs from the table. Find the difference in the *x*-values. Find the difference in the *y*-values. Write a ratio of the difference in the *y*-values to the difference in *x*-values. Repeat this process for all combinations of ordered pairs. If all ratios are equal, the ordered pairs model a function.

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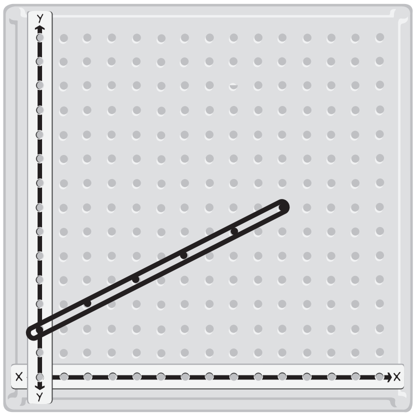
**Use an XY Coordinate Pegboard to model the graph of the function. Make a table of the ordered pairs. Is the function linear? Write yes or no.**

**1.**



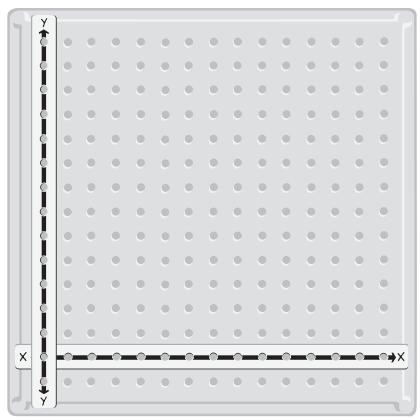

| *x* | *y* |
|---|---|
| 0 | 2 |
| | |
| | |
| | |
| | |
| | |

__________

**Using an XY Coordinate Pegboard, graph the function. Sketch the graph of the function. Is the function linear? Write yes or no.**

**2.**

| *x* | *y* |
|---|---|
| 0 | 4 |
| 1 | 5 |
| 2 | 7 |
| 3 | 9 |
| 2 | 1 |
| 4 | 5 |

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**Determine if each function is linear. Write yes or no.**

**3.**

| *x* | *y* |
|---|---|
| 1 | 2 |
| 3 | 4 |
| 5 | 6 |
| 7 | 8 |
| 9 | 11 |
| 11 | 13 |

__________

**4.**

| *x* | *y* |
|---|---|
| 4 | 1 |
| 1 | 4 |
| 5 | 2 |
| 2 | 5 |
| 6 | 3 |
| 3 | 6 |

__________

**5.**

| *x* | *y* |
|---|---|
| 0 | 3 |
| 1 | 3 |
| 2 | 3 |
| 3 | 3 |
| 2 | 3 |
| 4 | 3 |

__________

Name ___________________________________

**Challenge!** How can you determine without graphing a set of ordered pairs if the set of ordered pairs models a linear function? Show an example.