

Lesson Plan

Mine Shaft Grade 8 Slope

CCSSM: Grade 8

DOMAIN: Expressions and Equations

Cluster: Understand the connections between proportional relationships, lines, and linear equations.

Standard: 8.EE.5: Graph proportional relationships, interpreting the **unit rate** as the **slope** of the graph. Compare two different proportional relationships represented in different ways.

CCSSM: Grade 8

DOMAIN: Functions

Cluster: Define, evaluate, and compare functions.

Standard: 8.F.1: Understand that a **function** is a rule that assigns to each input exactly one output. The **graph of a function** is the set of ordered pairs consisting of an input and the corresponding output.

Standard: 8.F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

Standard: 8.F.3: Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.

Standard: 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.

Clarification: The clarification is an explanation of the indicator and objective and how these math concepts appear in the puzzle.

Materials and /or Set Up: *Mine Shaft Part 1; Mine Shaft Part 2, Mine Shaft Graphs and Answers, More Graphs and Answers, A Final Look at Graphs and Answers, Interactive Resource 1, Mine Shaft Paths, Interactive Resource 2, Exploring the Triangle Path and Answers, Assessment*

Relevant Vocabulary: polygon, triangle, square, pentagon, hexagon, septagon, octagon, rule, table of values, graph, linear equation, rate of change, slope, y -intercept, segment, parallel

Note to Teacher – Students should have attempted all three levels of the Mine Shaft puzzle before this lesson is implemented.

It is recommended that the *Interactive Resources* be projected to encourage a rich and active discussion of math strategies and concepts.

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Activities:

1. Distribute *Mine Shaft Part 1* and ask students to complete the table of values for each of the bots.
2. Using *Mine Shaft Part 2*, facilitate a discussion about the differences between the consecutive step numbers and the differences between the consecutive position numbers and how they are related to the bot (*polygon*). Define the constant difference between the position numbers moving from step to step as the **rate of change** for the path of the bot. Ask students how the rate of change is related to the bot.
3. Using *Mine Shaft Graph*, complete the first graph for the square bot together. Have students complete the remaining graphs. (*Note that not all points will fit on the graphs for the octagon and septagon.*) Ask students to describe the pattern of the points on each graph. (*The points lie on a line.*) Ask how the patterns are different. (*The “slopes” of the lines differ; some are steeper than others. Note that students may not use the word slope.*)
4. Display the first graph on *Mine Shaft Graph-Answers* and use it to illustrate the relationship between the positions of the points and the rate of change by counting up 4 units and to the right 1 unit from point to point. Call attention to the relationship between the rate of change and the moves on the graph. The rising movements correspond to the values on the vertical axis (the y -axis) while the movements to the right correspond to the values on the horizontal axis (the x -axis.) These movements match the rate of change from the table of values. The position numbers (the y -values) increased by 4 as the step numbers (the x -values) increased by 1. Explain that the rate of change is always apparent in the graph.
5. Use the remaining graphs to have students illustrate how the movement from point to point on the graph corresponds to the rate of change they identified from the table of values. Facilitate a discussion leading to the conclusion that the constant **rate of change** causes the pattern of points to lie on a line since the movement is always up a certain constant number of units and to the right one unit. If the differences had not been constant the points would not lie on a line. (*Mention that the constant rate of change is called the **slope** of the line.*)
6. Ask the students to return to the tables of values on *Mine Shaft Part 1* and write the equation for each one using x to represent the step number and y to represent the position number. (*square: $y = 4x$; pentagon: $y = 5x$; octagon: $y = 8x$; septagon: $y = 7x$; triangle: $y = 3x$*) Facilitate a discussion to assist students in relating the rate of change to the coefficient of x in the equations. Explain that equations of this type are called linear equations because their solutions result in a graph in which the points lie on a line. Write the equation for each under its graph. Call attention once again to the pattern of the points and its relationship to the coefficient of x in the equations.
7. Distribute *More Graphs* and have students work with a partner to determine the rate of change for the points on each graph. After checking their answers, ask them to write the equation that corresponds to each set of points.
8. Use the last graph to facilitate a discussion about why the equation $y = 3x$ is not correct and how they determined the correct equation. Point out that an equation may have a constant added at the end. In general, the form of the equation is $y = mx + b$. Note that the constant added at the end of the equation corresponds to the y -value when x is 0. Define this point as the y -intercept of the graph; it is the point at which the line crosses the y -axis.
9. Distribute *A Final Look at Graphs* and have students work with a partner to determine the equation for each set of points.

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10. Display ***Interactive Resource 1***. Have the students share several possible paths for a bot. Ask the students to justify their selections. Distribute ***Mine Shaft Paths*** and provide the students time to work with a partner to determine the correct paths. (*Although some of the polygons may be able to use more than one path, there is only one correct solution for all five polygons to reach the end of all five rows. Be aware that the students may need assistance to determine the path for the triangle.*)
11. Display ***Interactive Resource 1-Answers*** to discuss the path solutions for each **polygon**.
12. Using ***Exploring the Triangle Path***, ask the students to make a table of values for the triangle bot. Discuss how this table is different from previous ones. Have the students graph the values from the table. Facilitate a discussion about why the graph is not linear.
13. Demonstrate how to consider each part of the graph as a separate segment. Determine the rate of change for each segment. Draw attention to the relationship between the first and third segments on the graph. Ask students to describe how the lines containing these segments are related. (*They are parallel.*) Lead the students to conclude that the segments are parallel because they have the same slope.

Differentiation Suggestions:

- For students who are having difficulty identifying the rate of change, have them create and graph the tables of values for the other four bots from ***Interactive Resource 1***, identify the rate of change for each, and write the equation.
- For students who have mastered these concepts, challenge them to find the equations that describe each of the three segments on the graph for the triangle bot from ***Exploring the Triangle Path***.

Assessment

- Distribute the ***Assessment*** resource sheet.
Answers:
 1. 4
 2. 2
 3. $y = 2x + 5$

Follow Up:

- Have students return to the puzzle to apply what they learned in the lesson. Ask: Did the lesson help you to clarify the math in the puzzle? How? What other strategies could you have used to help you solve the puzzle? Additionally, check student game progress through the Administrator's Tool to determine students' level of understanding.
- Provide the students with this scenario:

The meter lady is giving parking tickets outside of a concert. She's writing a ticket for every 4th car. She has 50 tickets in her book.

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1. If you have a choice between parking space # 101 and #56 which would you choose? Would it make a difference to your pocket book? (*You should choose 101 because it does not get a ticket, but 56 does. Since every 4th car receives a ticket, the equation is $y = 4x$. When $x = 14$, the parking space is $4(14)$ which is 56. There is no whole number that results in $4x$ having a value of 101.*)
2. What is the last parking space to receive a ticket prior to her running out of tickets? (*Since $4(50) = 200$, the last space to receive a ticket is 200.*)

Real World Connection:

- Provide the students with this scenario:

To become a member of Fit Gym, there is an initial fee of \$75.00. Each month members have to pay \$15.00.

Create a table of values to show the cost of joining Fit Gym each month for 6 months. Let x represent the number of months and y represent the total cost. (*Answers in table below.*)

| | | | | | | |
|-----|----|-----|-----|-----|-----|-----|
| x | 1 | 2 | 3 | 4 | 5 | 6 |
| y | 90 | 105 | 120 | 135 | 150 | 165 |

What is the rate of change for the table of values? (*15*)

Challenge: write an equation to represent the total cost of membership based on the number of months a person belongs to Fit Gym. ($y = 15x + 75$)

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Mine Shaft Part 1



| | | | | | | |
|----------|---|---|---|---|---|---|
| Step | 0 | 1 | 2 | 3 | 4 | 5 |
| Position | | | | | | |



| | | | | | | |
|----------|---|---|---|---|---|---|
| Step | 0 | 1 | 2 | 3 | 4 | 5 |
| Position | | | | | | |



| | | | | | | |
|----------|---|---|---|---|---|---|
| Step | 0 | 1 | 2 | 3 | 4 | 5 |
| Position | | | | | | |



| | | | | | | |
|----------|---|---|---|---|---|---|
| Step | 0 | 1 | 2 | 3 | 4 | 5 |
| Position | | | | | | |



| | | | | | | |
|----------|---|---|---|---|---|---|
| Step | 0 | 1 | 2 | 3 | 4 | 5 |
| Position | | | | | | |

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Mine Shaft Part 2



| | | | | | | | |
|----------|---|---|---|----|----|----|--|
| | | | | | | | |
| Step | 0 | 1 | 2 | 3 | 4 | 5 | |
| Position | 0 | 4 | 8 | 12 | 16 | 20 | |

Increases by ___
each time



Increases by ___
each time



| | | | | | | | |
|----------|---|---|----|----|----|----|--|
| | | | | | | | |
| Step | 0 | 1 | 2 | 3 | 4 | 5 | |
| Position | 0 | 5 | 10 | 15 | 20 | 25 | |

Increases by ___
each time



Increases by ___
each time



| | | | | | | | |
|----------|---|---|----|----|----|----|--|
| | | | | | | | |
| Step | 0 | 1 | 2 | 3 | 4 | 5 | |
| Position | 0 | 8 | 16 | 24 | 32 | 40 | |

Increases by ___
each time



Increases by ___
each time



| | | | | | | | |
|----------|---|---|----|----|----|----|--|
| | | | | | | | |
| Step | 0 | 1 | 2 | 3 | 4 | 5 | |
| Position | 0 | 7 | 14 | 21 | 28 | 35 | |

Increases by ___
each time



Increases by ___
each time



| | | | | | | | |
|----------|---|---|---|---|----|----|--|
| | | | | | | | |
| Step | 0 | 1 | 2 | 3 | 4 | 5 | |
| Position | 0 | 3 | 6 | 9 | 12 | 15 | |

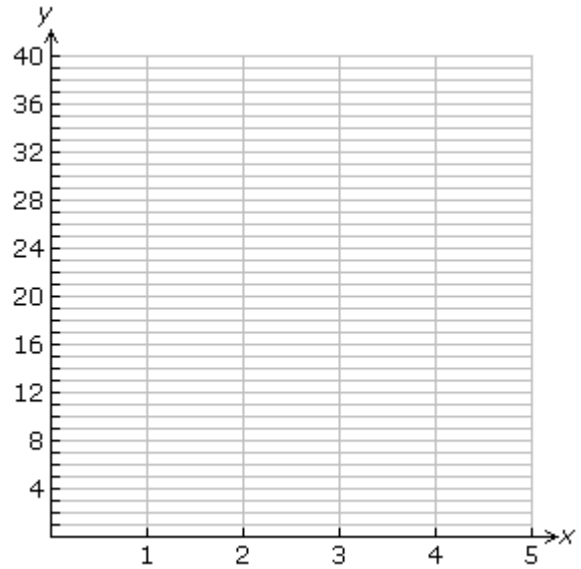
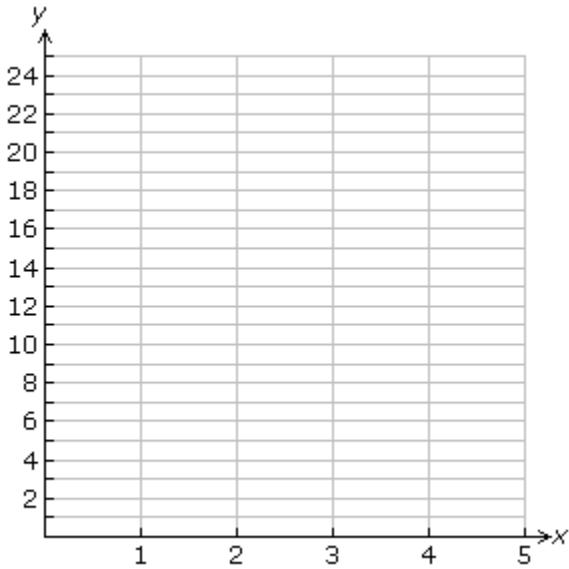
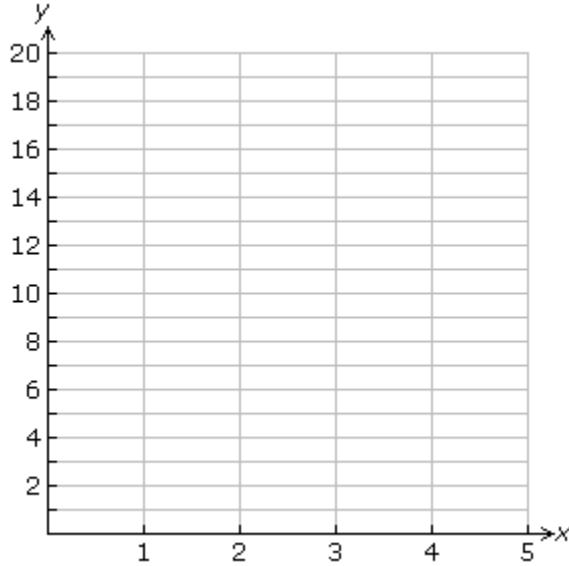
Increases by ___
each time



Increases by ___
each time

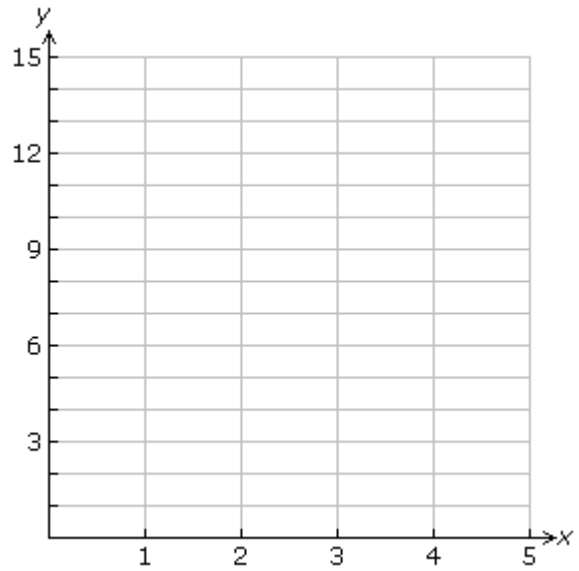
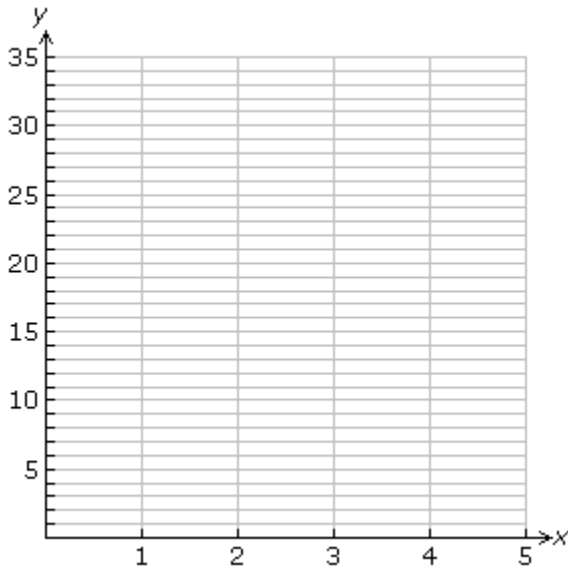
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Mine Shaft Graphs



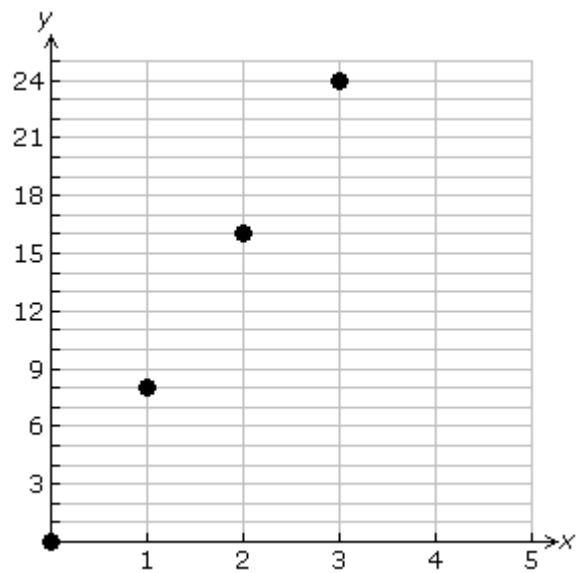
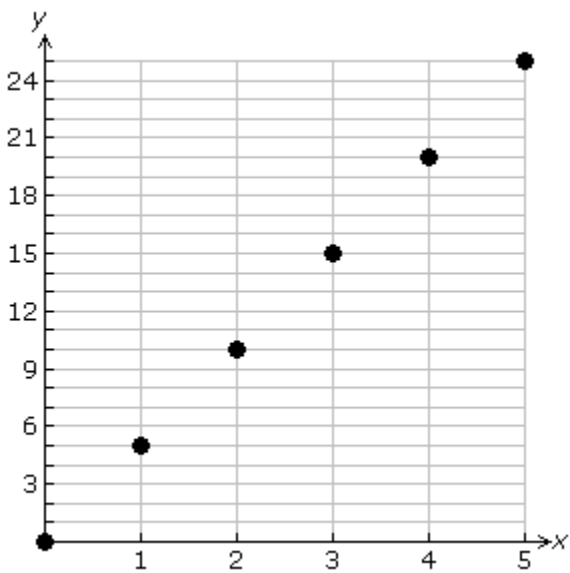
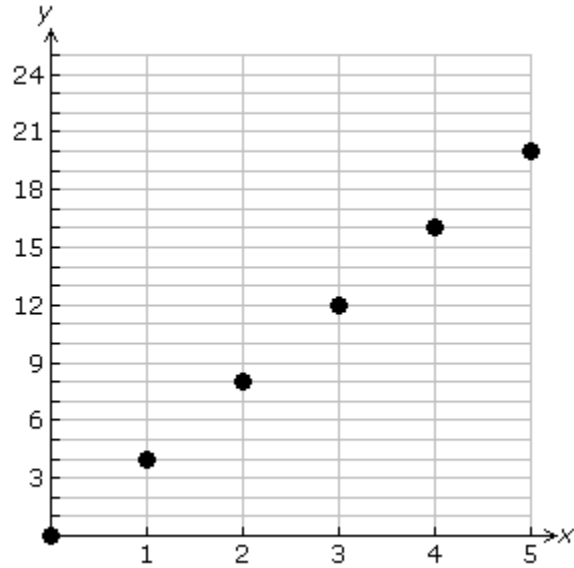
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Mine Shaft Graphs



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Mine Shaft Grade 8 Slope

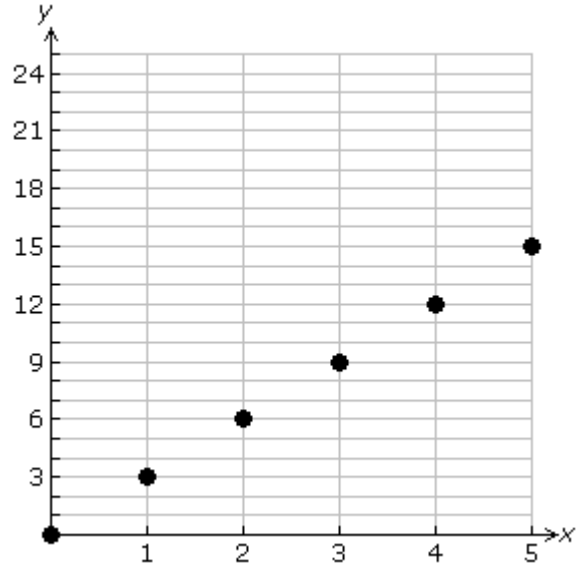
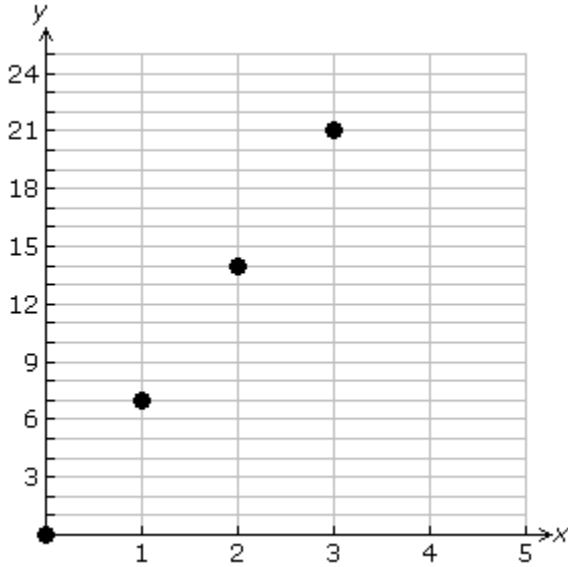
Mine Shaft Graphs *Answers*



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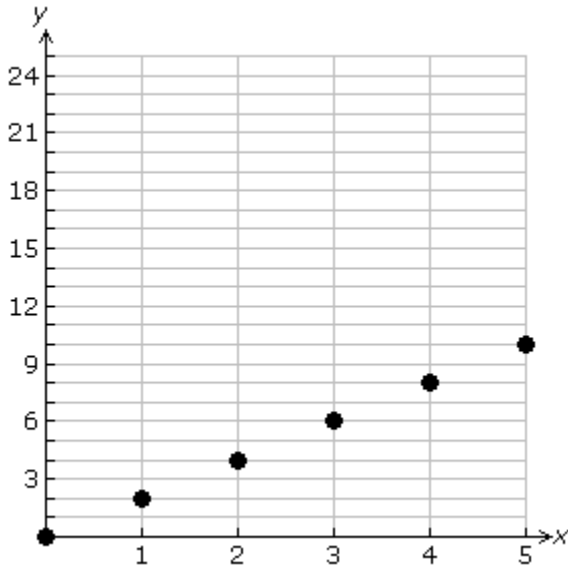
Mine Shaft Graphs *Answers*



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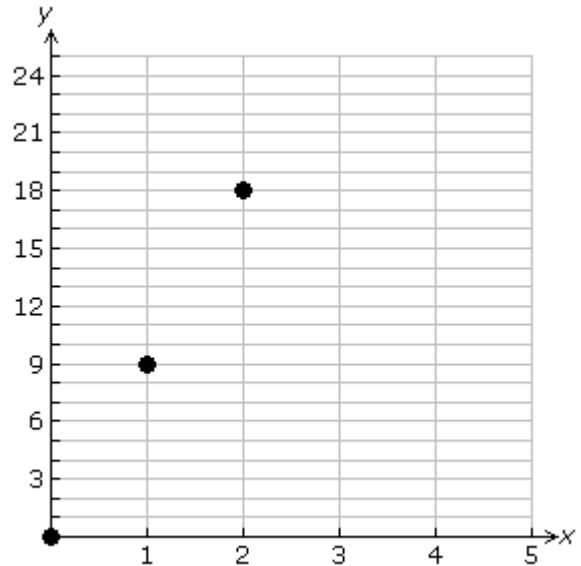
More Graphs



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

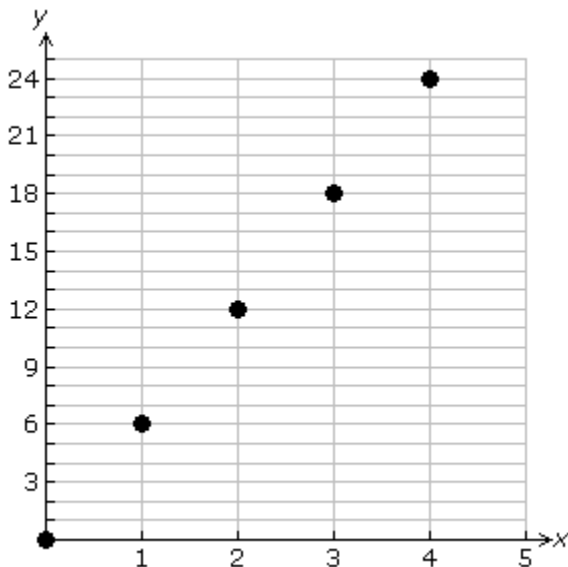
Equation:



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

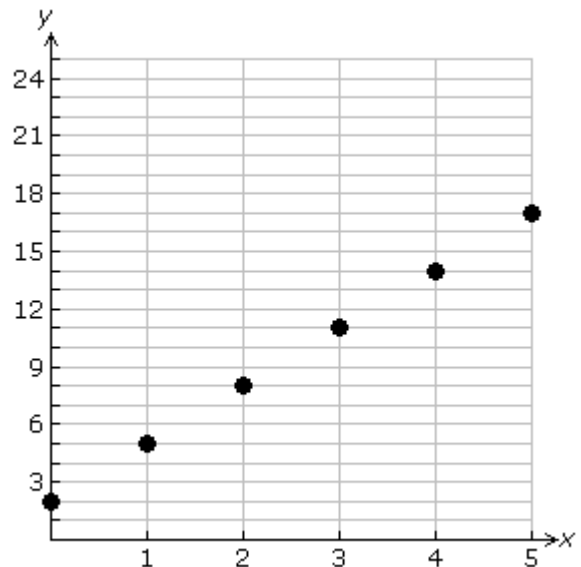
Equation:



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

Equation:



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

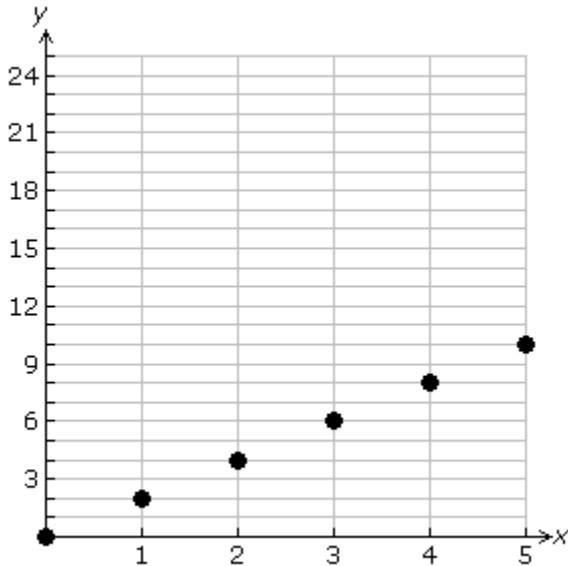
Rate of change =

Equation:

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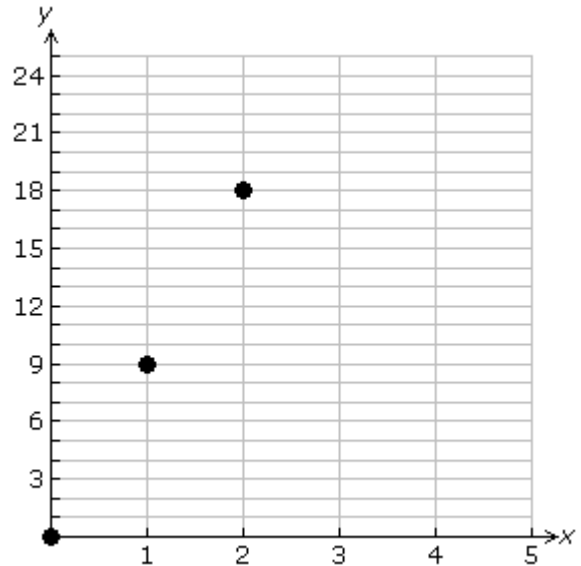
More Graphs *Answers*



| x | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|----|
| y | 0 | 2 | 4 | 6 | 8 | 10 |

Rate of change = 2

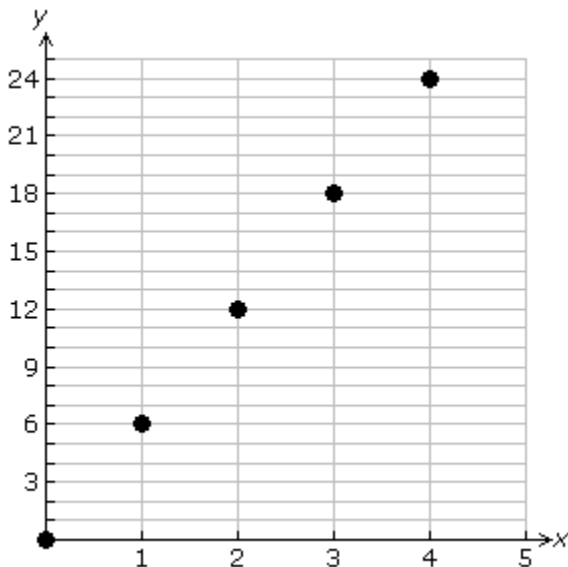
Equation: $y = 2x$



| x | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|----|----|----|----|
| y | 0 | 9 | 18 | 27 | 36 | 45 |

Rate of change = 9

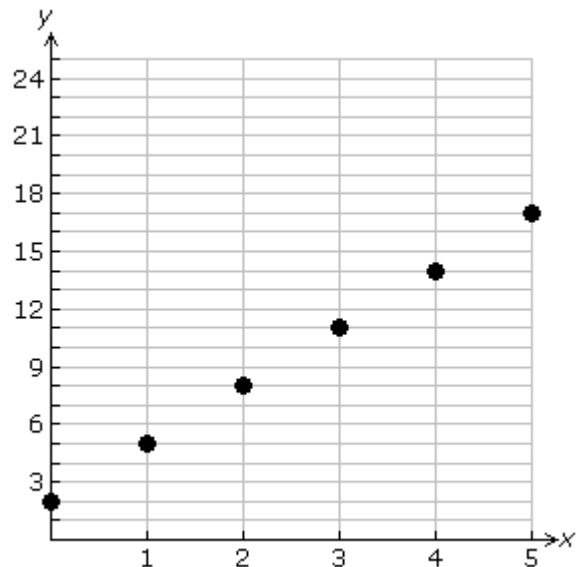
Equation: $y = 9x$



| x | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|----|----|----|----|
| y | 0 | 6 | 12 | 18 | 24 | 30 |

Rate of change = 6

Equation: $y = 6x$



| x | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|----|----|----|
| y | 2 | 5 | 8 | 11 | 14 | 17 |

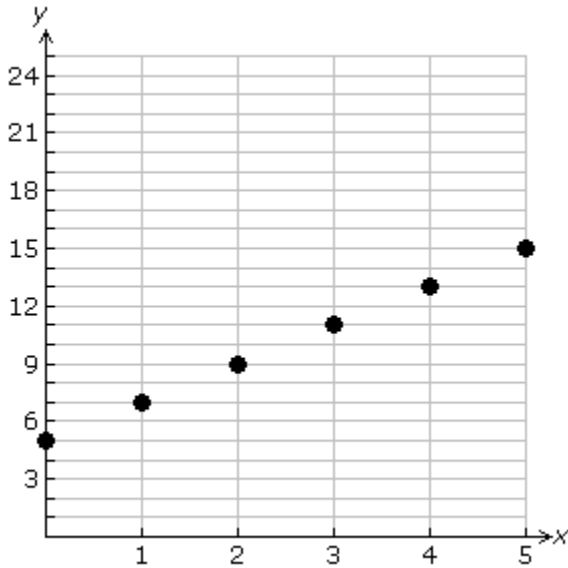
Rate of change = 3

Equation: $y = 3x + 2$

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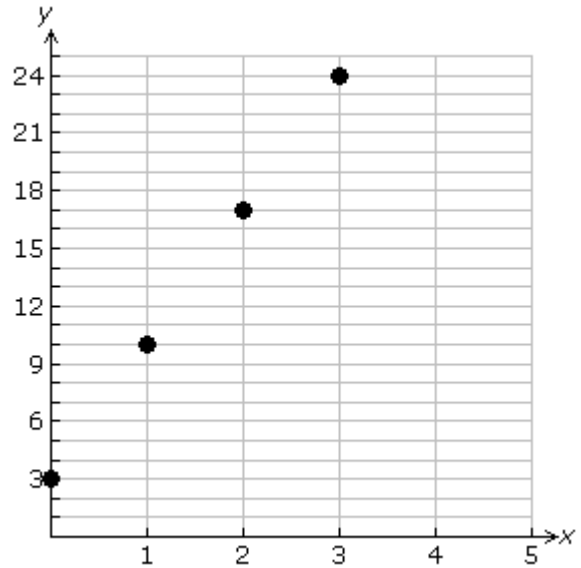
A Final Look at Graphs



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

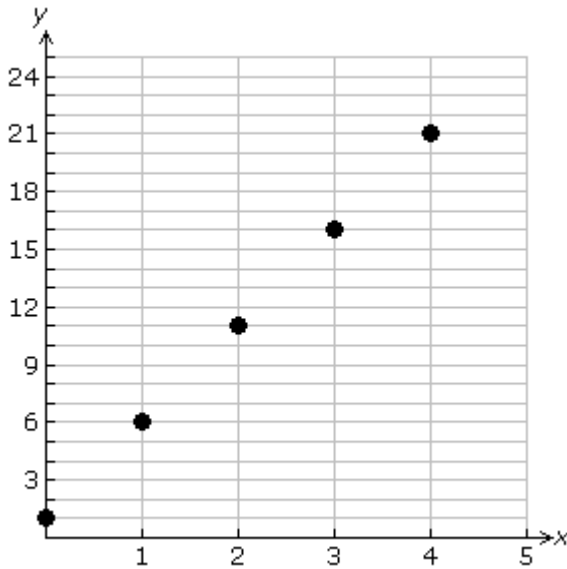
Equation:



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

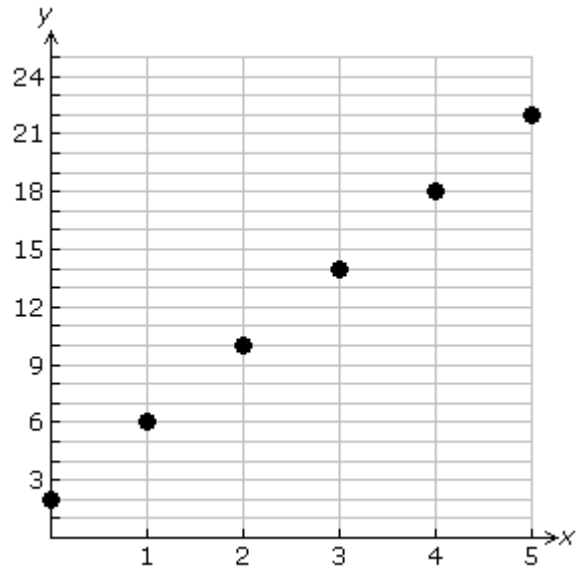
Equation:



| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

Equation:



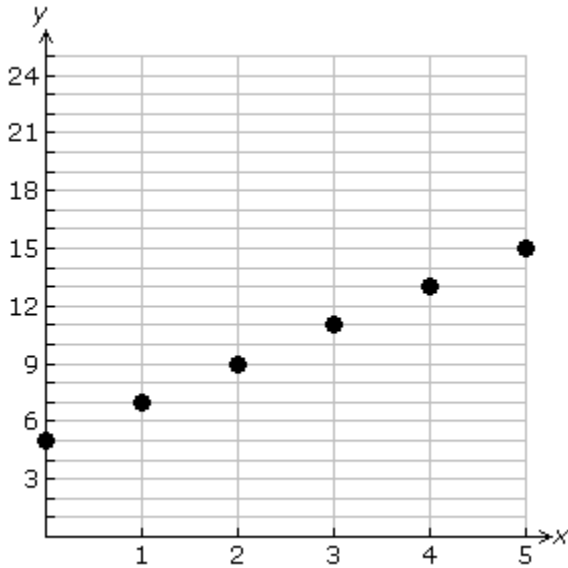
| | | | | | | |
|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | | | | | | |

Rate of change =

Equation:

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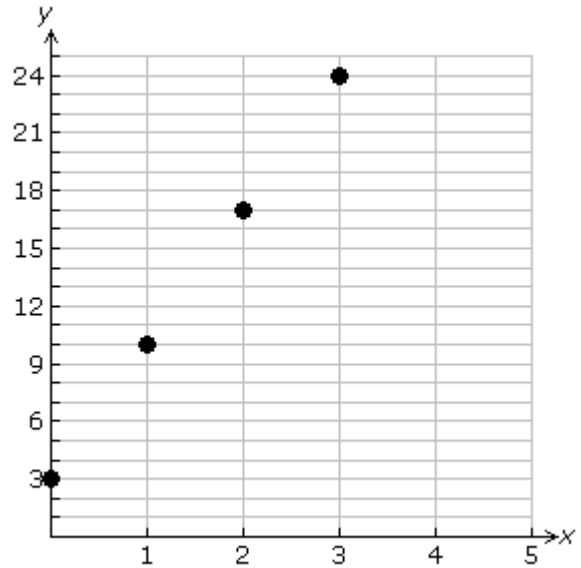
A Final Look at Graphs *Answers*



| | | | | | | |
|---|---|---|---|----|----|----|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | 5 | 7 | 9 | 11 | 13 | 15 |

Rate of change = 2

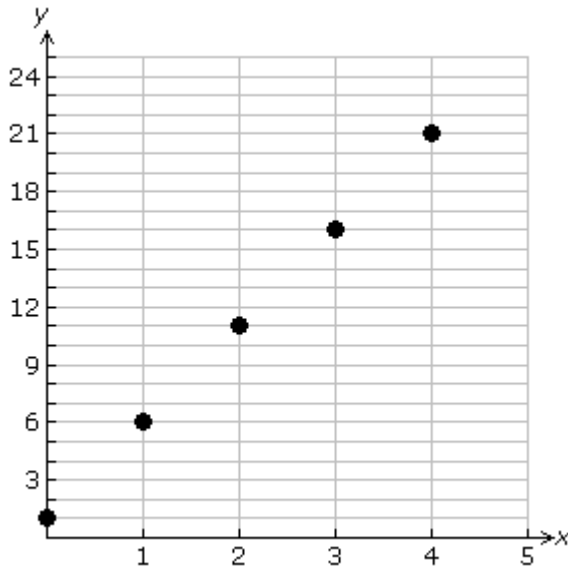
Equation: $y = 2x + 5$



| | | | | | | |
|---|---|----|----|----|----|----|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | 3 | 10 | 17 | 24 | 31 | 38 |

Rate of change = 7

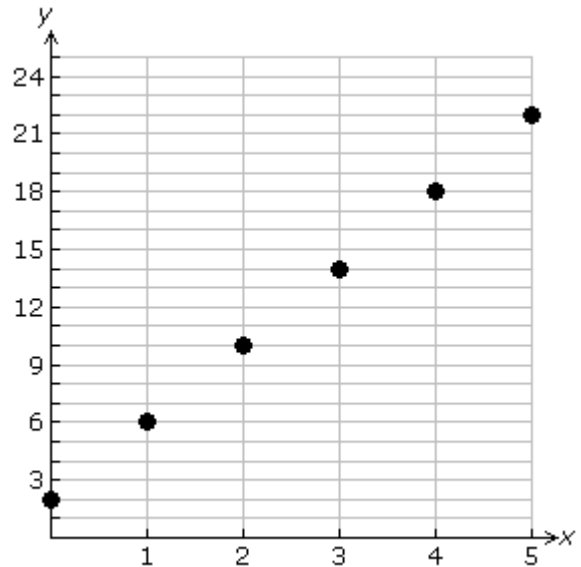
Equation: $y = 7x + 3$



| | | | | | | |
|---|---|---|----|----|----|----|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | 1 | 6 | 11 | 16 | 21 | 26 |

Rate of change = 5

Equation: $y = 5x + 1$



| | | | | | | |
|---|---|---|----|----|----|----|
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | 2 | 6 | 10 | 14 | 18 | 22 |

Rate of change = 4

Equation: $y = 4x + 2$

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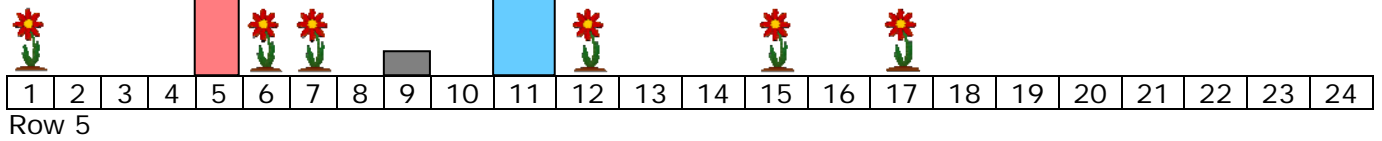
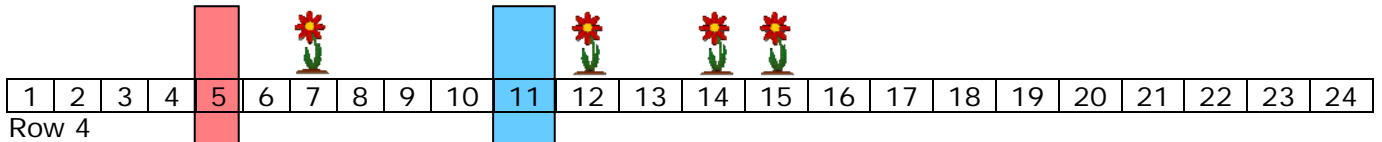
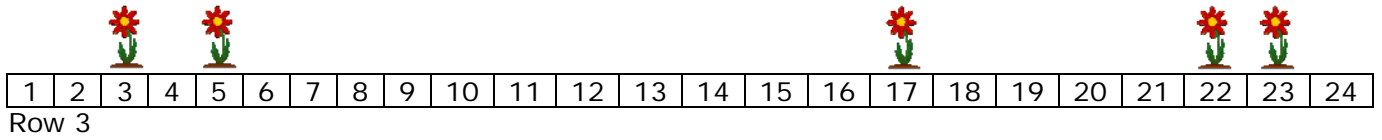
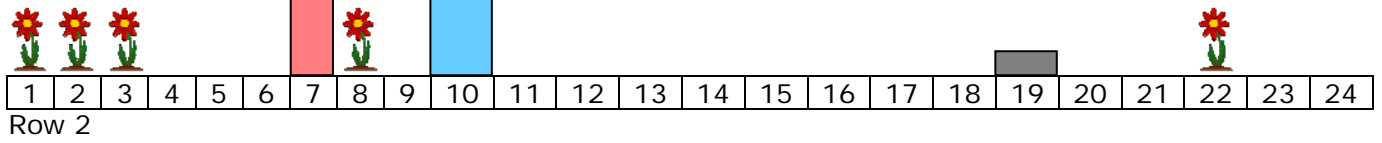
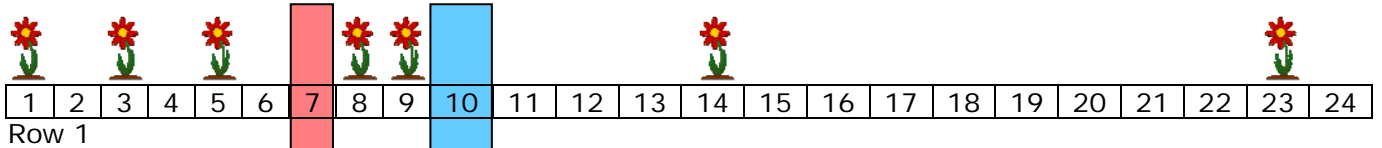
Interactive Resource 1



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Mine Shaft Paths



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Interactive Resource 1-Answers

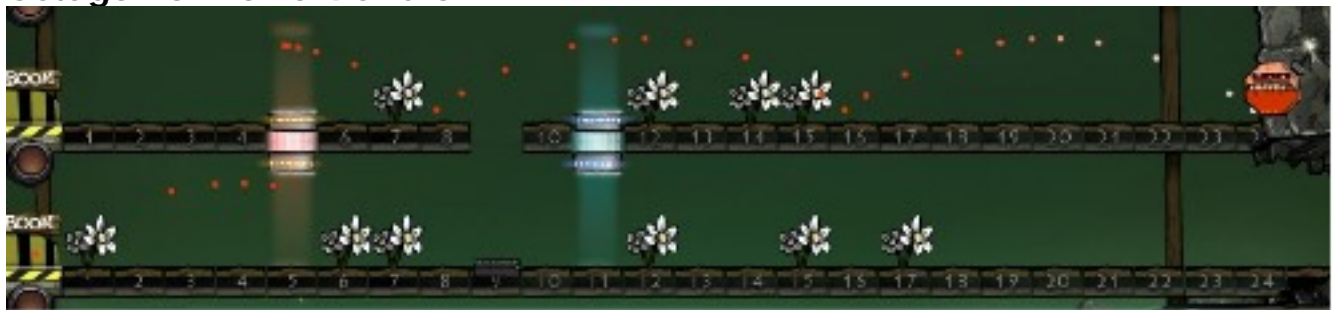
Square on row 3



Pentagon on rows 1 and 2



Octagon on rows 4 and 5



Septagon on rows 1 and 2



Triangle on rows 4 and 5

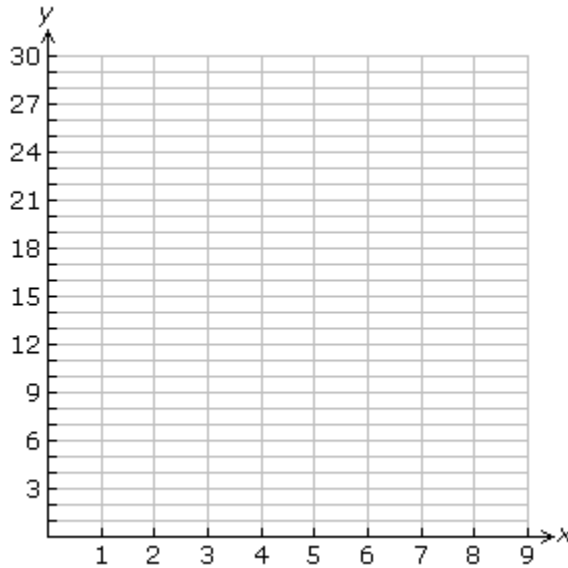


Lesson Plan
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Exploring the Triangle Path



| | | | | | | | | | |
|-----|---|---|---|---|---|---|---|---|---|
| x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| y | | | | | | | | | |



Rate of change for first segment:

Rate of change for second segment:

Rate of change for third segment:

Relationship between lines containing first and third segments:

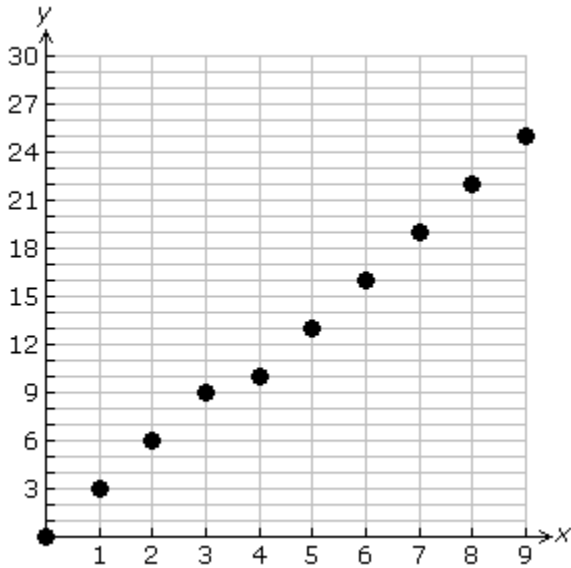
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Exploring the Triangle Path *Answers*

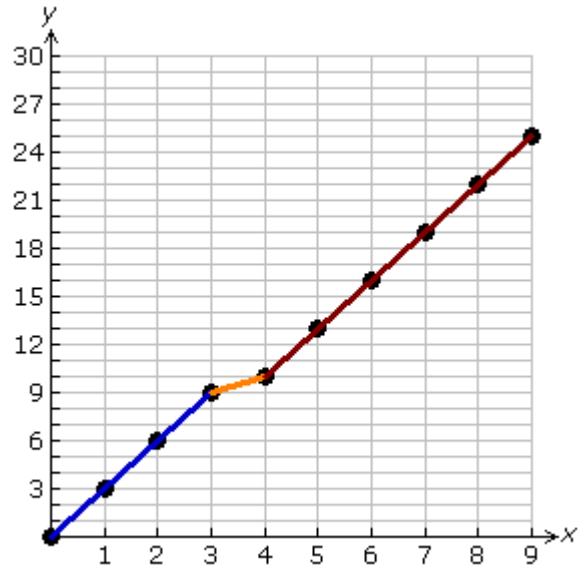


| | | | | | | | | | | |
|-----|---|---|---|---|----|----|----|----|----|----|
| x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| y | 0 | 3 | 6 | 9 | 10 | 13 | 16 | 19 | 22 | 25 |

Without segments:



With segments:



Rate of change for first segment: 3

Rate of change for second segment: 1

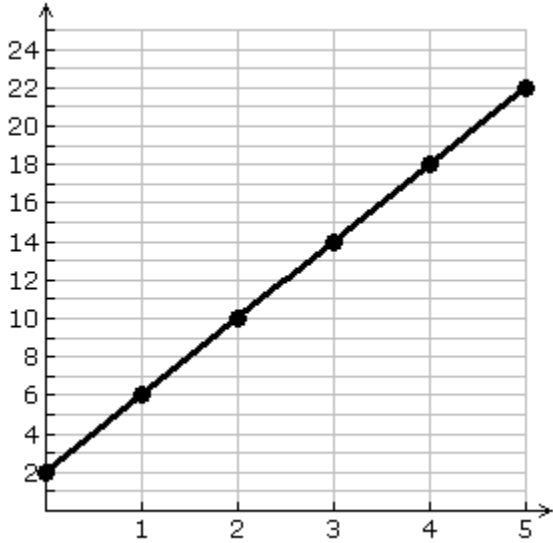
Rate of change for third segment: 3

Relationship between lines containing first and third segments: *parallel*

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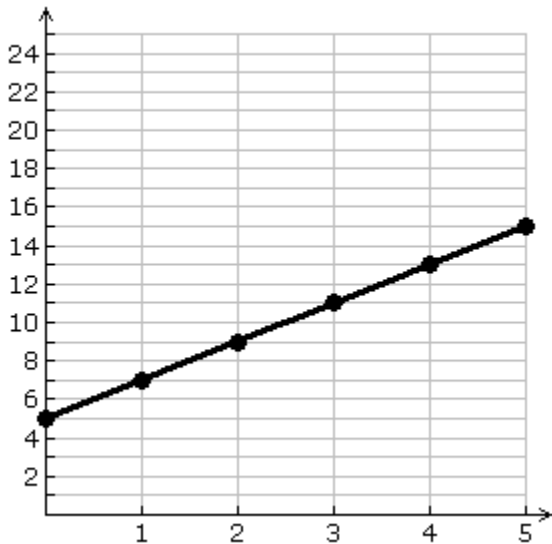
Assessment

Determine the rate of change from point to point on the line.



1. Rate of change =

Determine the rate of change and the equation that is represented by the points on the line.



2. Rate of change =

3. Equation: