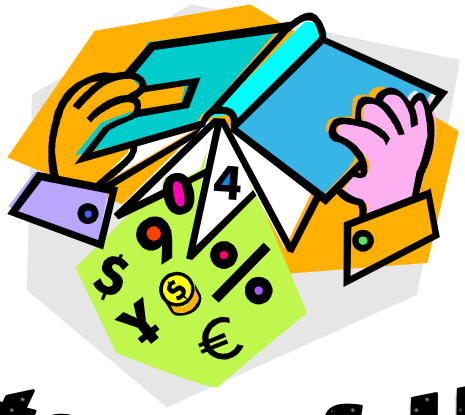
Mathematics:



"A Story of Units"

Parent Handbook

Grade 5
Module 6

Grade 5 • Module 6

Problem Solving with the Coordinate Plane

OVERVIEW

In this 40-day module, students develop a coordinate system for the first quadrant of the coordinate plane and use it to solve problems. Students use the familiar number line as an introduction to the idea of a coordinate and construct two perpendicular number lines to create a coordinate system on the plane. They see that just as points on the line can be located by their distance from 0, the plane's coordinate system can be used to locate and plot points using two coordinates. They then use the coordinate system to explore relationships between points, ordered pairs, patterns, lines and, more abstractly, the rules that generate them. This study culminates in an exploration of the coordinate plane in real world applications.

In Topic A, students come to realize that *any* line, regardless of orientation, can be made into a number line by first locating zero, choosing a unit length, and partitioning the length-unit into fractional lengths as desired. They are introduced to the concept of a coordinate as describing the distance of a point on the line from zero. As students construct these number lines in various orientations on a plane, they explore ways to describe the position of points *not* located on the lines. This discussion leads to the discovery that a second number line, perpendicular to the first, creates an efficient, precise way to describe the location of these points. Thus, points can be located using coordinate pairs, ***(a, b)***, by starting at the origin, travelling a distance of ***a*** units along the *x*-axis, and ***b*** units along a line parallel to the *y*-axis. Students describe given points using coordinate pairs as well as use given coordinate pairs to plot points. The topic concludes with an investigation of patterns in coordinate pairs along lines parallel to the axes, which leads to the discovery that these lines consist of the set of points whose distance from the *x*- or *y*-axis is constant.

Students move in to plotting points and using them to draw lines in the plane in Topic B. They investigate patterns relating the *x*- and *y*-coordinates of the points on the line and reason about the patterns in the ordered pairs, laying important groundwork for Grade 6 proportional reasoning**.** Topic B continues as students use given rules (e.g., multiply by 2, then add 3) to generate coordinate pairs, plot points, and investigate relationships. Patterns in the resultant coordinate pairs are analyzed, leading students to discover that such rules produce collinear sets of points. Students next generate two number patterns from two given rules, plot the points, and analyze the relationships within the sequences of the ordered pairs. Patterns continue to be the focus as students analyze the effect on the steepness of the line when the second coordinate is produced through an addition rule as opposed to a multiplication rule. Students also create rules to generate number patterns, plot the points, connect those points with lines, and look for intersections.

Topic C finds students drawing figures in the coordinate plane by plotting points to create parallel, perpendicular, and intersecting lines. They reason about what points are needed to produce such lines and angles, and then investigate the resultant points and their relationships. Students also reason about the relationships among coordinate pairs that are symmetric about a line.

Problem solving in the coordinate plane is the focus of Topic D. Students draw symmetric figures using both angle size and distance from a given line of symmetry. Line graphs are also used to explore patterns and make predictions based on those patterns. To round out the topic, students use coordinate planes to solve real world problems.

Topic E provides an opportunity for students to encounter complex, multi-step problems requiring the application of concepts and skills mastered throughout the Grade 5 curriculum. They use all four operations with both whole numbers and fractions in varied contexts. The problems in Topic E are designed to be non-routine, requiring students to persevere in order to solve them. While wrestling with complexity is an important part of Topic E, the true strength of this topic is derived from the time allocated for students to construct arguments and critique the reasoning of their classmates. After students have been given adequate time to ponder and solve the problems, two lessons are devoted to sharing approaches and solutions. Students will partner to justify their conclusions, communicate them to others, and respond to the arguments of their peers.

In this final topic of Module 6, and in fact, *A Story of Units*, students spend time producing a compilation of their learning. They not only reach back to recall learning from the very beginning of Grade 5, but they also expand their thinking by exploring such concepts as the Fibonacci sequence. Students solidify the year's learning by creating and playing games, exploring patterns as they reflect back on their elementary years. All materials for the games and activities are then housed for summer use in boxes created in the final two lessons of the year.

**The sample questions/responses contained in this manual are straight from http://www.engageny.org/. They are provided to give some insight into the kinds of skills expected of students as each lesson is taught.

Terminology

New or Recently Introduced Terms

- Axis (fixed reference line for the measurement of coordinates)
- Coordinate (number that identifies a point on a plane)
- Coordinate pair (two numbers that are used to identify a point on a plane; written (*x, y*) where *x* represents a distance from 0 on the *x*-axis and *y* represents a distance from 0 on the *y*-axis)
- Coordinate plane (plane spanned by the *x*-axis and *y*-axis in which the coordinates of a point are distances from the two perpendicular axes)
- Ordered pair (two quantities written in a given fixed order, usually written as (*x*, *y*))
- Origin (fixed point from which coordinates are measured; the point at which the *x*-axis and *y*-axis intersect, labeled (0, 0) on the coordinate plane)
- Quadrant (any of the four equal areas created by dividing a plane by an *x*-axis and *y*-axis)

Familiar Terms and Symbols

- Angle (union of two different rays sharing a common vertex)
- Angle measure (number of degrees in an angle)
- Degree (unit used to measure angles)
- Horizontal (parallel to the *x*-axis)
- Line (two-dimensional object that has no endpoints and continues on forever in a plane)
- Parallel (two lines in a plane that do not intersect)
- Perpendicular (two lines are *perpendicular* if they intersect, and any of the angles formed between the lines are 90-degree angles)
- Point (zero-dimensional figure that satisfies the location of an ordered pair)
- Rule (procedure or operation(s) that affects the value of an ordered pair)
- Vertical (parallel to the *y*-axis)

Suggested Tools and Representations

- Ruler
- Protractor
- Set square
- Tape diagrams

Lesson 1

Objective: Construct a coordinate system on a line.

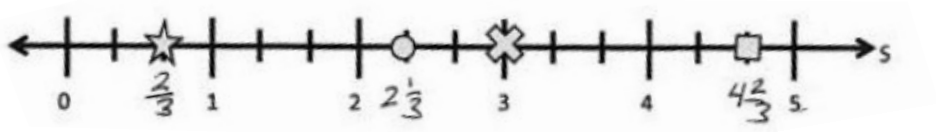
Each shape was placed at a point on the number line S. Give the coordinate of each point below.

a. ✖ 3

b. ☆ $\frac{2}{3}$

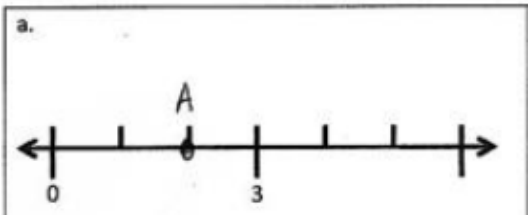
c. ○ $2\frac{1}{3}$

d. □ $4\frac{2}{3}$



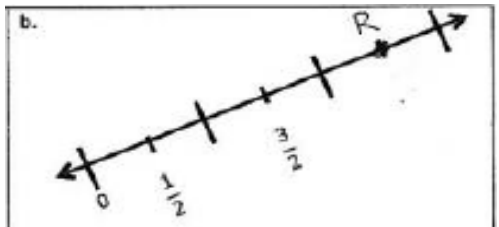
Plot the points on the number lines.

a.



Plot *A* so its distance from the origin is 2.

b.

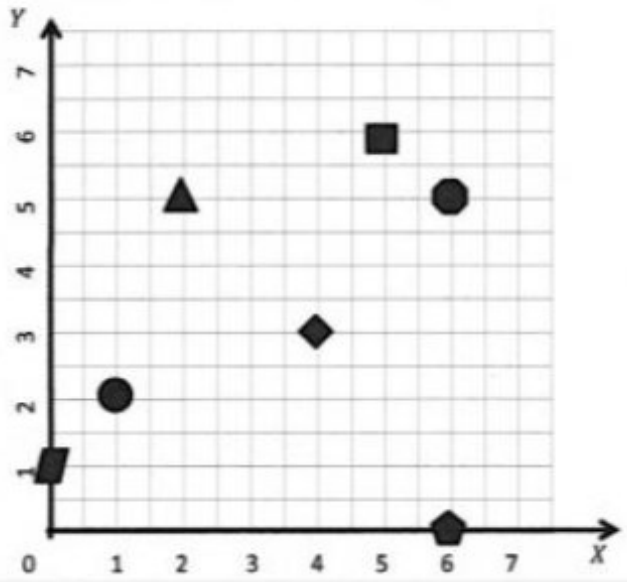


Plot *R* so that its distance from the origin is $\frac{5}{2}$.

Lesson 2

Objective: Construct a coordinate system on a plane.

Use the coordinate plane to answer



a. Tell the shape at each location

x-coordinate	*y*-coordinate	Shape
2	5	triangle
1	2	circle
5	6	square
6	5	octagon

b. Which shape is 2 units from the *y*-axis?
triangle

c. Which shape has an *x*-coordinate of 0?
parallelogram

d. Which shape is 4 units from the *y*-axis and 3 units from the *x*-axis?
square (diamond)

Lesson 3- Objective: Name points using coordinate pairs, and use the coordinate pairs to plot points.

Use the grid (right) to complete the following tasks.

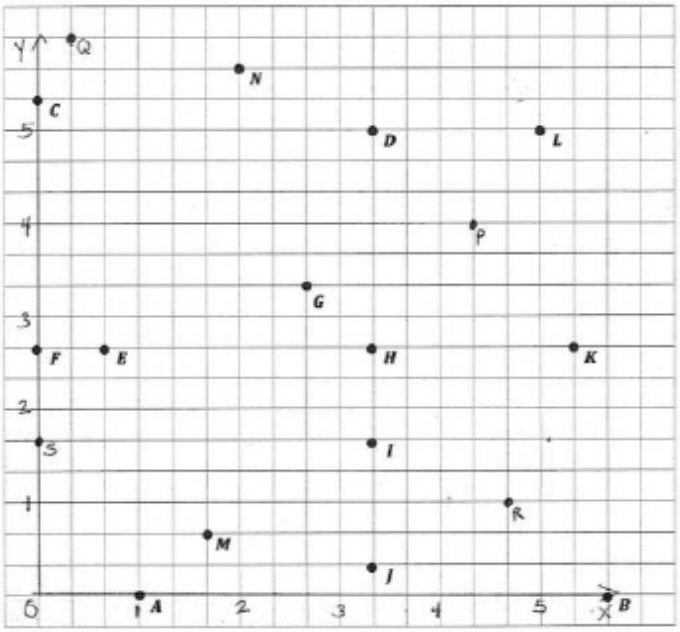
a. Construct an *x*-axis that passes through points *A* and *B*.

b. Construct a perpendicular *y*-axis that passes through points *C* and *F*.

c. Label the origin as 0.

d. The *x*-coordinate of *B* is $5\frac{2}{3}$. Label the whole numbers along the x-axis.

e. The *y*-coordinate of *C* is $5\frac{1}{3}$. Label the whole numbers.



Lesson 4

Objective: Name points using coordinate pairs, and use the coordinate pairs to plot points.

Enemy Ships

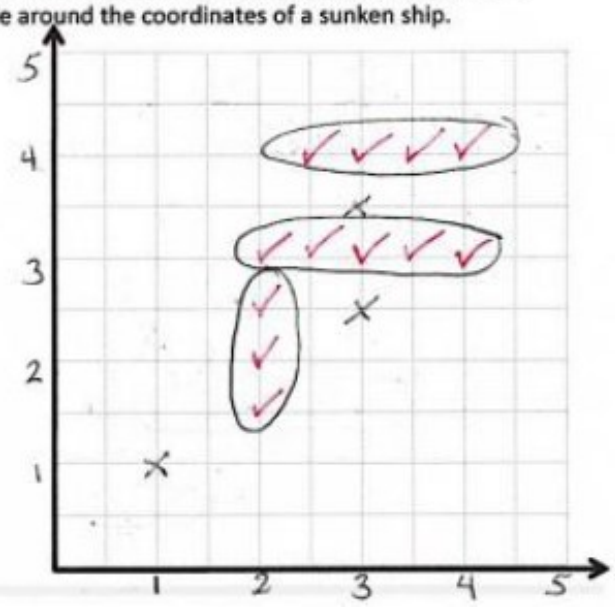
- Draw a black ✖ on the coordinate if your opponent says, "miss".
- Draw a red ✓ on the coordinate if your opponent says, "hit".
- Draw a circle around the coordinates of a sunken ship.

Attack Shots

- Record the coordinates of each shot below and whether it was a ✓(hit) or a ✖ (miss).

1, 1 ✗
2, 2 ✓
2, 2½ ✓
2, 1½ ✓
3, 3 ✓
3, 2½ ✗
3, 3½ ✗
2½, 3 ✓

3½, 3 ✓
4, 3 ✓
4½, 3 ✗
2, 3 ✓
4, 4 ✓
3½, 4 ✓
3, 4 ✓
2½, 4 ✓



Lesson 5

Objective: Investigate patterns in vertical and horizontal lines, and interpret points on the plane as distances from the axes.

Use the coordinate plane below to answer the following questions.

a. Use a straight edge to construct a line that goes through points A and B. Label the line e.

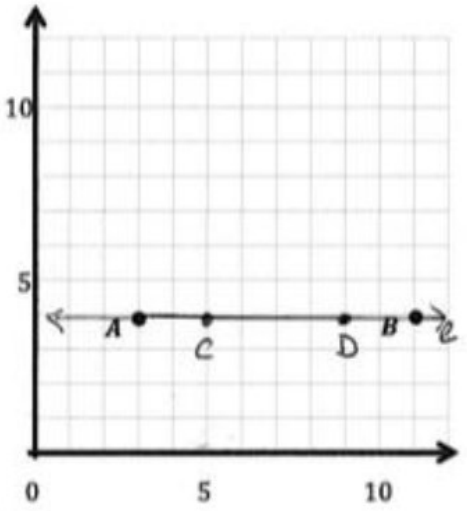
b. Line e is parallel to the X -axis and is perpendicular to the Y -axis.

c. Plot two more points on line e. Name them C and D.

d. Give the coordinates of each point below.

A: (3, 4) B: (11, 4)

C: (5, 4) D: (9, 4)



e. What do all of the points of line e have in common?

They all have a y-coordinate of 4.

f. Give the coordinates of another point that would fall on line e with an x-coordinate greater than 15.

(16, 4)

Lesson 6

Objective: Investigate patterns in vertical and horizontal lines, and interpret points on the plane as distances from the axes.

1. Plot the following points and label them on the coordinate plane.

A: (0.3, 0.1) B: (0.3, 0.7)

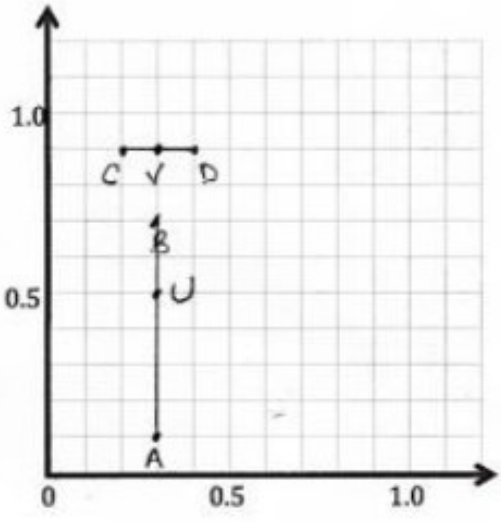
C: (0.2, 0.9) D: (0.4, 0.9)

a. Use a straight edge to construct line segments $\overline{AB}$ and $\overline{CD}$.

b. Line segment $\overline{CD}$ is parallel to the x-axis and is perpendicular to the y-axis.

c. Line segment $\overline{AB}$ is parallel to the y-axis and is perpendicular to the x-axis.

d. Plot a point on line segment $\overline{AB}$, not at the endpoints and name it U. Write the coordinates. U (0.3, 0.5)



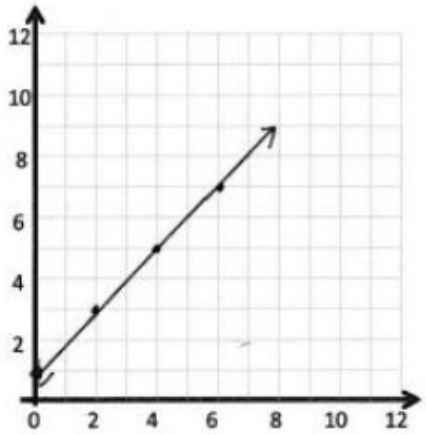
e. Plot a point on line segment $\overline{CD}$ and name it V. Write the coordinates. V (0.3, 0.9)

Lesson 7

Objective: Plot points, use them to draw lines in the plane, and describe patterns within the coordinate pairs.

Complete the chart. Then plot the points on the coordinate plane below.

x	y	(x, y)
0	1	(0, 1)
2	3	(2, 3)
4	5	(4, 5)
6	7	(6, 7)



a. Use a straight edge to draw a line connecting these points.

b. Write a rule showing the relationship between the x and y-coordinates of points on the line.

Each y-coordinate is 1 more than its corresponding x-value.

c. Name 2 other points that are on this line.

(7, 8) (9, 10)

Lesson 8

Objective: Generate a number pattern from a given rule, and plot the points.

a. Graph the lines on the plane.

line ℓ: x is equal to y

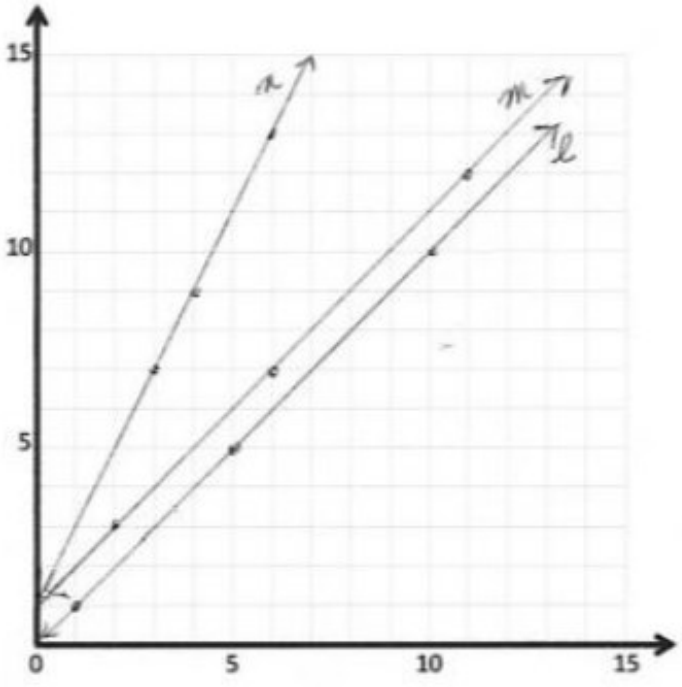
	x	y	(x, y)
A	1	1	(1, 1)
B	5	5	(5, 5)
C	10	10	(10, 10)

line m: y is 1 more than x.

	x	y	(x, y)
G	2	3	(2, 3)
H	6	7	(6, 7)
I	11	12	(11, 12)

line n: y is 1 more than twice x

	x	y	(x, y)
S	3	7	(3, 7)
T	4	9	(4, 9)
U	6	13	(6, 13)



Lesson 9

Objective: Generate two number patterns from given rules, plot the points, and analyze the patterns.

Complete the table for the given rules, for *x* values 0, 3, 7, & 9.

Line E

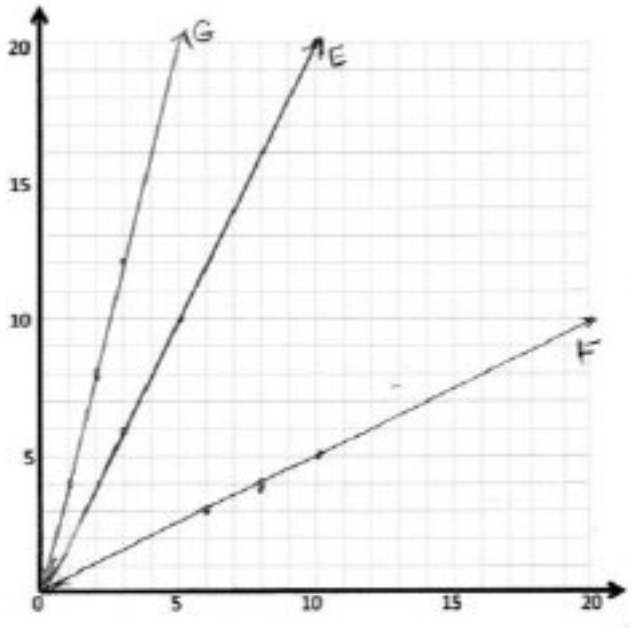
Rule: *y* is twice as much as *x*

x	y	(x, y)
0	0	(0, 0)
3	6	(3, 6)
5	10	(5, 10)
10	20	(10, 20)

Line F

Rule: *y* is half as much as *x*

x	y	(x, y)
6	3	(6, 3)
8	4	(8, 4)
10	5	(10, 5)
20	10	(20, 10)



Lesson 10

Objective: Compare the lines and patterns generated by addition rules and multiplication rules.

Use the coordinate plane below to complete the following tasks.

a. Line *p* represents the rule, "*x* and *y* are equal".

b. Construct a line, *d*, that is parallel to line *p* and contains point *D*.

c. Name 3 coordinates pairs on line *d*.

$(1\frac{1}{2}, 3\frac{1}{2})$, $(2\frac{1}{2}, 4\frac{1}{2})$, (3, 5)

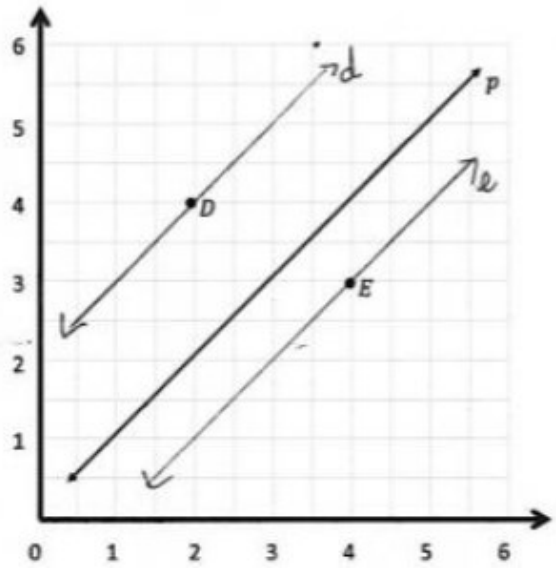
d. Identify a rule to describe line *d*.

y is 2 more than x.

e. Construct a line, *e*, that is parallel to line *p* and contains point *E*.

f. Name 3 points on line *e*.

(2, 1), (3, 2), (5, 4)



Lesson 11

Objective: Analyze number patterns created from mixed operations.

Complete the tables for the given rules.

Line ℓ

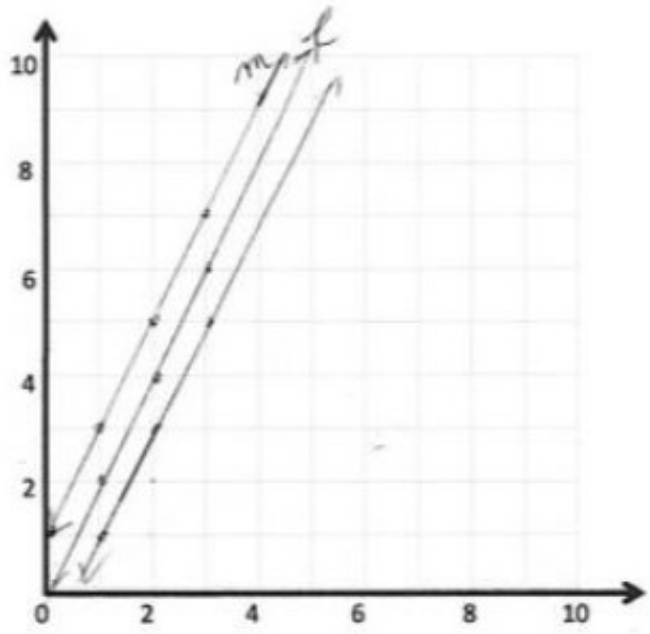
Rule: Double x

x	y	(x, y)
0	0	(0, 0)
1	2	(1, 2)
2	4	(2, 4)
3	6	(3, 6)

Line m

Rule: Double x, then add 1

x	y	(x, y)
0	1	(0, 1)
1	3	(1, 3)
2	5	(2, 5)
3	7	(3, 7)



Lesson 12

Objective: Create a rule to generate a number pattern, and plot the points.

Create a rule for a line that contains the point (1/4, 1 1/4) using the operation or description below. Then name two other points that would fall on each line.

a. Addition: add 1 to x

Point	x	y	(x, y)
T	2	3	(2, 3)
U	4	5	(4, 5)

b. A line parallel to the x-axis: y is always $1\frac{1}{4}$

Point	x	y	(x, y)
G	$\frac{1}{2}$	$1\frac{1}{4}$	$(\frac{1}{2}, 1\frac{1}{4})$
H	$2\frac{1}{2}$	$1\frac{1}{4}$	$(2\frac{1}{2}, 1\frac{1}{4})$

c. Multiplication: multiply x by 5

Point	x	y	(x, y)
A	$\frac{1}{2}$	$2\frac{1}{2}$	$(\frac{1}{2}, 2\frac{1}{2})$
B	1	5	(1, 5)

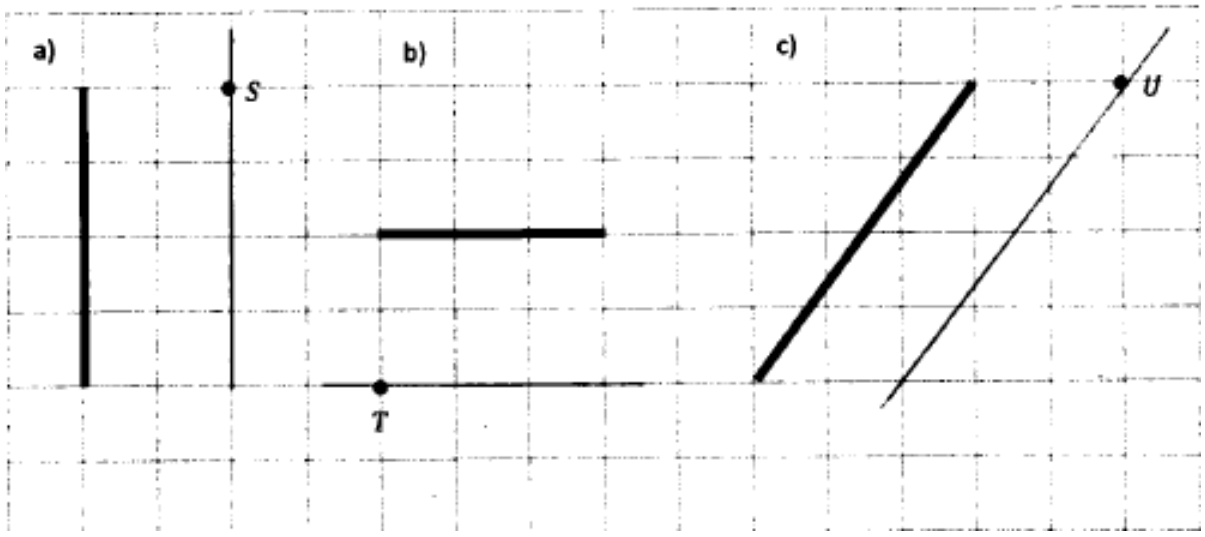
d. A line parallel to the y-axis: x is always $\frac{1}{4}$

Point	x	y	(x, y)
V	$\frac{1}{4}$	6	$(\frac{1}{4}, 6)$
W	$\frac{1}{4}$	12	$(\frac{1}{4}, 12)$

Lesson 13

Objective: Construct parallel line segments on a rectangular grid.

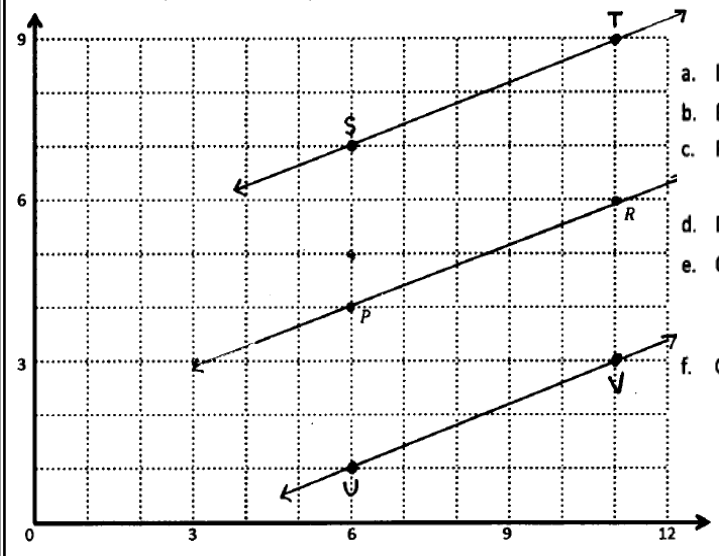
Use your straight edge to draw a segment parallel to each segment through the given point.



Lesson 14

Objective: Construct parallel line segments, and analyze relationships of the coordinate pairs.

Use the coordinate plane below to complete the following tasks.



a. Identify the locations of P and R. P: (6, 4) R: (11, 6)

b. Draw $\overleftrightarrow{PR}$.

c. Plot the following coordinate pairs on the plane.

S: (6, 7) T: (11, 9)

d. Draw $\overleftrightarrow{ST}$.

e. Circle the relationship between $\overleftrightarrow{PR}$ and $\overleftrightarrow{ST}$. $\overleftrightarrow{PR} \perp \overleftrightarrow{ST}$ $\overleftrightarrow{PR} \parallel \overleftrightarrow{ST}$

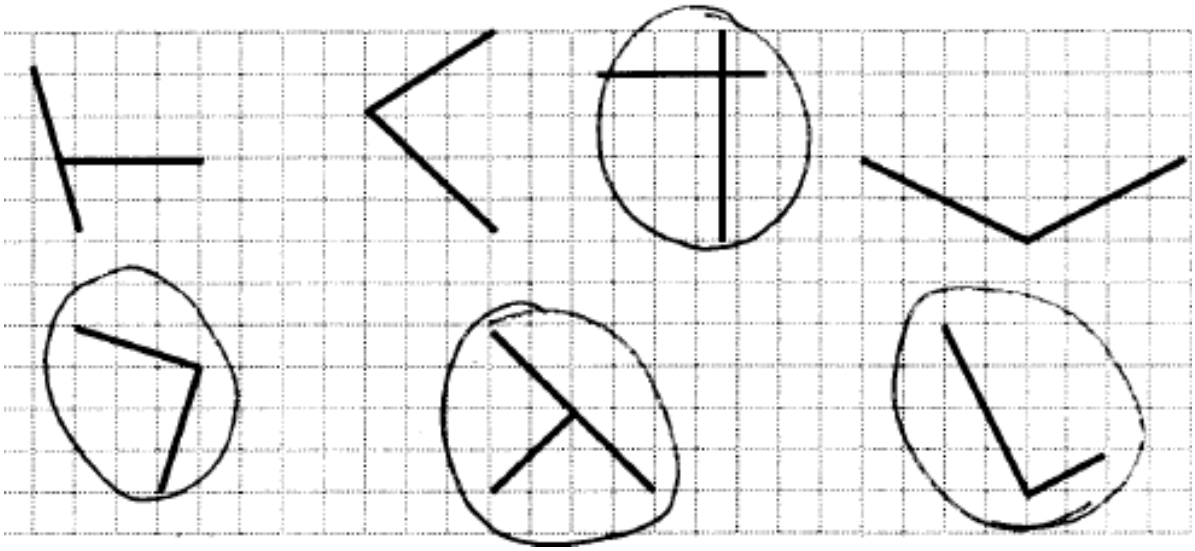
f. Give the coordinates of a pair of points, U and V, such that $\overleftrightarrow{UV} \parallel \overleftrightarrow{PR}$.

U: (6, 1) V: (11, 3)

Lesson 15

Objective: Construct perpendicular line segments on a rectangular grid.

Circle the pairs of segments that are perpendicular.



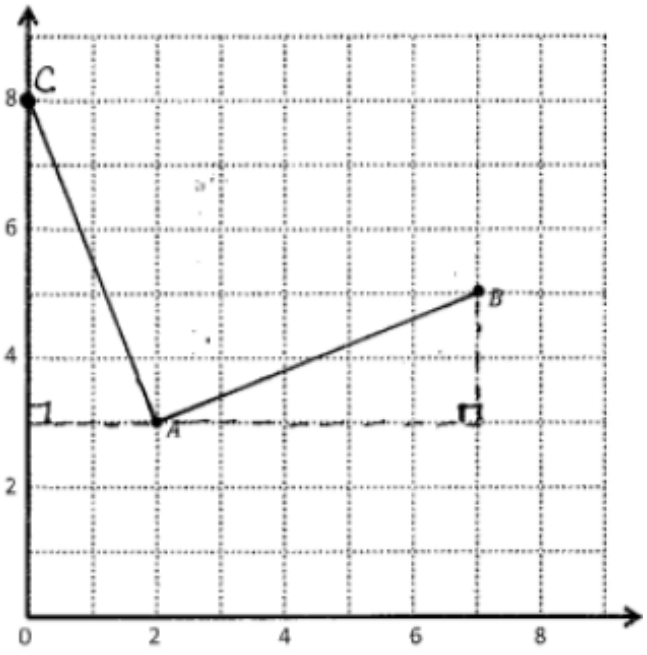
Lesson 16

Objective: Construct perpendicular line segments, and analyze relationships of the coordinate pairs.

Use the coordinate plane below to complete the following tasks.

a. Draw $\overline{AB}$
b. Plot point C (0, 8).
c. Draw $\overline{AC}$.
d. Explain how you know $\angle CAB$ is a right angle without measuring it.

∠CAB is a right angle because I can draw the triangle that has $\overline{AB}$ as its long side. The length is 5 units and the height is 2 units. When I slid the triangle to the left and rotated, I know the 2 acute angles will form a 90° right angle.



Lesson 17

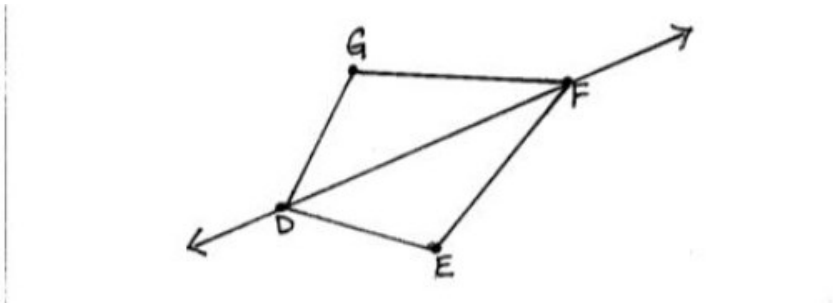
Objective: Draw symmetric figures using distance and angle measure from the line of symmetry.

Complete the following construction in the space below.

a. Plot 3 non-collinear points D, E, and F.

b. Draw $\overline{DE}$, $\overline{EF}$, and $\overleftrightarrow{DF}$.

c. Plot point G, and draw the remaining sides, such that quadrilateral $DEFG$ is symmetric about $\overleftrightarrow{DF}$.



Lesson 18

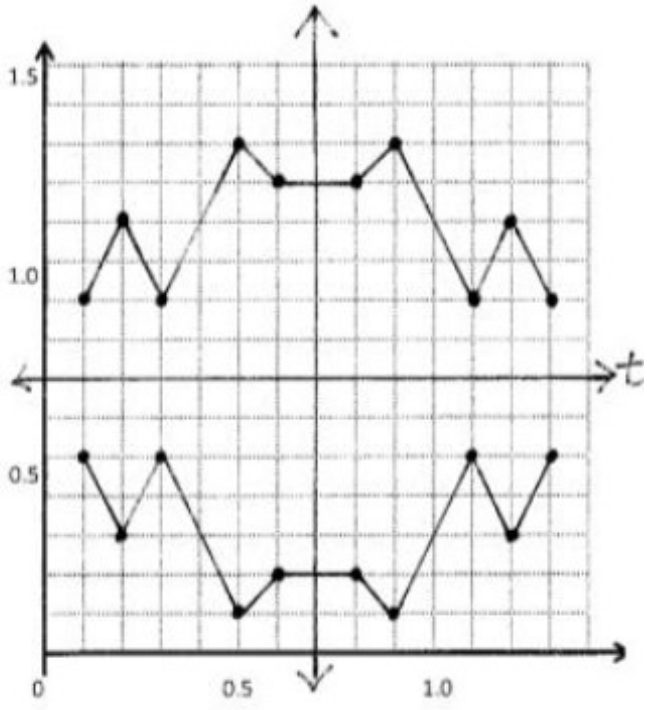
Objective: Draw symmetric figures on the coordinate plane.

Use the plane at right to complete the following tasks.

a. Draw a line t whose rule is, y *is always 0.7*.

b. Plot the points from Table A on the grid in order. Then draw line segments to connect the points.

Table A	*Table B*
(0.1, 0.5)	(0.1, 0.9)
(0.2, 0.3)	(0.2, 1.1)
(0.3, 0.5)	(0.3, 0.9)
(0.5, 0.1)	(0.5, 1.3)
(0.6, 0.2)	(0.6, 1.2)
(0.8, 0.2)	(0.8, 1.2)
(0.9, 0.1)	(0.9, 1.3)
(1.1, 0.5)	(1.1, 0.9)
(1.2, 0.3)	(1.2, 1.1)
(1.3, 0.5)	(1.3, 0.9)



Lesson 19-Objective: Plot data on line graphs and analyze trends.

Mr. Boyd checks the gauge on his home's fuel tank on the first day of every month. The line graph at right was created using the data he collected.

a. According to the graph, during which month(s) does the amount of fuel decrease most rapidly?

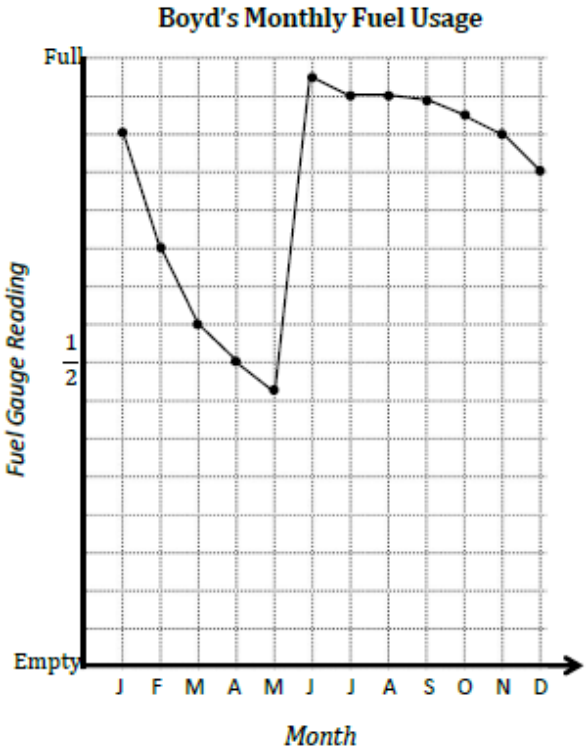
January is the month in which fuel decreases most rapidly.

b. The Boyds took a month-long vacation. During which month did this most likely occur? Explain how you know using the data in the graph.

In July no fuel was used because the line is flat. That is when they went on vacation.

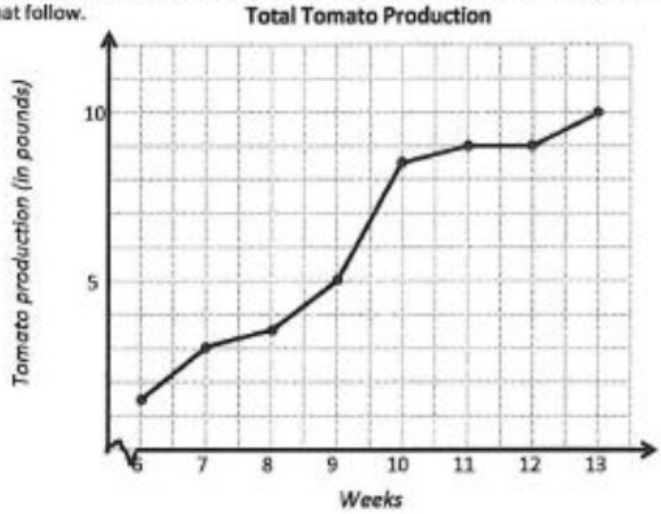
c. Mr. Boyd's fuel company filled his tank once this year. During which month did this most likely occur? Explain how you know.

The tank was filled in May because the line went up meaning fuel was added.



Lesson 20- Objective: Use coordinate systems to solve real world problems.

The line graph below tracks the total tomato production for one tomato plant. The total tomato production is plotted at the end of each of 8 weeks. Use the information in the graph to answer the questions that follow.



a. How many pounds of tomatoes did this plant produce at the end of 13 weeks?

The plant produced 10 lbs of tomatoes at the end of 13 weeks.

b. How many pounds of tomatoes did this plant produce from week 7 to week 11? Explain how you know. The plant produced 6 lbs of tomatoes from week 7 to 11. It had 3 lbs at week 7 and it was up to 9 lbs by week 11. The difference is 6 lbs.

Post-Module Work

Lessons 21-25

Objective: Make sense of complex multi-step problems and persevere in solving them. Share and critique peer solutions.

Lessons 26-27

Objective: Solidify writing and interpreting numerical expressions.

Lesson 28

Objective: Solidify fluency with Grade 5 Skills.

Lessons 29-30

Objective: Solidify the vocabulary of geometry.

Lesson 31

Objective: Explore the Fibonacci sequence.

Lesson 32

Objective: Explore patterns in saving money.

Lesson 33-34

Objective: Design and construct boxes to house materials for summer use.