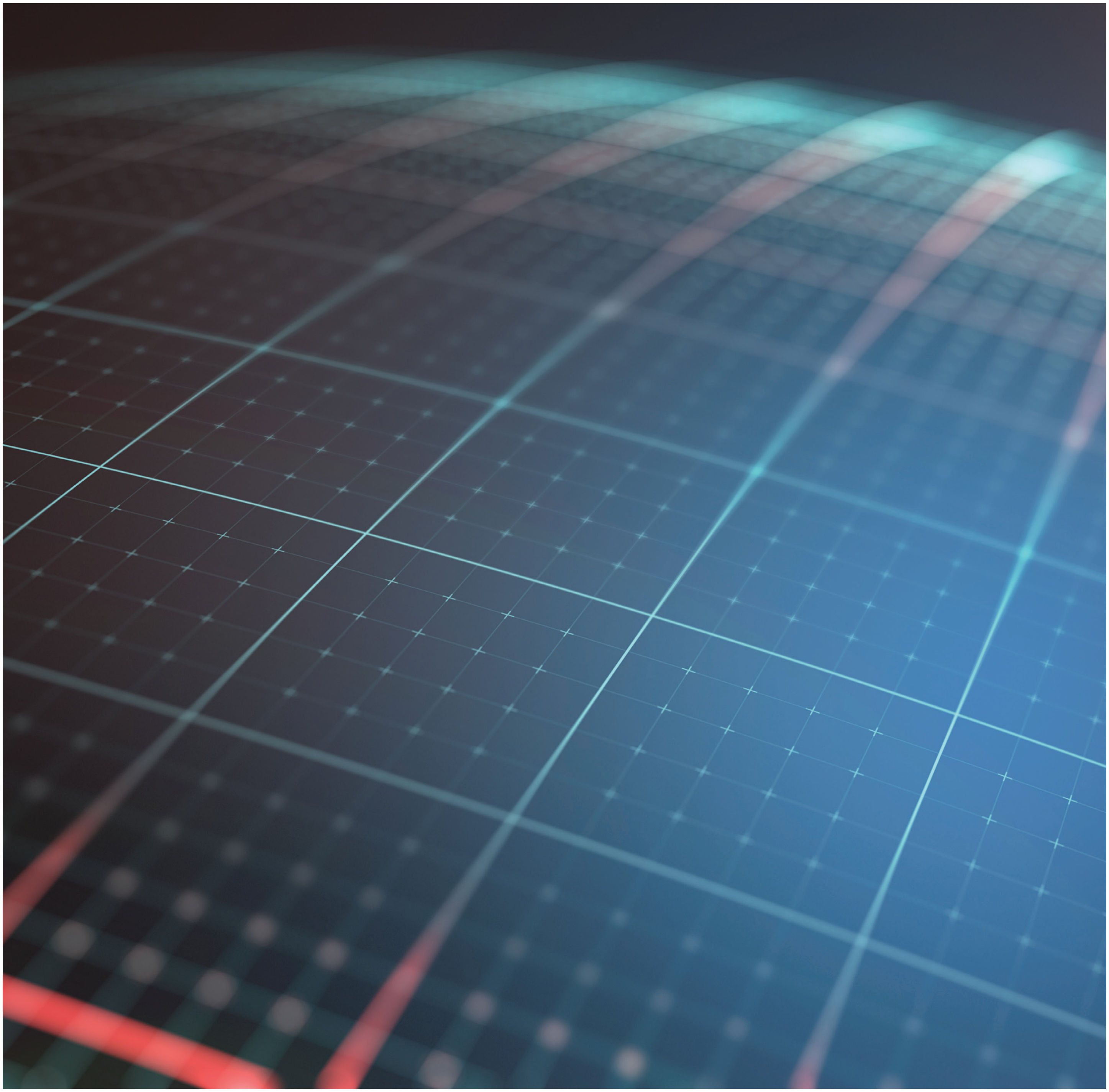

The Coordinate Plane

&

The Work of Renè Descartes

ETC MONTESSORI

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Strike the Imagination Story

Rene Descartes and the Merging of Geometry and Algebra
(Adapted from Marvels of Math, Kendall Haven, Teacher Ideas Press, 1998)

Rene Descartes was born a sickly child and spent many of his early years in bed. This soon became a habit, and while he grew up to be a strong, healthy man, his preference for lying in bed, throughout the morning stayed with him, much to many people's dismay.

"SERGEANT! WHERE IS CAPTAIN DESCARTES?" thundered Colonel Gasper.
"I believe he is still in bed, sir," answered the aroused Sergeant.
"But, it is after ten in the morning! Go and fetch him immediately.....NO, never mind, I shall go get him myself!"
Stomping into the Captain's tent, Colonel Gasper was surprised to see Rene still lounging in bed, apparently unperturbed by the Colonel's entrance.
"I need to see all officers in my tent, immediately, why are you not up yet?" asked the frustrated Colonel.
"I had the most confusing dream," answered Descartes, "I dreamt that there was a savage war taking place; a war between good and evil. People were screaming and asked for mercy, but I was not afraid. Do you know why I was not afraid? Heaven had given me a golden key."
"A key? What kind of key?" asked the Colonel.
"It was the key to the understanding of all nature."
"What the devil does that mean? What was it?" asked the frustrated Colonel.
"The key was to use algebra and geometry together, to combine all of mathematics into one system to describe and explain the universe," answered Descartes with a faraway look on his face.
"This is about mathematics! You are still in bed, because you are dreaming about mathematics? Sir, we have a war to fight, I suggest you get dressed immediately and keep your mind on the problem at hand! Mathematics, indeed!" The frustrated Colonel turned around and quickly marched out of the tent, followed by a smiling Sergeant.

A year an a half later, Rene Descartes was transferred to the Bavarian army, which was far more engaged in battle than his previous assignment. Each attack was met with a counterattack, and many lives were lost to gain a few inches of charred soil. It was an early August morning of 1620, when Rene met up with his leader. "Major Haflen, may I have a word please?"

With cannons roaring around him, the Major snapped back, "I'm a little busy right now, Captain, so unless this has to do with how to reposition the cannons to break through this fortified wall, I suggest you find another time to discuss your idea!"
"But, I think you will find this fascinating, I really do." The young Captain climbed the small hill to be beside the artillery Major, and continued his story. "I was lying in bed this morning and I realized that for all regular three-dimensional objects, that it is true that the number of vertices, or corners, plus the number of faces, minus the number of edges, always equals two! It's amazing, for any shape, it will always equal two!"

The Major looked at Descartes with disbelief. "This is why you climbed up here, in the middle of battle, to tell me this?"
"But don't you see, it's an algebraic equation that describes a geometric relationship.
This might be the beginning of my bridge between geometry and algebra!" explained the excited Descartes. The Colonel climbed the hill to join the Major and Descartes. With surprise the Colonel asked, "Captain Descartes, I hope that we have not disturbed you with our little war. It is, after all, still early in the day."

“Oh, not at all, sir, I do my best thinking in the morning, and it is well past noon.”
A few days later, on a stifling morning, Descartes could be found lying on his cot, staring at the ceiling, on which moved a fly. “That fly is moving in small arcs through the air. It is making geometric shapes, and it doesn’t even know it,” thought Rene. “If I could somehow measure, or describe each point of the fly’s path, I could write down the equation that would describe the fly’s arc.” Slowly, an idea emerged. “If I could do that, I would be able to translate algebraic equations into geometry!” He bolted out of bed, but how could he describe the fly’s location? HOW! Then it hit him. The fly landed in the corner, three inches from the back of the wall, and four inches from the side wall. Then he buzzed off again. Descartes fixed the fly again, six inches from the back of the wall and four inches from the side wall. With shock, Rene realized that he could describe the fly’s position at any time, just by using this idea. Better still, he didn’t need solid surfaces, if he used lines for axes, similar to the lines that were formed by the corner of the room, he could make a grid. Immediately, he saw the room framed off in a giant grid.

Every point in the room could be described in this simple way. Borrowing a term from cartographers, Descartes called the distance of a point from the axes, a coordinate, and it is from this idea that we have the system termed “Cartesian coordinates”. With these coordinates, any geometric shape could be defined as a set of points, and in turn also defined as an algebraic equation and vice versa. Geometry and algebra had been merged, all thanks to a listless man, and a lethargic fly.

Introduction to the Coordinate Plane

Age

9 -10 years

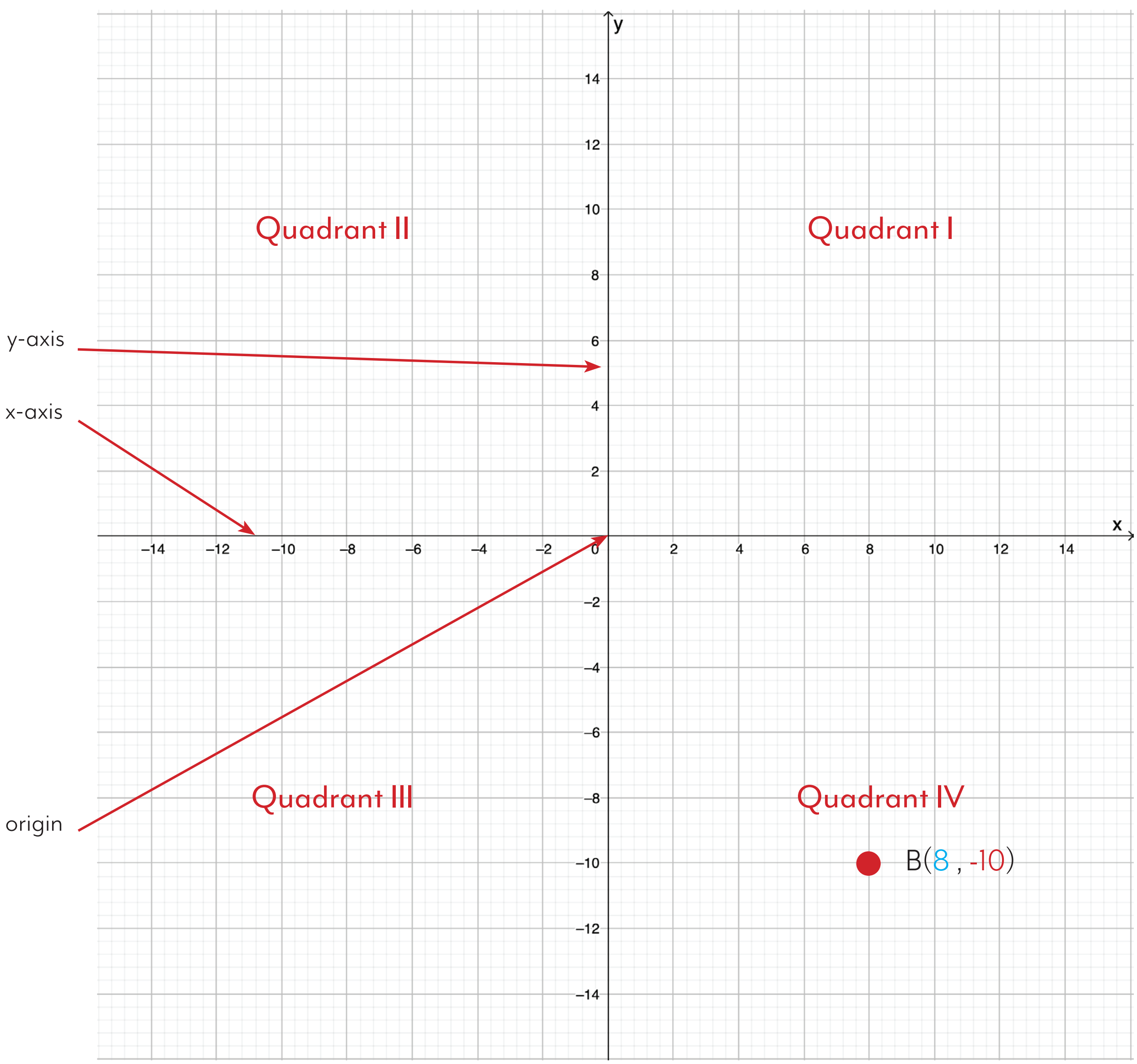
Aim

Direct: to understand what the coordinate plane is and what are its parts
Indirect: to prepare for pre-algebra concepts

Materials

Strike the imagination with the Descartes story.
The coordinate plane board and the pegs.
Coordinate grid nomenclature.

Presentation



1. Read the story of Rene Descartes to the children.
2. Introduce the nomenclature of the coordinate plane.
3. Introduce the students to the coordinate board.
4. Say: A coordinate plane is formed by the intersection of two number lines. The horizontal number line is called the x-axis and the vertical line is called the y-axis. Point to the two number lines as you describe it.
5. Identify the four quadrants.
6. Explain how we use the lines to name a given point on the coordinate plane.
7. Say: A point on the coordinate plane is named by calling out the ordered pair of numbers. The ordered pair of numbers gives the coordinates and location of a point. For example point B may be identified by the ordered pair (8,-10) and it is located in Quadrant IV.
8. Show the student the ordered pair and help them understand that the first number is located on the x-axis, while the second number is located on the y-axis.

These are new concepts for some students and the following vocabulary needs to be reinvorced. Use the included nomenclature cards to do this.

- Coordinate plane
- x-axis
- y-axis
- quadrant
- origin
- ordered pair
- x-coordinate
- y-coordinate

Follow Up:

1. Prepared task cards on coordinate plane.
2. Work with the Geometry/Algebra Timeline (Timeline of History of Numbers)

Graphing Points on a Coordinate Plane

Age

9 -10 years

Aim

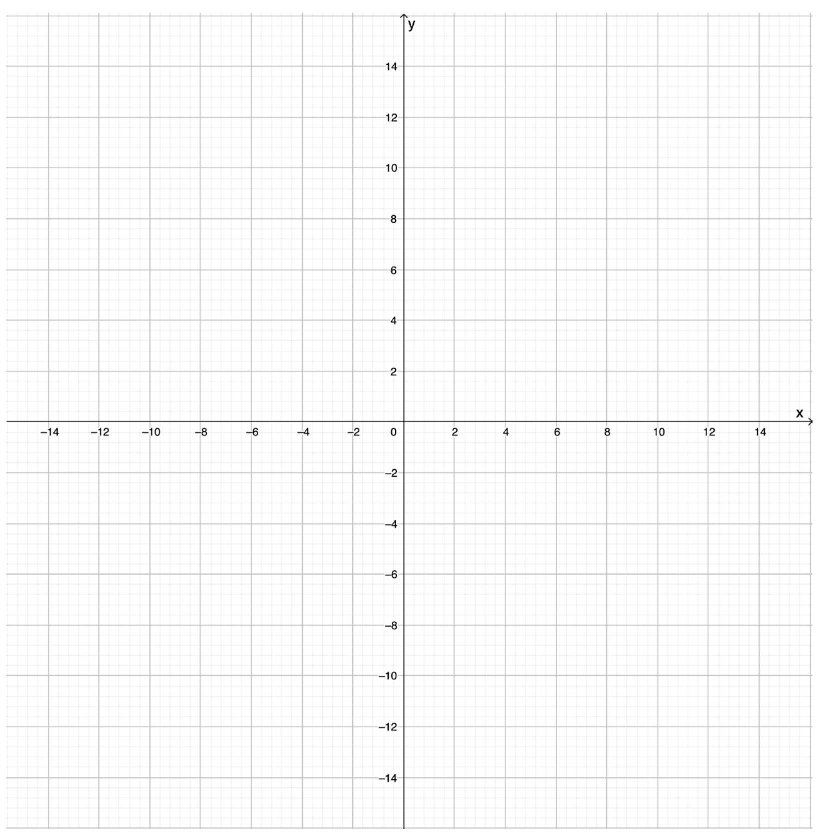
Direct: to understand how to graph a point on a coordinate plane using the ordered pair
Indirect: to prepare for pre-algebra concepts

Materials

The coordinate plane board and the pegs.

Presentation

- Given a point A(x , y) in a coordinate plane, you graph the ordered pair (x , y)
- Start at the origin and count to the left or right on the x-axis. This will be the first number of the ordered pair.
- To locate the second number of the ordered pair continue up or down from the point you located on the previous step.



Operations With Integers

Age

10 -11 years

Aim

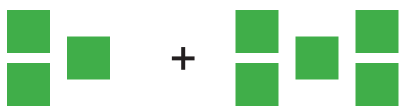
Direct: to understand operations using negative numbers
Indirect: to prepare for pre-algebra concepts

Materials

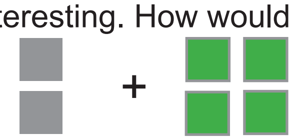
Set of operational signs, set of tiles that are green on one side and gray on the other, picture set of green skittles, picture set of gray skittles, slips of paper, teacher created negative number line or you may use the coordinate plane board x-axis.

Presentation 1 - Addition and Subtraction (D 4-10)

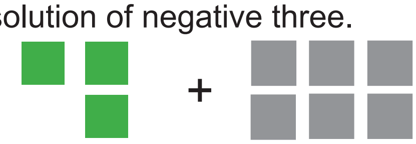
1. Invite the child to the lesson.
2. “Today, we are going to use a new piece of material. You will notice that these tiles are two sided. The green side represents a positive quantity and the gray side represents a negative quantity. “
3. Place 3 green sided tiles and five green sided tiles with a plus sign between them.



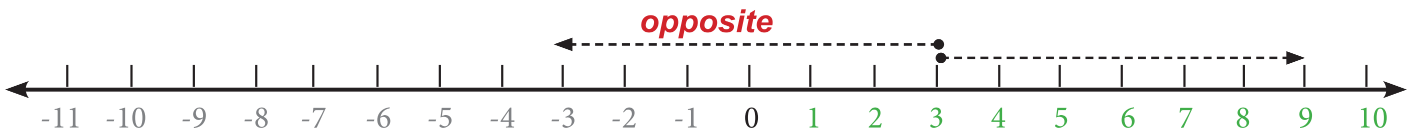
4. “This would be read as three plus five. Record this expression in your notebook and solve.”
5. Provide the next example using a subtraction sign and ask the child to record and solve. Seven minus five. Record 7 - 5 = 2
6. “What would happen if we took -4 + -3?”
7. Build the equation with the tiles.
8. “When we have a plus sign it means ‘put them together’. Grouping the -4 + -3 will give -7.”
9. “Record this equation in your math notebook.”
10. “Let’s make this a little more interesting. How would you read the following expression?”



11. “This is negative two plus positive 4. It is written as -2 + 4 or -2 + (+4). What do you think is the solution? If we take one negative tile and pair it with a positive tile, this is negative one plus positive one. They will cancel each other out and make a ***zero pair***.”
12. “The solution to the expression is two. Record this equation in your math notebook.”
13. Build the last equation and ask the child to solve. 3 + -6 =. Using the concept of zero pairs the child will arrive at the solution of negative three.

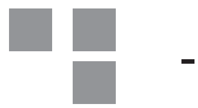


14. “On a number line it will look like this. I have three but I add six negatives. When I add I go to the right on a number line. I can also think of the negative sign as the opposite of addition.”

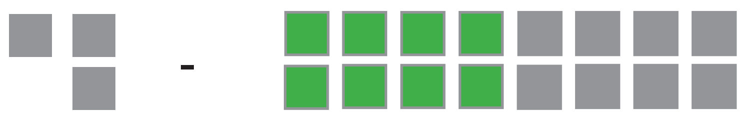


Presentation 2 - Adding Zero Pairs to Subtract a Positive (F 1-3)

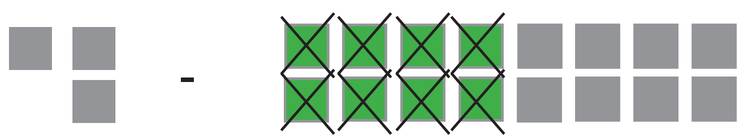
1. Invite the child to the lesson.
2. "Today, we are going to use our strategy of adding zero pairs to help us with a subtraction equation."
3. Build the following expression. -3 - 8.



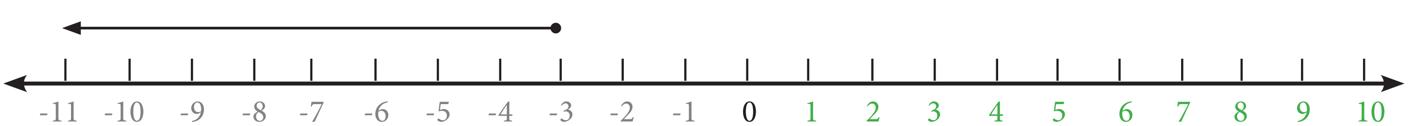
4. "We don't actually have eight positive to take away. However, if we add eight zero pairs it will not change anything."



5. "Now, we can take away the 8 positives. When we do that we are left with 11 negatives. Record this in your math notebook. "

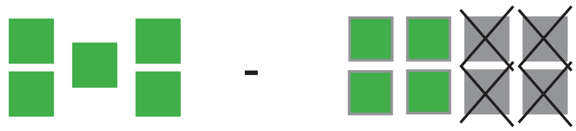


6. Bring out the number line. "We can also show this on the number line. When ever we add on the number line we move to the right a certain number of spaces. Whenever we subtract on the number line we move to the left a certain number of spaces."
7. "If we start at -3 on the number line and we need to subtract 8, that means we will move to the left eight spaces."
8. Model this on the number line.
9. "When we count eight spaces to the left, we end up at -11.

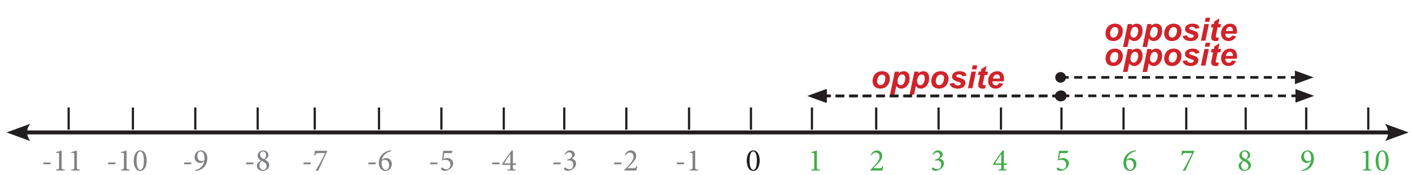


Presentation 3 - Subtracting a Negative Number (F 1-5)

1. Invite the child to the lesson.
2. "We can also use the same strategy of adding zero pairs when we have to subtract a negative number. Let's look at the expression of 5 - (-4)."
3. Build the positive five. "We, have positive five, but we do not have any negatives to take away. However, if we add zero pairs, it will not change the value of what we have."

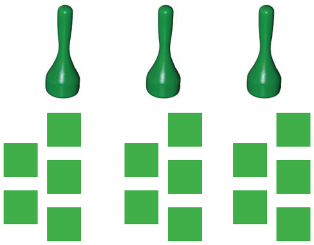


4. "This leaves us with +9. Record this equation in your math notebook."
5. "We can do this same problem with a number line. The only difference is that we are subtracting a negative number."
6. "Before, when we were subtracting, we moved to the left. We went in the ***opposite*** direction of addition. We can think of the negative sign as an ***opposite*** as well."
7. "We start at positive 5. We need to subtract so that means that we will go to the left in the opposite of addition. However, we have a negative, which is another opposite"
8. "So what we are doing is we are going ***opposite, opposite***. This will actually make us go to the right."
9. Model this on the number line.
10. "We see the same thing in language when we have double negatives. If I say "Sit!" I am telling you to sit (positive)."
11. "But if I say,"Do not sit!" I am saying I want you to stand, not sit (negative).
12. Now if I say, "Do NOT not sit!" I am saying I don't want you to stand, so I am back to saying sit (positive). So, two negatives make a positive."
13. As the child continues to work with negative numbers they will begin to formulate rules. Both visuals are used to help child to abstract these rules as some operations are easier with the number line, and some operations are easier with the tiles.

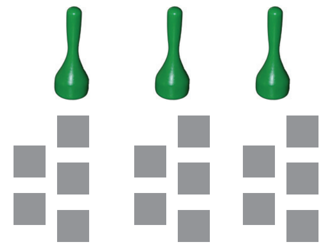


Presentation 4 - Division with Negative Integers (G 1-4)

1. Invite the child to the lesson.
2. “Remember, when we divided we used skittles to represent our divisor? The quotient was always what one whole unit received.”

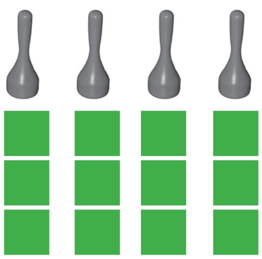


3. Model the following problem with the picture skittles and the tiles, fifteen divided by three. 15 ÷ 3
4. “Therefore, 15 ÷ 3 = 5. Record this in your math notebook.”
5. “This time, we are going to use our positive skittles to make the following problem. Negative fifteen divided by three. -15 ÷ 3.

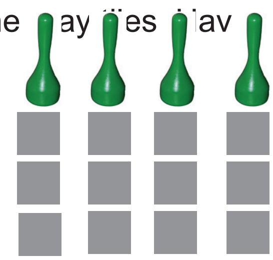


6. “The quotient in division is what one whole unit receives. Each unit skittle received -5. Record this in your math notebook.”

7. “This time we will do something different. Instead of using a positive skittle, we will use a negative skittle.”
8. Take out the picture of the negative skittle and use it to model the following problem. Twelve divided by negative four. 12 ÷ -4 =



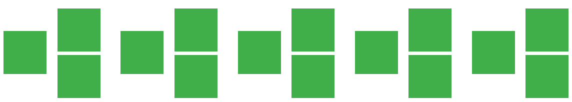
9. “We have a problem. The quotient is what one whole ***positive*** unit receives. This is not a positive unit. Remember, before when we were working with the number line? We said we could think of the negative sign as the ***opposite***. Let’s use that strategy here.”
10. “We need to take the opposite. So, if the quotient of one negative unit is positive three, then the quotient for one positive skittle would be negative three.
11. Replace the negative skittles with the picture of the positive skittles and replace the green tiles with the gray tiles. Have the child write this statement in their math notebook. 12 ÷ -4 = -3.



Presentation 5 - Multiplication with Negative Integers (G 5-10)

1. Invite the child to the lesson.
2. “When we are multiplying sets of negative numbers it is just like our lesson on multiplying sets of positive numbers. In the following problem, -3 x 4, we need to think of it as a set of -3 taken four times.”
3. Build that set with the tiles.

4. “So, a set of negative three taken four times equals negative twelve. Record this equation in your math notebook. -3 x 4 = -12.”
5. “Things look a little different in this next problem. Let’s say we have three taken negative five times 3 x -5. How can we take a set of three negative times.”
6. “For now, let’s just take a set of three five times.”



7. “Remember what we did before when we were working with a negative? We did the ***opposite.”***
8. “Let’s use that strategy again.”

9. Replace the green tiles with gray tiles and the solution becomes 3 x -5 = -15. Have the child record this in their math notebook.
10. “We have one other form of multiplication. Let’s take multiply a set of negative two by a set of negative four.” -2 x -4 =
11. “Again, we are unable to build a set of negative two negative four times. But for just this moment, let’s build a set of negative two, four times.”
12. “What strategy do you think we will use? Yes, we have a set of negative two taken four times and that equals negative eight.” -2 x 4 = -8.
13. “However, we need to take the set of negative two, negative four times. Let’s do the ***opposite***.”
14. Replace the gray tiles with the green tiles producing the following product. -2 x -4 = 8
15. Have the child record this equation in their math notebook.

Negative Numbers

Age

10-11 years

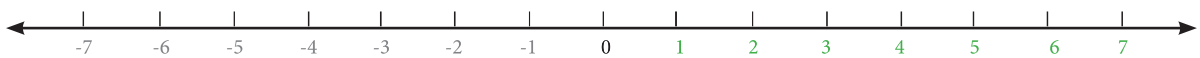
Aim

Direct: to recognize and place negative numbers in relation to positive numbers
Indirect: to understand the 4 operations with negative numbers

Materials

Number line with positive and negative numbers. You may use the coordinate plane board. Depending on which way you position it, you may use the x-axis or the y-axis

Presentation



1. Invite the child to the lesson.
2. "When people first started using numbers, they counted using what we call ***real*** numbers. These are the numbers that we see on our number line, starting at one."
3. Indicate this on the number line (x-axis) using the coordinate plane.
4. "Later, zero was added to the number system to be used as a place holder in different operations. This added the set of ***whole*** numbers to our classification of numbers."
5. "As traders, scribes, and merchants began to record their transactions, they discovered they needed to record amounts owed them. This brought about a new set of numbers, which we call negative numbers."
6. "Can you think of instances where negative numbers are used?" (temperatures below 0, money owed, elevation below sea level)
7. "When we place these values on a number line, they are on the opposite side of the positive numbers; just like the positive numbers, they go on infinitely. This gives us a new classification of numbers termed ***integers***."
8. Indicate the negative numbers on the number line.
9. "Remember, zero is neither positive nor negative."
10. "We can measure the space between any integer and zero. This is called the ***absolute value*** of a number."
11. "We record the absolute value of a number in this way, /8/, and say, 'The absolute value is 8'."

Using the Point-Slope Form to Write an Equation

Age

10-11 years

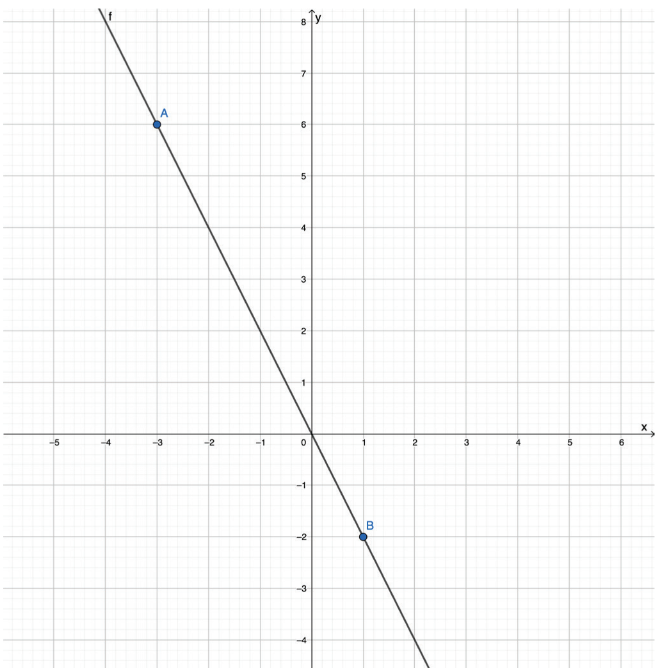
Aim

Direct: to write an equation of a line given two points through which the line passes
Indirect: to understand the use of the slope equation, and how to substitute values

Materials

The coordinate plane board.

Presentation



Given the task of figuring out the equation that represents a line, that passes through two given points we begin by looking at the slope equation:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Since the line passes through $(x_1 , y_1) = (-3 , 6)$ and point $(x_2 , y_2) = (1 , -2)$ its slope is

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 6}{1 - (-3)}$$

$$= \frac{-8}{4}$$

$$= -2$$

To find an equation of the line, use the point-slope form and then simplify:

$$y - y_1 = m(x - x_1)$$

$$y - 6 = -2(x - (-3))$$

$$y - 6 = -2(x + 3)$$

$$y - 6 = -2x + 6$$

Stop the presentation at this point.

$$y = 6 - 2x + 6$$

$$y = -2x + 12$$

Note:

1. It is important to remember that the point slope form $y - y_1 = m(x - x_1)$ has two minus signs. Make sure that the students understand that they need to account for these signs when the point (x_1, y_1) contains a negative number.
2. The point slope form of an equation can be used to represent a line. However, it is usually far more common to change the point-slope form into the slope-intercept form.

Changing from Point-Slope Form to Slope-Intercept Form

Age

10-11 years

Aim

Direct: to write an equation of a line given two points through which the line passes
Indirect: to understand the use of the slope-Intercept form instead of the point-slope form

Materials

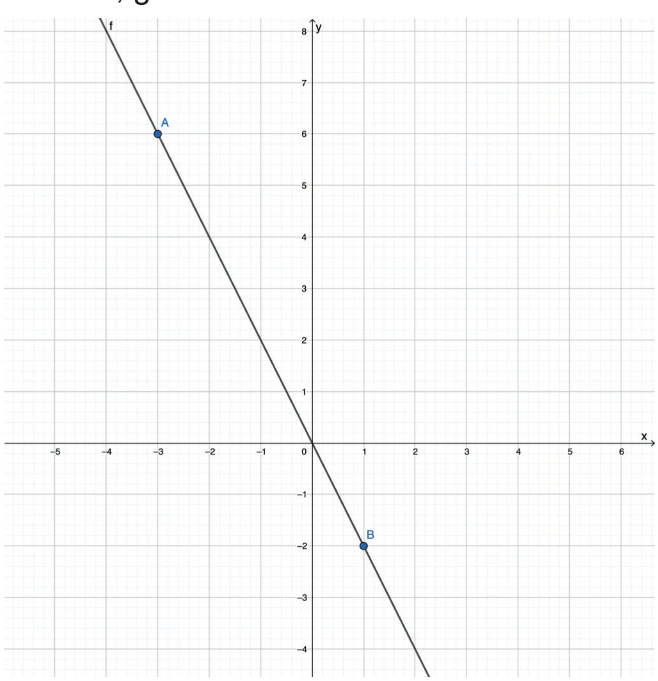
The coordinate plane board.

Presentation

This idea is very similar to the previous presentation. Looking at the same example we will try to place the equation in the traditional y-intercept form. That means that instead of stopping where we did in the previous presentation, we will continue until we bring the equation to look like this:

$$y = mx + b$$

So, given the same line:



Since the line passes through $(x_1 , y_1) = (-3 , 6)$
and point $(x_2 , y_2) = (1 , -2)$ its slope is

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 6}{1 - (-3)}$$

$$= \frac{-8}{4}$$

$$= -2$$

To find an equation of the line, use the point-slope form and then simplify:

$y - y_1 = m(x - x_1)$

$y - 6 = -2(x - (-3))$ Point-slope form

$y - 6 = -2(x + 3)$

$y - 6 = -2x + 6$ Distributive Property

$y = 6 - 2x + 6$

$y = -2x + 12$ Slope-intercept form

Follow-up

Once the student has converted from the point-slope form to the slope-intercept form it is very easy to check their answer graphically. Using their coordinate board, they can graph the line and then use the slope to see where the line crosses the y-axis. Does it appear that the y-intercept is correct based on the values they have?

Answer Key

Card: A-01

1. (-2 , 5)
2. (3 , 2)
3. (-2 , -4)
4. (-4 , -2)
5. (5 , 4)
6. (-4 , 3)
7. (2 , -4)
8. (3 , -2)

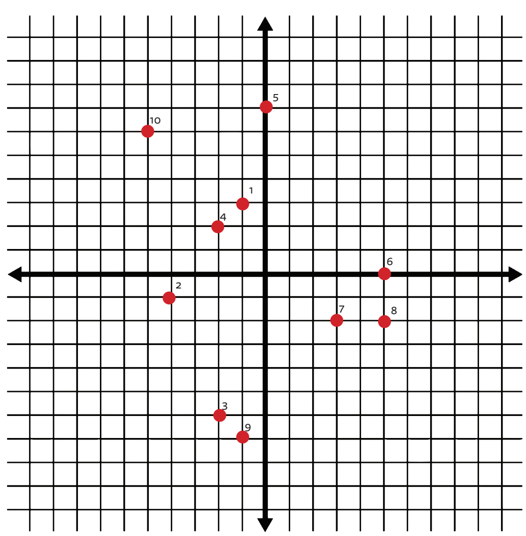
Card: A-02

1. Quadrant I
2. Quadrant IV
3. Quadrant I
4. Quadrant IV
5. Quadrant III
6. Quadrant II
7. Quadrant II
8. Quadrant III

Card: A-03

Names given to the points will vary.
1. Quadrant I
2. Quadrant II
3. Quadrant I
4. Quadrant IV
5. Quadrant IV
6. Quadrant III
7. Quadrant III
8. Quadrant II
9. Quadrant I
10. Quadrant IV

Card: A-04

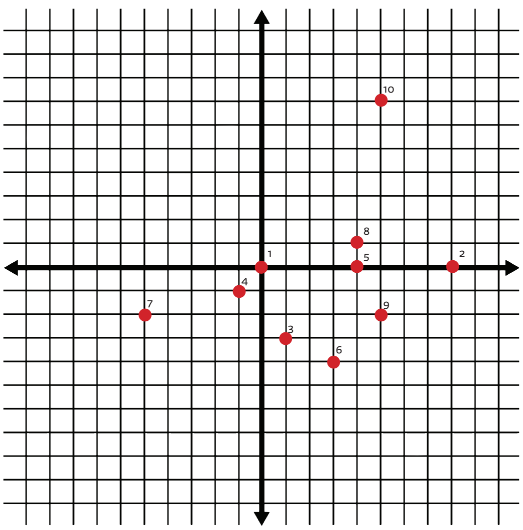


Card: A-05

Names given to the points will vary.

1. Quadrant I
2. Quadrant II
3. Quadrant IV
4. Quadrant III
5. Quadrant III
6. Quadrant II
7. Quadrant III
8. Quadrant IV
9. Quadrant IV
10. Quadrant II

Card: A-06



Card: A-07

1. F
2. J
3. N
4. A
5. C
6. H
7. L
8. B
9. E
10. M
11. I
12. K
13. D
14. G

Card: A-08

1. (-3, -6)
2. (0 -6)
3. (5 , 0)

Card: A-09

1. Quadrant III
2. Quadrant I
3. Found on the y-axis
4. Quadrant I or Quadrant II
5. Quadrant IV
6. Quadrant II

Card: A-10

1. Triangle
2. Parallelogram
3. Triangle
4. Square
5. Triangle

Card: A-11

1. (0 , 5)
2. (-1 , -2)
3. (3 , -4)
4. (6 , 6)
5. (-7 , -8)

Card: A-12

Answers will vary. However, common answers are:

1. Translation, or the figure shifted to the right
2. Translation, or the figure shifted down
3. Dilation, or the figure increased in size
4. Dilation, or the figure increased in size

Card: A-13

Answers will vary

Card: A-14

Simple point plotting. This work may be done in a group or individually. Have the student show you the work, and identify each point.

Card: A-15

Review of concept presented in card A-14. Use the same approach.

Card: A-16

1. Above, left
2. Below, right
3. Below, left
4. Above, right
5. Above, left

Card: B-01

(1 , 2) (2 , 3) (3 , 4) (4 , 5) (5 , 6) (6 , 7) (7 , 8)

Card: B-02

(0 , 8) (-1 , 6) (-2 , 4) (-3 , 2) (-4 , 0) (-5 , -2) (-6 , -4)

Card: B-03

(-8 , -9) (-6 , -6) (-4 , -3) (-2 , 0) (2 , 6) (4 , 9)

Card: B-04

(-9 , 9) (-5 , 5) (-1 , 1) (3 , -3) (7 , -7) (11 , -11)

Card: B-05

(-10 , -6) (-7 , -3) (-4 , 0) (-1 , 3) (2 , 6) (5 , 9)

Card: B-06

1 up and 1 over

Card: B-07

1. 3 up and 3 over
2. 3 up and 3 over

Slope: $slope = \frac{3}{3} = \frac{1}{1} = 1$

Card: B-08

2 up and 3 over
2 up and 3 over

Slope: $slope = \frac{2}{3}$

Card: B-09

1. 4 up and over 1
2. 4 up and over 1

$$slope = \frac{4}{1} = 4$$

Card: A-10

1. 2 up and over 5
2. 2 up and over 5

Card: A-11

1. 1 down and over 1

$$slope = \frac{-1}{1} = -1$$

Card: A-12

1. 3 down and over 4
2. 3 down and over 4

$$slope = \frac{-3}{4}$$

Card: A-13

Answers will vary. However, common answers are:

1. 5 down and over 2
2. 5 down and over 2

$$slope = \frac{-5}{2}$$

Card: A-14

1. 2 down and over 6
2. 2 down and over 6

$$slope = \frac{-2}{6} = \frac{-1}{3}$$

Card: A-15

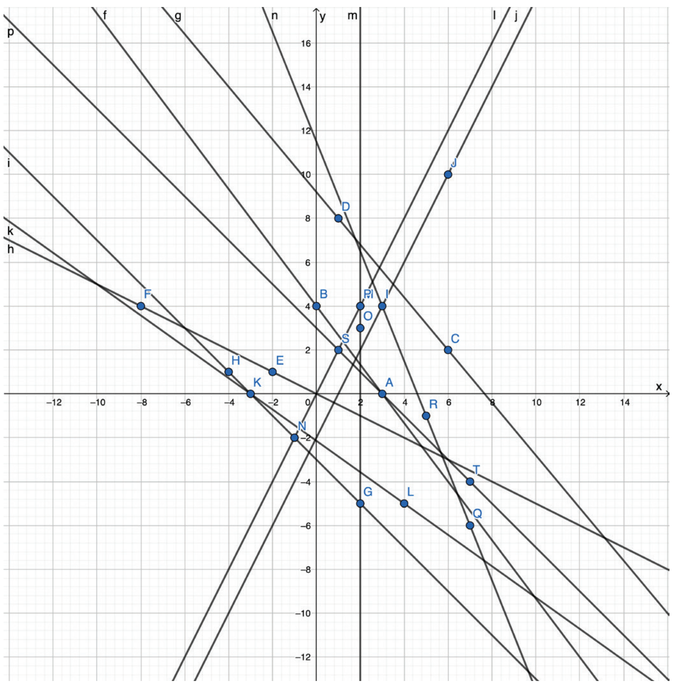
1. 1 down and over 5
2. 1 down and over 5

$$slope = \frac{-1}{5}$$

Card: B-16

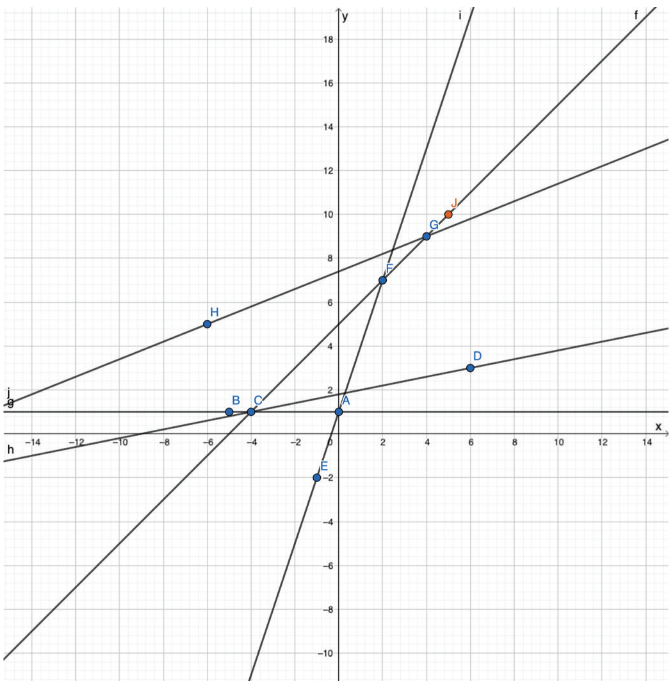
1. $\frac{6}{8} = \frac{3}{4}$
2. $\frac{-5}{6}$
3. $\frac{-10}{3}$
4. $\frac{-6}{6}$ $or - 1$

Card: B-17



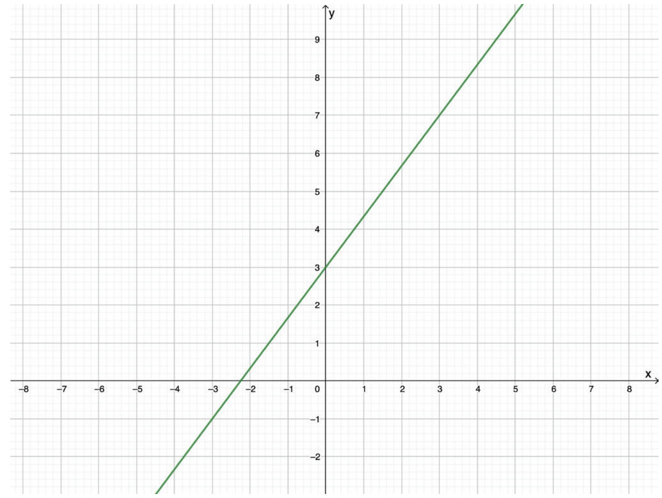
1. $\frac{5}{3}$
2. $\frac{-6}{5}$
3. $\frac{-3}{6} = \frac{-1}{3}$
4. $\frac{-6}{6} = \frac{-1}{1} = -1$
5. $\frac{6}{3} = \frac{2}{1} = 2$
6. $\frac{-5}{7}$
7. $\frac{6}{3} = \frac{2}{1} = 2$
8. $vertical\ \ line\ \ \frac{4-3}{2-2} = \frac{1}{0}\ \ undefined$
9. $\frac{-5}{2}$
10. $-\frac{6}{6} = -1$

Card: B-18



1. $\frac{1-1}{-5-0} = \frac{0}{-5}$
2. $\frac{3-1}{6-(-4)} = \frac{2}{10} = \frac{1}{5}$
3. $\frac{7-(-2)}{2-(-1)} = \frac{9}{3} = \frac{3}{1} = 3$
4. $\frac{5-9}{-6-4} = \frac{-4}{-10} = \frac{4}{10} = \frac{2}{5}$
5. $\frac{10-7}{5-2} = \frac{3}{3} = \frac{1}{1} = 1$

Card: C-01



1. $\frac{4}{1} = 4$

2. positive

3. 3

4. (0,3)

Card: C-02

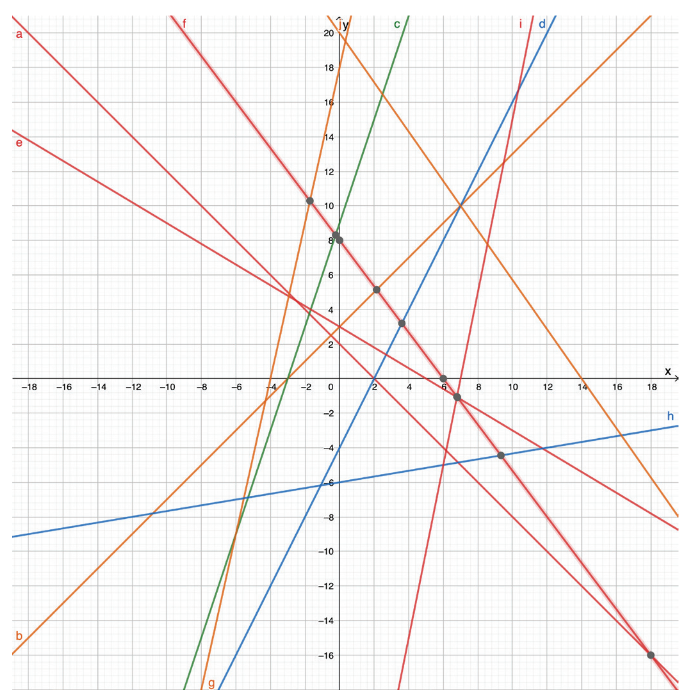
a. x = 4
b. x = 3
c. x = -21
d. x = -12

Card: C-03

a. x = -2
b. x = 26
c. x = 4
d. x = 5

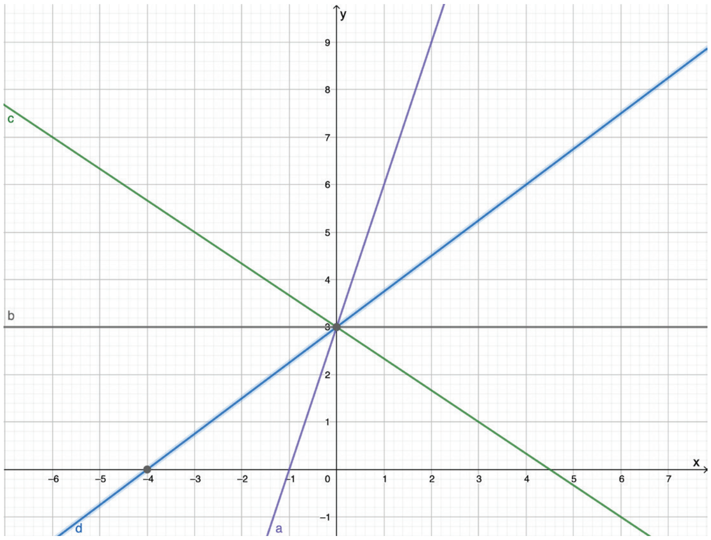
Card: C-04

	x-intercept	y-intercept
a.	(2,0)	(0,2)
b.	(-3,0)	(0,3)
c.	(-3,0)	(0,9)
d.	(2,0)	(0,-4)
e.	(5,0)	(0,3)
f.	(6,0)	(0,8)
g.	(-4,0)	(0,18)
h.	(36,0)	(0,-6)
i.	(7,0)	(0,-35)
j.	(-14,0)	(0,-20)

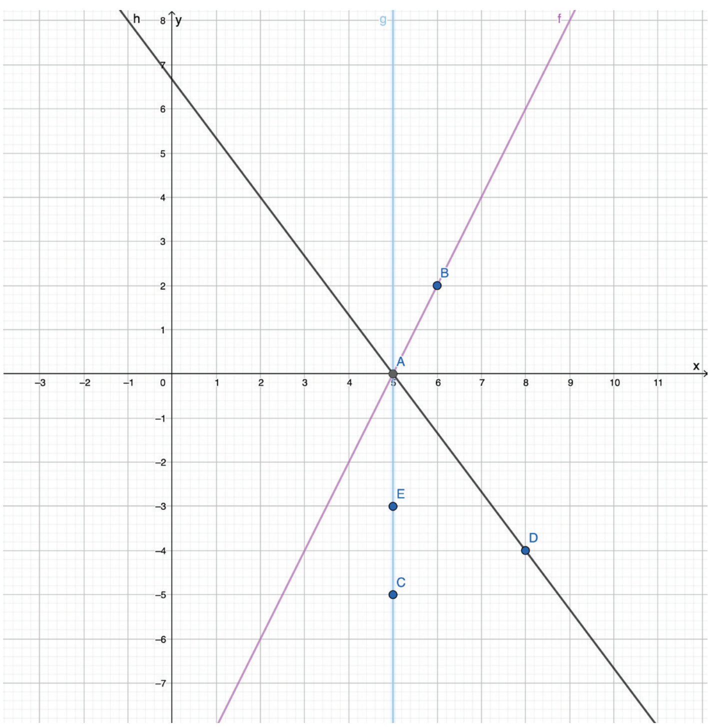


t

Card: C-05

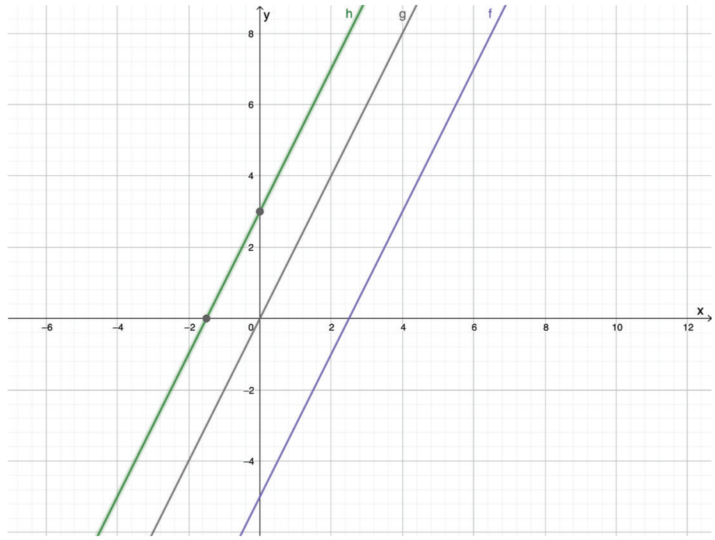


Card: C-06

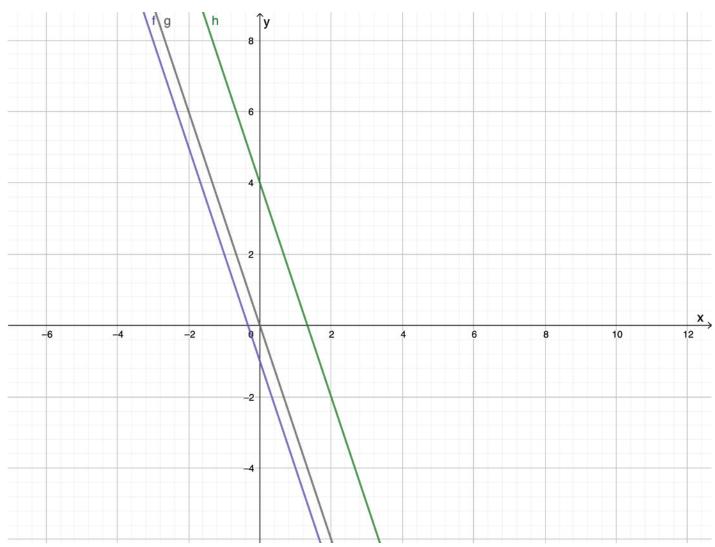


Card: C-07

Group 1
Lines are parallel with a positive slope

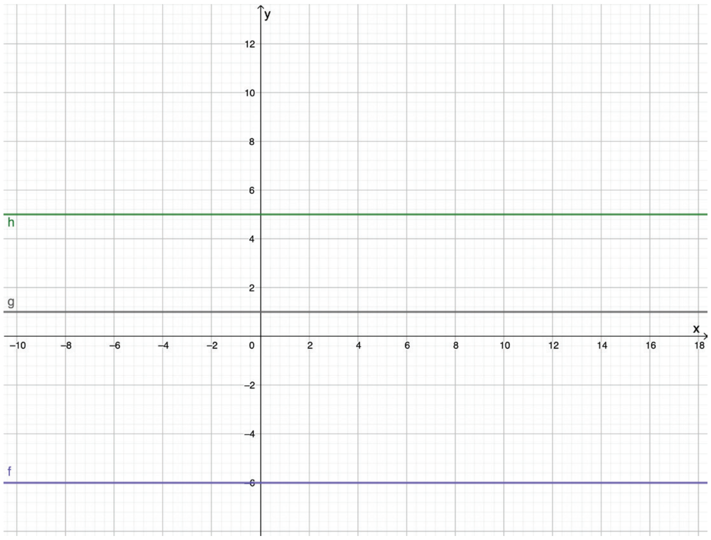


Group 2
Lines are parallel with a negative slope



Group 3

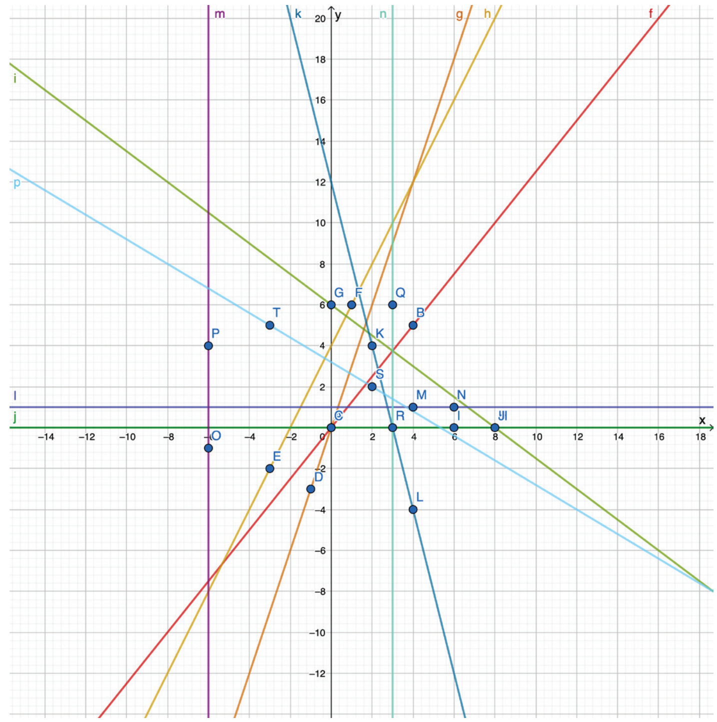
Lines are parallel with 0 slope



Card: C-08

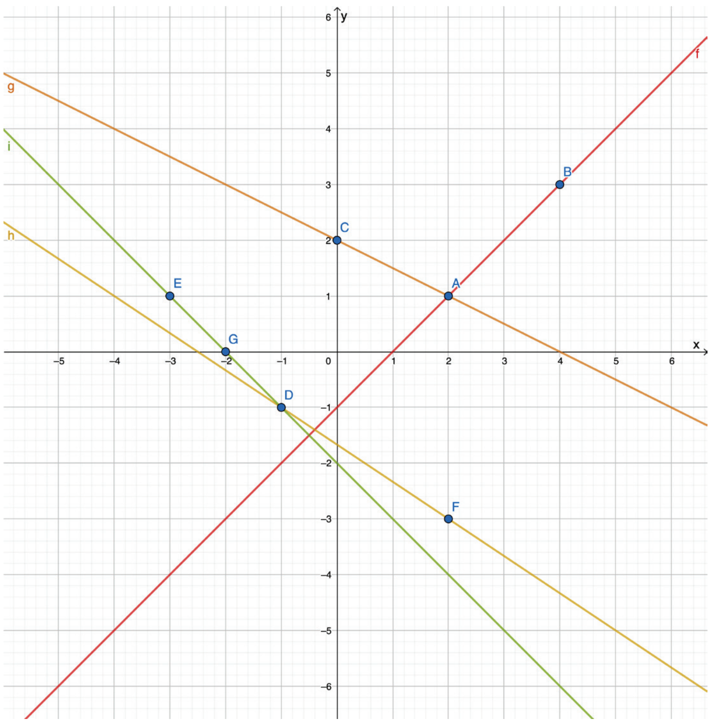
1. Slope 2 and y-intercept -3
2. Slope 6 and y-intercept 3
3. Slope 7 and y-intercept -2
4. Slope 2 and y-intercept 1
5. Slope -3 and y-intercept 3
6. Slope -1 and y-intercept 0
7. Slope -1 and y-intercept 4
8. Slope 4 and y-intercept 7
9. Slope -1 and y-intercept -4
10. Slope 5 and y-intercept -3

Card: C-09



1. $\frac{4}{1} = 4$
2. $m = \frac{3}{1} = 3$
3. $m = \frac{8}{4} = 2$
4. $m = \frac{-6}{8} = \frac{-3}{4}$
5. $m = 0$
6. $m = \frac{-8}{2} = -4$
7. $m = 0$
8. $m = undefined$
9. $m = undefined$
10. $m = \frac{-3}{5}$

Card: C-10



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