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Common Core
8th Grade Math
Volume I

by

Robert F. Loftus, MSLIS
Systems Librarian
Baldwinsville Public Library
Baldwinsville, NY

Introduction

This booklet employs a very linear approach to the Common Core Math 8 standards. Each standard is presented in the same order and language used in the New York State p-12 Common Core Learning Standards for Mathematics, which were published by the New York State Education Department. Interpretive paragraphs and examples are offered, along with links to instructional materials.

The Common Core Learning Standards are arranged into *Conceptual Categories*, *Domains*, *Clusters, Standards*, and sometimes *Standards components*. This is a hierarchical sorting system. You may remember the mnemonic from high-school: “Kings play chess on funny green squares”; with the “funny green squares” referring to the family, genus and species of a particular animal. In the Common Core learning standards, Domains, Clusters and Standards are your funny green squares, or -more directly- Domains are to Clusters and Standards as Family is to Genus and Species.

The *Appendix: Resources* section provides explanations of how to use resources from websites cited in this document, all of which are Open Source or Public Domain sites that do not require a subscription. Some of the textbooks cited are older, but 8th grade math and algebra has not changed significantly in the last 100 years, and carefully selected passages from older textbooks can still be very helpful. Where possible, links to a variety of instructional materials are offered to meet the learning needs of different students. It isn't necessary for a student to work through every link, but the student should keep working through the materials until they are confident they've mastered the standard concept.

Content

The order in which standards are addressed in this guide may seem slightly erratic. New York State advises that certain standards be addressed later in the school year, after students have been given an opportunity to master all preliminary material. All of the material addressed in this guide coincides with the selection of content outlined in the *State University of New York Educator's Guide to the Regents Examination in Math 8*. You will also notice some minor variations in how some of the standards are labeled when reviewing linked material. The systems used to label standards vary slightly by state, but the overall content structure remains constant. This guide covers the *Expressions and Equations and Functions* sections of the Math 8 standards.

Each section includes a *Conceptual Category* (shown centered and underlined in 14 pt type), a *Content Domain* (left-justified, Bold 14 pt type), the relative *Clusters* (12 pt bold text) and the *individual standards* (numbered alpha-numerically in the format “x-x.x”), some entries also include standard components, which are labeled with “a, b, c, etc...” Explanatory language and links to online resources follow the individual standards.

PDF copies of this study guide are available from the Baldwinsville Public Library website at:

http://www.bville.lib.ny.us/content/pdf_handouts/CC8mathV1.pdf

Writing a study guide like this will always involve some amount of trial and error. Although I have done my best to ensure accuracy, the reader may occasionally encounter small errors in the text, or be aware of other examples or materials which may be more effective. I am eager to hear from both math educators and students who have suggestions on how to improve this guide. Please direct your comments to the author's e-mail at: robertl@bville.lib.ny.us

<u>Expressions and Equations</u>

Work with radicals and integer exponents

8.EE.1: **Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, 3^2 x 3^{-5} = 3^{-3} = $1/3^3$ = 1/27.** This standard refers to dealing with *Properties of Exponents*, and knowing how to apply those properties to manipulate the form of an equation:

Properties of Exponents

- **Multiplication Through Addition of Exponents**: $a^m\,x\,a^n = a^{m+n}$

  $a^2 \times a^3 = a^5$

  $x^a \times x^b = x^{a+b}$

  $m^c \times m^{-d} = m^{c-d}$

- **Division Through Subtraction of Exponents**: $a^m \div a^n = a^{m-n}$

  $a^7 \div a^4 = a^3$

  $a^q \div a^r = a^{q-r}$

  $a^f \div a^{-g} = a^{f+g}$

- **Raising Powers of Exponents**: $(a^m)^n = a^{mn}$

  $(a^3)^4 = a^7$

  $(a^x)^y = a^{xy}$

- **Negative Exponents Property**: $a^{-m} = \frac{1}{a^m}$

  $(a^m)^{-n} = a^{\frac{m}{n}}$

- **Zero Exponent Property**: $a^0 = 1$

Resources related to this standard:

- **CK12.org: Whole Number Exponents**

  http://www.ck12.org/arithmetic/Whole-Number-Exponents/

- **Khan Academy: Properties of Exponents**
  https://www.khanacademy.org/math/pre-algebra/exponents-radicals/exponent-properties/v/exponent-rules-part-1

8.EE.3: Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as *3×10^8* and the population of the world as *7×10^9*, and determine that the world population is more than 20 times larger.

Large numbers can be represented as powers of 10. This means that a number like 328,000 can be written as 3.28×10^5.

$$10^1 = 10$$

$$10^2 = 10 x 10 = 100$$

$$10^3 = 10 x 10 x 10 = 1000$$

and this pattern continues to infinity

So 3.28×10^5 = 3.28 (10 x 10 x 10 x 10 x 10) or 3.28 (100,000) or 328,000. When you're multiplying by your power of ten, the number of digits following the leading integer (the number to the left of the decimal point) will equal the power that you're multiplying to, so 10^2 = 2 zeros after the 1, or 100; 10^4 = 4 zeros after the 1 or 10,000; 10^6 = 6 zeros after the 1 or 1,000,000, etc.

You can also use this method to multiply or divide very large numbers. Instead of writing:

you would write $4.5 x 10^5 x 20$

which becomes $4.5 \times 20 \times 10^5$

which equals $90 x 10^5$ or $9 x 10^6$

And for division problems:

$750{,}000 \div 25$ you would write $75 x 10^3 \div 25$

which equals $3 x 10^3$

Resources related to this standard:

- **CK12.org: Mental math to multiply by whole number powers of ten**
  http://www.ck12.org/arithmetic/Mental-Math-to-Multiply-by-Whole-Number-Powers-of-Ten/?by=all&difficulty=all

- **Khan Academy: Multiplying by powers of ten**
  https://www.khanacademy.org/math/cc-fifth-grade-math/cc-5th-place-value-decimals-top/cc-5th-mult-powers-of-10/e/powers-of-ten

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8.EE.4: Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Scientific notation is a specific application of the same principle that was addressed in 8.EE.3. Scientists frequently have to deal with numbers that describe incredibly large or small quantities. The distance from the Earth to the Sun is estimated to be 92,960,000 miles, or 9.296×10^7 miles. The diameter of an electron is described as 2.82×10^{-13} centimeters. In scientific notation, numbers are represented using a *leading digit* between 1 and 9. The leading digit is the number left of the decimal point. *Trailing digits* are numbers to the right of the decimal point.

5280 feet per mile becomes 5.28×10^3 feet per mile

128 ounces per gallon becomes 1.28×10^2 ounces per gallon

746 coulombs per horsepower-second becomes 7.46×10^2 coulombs

An example of a problem using scientific notation: An antique trolley has two electric wheel motors, and each wheel motor has a metal label that reads "Max Load: 8.04×10^5 coulombs per minute". Given the information above about comparing coulombs to horsepower-seconds, what was the maximum continuous output of each of these motors in horsepower, when they were new?

1 coulomb is 1 watt-second, and there are 60 seconds per minute so:

$$8.04\, x\, 10^5 \div 6.0\, x\, 10 = 1.34\, x\, 10^4$$

To simplify the problem we change *1.34 x 10*^{4} to *13.4 x 10*^{3}

$$13.4\, x\, 10^3 \div 7.46\, x\, 10^2 = 1.79\, x\, 10$$

or 17.9 horsepower

Online resources related to this standard:

- **CK12.org: Scientific Notation**
  http://www.ck12.org/algebra/Scientific-Notation/

- **Khan Academy: Scientific Notation**
  https://www.khanacademy.org/math/cc-eighth-grade-math/cc-8th-numbers-operations/cc-8th-scientific-notation/v/scientific-notation

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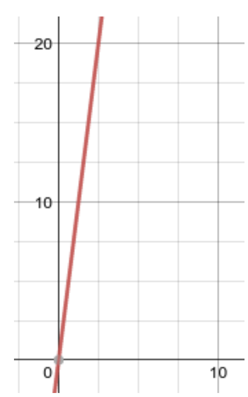
Understand the connections between proportional relationships, lines, and linear equations.

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. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

A *unit rate* is a comparison of two quantities, where one of the quantities is set to 1. A common example of a unit rate is the phrase "miles per hour", which is a description of how much distance would be covered if you maintained a given speed for one hours time. The prices you see in the meats and produce sections of a grocery store -where goods are often priced in dollars per pound- are another. Graphs may be used to show the range of values that satisfy the parameters of a mathematical relationship.

The time it took for a solar powered trawler to cover a distance of 20 nautical miles is shown in the graph at the right. Another solar powered trawler covered the same distance at an average speed of 9 knots (1 *knot* equals 1 nautical mile per hour). Which trawler moved at the faster speed?



Trawler speed

Looking at the graph you notice that the space between 0 and 10 is broken up into four units, meaning each unit must equal 2.5, which means where y = 20, the value for x must be 2.5. Therefore, the speed shown on the graph must equal $\frac{20}{2.5} = \frac{40}{5}$ = 8 knots. The second solar powered trawler moved at an average speed of 9 knots, so the second boat was faster. We can confirm this by checking $\frac{20}{9}$ which may also be written as $20 \div 9 = 2.2\overline{2}$, which is less than the 2.5 hours that the first boat required.

Online resources related to this standard

- **CK12.org: Rates of change**
  http://www.ck12.org/ccss/grade-8/expressions-and-equations
- Khan Academy: Comparing proportional relationships
  https://www.khanacademy.org/math/cc-seventh-grade-math/cc-7th-ratio-proportion/cc-7th-proportional-rel/v/comparing-proportional-relationships

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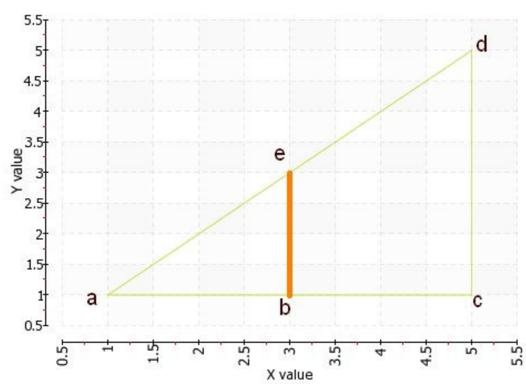
8.EE.6: Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b.

In the triangle shown at the right, $\overline{ae}$ is a section of $\overline{ad}$. From looking at the graph, you can find the points a, e and d:



a = (1, 1)
e = (3, 3)
d = (5, 5)

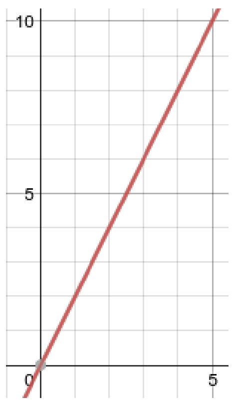
To show the slope of a line you use the equation: $\frac{y_2 - y_1}{x_2 - x_1}$ where your x_2 and y_2 values represent the coordinates of your second point, and x_1 and y_1 are the coordinates of your first point. In this case, we need to show that $m\,\overline{ae} = m\,\overline{ad}$. To find the $m\,\overline{ae}$ we calculate:

x	2x	y
0	2 x 0	0
1	2 x 1	2
2	2 x 2	4
3	2 x 3	6

$\frac{3-1}{3-1}=\frac{2}{2}=1$. To find $m\,\overline{ad}$: $\frac{5-1}{5-1}=\frac{4}{4}=1$. Any two line segments that have the same slope and share a common point are part of the same line.

The equation of a line may be represented in the form *y = mx,* which means that you can find values for y, by multiplying values along your *x-axis* by m. You begin graphing such an equation by creating a table of x and y values. At right is the table for y = 2x.

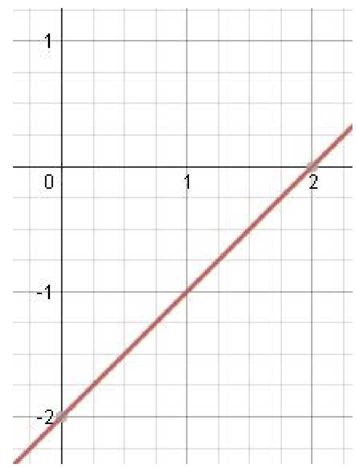
As you can see, we've created a series of x and y values that can now be plotted onto a graph. The graph below illustrates what this equation looks like.



y = 2x

A line won't always cross the origin of the graph. In these cases, you will have a value which is added to the equation *y = mx*, so it becomes *y = mx + b*. The value of *b* is the value of y-coordinate, where the line crosses the x-axis. If you have the equation y = x - 2, you can find the coordinates of the expression by creating a table of values.

x	x - 2=y
0	0 - 2 =-2
1	1 - 2 =-1
2	0 - 2 = 0
3	3 - 2 =1



y = x - 2

Once you've created the table of values, plot your points on a graph, and draw a line connecting the points, to get the graph with the caption *y=x-2*.

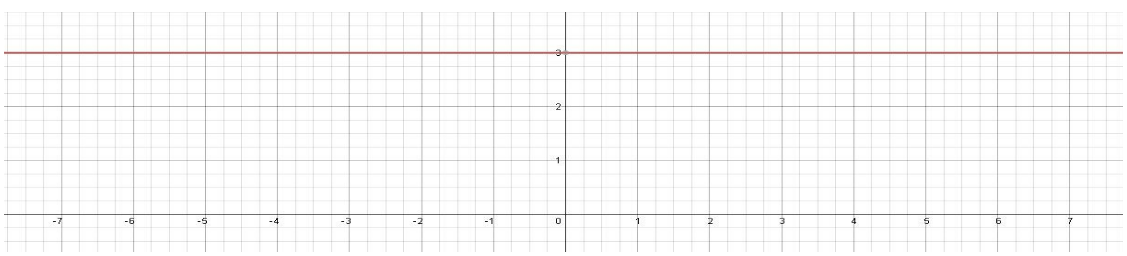
Online resources related to this standard

- CK12.org: http://www.ck12.org/algebra/Slope-of-a-Line-Using-Two-Points/?by=all&difficulty=all
- Khan Academy: https://www.khanacademy.org/math/algebra/linear-equations-and-inequalitie/graphing-slope-intercept/v/graphing-a-line-in-slope-intercept-form

Solve linear equations in one variable:

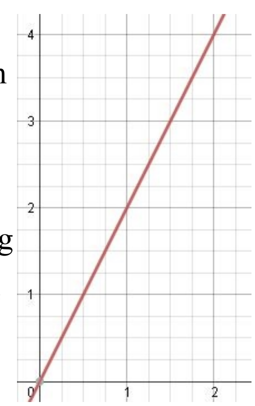
8.EE.7a) Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers).

An example of a linear equation with one solution is $x = 2$. You can multiply both sides to make it $3x = 6$, but no matter how you manipulate the equation you always come back to $x = 2$. Anytime you see an equation of the form *variable = integer*, you have a linear equation with one solution. When graphed these equations become straight horizontal or vertical lines. If x = 2, then x will equal 2 regardless of your y-value, likewise, if you have an equation with the solution y= 3, y will always equal three, regardless of what value of x you plug into the equation.



When y=3, y will always equal 3, regardless of the value of x.

An equation with infinitely many solutions is one that represents a mathematical relationship that extends to infinity, such as the equation $y = 2x$, which is shown in the graph to the left. Because the equation describes a relationship or ratio of values, and neither x nor y are tied to any specific integer value, there's no practical limit on the number of possible solutions. Even though we're only graphing a tiny little portion of the line, the possible solution set to the equation $y=2x$ is a line that extends into infinity.



$y = 2x$

An equation with no solutions is one that simply doesn't make mathematical sense, such as $3a + 5 = 3a$. There's no value in the rational number system that will make such an equation work.

Online resources related to this standard:

- **CK12.org**: 8.EE.c.7.a (scroll down the page to find it) http://www.ck12.org/ccss/grade-8/expressions-and-equations

- **Khan Academy**: Linear equations with one, zero or infinite solutions (scroll down)
  https://www.khanacademy.org/commoncore/grade-8-EE

8.EE.7b) Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

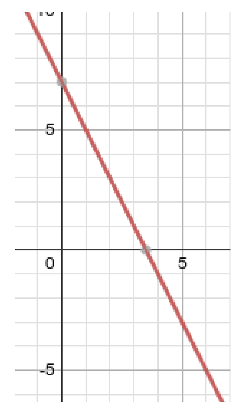
A linear equation with a rational number coefficient is one where the equation describes a straight line, and the numbers that precede the variables are all rational. In the equation 4x + 2y = 14, the coefficient of x is 4, and the coefficient of y is 2. To simplify graphing the equation, put it into slope-intercept form:

4x + 2y = 14 > subtract 4x from both sides to get

2y = 14 - 4x > divide both sides by 2 to simplify the equation - thi is what the standard is referring to as the Distributive Property. When you divide by 2 to find the value of x, you must divide all of the value in the equation by 2, so as to maintain the relation between values.

x	7 - 2x = y
0	7 - 2(0) = 7
1	7 - 2(1) = 5
2	7 - 2(2) = 3
3	7 -2(3) = 1
4	7 - 2(4) = -1

Create a table of value so the equation may be graphed. At left if a table of values for x = 0 through x = 4. At the right is the graph for this range of value.



y = 7 - 2x

Online resources related to this standard:

- **CK12.org:** 8.EE.C.7.b (scroll down the page to find the lesson)
  http://www.ck12.org/ccss/grade-8/expressions-and-equations
- **Khan Academy:** Solving equation with distribution
  https://www.khanacademy.org/math/cc-eighth-grade-math/cc-8th-solving-equations

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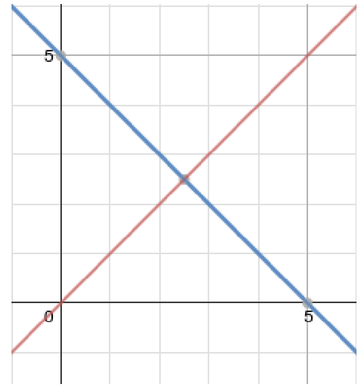
Analyze and solve pairs of simultaneous linear equations.

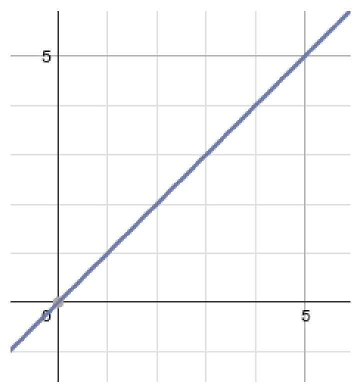
8.EE.8a) Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.



The set of equations y=x and y=5-x have one solution

When you graph a line you are creating a representation of all the points in the coordinate plane that satisfy that equation. In a system of equations you have two lines to graph on the coordinate plane. The point(s) where the two lines intersect represent the pair of coordinates that are a common element in both solution sets. A system of equations may have only one solution - such as when you are graphing two straight lines with different slopes, an infinite number of solutions - such as when you have two equations that are multiple instances of the same line, or no solutions - if the two lines are parallel and therefore have no common points because they never intersect.

The lines y=x and y=x+3 are parallel, and therefore they have no points of interesction, and therefore no solution.



The lines y=x and x=y are two instances of the same line, and therefore have an infinite number of solutions.

Online resources related to this standard:

- **CK12.org:** http://www.ck12.org/algebra/Systems-of-Linear-Equations-in-Two-Variables/

- **Khan Academy:** https://www.khanacademy.org/math/algebra/systems-of-eq-and-ineq/systems-of-eq-overview/v/trolls-tolls-and-systems-of-equations

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8.EE.8b) Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x + 2y = 5 and 3x + 2y = 6 have no solution because 3x + 2y cannot simultaneously be 5 and 6.

Systems of linear equations can be solved graphically, by the addition of equations, or through substitution. Dealing with equations graphically was described in the prior standard. Solving systems through addition involves multiplying equations so they have like coefficients, then using addition or subtraction to isolate variables. Solving through substitution involves substituting one variable into an equation and solving the equation mathematically.

Solving through addition:

$3x + 2y = 4$ $2x - 3x = 7$	$3(3x + 2y = 4)$ $2(2x - 3y = 7)$	$9x + 6y = 12$ $4x - 6y = 14$ $13x = 26$ $x = 2$

Once the value of x has been isolated, it's possible to find the solution by substituting x=2 into either of the equations: *3(2) + 2y = 4 > 6 + 2y = 4 > 2y = -2 > y = -1*

Solving through substitution requires isolating one variable, then adding that value to the equation and solving mathematically.

- *7x + y = 15*
  - *3x - y = 5*
  - *y - 3x = -5*
  - *y = 3x - 5*
  - *7x + y = 15*
  - *7x + 3x - 5 = 15*

- $10x = 20$

- $x = 2$
    - $7(2) + y = 15$
    - $14 + y = 15$
    - $y = 1$

Online resources related to this standard

- **CK12.org: 8.EE.C.8.B (scroll down)**
  http://www.ck12.org/ccss/grade-8/expressions-and-equations
- **Khan Academy:**
  https://www.khanacademy.org/math/algebra/systems-of-eq-and-ineq/systems-of-eq-overview/v/king-s-cupcakes-solving-systems-by-elimination

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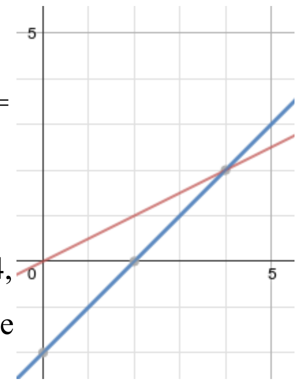
8.EE.8c) Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Two construction teams use materials at different rates. Team number one starts at 8am and uses 0.5 pallets of timber per hour. Team number two start two hours later, but has more people and uses 1 pallet of timber per hour. Graph the rate at which the two teams use materials, and find the time when the two teams will have used the same quantity of materials.



As you can see in the graph at the left, the first equation translates to y = 1/2x. The second team uses 1 pallet of materials per hour, which translates to y = x, because the number of pallets of materials equals the number of hours they work, but because they started two hours later, their graph starts at y = -2. Looking at the graph you can see that the two lines appear to intersect where x=4, which suggests it took 4 hours for the two groups to reach the point where they've used the same amount of materials.

Online resources related to this standard

- **CK12.org:** http://www.ck12.org/book/CK-12-Basic-Algebra-Concepts/r13/section/7.0/Systems-of-Equations-and-Inequalities-%253A%253Aof%253A%253A-CK-12-Basic-Algebra-Concepts/
- **Khan Academy:** https://www.khanacademy.org/math/algebra/systems-of-eq-and-ineq/fast-systems-of-equations/v/solving-linear-systems-by-graphing

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Functions

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.

A function is a system where for each input, three is exactly one output. Think of the produce scale at your grocery store. It measures the weight of your fruits or vegetables, multiplies that weight by the price per pound or *unit price* of the item you're purchasing, and produces a purchase price. In this system, the purchase price is the *fixed value,* because it is a set value that remains constant regardless of variations in the weight of the items. The weight of the items you're purchasing is the *input* or *independent variable*, because the value is a condition of how much of an item you choose to purchase. The purchase price is the output of the function, and may also be referred to as your *dependent variable*, because the quantity of this value depends upon the quantities of the other variables. Each weight multiplied by each unit price produces a single purchase price. You will not get a different purchase price unless you change either the unit price, or the amount of product being purchased.

The Domain of a function is the range of all the x-coordinates available in a given problem. In the case of our fruits and vegetables example, the domain would range from zero -no purchase- to the weight of all of the fruits or vegetables of any one type available on the store shelf. Your fixed value -the price- determines the slope of your graph - your *m-value*. The output of the equation is your set of y-coordinates - which represent the purchase prices associated with buying various weights of the product. The description you've just read is what is meant by the phrase $y = f(x)$: your range of y-values equals your fixed variable multiplied by the range of possible input values. This may be illustrated with a table of values:

lbs of potatoes	0	1	2	3	4	independent variable
Price	$0.72/lb	$0.72/lb	$0.72/lb	$0.72/lb	$0.72/lb	fixed variable
cost	0	$0.72	$1.44	$2.16	$2.88	output

IF you were to graph this relationship, the “lbs of potatoes” would be along your x-axis. The price would be the slope of your graph, and the cost would by your set of y-values, or the output of your function.

Online resources related to this standard

- **CK12.org: Graphs of linear functions**
  http://www.ck12.org/algebra/Graphs-of-Linear-Functions/
- **Khan Academy: Graphing and analyzing linear functions**
  https://www.khanacademy.org/math/algebra/linear-equations-and-inequalitie/coordinate-plane/v/graphing-points-and-naming-quadrants-exercise

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8.F.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

Did you notice how in the description of 8.F.1 we took a verbal description of a situation, then converted that into a table of values that could be graphed by completing a series of simple math problems? Or how in earlier standards you looked at comparisons of graphs to measurements such as “miles per hour” to determine which boat was moving faster? That's all this standard wants you to be able to do. You need to practice reading different representations of data, and creating graphs from verbal descriptions and tables of values, so that you'll be able to make accurate comparisons between different functions. Remember that a function may be represented either as a verbal description, a math problem, a table of values or a graph. It is important to be able to translate between these different types of data.

We'll break the process of comparing data down into four steps:

Step 1: Read a verbal description of a problem and translate it into a function

Step 2: Use the function writing process to describe how to create a series of simple math problems that will allow you to fill out a table of values.

Step 3: Create a graph of the data -if necessary- to aid in comparison

Step 4: Compare the output of the two functions

Successful achievement of this standard involves being able to move backwards or forwards through this process of four steps, so you'll be able to make effective comparisons of data.

A function is described by In the triangle shown at the right, $\overline{ae}$ is a section of $\overline{ad}$. From looking at the graph, you can find the points a, e and d:

a = (1, 1)

e = (3, 3)

d = (5, 5)

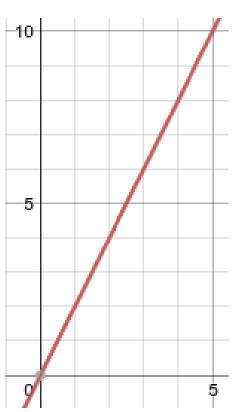
x	2x	y
0	2 x 0	0
1	2 x 1	2
2	2 x 2	4
3	2 x 3	6

To show the slope of a line you use the equation: $\frac{y_2 - y_1}{x_2 - x_1}$ where your x_2 and y_2 values represent the coordinates of your second point, and x_1 and y_1 are the coordinates of your first point. In this case, we need to show that $m\,\overline{ae} = m\,\overline{ad}$. To find the $m\,\overline{ae}$ we calculate:

$\frac{3-1}{3-1} = \frac{2}{2} = 1$. To find $m\,\overline{ad}$: $\frac{5-1}{5-1} = \frac{4}{4} = 1$. Any two line segments that have the same slope and share a common point are part of the same line.

The equation of a line may be represented in the form *y = mx,* which means that you can find values for y, by multiplying values along your *x-axis* by m. You begin graphing such an equation by creating a table of x and y values. At right is the table for y = 2x.

As you can see, we've created a series of x and y values that can now be plotted onto a graph. The graph below illustrates what this equation looks like.



the equation $y = 1.5x + 3$, another function is represented using the following table of values, which function has the greater rate of change?

x	0	1	2	3	4
y	3	4.25	5.5	6.75	8

Looking at the first equation we see it has a slope of 1.5. In the second, looking at the degree of difference as the values of x change by 1, you should notice that the rate of change equals 1.25, so it's obvious that the first equation has the greater rate of change. You can confirm this by creating a table of values for the first equation and comparing.

y = 1.5x + 3

x	0	1	2	3	4
y	3	4.5	6	7.5	9

Online resources related to this standard:

- **CK12.org: Linear functions and graphs**
  http://www.ck12.org/book/CK-12-Middle-School-Math-Concepts-Grade-8/section/9.0/
- **Khan Academy: Coordinate plane word problem exercises**
  https://www.khanacademy.org/math/algebra/linear-equations-and-inequalitie/coordinate-plane/v/coordinate-plane-word-problems-exercise

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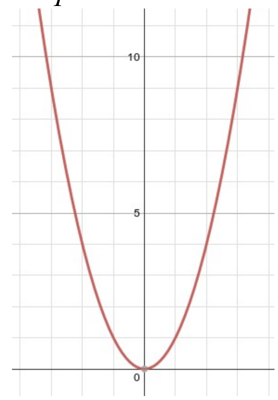
8.F.3: Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

The form $y=mx + b$ is referred to as slope-intercept form. When you put an equation into slope intercept form, you can get an idea of what the shape of the graph is.

If the value of x in $y=mx+b$ is to the first power, then the graph of the equation will be a straight line. If x is to the second power, then the graph will be a parabola. Parabolas represent squared relationships, such as graphs of the area of a geometric figure. Figure such as squares and circles, whose areas are a product of the length of the side, or the diameter of the figure have area graphs that are parabolic.

The graph of $y = x^2$ is a parabola.



Online resources related to this standard:

- **CK12.org:** https://ck12.org/algebra/Graphs-of-Linear-Equations/
- **Khan Academy:** https://www.khanacademy.org/math/algebra/linear-equations-and-inequalitie/graphing-slope-intercept/v/graphing-a-line-in-slope-intercept-form

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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.

In real life there are situation that can be modeled using linear functions. These kinds of relationships are very common when it comes to billing for services. You should be able to identify the domain -what the equation describes- and range -how much of what the function describes- of a function.

Mark is having his computer repaired. When he gets to the computer repair shop he sees a sign that reads: "PC Virus Removal: $40 flat rate for the first hour, $20 each additional hour." Create an equation that describes this relationship.

- Since we know the price for each additional hour is $20, we know the total must equal some amount plus $20 x time in hours or 20t.
- $40 is the flat rate for the first hour. When a company says a fee is a flat rate, that means that you're basically paying $40 for the item to be taken across the counter and set on the work-

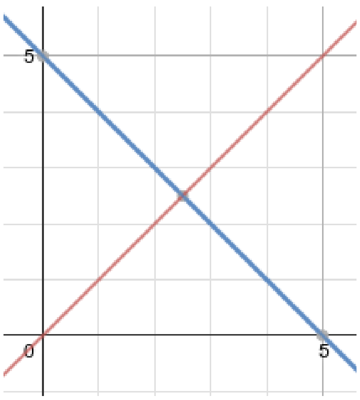
bench, so this is the point we'll start with: $40,

- adding the *rate x time* to that gives us: Fee = $40 + $20t.

You can also model relationships on a graph by filling out a set of points, then visually interpreting the equation from the graph.

x	y
0	5
3	2
5	0

x	y
0	0
3	3
5	5



Graphing out the points from the two tables above, shows two lines, one that crosses the x-axis and has the equation *y=x*, and *y=5-x*.

Online resources related to this standard:

- **CK12.org:** http://www.ck12.org/algebra/Domain-and-Range-of-a-Function/
- **Khan Academy:** https://www.khanacademy.org/math/algebra/algebra-functions/domain_and_range/v/domain-and-range-of-a-function

8.F.5: Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

This standard involves being able to describe the nature of a relationship by looking at a graph or table of values. Look back at the graph of the two crossing lines used in 8.F.4. The student should be able to look at the graph, recognize that one of the lines crosses the y-axis at 0, and the other line crosses the y-axis at 5. You should also be able to recognize that the line that crosses the graph at the origin has a slope of $m=1$, and the line which crosses the *y-axis* at $y=5$ has a slope of -1. Furthermore, from inspecting the graph you should be able to recognize that the two lines appear to intersect each other at the point (2.5, 2.5).

You should also be able to recognize when a graph represents a linear relationship, and when a graph represents a linear relationship, and when it represents a squared relationship. When an equation is put into slope-intercept form, if the exponent value of x equals 1, then the relationship is a linear equation. If the exponent of x equals 2, then it's a squared relationship and the graph will be a parabola.

Online resources related to this standard:

- **CK12.org:** http://www.ck12.org/algebra/Linear-Exponential-and-Quadratic-Models/
- **Khan Academy:** https://www.khanacademy.org/math/algebra/algebra-functions/graphing_functions/v/graphing-exponential-functions

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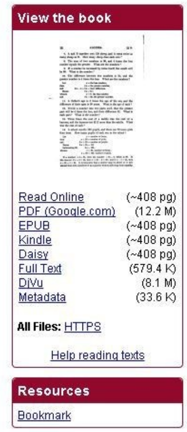
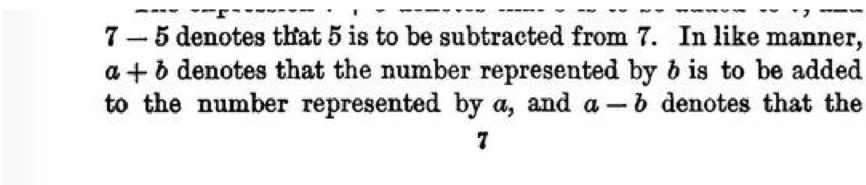
Appendix: Resources

Users Left versus Screen Left: When referring to navigation of web-pages, you'll see references to *Users Left or Right*. This is similar to Stage directions for an ac ***Read Online*** tor. Users Left refers to your left as you're facing the screen.

Archive.org textbooks: All of the Archive.org links in this booklet will refer you to the Archive.org catalog page for that title. Clicking on the *Read Online* link will open the book in your browser window. Right clicking on the PDF link will open a drop-down menu with a *Save As* option, so you can keep a copy of the book for your own use. The EPUB, Kindle, Daisy and DjVu links are for use with assorted e-reader devices. It is important to note the difference between the printed page number, and the file page number with these documents. In this handout, the page number that's given will always refer to the printed page number that appears at the bottom of the scanned page, rather than the file page number. This is because the file page number can vary depending upon the format of the file.




7 — 5 denotes that 5 is to be subtracted from 7. In like manner, $a + b$ denotes that the number represented by b is to be added to the number represented by a, and $a - b$ denotes that the

7

The printed page number appears at the bottom of the scanned page. The file page number can vary by formats. This example was taken from the *Read Online* version of the file, the printed page 7 is on file page 13.

CK12.org links

On the CK12.org pages you'll see headings for each standard, over tables that are labeled with various sub-topics within that standard. On some of the pages clicking on the sub-topic will open up a practice test. Other times you'll get print reference materials or instructional videos. In cases where multiple standards are referenced on a single page, it's best to help avoid confusion by not skipping ahead, and reviewing videos, texts and quizzes related to prior standards when you feel you need a review.

Khan Academy Videos

On the Khan Academy pages you'll a navigation bar to the Users left of the video screen. Links to instructional videos are marked by an icon that looks like a

VCR play button, along with the video title. Khan Academy groups videos by subject, so all of the videos in a set are usually related to the standard being addressed. In some cases there will be a note telling you to focus on particular videos and to skip over others. On some of the pages you'll see videos that relate to more than one standard. It's recommended that you only concern yourself with the videos related to the standard you're currently working on, and go back to earlier videos if you feel you need to review those concepts.

Many of the Khan Academy links will take you to a quiz page. If you look in the lower right hand of the quiz window you'll see a link that's marked *"Stuck? Watch a Video"*, which will provide additional instruction on the topic.