

4.1

Variation

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Direct Variation

- Variation is an equation that relates one variable to one or more other variables.
- In *direct variation*, the values of the two related variables increase or decrease together.
- If a variable y varies directly with a variable x , then

$$y = kx$$

where k is the **constant of proportionality** (or the variation constant).

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Example

The weight on the Earth of an object varies directly to its weight on the moon. If an astronaut weighs 155 lbs on the Earth and 24.8 lbs on the Moon. How much would a 85 pound dog weigh on the Moon?

$$W_M = gW_E$$

$$24.8 = g155$$

$$0.16 = g$$

$$W_M = gW_E$$

$$W_M = (0.16)85$$

$$W_M = 13.6$$

The dog would weigh 13.6 pounds on the Moon.

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Inverse Variation

- When two quantities vary inversely, as one quantity increases, the other quantity decreases, and vice versa.
- If a variable y varies inversely with a variable, x , then

$$y = \frac{k}{x}$$

where k is the *constant of proportionality*.

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Example

The string on a musical instrument vibrates at a frequency that varies inversely with its length. So a longer string vibrates slower than a shorter string. If a 1.5 foot piano string vibrates at 187.5 cycles per second. What is the frequency of a 3 foot string?

$$f = \frac{k}{l}$$

$$187.5 = \frac{k}{1.5}$$

$$1.5(187.5) = k$$

$$281.25 = k$$

$$f = \frac{k}{l}$$

$$f = \frac{281.25}{3}$$

$$f = 93.75$$

So the string will vibrate at a frequency of 93.75 cycles per second.

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Joint Variation

- One quantity may vary directly as the product of two or more other quantities.
- The general form of a joint variation, where y , varies directly as x and z , is

$$y = kxz$$

where k is the *constant of proportionality*.

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Example

With Simple Interest, the interest will vary jointly with the principal & time. If \$2500 is put into an account for 3 years and earns \$262.50, how much will be earned in 7 years?

$$I = rPt \qquad I = rPt$$

$$262.50 = r(2500)(3) \qquad I = (0.035)(2500)(7)$$

$$262.5/7500 = r \qquad I = 612.5$$

$$0.035 = r$$

The amount of interest earned in 7 years is \$612.5.

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Combined Variation, example

The force needed to keep a car from skidding on a curve varies jointly with the weight of the car and the speed squared, and inversely with the radius of the curve. If 242 pounds of force would keep a 2000 pound car from skidding on a curve with a radius of 500 feet at 30 mph, what force would keep the same car from skidding on a curve with a radius of 750 feet going 50 mph?

$$f = \frac{kws^2}{r}$$

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Continued; If $f = 242$ when $w = 2000$, $s = 30$, and $r = 500$, find f when $w = 2000$, $s = 50$, and $r = 750$.

Find the constant of proportionality.

$$f = \frac{kws^2}{r}$$

$$242 = \frac{k(2000)(30)^2}{500}$$

Now find f .

$$f = \frac{kws^2}{r}$$

$$f = \frac{.0672(2000)(50)^2}{750}$$

$k = 0.0672$

$f = 448.1$ pounds of force

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4.2

Linear Inequalities

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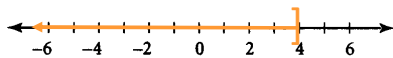
Symbols of Inequality

- $a < b$ means that a is less than b .
- $a \leq b$ means that a is less than or equal to b .
- $a > b$ means that a is greater than b .
- $a \geq b$ means that a is greater than or equal to b .
- Find the solution to an inequality by adding, subtracting, multiplying or dividing both sides by the same number or expression.
- **Important!** Change the direction of the inequality symbol when multiplying or dividing both sides of an inequality by a negative number.

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Example: Graphing

- Graph the solution set of $x \leq 4$, where x is a real number, on the number line.
- The numbers less than or equal to 4 are all the points on the number line to the left of 4 and 4 itself. The bracket at 4 shows that 4 is included in the solution set.



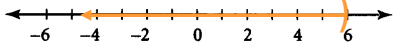
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Example: Solve and graph the solution

Solve $3x - 8 < 10$ and graph the solution set.

$$\begin{array}{l}
 3x - 8 < 10 \\
 3x - 8 + 8 < 10 + 8 \\
 3x < 18 \\
 \frac{3x}{3} < \frac{18}{3} \\
 x < 6
 \end{array}$$

The solution set is all real numbers less than 6.



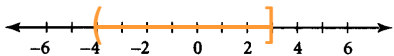
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Compound Inequality

Graph the solution set of the inequality $-4 < x \leq 3$

The solution set consists of all real numbers between -4 and 3, including the 3 but not the -4.



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Example

A student must have an average (the mean) on five tests that is greater than or equal to 85% but less than 92% to receive a final grade of B. Jamal's grade on the first four tests were 98%, 89%, 88%, and 93%. What range of grades on the fifth test will give him a B in the course?

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Continued: 85% but less than 92; first four tests were 98%, 89%, 88%, and 93%.

$$85 \leq \frac{98 + 89 + 88 + 93 + x}{5} < 92$$

$$85 \leq \frac{368 + x}{5} < 92$$

$$5(85) \leq 368 + x < 92(5)$$

$$425 \leq 368 + x < 460$$

$$425 - 368 \leq 368 - 368 + x < 460 - 368$$

$$57 \leq x < 92$$

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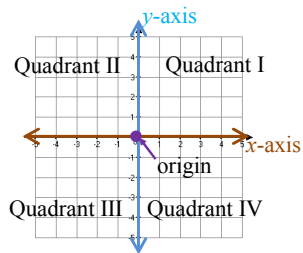
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Graphing Linear Equations

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Rectangular Coordinate System

- The horizontal line is called the **x-axis**.
- The vertical line is called the **y-axis**.
- The point of intersection is the **origin**.

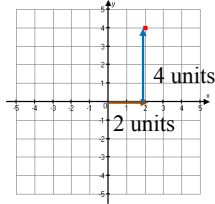


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Plotting Points

Each point in the xy -plane corresponds to a unique ordered pair (a, b) .

Plot the point $(2, 4)$.
 Move 2 units right
 Move 4 units up



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To Graph Equations by Plotting Points

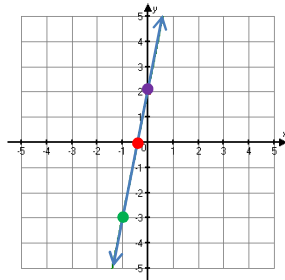
- Solve the equation for y .
- Select at least three values for x and find their corresponding values of y .
- Plot the points.
- The points should be in a straight line. Draw a line through the set of points and place arrow tips at both ends of the line.

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Graphing Linear Equations

Graph the equation
 $y = 5x + 2$

x	y
0	2
-2/5	0
-1	-3



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Graphing Using Intercepts

- The x-intercept is found by letting $y = 0$ and solving for x .

Example: $y = -3x + 6$
 $0 = -3x + 6$
 $-6 = -3x$
 $2 = x$, so the x-intercept is $(2, 0)$

- The y-intercept is found by letting $x = 0$ and solving for y .

Example: $y = -3x + 6$
 $y = -3(0) + 6$
 $y = 6$, so the y-intercept is $(0, 6)$

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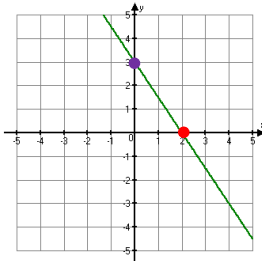
Example: Graph $3x + 2y = 6$

- Find the x-intercept.

$3x + 2y = 6$
 $3x + 2(0) = 6$
 $3x = 6$
 $x = 2$, the x-intercept is $(2, 0)$

- Find the y-intercept.

$3x + 2y = 6$
 $3(0) + 2y = 6$
 $2y = 6$
 $y = 3$, the y-intercept is $(0, 3)$



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Slope

The ratio of the vertical change to the horizontal change for any two points on the line.

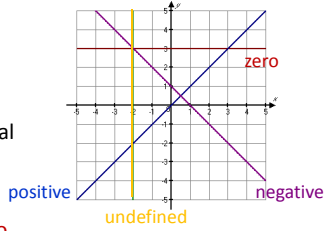
$$\text{Slope} = \frac{\text{vertical change}}{\text{horizontal change}}$$

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

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Types of Slope

- **Positive** slope rises from left to right.
- **Negative** slope falls from left to right.
- The slope of a vertical line is **undefined**.
- The slope of a horizontal line is **zero**.



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Example: Finding Slope

Find the slope of the line through the points:
(5, -3) and (-2, -3)

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

$$m = \frac{-3 - (-3)}{-2 - 5}$$

$$m = \frac{-3 + 3}{-7}$$

$$m = \frac{0}{-7} = 0$$

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The Slope-Intercept Form of a Line

Slope-Intercept Form of the Equation of the Line
 $y = mx + b$

where m is the **slope** of the line and $(0, b)$ is the **y-intercept** of the line.

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Graphing Equations by Using the Slope and y-Intercept

- Solve the equation for y to place the equation in **slope-intercept form**.
- Determine the **slope** and **y-intercept** from the equation.
- Plot the **y-intercept**.
- Obtain a second point using the **slope**.
- Draw a straight line through the points.

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Example

Graph $2x - 3y = 9$.
Write in **slope-intercept form**.

$$2x - 3y = 9$$

$$-3y = -2x + 9$$

The **y-intercept** is $(0, -3)$
and the **slope** is $2/3$.

$$\frac{-3y}{-3} = \frac{-2x}{-3} + \frac{9}{-3}$$

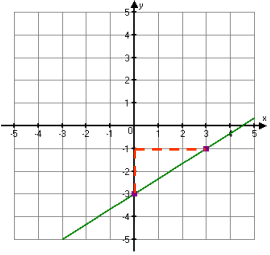
$$y = \frac{2}{3}x - 3$$

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Example continued

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

Plot a point at $(0, -3)$ on the y -axis, then move **up 2** units and to the **right 3** units.



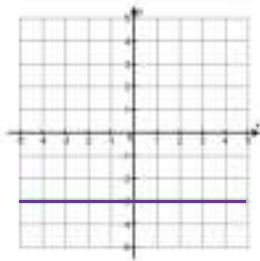
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Horizontal Lines

Graph $y = -3$.

y is always equal to -3 , the value of y can never be 0 .

The graph is parallel to the x -axis.



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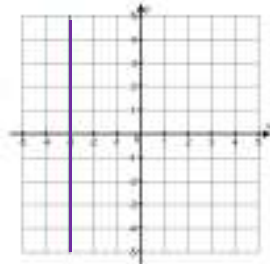
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Vertical Lines

Graph $x = -3$.

x always equals -3 , the value of x can never be 0 .

The graph is parallel to the y -axis.



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Audio will start on the hour.

There are some good graphing calculators online.

The PDF of the PowerPoint is at: www.ramshillfarm.com/Math/Math150/Unit_4.htm

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Final Project Information

The PDF of this PowerPoint, Final Project Information video & more are on my site http://www.ramshillfarm.com/Math/Math150/Unit_6.html

- a) Found under Final Project in Units 6, 7, & 8
 - i. with examples
 - ii. A different example in Unit 9
- b) Must be in MS Word or MS PPT format.
- c) 5 pages or slides, **includes** Title & Reference Slides!
- d) Select a topic in the course and discuss a potential application for this concept in your chosen profession.

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