Unit Calendar

<table>
<thead>
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<th>Topic</th>
<th>Homework</th>
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<td>Nov 5 (A)</td>
<td>6.1 Solving Linear Inequalities +/-</td>
<td>6.1-6.3 HW worksheet (drilling holes/crossword puzzle)</td>
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<td>6.2 Solving Linear Inequalities x/÷</td>
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<td>4.3 Worksheet (purpose of HW/did you hear about)</td>
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Vocabulary: inequality, equivalent inequalities, solution of an inequality, quadrant, standard rom, linear function, x-intercept, y-intercept, slope, rate of change, slope-intercept form, parallel, direct variation, constant of variation, parent linear function

SOLs:

A.5 The student will solve multistep linear inequalities in two variables, including
   b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets;
   c) solving real-world problems involving inequalities.

A.7 The student will investigate and analyze function (linear) families and their characteristics both algebraically and graphically, including
   d) x- and y-intercepts;
   f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.

A.8 The student, given a situation in a real-world context, will analyze a relation to determine whether a direct or inverse variation exists, and represent a direct variation algebraically and graphically and an inverse variation algebraically.

Textbook reference: Chapter 6, sections 1-3, Chapter 4
Introduction to Inequalities

An inequality is a mathematical sentence that uses an inequality symbol to compare the values of two expressions. The word inequality means not equal.

The table shows some of the meanings for the inequality symbols.

<table>
<thead>
<tr>
<th></th>
<th>&lt;</th>
<th>&gt;</th>
<th>≤</th>
<th>≥</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>is less than</td>
<td>is greater than</td>
<td>is less than or equal to</td>
<td>is greater than or equal to</td>
</tr>
<tr>
<td></td>
<td>is fewer than</td>
<td>is more than</td>
<td>is no more than</td>
<td>is no less than</td>
</tr>
<tr>
<td></td>
<td>exceeds</td>
<td></td>
<td>is at most</td>
<td>is at least</td>
</tr>
</tbody>
</table>

Verbal Phrase | Inequality | Graph
---|---|---
All real numbers less than 2 | < 2 |  |
All real numbers greater than −2 | > −2 |  |
All real numbers less than or equal to 1 | ≤ 1 |  |
All real numbers greater than or equal to 0 | ≥ 0 |  |

***When you just want greater than or less than, you use a on the graph.***

***When you want equal to as well as greater than or less than, you use***

Try these:

1. \( x > 3 \)
2. \( x < -1 \)
3. \( x \geq 2 \)
4. \( x \leq 0 \)

STOP

What if an equation is not quite ready to graph? You already know how to get a variable by itself . . . that is just what you'll do here!!

Example: \( x + 3 < 10 \)

\[
\begin{align*}
-3 & \quad -3 \\
\hline
x & < 7
\end{align*}
\]

Undo the added 3 by subtracting 3 from both sides

\( x < 7 \) Easy!!
Another example: \[5x > 20\]

\[
\frac{5x}{5} > \frac{20}{5}
\]

\[x > 4\]

Easy!!

**Practice:**

More than 15,000 fans, \(f\), attended the football game last night.

Examples: Solve and **check**.

\[y + 5 > 11\]

\[-21 > d - 8\]

Solve and graph on a number line.

\[c - (-2) \leq 3\]

\[y < n - 2\]

A number, \(n\), decreased by 7 is at most 23.
** Multiplication and Division Properties of Equality introduce a new concept. **

**THE FLIPPER RULE**

When multiplying or dividing by a negative number, flip the inequality symbol.

So, when you multiply or divide both sides by a negative number, just flip the inequality!!

Watch:

\[-3x > 15\]

\[
\begin{align*}
\frac{-3x}{-3} &> \frac{15}{-3} \\
x &< -5
\end{align*}
\]

As soon as I divide by the negative number, I circle the inequality to remind me to change it on the next line!!

Check:

\[
\begin{align*}
\frac{x}{-4} &< -2 \\
\frac{-4}{1} \cdot \frac{x}{-4} &< -2(-4) \\
x &> 8
\end{align*}
\]

When I multiplied both sides by -4, I circled <!!

Circling the inequality helps me to remember to change the direction of the inequality.

Check:

You try. Solve and graph.
## Solving Multi-Step Inequalities

Multi-step inequalities are solved in the same way that one-step inequalities are solved. We use the **properties of inequality** to transform the original inequality into a series of simpler, equivalent inequalities.

1) Simplify each side of the inequality  
2) Add or subtract – Addition or Subtraction Properties of Inequality  
3) Multiply or divide to isolate the variable – Multiplication or Division Properties of Inequality (Remember FLIPPER!!)  
4) Check by substitution

Examples: Solve and graph.

1. $5x + 13 > 83$  

2. $2(n + 3) < -4$
13 > $\frac{-3}{4}x - 5$

Practice. Solve and graph.

$7 - 4a \leq 23$

$5x - 3 + 2x > 25$

$6x - 9 \leq 4x + 11$

$7 - \frac{n}{3} \geq 9$

$\frac{1}{3}x + 4 < 2$
The admission fee to the fair is $5 and each ride costs $2. How many rides, \( r \), can you go on if you have $20 to spend?

Dante’s cell phone company charges him $10 per month plus $0.05 for every minute or part of a minute of use. Dante wants his monthly bill to be under $20. What is the greatest number of minutes he can talk on his phone each month?

In a community garden, you want to fence in a vegetable garden that is adjacent to your friend’s garden. Your friend’s garden is 12 feet wide. You have at most 42 feet of fence. How wide can your garden be? (Remember the perimeter formula: \( P = 2l + 2w \))

**Inequalities with Special Solutions**

Sometimes solving an inequality gives a statement that is always true, such as \( 4 > 1 \). In that case, the solutions are all real numbers. If the statement is never true, as is \( 9 < 5 \), then the inequality has no solution.

Examples

What are the solutions of \( 10 - 8a \geq 2(5 - 4a) \)?

What are the solutions of \( 6m - 5 > 7m + 7 - m \)?
Label the Coordinate Plane with the following vocabulary terms:

<table>
<thead>
<tr>
<th>Coordinate Plane</th>
<th>X-axis</th>
<th>Y axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadrants 1-4</td>
<td>Origin</td>
<td>+/- values of each quadrant</td>
</tr>
</tbody>
</table>
Chapter 4-1: The Coordinate Plane and Ordered Pairs

The coordinate plane consists of a grid crossed by two perpendicular axes.

The horizontal axis is the x-axis. The vertical axis is the y-axis. The axes intersect at a right angle. They are perpendicular. The intersection of the two axes is called the origin.

The axes split the coordinate plane into 4 quadrants. The quadrants are numbered with roman numerals. (The numbering starts in the top right quadrant and goes counterclockwise).

An ordered pair is used to locate points on the coordinate plane. The first coordinate is the x value. The second coordinate is the y-value. Ordered pairs are written (x, y).

The origin is at (0, 0).

Graph each ordered pair on the coordinate system. Name the quadrant in which each point lies.

M: (3,4)  D: (-3,-1)  R: (-3,2)  K: (4, -2)  G: (2,0)
Examples: Write the coordinates for each of the points on the graph.

A:__________
B:__________
C:__________
D: ___________
E:___________
F:___________
Chapter 4-2: Graph Linear Equations

Standard Form of a linear equation is: \( Ax + By = C \). A linear function

A relation is a set of ordered pairs \((x, y)\). The domain is the set of input values (x coordinates). The range is the set of output values (y coordinates).

A function is a special type of relation where each input has only one output – for each \( x \) value, there is only one \( y \) value.
Eleanor stayed home from school yesterday because she had a fever. The graph below charts her temperature throughout the day. Think about Eleanor’s illness throughout the day. What happened to her fever? Did she get better or worse during the day? Why?

Does Eleanor’s temperature represent a relation? Why?

Is this a function? Why?

What is a reasonable domain?

A reasonable range?
A relation is a set of ordered pairs. The domain is the set of x-values (x coordinates). The range is the set of y-values (y coordinates).

In a function, each member in the domain is related to exactly one member in the range.

Use a table, a graph, or a picture to help you determine whether or not the relation is a function.

A table of values can be used to organize relations.

Example 1: Express this relation as a table.
\{(-2, 4), (0, 5), (1, 3), (1, -1), (2, 1)\}

\[
\begin{array}{c|c}
 x & y \\
\hline
-2 & 4 \\
0 & 5 \\
1 & 3 \\
1 & -1 \\
2 & 1 \\
\end{array}
\]

From the table, you can graph the relation using set notation.

Domain: \{x|x = \}

Range: \{y|y = \}
Express the relation \{(1, 4), (2, 2) (3, 0), (2, -2), (0, 2)\} as a table. Graph the relation. Determine the domain and range.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
</table>

Domain:

Range:

Express the relation, create a table of values, and graph the sets of ordered pairs for the equation \( y = 3x \), when \( x = -2, -1, 0, 1, 2 \). Determine the domain and range.

Relation: \{ }
Emily earns $5 an hour doing yard work. Suppose $x$ represents the number of hours that she works. Create a table for the amount of money Emily earns for 1, 2, 3, 4, and 5 hours of work. Graph the relation. Determine the domain and the range of the data.

Create a table of values and graph the sets of ordered pairs for the equation $x + y = 4$. Determine the domain and range.

Create a table of values and graph the sets of ordered pairs for the equation $y = 3x$. Determine the domain and range.
### Practice Graphing Linear Equations

For each of the following:

- Fill in the input/output table for each equation using the domain values.
- Graph the solutions, then connect them to create a line.

1. **x = y**

<table>
<thead>
<tr>
<th>x</th>
<th>y = x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph for x = y](image)

2. **y = 2x - 3**

<table>
<thead>
<tr>
<th>x</th>
<th>y = 2x - 3</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph for y = 2x - 3](image)

3. **2x + y = 3**

<table>
<thead>
<tr>
<th>x</th>
<th>2x + y = 3</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph for 2x + y = 3](image)
Chapter 4-4: Find Slope and Rate of Change

The Slope of a Line

The slope of something measures how steep it is.

Where do you find slopes in real life?

To measure the slope we measure the distance it goes up or down, over the distance it goes right or left.

Ex 1: Pretend the figure is a slide. It goes down 6 ft and right 12 ft.
Therefore the slope is:

Ex 2: Pretend the figure is a ramp. It goes up 2 ft and right 8 ft.
Therefore the slope is:

**Up and Right are positive directions
**Down and Left are negative directions

Ex 3: Find the slope between the points by counting up or down, then right or left.

a) (-2, -1) (1, 5) 

b) (0, 3) (4,1)
Some special slopes:

1) A line with a **positive** slope rises.

2) A line with a **negative** slope falls.

3) The slope of a **horizontal** line is **zero**.

4) The slope of a **vertical** line is **undefined**.
The Slope Formula

Using the slope formula is another way to determine the slope of a line through two given points. The slope of a line is the ratio of: \textbf{change in y} \quad \text{change in x} \\

\[ m \text{ represents the slope} \]

The slope formula is: 
\[ m = \frac{y_2 - y_1}{x_2 - x_1} \]

1) Find the slope of the line through points A and B: 
   a) by counting rise over run: 
   b) by using the formula: 

2) Find the slope of the line through points B and C: 
   a) by counting rise over run: 
   b) by using the formula: 

3) Find the slope of the line through points D and E: 
   a) by counting rise over run: 
   b) by using the formula:
Spencer – Algebra – Unit 4: Inequalities and Linear Equations

Practice. Find the slope of each line. (count rise over run)

Find the slope of the line through each pair of points using the formula.

a) (3, 5) and (7, 9)                b) (6, 8) and (1, 2)

c) (-2, -4) and (8, 1)             d) (5, 2) and (-1, -10)

e) (-4, 13) and (0, 1)             f) (-6, 7) and (2, -9)
Chapter 4-5: Graph Slope Using Slope-Intercept Form

Slope-Intercept Form of a Linear Equation

Slope-Intercept Form is a common way to write linear equations.

It is:

\[ y = mx + b \]

It is called that because the slope is the coefficient of \( x \), and the other term gives the \( y \)-intercept. **Slope-intercept form is also called function form.**

Video -- [http://www.youtube.com/watch?v=Yw4PdF-aMgA](http://www.youtube.com/watch?v=Yw4PdF-aMgA)

**Using the \( y \)-intercept and Slope to Graph Linear Equations**

To graph an equation that is written in function form:
1) Determine and graph the \( y \)-intercept (where \( x = 0 \)).
2) Use the slope ratio to graph one or two more points, starting from the \( y \)-intercept.
3) Use a straight edge to draw the line (with arrows).

Examples: Graph each equation.

a) \( y = 2x + 1 \)

\[ \text{y-intercept: } (0, 1) \]

\[ \text{slope ratio: } \frac{1}{2} \]

b) \( y = \frac{4}{5}x - 2 \)

\[ \text{y-intercept: } (0, -2) \]

\[ \text{slope ratio: } \frac{4}{5} \]
c) $y = -3x + 2$

y-intercept:

slope ratio:

d) $y = -\frac{1}{4}x$

y-intercept:

slope ratio:

Practice. Graph the line.

1) $y = \frac{7}{2}x - 2$

y-intercept:

slope ratio:

2) $y = -6x + 3$

y-intercept:

slope ratio:
3) \( y = \frac{6}{5}x + 1 \)  
\text{y-intercept:} \ 0 
\text{slope ratio:} \ \frac{6}{5} 

4) \( y = \frac{5}{3}x \)  
\text{y-intercept:} \ 0 
\text{slope ratio:} \ \frac{5}{3} 

Getting an equation in to slope-intercept form (solve for \( y \)): 

Remember your steps to isolate the variable!

1) Simplify each side: Use the distributive property and combine like terms.
2) Use the addition or subtraction properties of equality.
3) Use the multiplication or division properties of equality.

Examples: Rewrite the following equations so that \( y \) is a function of \( x \).

1) \( 2x + 3y = 6 \)  
2) \( 5 - y = 4x \)  
3) \( 4(2y + 3) + 3x = 7x \)  
4) \( 6y - 4x + 5 = 2x \)
Practice. Write the equation in slope-intercept form, then graph it.

1) \(7x + y = 5\)  

2) \(3x + 5y = -5\)  

3) \(6x + 5y = 20\)  

4) \(10x - 3y = 15\)
Horizontal and Vertical Lines

Graphing $y = b$

Graph the equation $y = -3$

The $y$-value is always -3, regardless of the value of $x$. The points (-1, -3), (0, -3), (2, -3) are some of the solutions of the equation.

The graph of the equation is a ________________ line _____ units below the $x$-axis.

Graphing $x = a$

Graph the equation $x = 5$.

The $x$-value is always 5, regardless of the value of $y$. The points (5, -2), (5, 0), (5, -6) are some of the solutions of the equation.

The graph of the equation is a ________________ line _____ units to the right of the $y$-axis.

Horizontal and Vertical Lines

Graphing $y = b$

Graph the equation $y = 5$

Graphing $x = a$

Graph the equation $x = -2$. 

Chapter 4-3 Graph Using Intercepts

An **x-intercept** of a graph is the coordinate of a point where the graph crosses the x-axis.

A **y-intercept** of a graph is the coordinate of a point where the graph crosses the y-axis.

Graph the equation $x + 2y = 4$.

**Solution**

**STEP 1** Find the intercepts.

\[
\begin{align*}
  x + 2y &= 4 \\
  x + 2(0) &= 4 \\
  x &= 4 \quad \leftarrow \quad \text{x-intercept} \\
  0 + 2y &= 4 \\
  y &= 2 \quad \leftarrow \quad \text{y-intercept}
\end{align*}
\]

**STEP 2** Plot points. The x-intercept is 4, so plot the point (4, 0). The y-intercept is 2, so plot the point (0, 2). Draw a line through the points.

**Practice:** Find the x and y intercepts of the following equations.

1. $3x + 2y = 6$
2. $4x - 2y = 10$
3. $-3x + 5y = -15$

Now, let’s use intercepts to graph an equation.

Graph the equation $x + 2y = 4$.

**Solution**

**STEP 1** Find the intercepts.

\[
\begin{align*}
  x + 2y &= 4 \\
  x + 2(0) &= 4 \\
  x &= 4 \quad \leftarrow \quad \text{x-intercept} \\
  0 + 2y &= 4 \\
  y &= 2 \quad \leftarrow \quad \text{y-intercept}
\end{align*}
\]

**STEP 2** Plot points. The x-intercept is 4, so plot the point (4, 0). The y-intercept is 2, so plot the point (0, 2). Draw a line through the points.
We can use a graph to find intercepts as well:

The graph crosses the \(x\)-axis at \((2, 0)\). The \(x\)-intercept is 2. The graph crosses the \(y\)-axis at \((0, -1)\). The \(y\)-intercept is \(-1\).

**X and Y Intercepts**

The **\(x\)-intercept** of a graph is where the graph crosses the **\(x\)-axis**. Where the graph crosses the \(x\)-axis, the \(y\) value is 0. Therefore, the \(x\)-intercept is identified as the point \((x, 0)\).

The **\(y\)-intercept** of a graph is where the graph crosses the **\(y\)-axis**. Where the graph crosses the \(y\)-axis, the \(x\) value is 0. Therefore, the \(y\)-intercept is identified as point \((0, y)\).

**Finding intercepts from an equation.**

Reminder: The **\(x\)-intercept** is the point at which \(y = 0\); the **\(y\)-intercept** is the point at which \(x = 0\).

1) **Find the \(x\) and \(y\) intercepts of** \(y = 3x + 6\).

The \(x\)-intercept is the point where \(y = 0\). To find this point, substitute 0 for \(y\) in the equation and solve for \(x\).

\[
\begin{align*}
y &= 3x + 6 \\
0 &= 3x + 6 \\
-6 &= 3x \\
\frac{-6}{3} &= \frac{3x}{3} \\
-2 &= x
\end{align*}
\]

The \(x\)-intercept is \((-2, 0)\).

The \(y\)-intercept is the point where \(x = 0\). To find this point, substitute 0 for \(x\) in the equation and solve for \(y\).

\[
\begin{align*}
y &= 3x + 6 \\
y &= 3(0) + 6 \\
y &= 6
\end{align*}
\]

The \(y\)-intercept is \((0, 6)\).
1) Find the x and y intercepts of $y = x + 5$.

2) Find the x and y intercepts of $3x - 4y = 12$.

3) Find the x and y intercepts of $y = \frac{3}{4}x + 6$.

4) Find the x and y intercepts of $y = -x - 4$.

5) Find the x and y intercepts of $y = -3x - 3$. 
Chapter 4-6: Model Direct Variation

When you buy a bottle of Pepsi out of the vending machine for $2, you will pay $2 times the number that you buy. This could be written as \( y = 2x \), where \( x \) is the number of bottles you buy. This is called a **direct variation** because no matter how many bottles you buy, \( x \), the value of \( y \) or the total cost, will always be two times that amount.

The formula for direct variation is \( Y = kx, \) where \( k \neq 0 \), and \( k \) is called the constant of variation.

The equation \( y = 5x \) is an example of direct variation, but the equation \( y = x + 5 \) is not.

Tell whether the following represent direct variations:

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

KEY POINT: Graphs with direct variation ALWAYS pass through the origin!

Real World Example:
The number of tablespoons of sea salt needed in a saltwater fish tank varies directly with the number of gallons of water in the tank. A pet shop owner recommends adding 100 tablespoons of sea salt to a 20 gallon tank.

Write a direct variation equation where \( s = \) tablespoons of sea salt and \( w = \) gallons of water. How many tablespoons of salt should be added to a 30 gallon saltwater fish tank?
Chapter 4-7: Graph Linear Functions - Function Notation

An equation written as \( y = 3x - 1 \) is saying that \( y \) is a function of \( x \).

All solutions of the equation are \((x, y)\) where \( x \) and \( y \) make the equation true. For example, \((1,2)\) is a solution – found by substituting 1 for \( x \), solving for \( y \) and getting 2 for \( y \).

Sometimes we give the functions names, such as \( f \), \( g \), or \( h \). When the function is named, notation such as \( f(x) \), \( g(x) \), \( h(x) \), etc. replaces the \( y \) in the equation.

**Function Notation** is \( f(x) = mx + b \).

In the example, the expression \( f(x) \) can take the place of \( y \), so we would have:

\[
f(x) = 3x - 1 \quad \text{which is read } " f \text{ of } x \text{ equals } 3x - 1 "
\]

The solutions are \((x, f(x))\).

\( f(2) \) is asking for the value of the function when \( x = 2 \).

\[
\begin{align*}
    f(x) &= 3x - 1 \\
    f(2) &= 3(2) - 1 \\
    &= 6 - 1 \\
    &= 5
\end{align*}
\]

Therefore one solution is \((2, 5)\).

1) Find \( f(-4) \):  

2) Find \( f(0) \):

3) Evaluate the functions when \( x = -4, \ x = 0, \) and \( x = 2 \).  
   (Hint: the easiest way to keep track is to create a table of values!)

   a) \( f(x) = 6x + 5 \)  

   b) \( g(x) = \frac{1}{2}x \)

4) Find the range of \( h(x) \) when the domain is \{-3, 0, 1\}

   \( h(x) = 4x - 3 \)
A **family of functions** is a group of functions with similar characteristics. For example, functions that have the form \( f(x) = mx + b \) make up the family of *linear* equations.

### KEY CONCEPT

**Parent Function for Linear Functions**

The most basic linear function in the family of all linear functions, called the **parent linear function**, is:

\[
    f(x) = x
\]

The graph of the parent linear function is shown.

### CONCEPT SUMMARY

**Comparing Graphs of Linear Functions with the Graph of \( f(x) = x \)**

Changing \( m \) or \( b \) in the general linear function \( g(x) = mx + b \) creates families of linear functions whose graphs are related to the graph of \( f(x) = x \).

- **\( g(x) = x + b \)**
  - The graphs have the same slope, but different \( y \)-intercepts.
  - Graphs of this family are vertical translations of the graph of \( f(x) = x \).

- **\( g(x) = mx \) where \( m > 0 \)**
  - The graphs have different (positive) slopes, but the same \( y \)-intercept.
  - Graphs of this family are vertical stretches or shrinks of the graph of \( f(x) = x \).

- **\( g(x) = mx \) where \( m < 0 \)**
  - The graphs have different (negative) slopes, but the same \( y \)-intercept.
  - Graphs of this family are vertical stretches or shrinks with reflections in the \( x \)-axis of the graph of \( f(x) = x \).