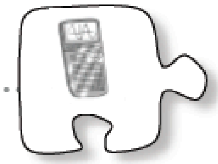

INVESTIGATIONS
AND
FUNCTIONS
1

Chapter 1 Teacher Guide

Section	Lesson	Days	Lesson Title	Materials	Homework
1.1	1.1.1	1	Solving Puzzles in Teams	• 8-foot lengths of yarn • Less. 1.1.1 Res. Pgs. • Plastic sheet protectors • Overhead pens • Models of geometric solids (optional)	1-3 to 1-9
	1.1.2	2	Using a Graphing Calculator to Explore a Function	• Less. 1.1.2A Res. Pg. (opt.) • Less. 1.1.2B Res. Pg. (opt.) • Less. 1.1.2C Res. Pg. (opt.) • Less. 1.1.2D Res. Pg. • Overhead pens and transparencies (or poster paper and markers) • Graphing calculators	1-13 to 1-19 and 1-20 to 1-26
	1.1.3	1	Domain and Range	• Less. 1.1.2A Res. Pg. (opt.)	1-35 to 1-41
	1.1.4	1	Points of Intersection in Multiple Representations	• Poster paper and markers • Less. 1.1.2A Res. Pg. (opt.)	1-47 to 1-53
1.2	1.2.1	3	Modeling a Geometric Relationship	• Less. 1.2.1 Res. Pg. • Rulers, Scissors, Tape • Less. 1.1.2A Res. Pg. (opt.)	1-60 to 1-65 and 1-66 to 1-71 and 1-72 to 1-77
	1.2.2	2	Function Investigation	• Overhead pens and transparencies for teams • Poster paper and markers • Less. 1.1.2A Res. Pg. (opt.)	1-84 to 1-90 and 1-91 to 1-98
	1.2.3	1	The Family of Linear Functions	None	1-105 to 1-111
	1.2.4	1	Function Investigation Challenge	None	1-113 to 1-119
Chapter Closure		Varied Format Options			

Total: **12 days plus optional time for Chapter Closure**

1.1.1 How can I work with my team to figure it out?



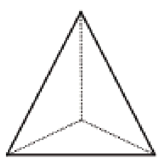
Solving Puzzles in Teams

Welcome to Algebra 2! This chapter will challenge you to use different problem-solving **strategies**. You will also be introduced to different tools and resources that you can use throughout the course as you **investigate** new ideas, solve problems, and share mathematical ideas.

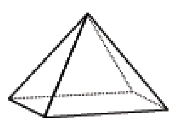
1-1. BUILDING WITH YARN

Work with your team to make each of the shapes you see below out of a single loop of yarn. You may make the shapes in any order you like. Before you start, review the team roles that are described on the next page. Use these roles to help your study team work together today. When you make one of the shapes successfully, call your teacher over to show off your accomplishment.

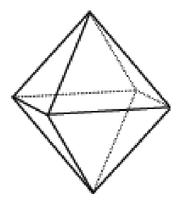
A Tetrahedron



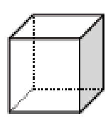
A Square-Based Pyramid



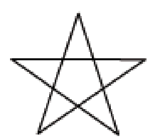
An Octahedron



A Cube



A Star



Team Roles

Resource Manager – If your name comes first alphabetically:

- Make sure your team has all of the necessary materials, such as yarn for problem 1-1 or the resource pages for problem 1-2.
- Ask your teacher a question when the *entire* team is stuck. Before raising your hand, you might ask your team, *"Does anyone have an idea? Should I ask the teacher?"*
- Make sure your team cleans up materials by delegating tasks. You could say, *"I will put away the ________ while you _________ ."*

Facilitator – If your name comes second alphabetically:

- Start your team's discussion by reading the question aloud and then asking, *"Which shape should we start with?"* or *"How can we work together to make this shape?"*
- Make sure that all of the team members get any necessary help. You do not need to answer all of the questions yourself. A good Facilitator regularly asks, *"Do we understand what we are supposed to do?"* and *"Who can answer ________'s question?"*

Recorder/Reporter – If your name comes third alphabetically:

- Be sure all team members are able to reach the yarn and have access to the resource pages. Make sure resource pages and work that is being discussed are placed in the center of the table or group of desks in a spot where everyone can see them.
- Be prepared to share your team's s**trategie**s and results with the class. You might report, *"We tried ___ , but it didn't work, so we decided to try ___ ."*

Task Manager – If your name comes fourth alphabetically:

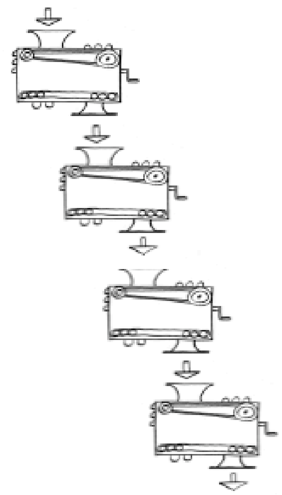
- Remind the team to stay on task and not to talk to students in other teams. You can suggest, *"Let's try working on a different shape,"* or *"Are we ready to try the function machines in a different order?"*
- Keep track of time. Give your team reminders, such as, "*I think we need to decide now so that we will have enough time to …*"

1-2. FUNCTION MACHINES

Your teacher will give you a set of four function machines. Your team's job is to get a specific output by putting those machines in a particular order so that one machine's output becomes the next machine's input. As you work, discuss what you know about the kind of output each function produces to help you arrange the machines in an appropriate order. The four functions are reprinted below.

$f(x) = \sqrt{x}$ $\qquad$ $g(x) = -(x-2)^2$

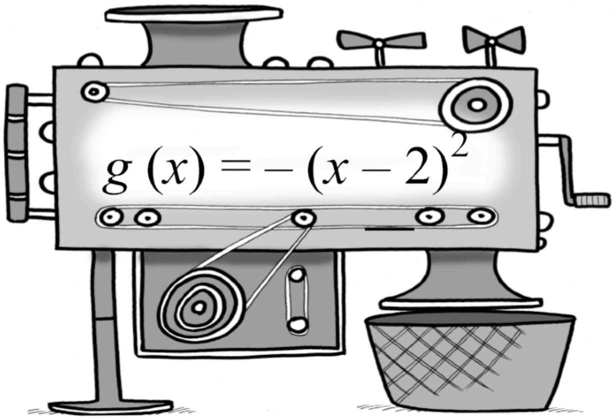
$h(x) = 2^x - 7$ $\qquad$ $k(x) = -\frac{x}{2} - 1$

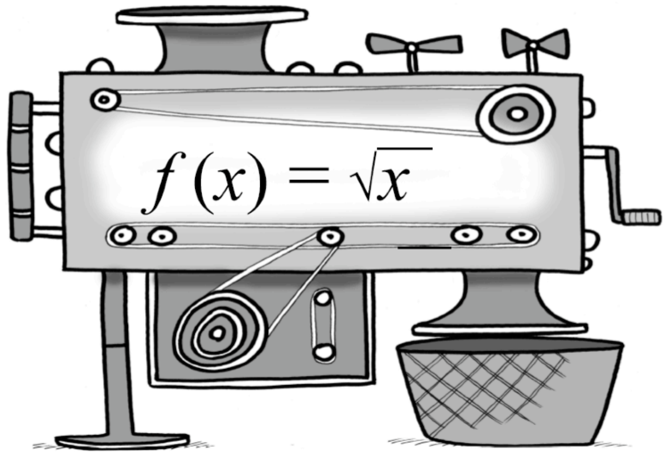


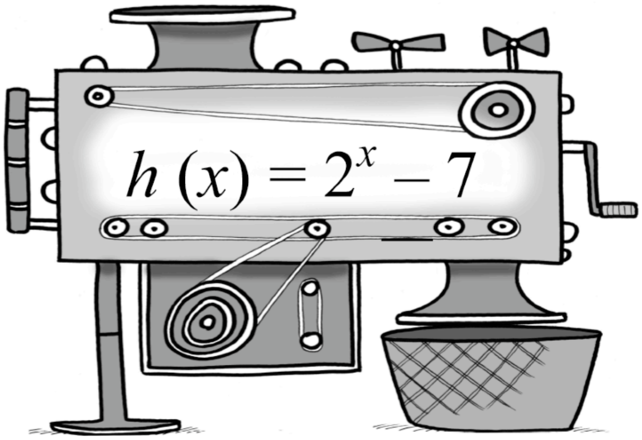
a. In what order should you stack the machines so that when **6** is dropped into the first machine, and all four machines have had their effect, the last machine's output is **11**?

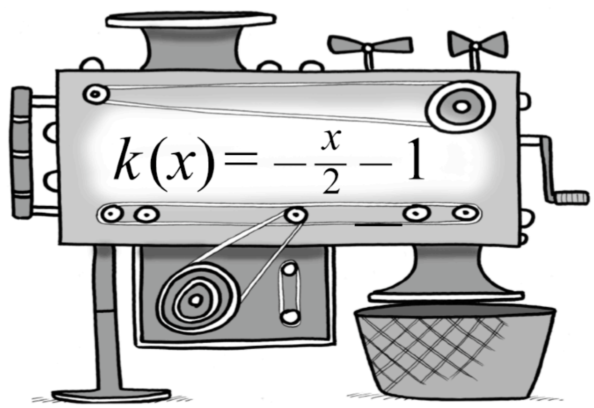
b. What order will result in a final output of 131,065 when the first input is 64?

Click on each of the machines and drag to position in a different order.









METHODS AND MEANINGS

MATH NOTES

Functions and Relations

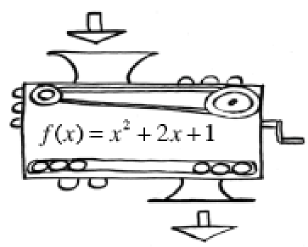
A **relation** establishes a relationship between inputs and outputs. A relation is a **function** if there is no more than one output for each input. For example, if a teacher assigns seats alphabetically, the **relation** between each student and his or her seat can be considered a **function**, since no student will receive more than one seat.

Relations and **functions** establish a correspondence between their inputs and outputs. For equations, they establish the relationship between two variables. Some examples are:

$$y = x^2,\ y = \tfrac{x}{x+3},\ y = -2x + 5$$

Since the value of y usually depends on x, y is often referred to as the **dependent variable**, while x is called the **independent variable**.

A convenient way to show what a function machine does is to use **function notation**. For the function machine at right, you would write $f(x) = x^2 + 2x + 1$. The f is just the *name* of the function machine; it is not a variable. It could just as well be $\text{Joe}(x) = x^2 + 2x + 1$ if the machine happened to be named Joe!



Be careful: $f(x)$ does *not* mean f times x; it is read as "f of x." It means, "The output of the function f resulting from the input x."
If you put $x = 3$ into this machine, you would write $f(3) = 3^2 + 2 \cdot 3 + 1 = 16$, or just $f(3) = 16$.

Review & Preview

1-3. KEEPING A NOTEBOOK

You will need to keep an organized notebook for this course. Below is one method of keeping a notebook. Ask your teacher if you should follow these guidelines or if there is another system you should follow.

- The notebook should be a sturdy, three-ring, loose-leaf binder with a hard cover.
- The binder should have dividers to separate it into five sections:

TEXT	TESTS AND QUIZZES
HOMEWORK	LINED AND GRAPH PAPER
CLASSWORK/NOTES	

You should put your name inside the front cover of your notebook so it will be returned to you if you lose it. Put your phone number and address (or the school's address, if you prefer) on the inside front cover. It will also help to put your name in large, clear letters on the outside so if someone sees it they can say, *"Hey, Julia, I saw your notebook in the cafeteria under the back table."*

Your notebook will be your biggest asset for this course and will be the primary resource you will use to study, so take good care of it!

1-4. "Find $f(3)$" means to find the output of function $f(x)$ for an input of $x = 3$. For the function $f(x) = \frac{1}{x-2}$, find each of the following values.

a. Find $f(4)$. (This means find the output of the function when $x = 4$.)

b. Find x when $f(x) = 1$. (This means find the input that gives an output of 1.)

1-5. Angelica is working with function machines. She has the two machines $g(x) = \sqrt{x-5}$ and $h(x) = x^2 - 6$. She wants to put them in order so that the output of the first machine becomes the input of the second. She wants to use a beginning input of 6.

a. In what order must she put the machines to get a final output of 5?

b. Is it possible for her to get a final output of –5? If so, show how she could do that. If not, explain why not.

1-6. An average school bus holds 45 people. Sketch a graph showing the relationship between the number of students who need bus transportation and the number of buses required. Be sure to label the axes.

1-7. In this course, you will learn shortcuts that allow you to sketch many different types of graphs quickly and accurately. However, when the directions ask you to **graph an equation** or to **draw a graph**, this means it is not just a sketch you should do quickly. You need to:

- Use graph paper.
- Label key points.
- Scale your axes appropriately.
- Plot points accurately.

On separate sets of axes, graph each of the following equations. If you do not remember any shortcuts for graphing, you can always make an $x \to y$ table.

a. $y = -2x + 7$

b. $y = \frac{3}{5}x + 1$

c. $3x + 2y = 6$

d. $y = x^2$

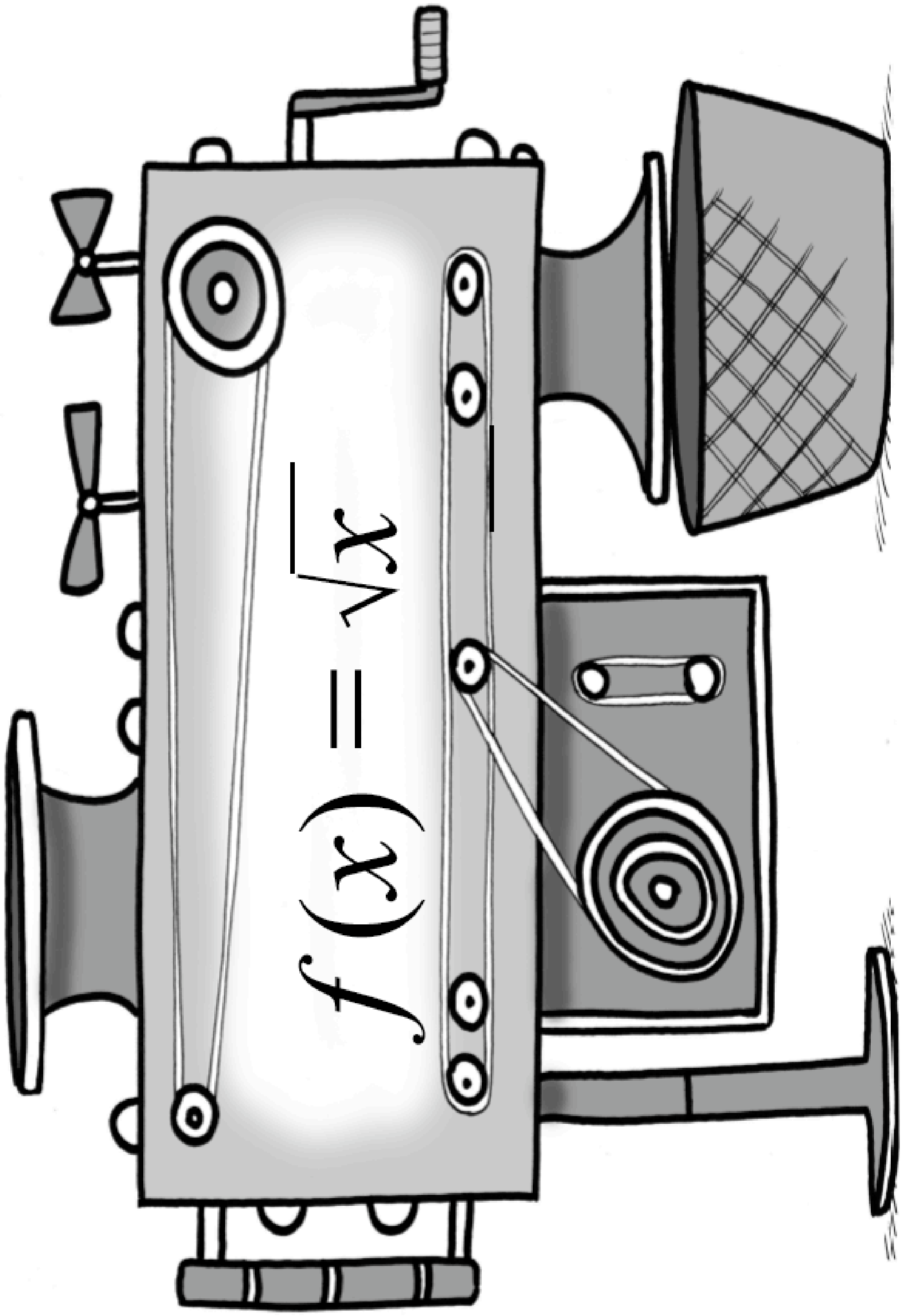
1-8. The graph for part (d) of problem 1-7 is different from the other three graphs.

a. Explain how the graph is different from the other three graphs.

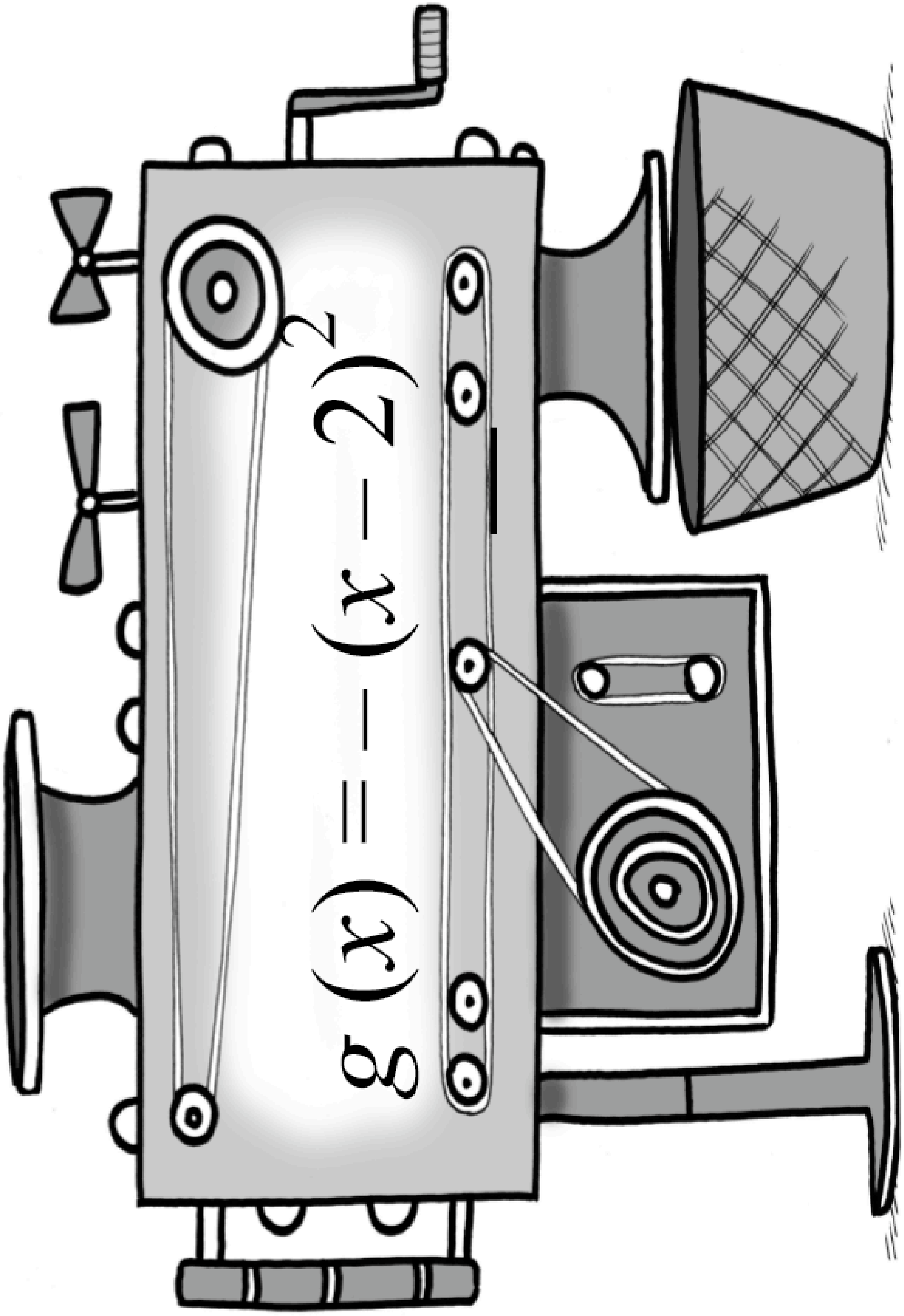
b. What in the equation of part (d) makes its graph different?

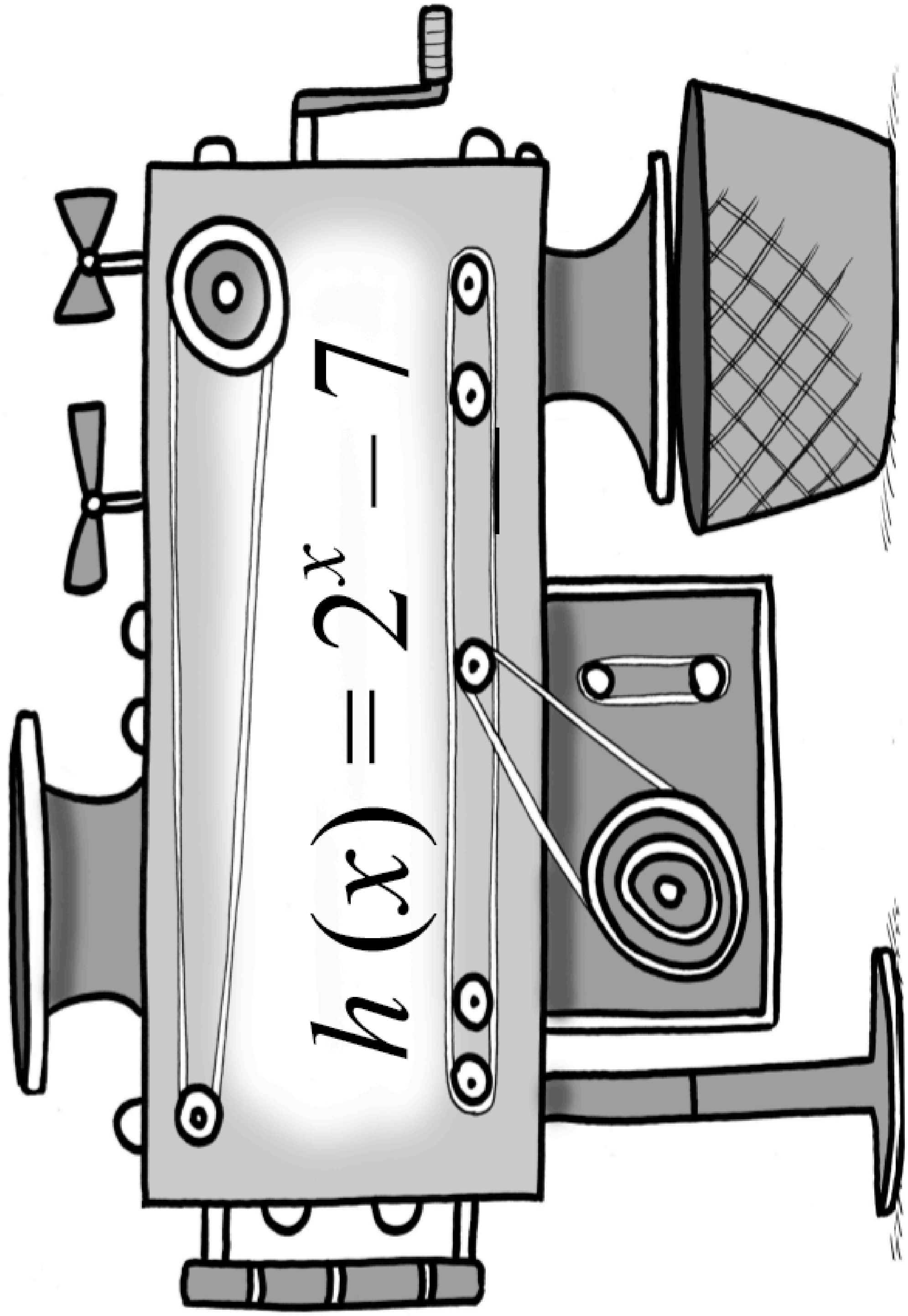
c. What is the graph of part (d) called?

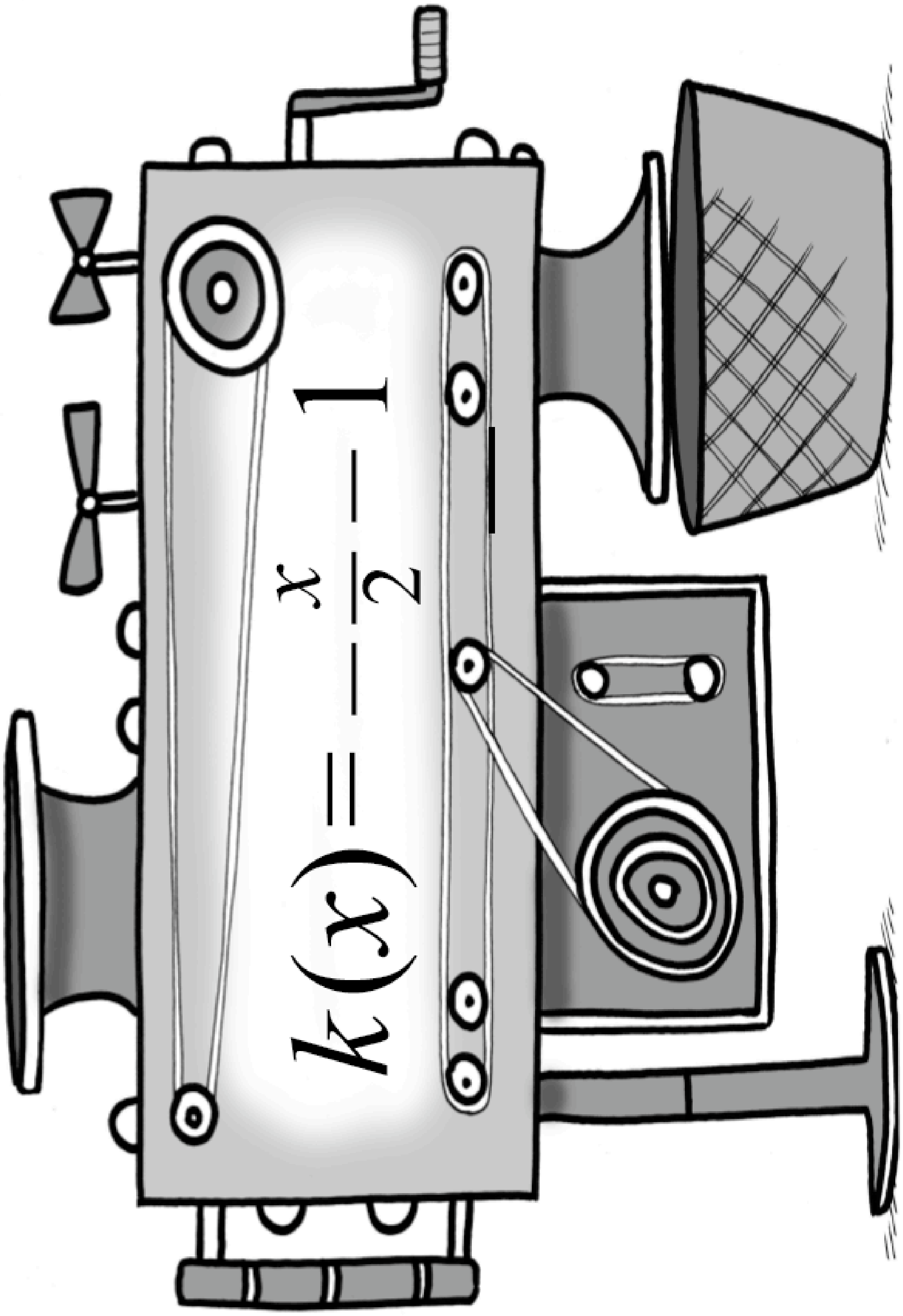
1-9. Write down everything you know about the equation $y = mx + b$. You should include what this general equation represents, as well as what each of the different letters represents. Be as thorough as possible.


$f(x) = \sqrt{x}$

October 24, 2010




$h(x) = 2^x - 7$


$k(x) = \frac{x}{2} - 1$

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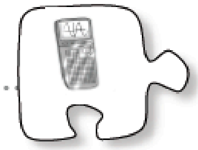
1.1.2 How can I use my graphing calculator?



Using a Graphing Calculator to Explore a Function

In Algebra 1 you learned that multiple representations such as situations, tables, graphs, and equations and their interconnections are useful for learning about functions. A graphing calculator can be a very useful tool for generating different representations quickly. Today, you will use this tool to explore a function. You will describe your function completely to the class.

1-10. Your team will use graphing calculators to learn about one of the following functions.

i. $y = 2\sqrt{9-x} - 4$ *ii.* $y = \sqrt{100-x^2}$

iii. $y = 3\sqrt{x+4} - 6$ *iv.* $y = 3\sqrt{4-x} - 3$

v. $y = -2\sqrt{25-x^2} + 8$ *vi.* $y = -3\sqrt{x+9} + 4$

vii. $y = 2\sqrt{25-x^2} - 1$ *viii.* $y = \sqrt{4-x} - 1$

Your task: Describe your team's function in as much detail as possible. Use your graphing calculator to help you generate a table and a complete graph of your function. Remember that drawing a complete graph means:

- Use graph paper.
- Scale your axes appropriately.
- Label key points.
- Plot points accurately.

As you work, keep your graphing calculators in the middle of your workspace, so that you can compare your screens and all team members can see and discuss your results. Be sure to record what you learn as you explore your function. As a team, you will be preparing a report about your function for the class. Consider the "Discussion Points" below as you work.

Discussion Points

What are the key points on the graph? Where are they exactly?

Are there values of x or y that do not make sense?

How high or low does the graph go?

Did the graphing calculator show an accurate graph?

How can we be sure the graph is complete?

Further Guidance

1-11. Use your graphing calculator to view the graph in the standard window.

a. Enter the equation in your graphing calculator and view the graph. Use the $\boxed{\text{TRACE}}$ feature to identify at least five possible integer inputs that give integer values as outputs.

b. Verify that each integer input gives an integer value as an output, and record these points in a table.

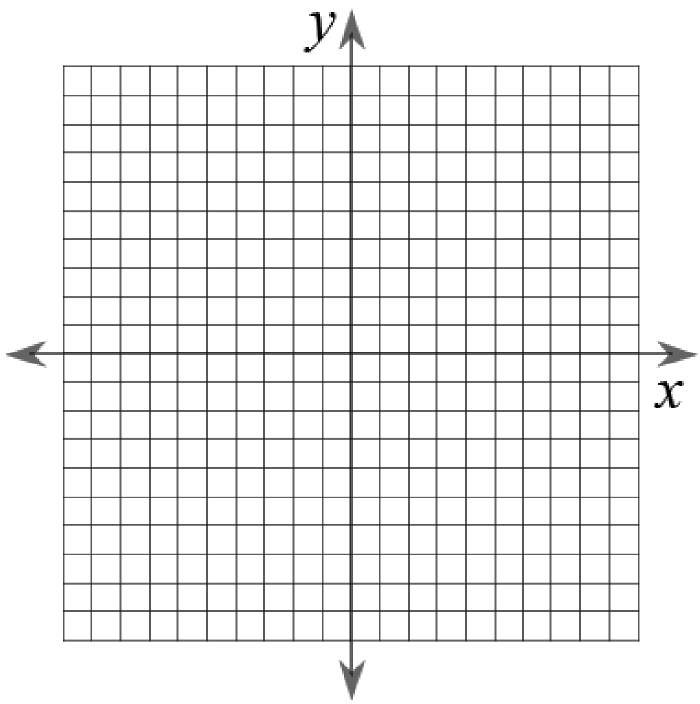
c. Is there a largest or smallest input value you can use for x? Describe and explain any values that cannot be used.

d. Is there a largest or smallest value for y? Describe and explain any values that will not occur as outputs.

e. Are you sure you have a complete graph? How can you be sure?

Further Guidance section ends here.

Equation: ___________________



Smallest x-value: ____

Largest x-value: _____

Smallest y-value: ____

Largest y-value: _____

Important Points

1-12. When your team has completed a table and drawn a complete graph, prepare a report for the whole class.

The class will get most out of your presentation if you focus on what was particularly interesting about your function or what you learned. Rather than saying, "*We plugged in a 2 and got a 5,*" consider using statements such as, "*We decided to try an input of 2 because we wanted to know what happened to the left of* $x = 3$."

The following sentence starters can help you make a meaningful and interesting presentation.

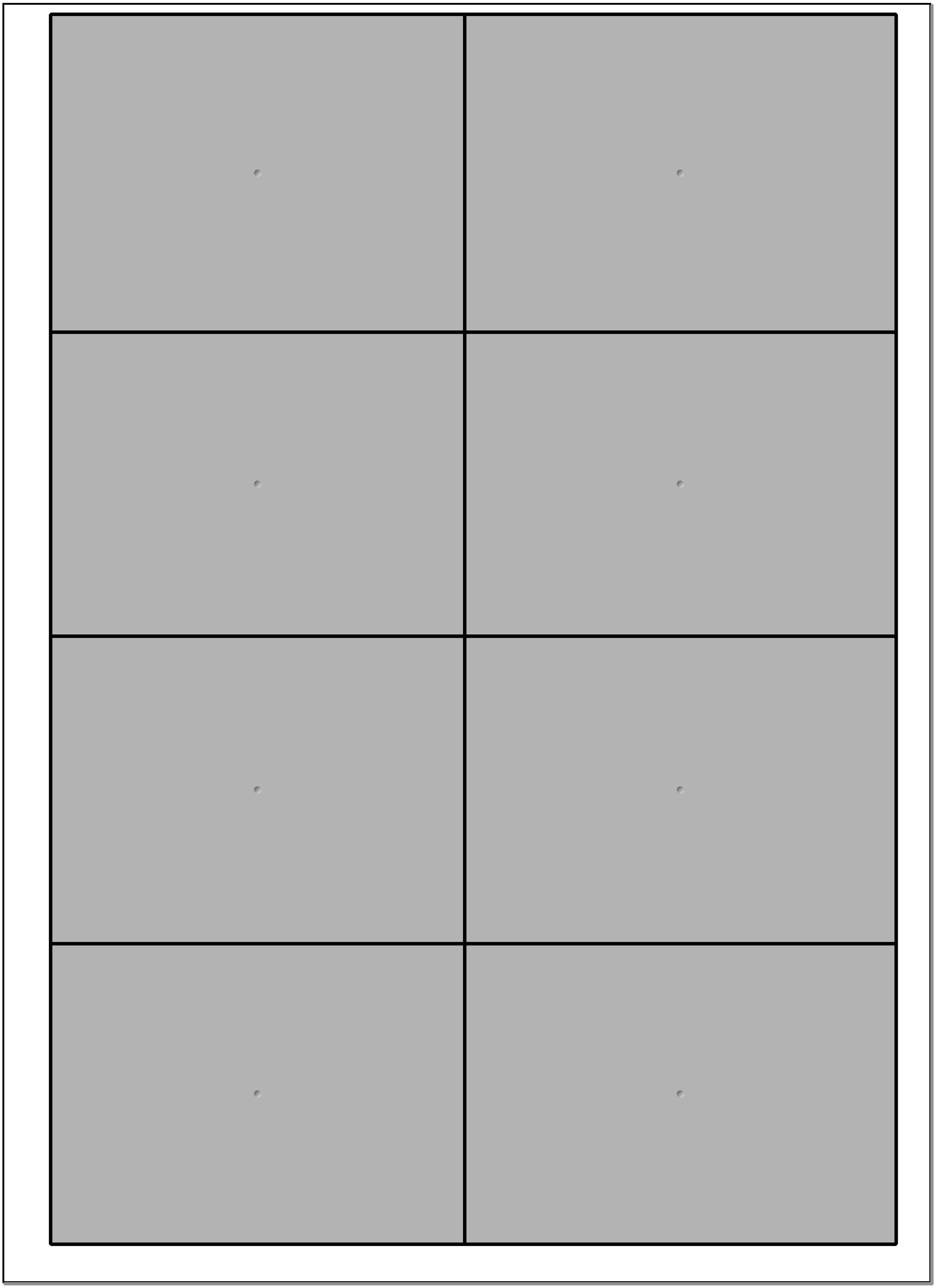
"At first we were confused by…"

"This makes sense because…"

"We weren't sure about…, so we tried…"

"Something interesting that we noticed about our graph is…"

As you prepare your presentation, your teacher will provide you with an overhead transparency or poster paper. Reread the task statement of problem 1-10 (labeled "Your task") and be sure to include all relevant information and ideas in your presentation.



MATH NOTES

METHODS AND MEANINGS

Linear Equations

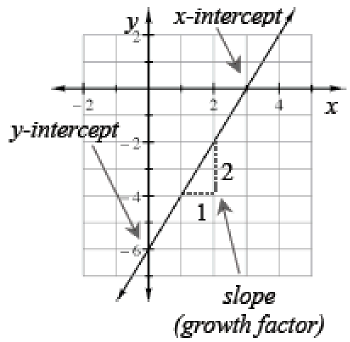
A **linear equation** is an equation that forms a line when it is graphed. This type of equation may be written in several different forms. Although these forms look different, they are equivalent; that is, their graphs are all the same line.

Standard Form: An equation in $ax + by = c$ form, such as $-6x + 3y = -18$.

Slope-Intercept Form: An equation in $y = mx + b$ form, such as $y = 2x - 6$.

You can find the **slope** (also known as the **growth factor**) and the ***y*-intercept** of a line in $y = mx + b$ form quickly. For the equation $y = 2x - 6$, the slope is 2, while the y-intercept is $(0, -6)$.

$$\underbrace{y = 2}_{slope}x - \underbrace{6}_{y\text{-intercept}}$$



Review & Preview

1-13. Junior is saving money in his piggy bank. He starts with 10 cents and adds two pennies each day. Create an $x \to y$ table and a graph for the function for which x represents the number of days since Junior started saving money and y represents the total money he has saved.

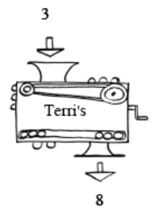
1-14. Use the Zero Product Property and factoring, when necessary, to solve for x. The Math Notes box for Lesson 1.1.4 or problems 3-111 and 4-80 may be useful, if you need help.

a. $(x+13)(x-7)=0$ b. $(2x+3)(3x-7)=0$

c $x(x-3)=0$ d. $x^2-5x=0$

e. $x^2-2x-35=0$ f. $3x^2+14x-5=0$

1-15. Terri's project for the Math Fair was a magnificent black box that she called a function machine. If you put 3 into her machine, the output would be 8. If you put in 10, the output would be 29; and if you put in 20, it would be 59.



a. What would her machine do to the input 5? What about –1? What about x? Making an input→output table may help you figure this out.

b. Write a rule for Terri's machine.

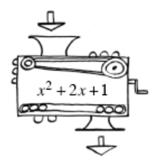
1-16. Nafeesa graphed a line with a slope of 5 and a y-intercept of $(0,-2)$.

a. Find an equation for her line. b. Find the value of x when $y=0$.

1-17. In each of the following equations, what is y when $x=2$? When $x=0$? Where would the graph of each equation cross the y-axis?

a. $y=3x+15$ b. $y=3-3x$

1-18. Carmichael made a function machine. The inner workings of the machine are visible in the diagram at right. What will the output be in each of the following cases?



a. If 3 is dropped in?

b. If –4 is dropped in?

c. If –22.872 is dropped in?

1-19. Does the temperature outside depend on the time of day, or does the time of day depend on the temperature outside? This may seem like a silly question, but to sketch a graph that represents this relationship, you first need to decide which axis will represent which quantity.

a. When you graph an equation such as $y=3x-5$, which variable (the x or the y) *depends* on the other? Which is not dependent? (That is, which is *in*dependent?) Explain.

b. Which variable is *dependent*: temperature or time of day? Which variable is *independent*?

c. Sketch a graph (with appropriately named axes) that shows the relationship between temperature outside and time of day.

1-20. Jill needs to cut a piece off of a 30-foot length of lumber. Create multiple representations ($x \rightarrow y$ table, graph, and equation) for the function with x-values that are the length of the piece Jill cuts off and y-values that are the length of the piece that is left over. Which representation best portrays the situation? Why? Explain.

1-21. Make a table and graph the function $f(x)=\frac{1}{2}x^2$. Describe all of the possible input and output values.

1-22. Given $f(x)=-\frac{2}{3}x+3$ and $g(x)=2x^2-5$, complete parts (a) through (f) below.

a. Calculate $f(3)$.

b. Solve $f(x)=-5$.

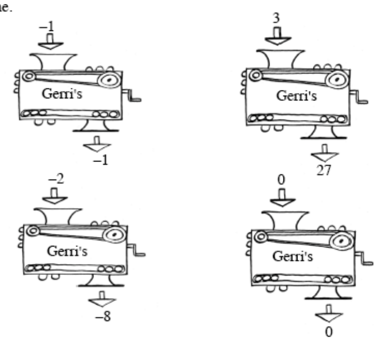
c. Calculate $g(-3)$.

d. Solve $g(x)=9$.

e. Solve $g(x)=8$.

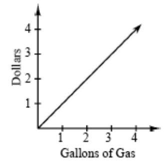
f. Solve $g(x)=-7$.

1-23. Gerri made a function machine. Below are four pictures of her machine. (Note that these are all pictures of the same function machine.) Find the rule for Gerri's function machine.

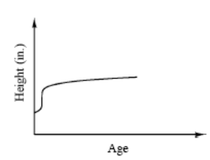


1-24. Examine each graph below. Based on the shape of the graph and the labels of the axes, write a sentence to describe the relationship that each graph represents. Then state which axis represents the independent variable and which one represents the dependent variable.

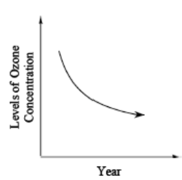
a.



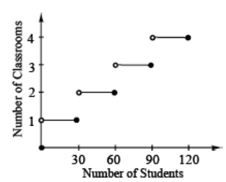
b.



c.



d.



e. What are all of the possible inputs of the graph in part (d)? What are all of the possible outputs?

1-25. Gregory planted a lemon tree in his back yard. When he planted the tree, it was 2 feet tall. He noticed that it has been growing 3 inches every week.

a. Create multiple representations ($x \rightarrow y$ table, graph, and equation) to represent the relationship between the days that have passed and the height of the tree.

b. If the tree continues growing at this rate, when will it be 6 feet tall? How can you see this in each of the representations?

c. State the possible inputs and outputs of the graph.

1-26. Find the error in the solution at right. Explain what the error is and solve the equation correctly. Show how to check your solution to be sure that it is correct.

$$3(x-2)-2(x+7)=2x+17$$
$$3x-6-2x+14=2x+17$$
$$x+8=2x+17$$
$$-9=x$$

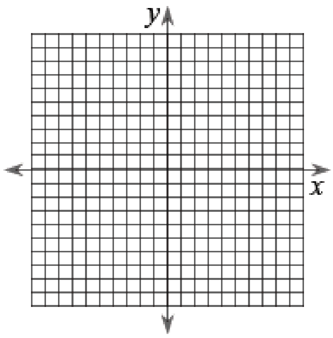
Note: The stoplight icon to the right of a problem indicates that there is an error in the problem.

Student's Name	Team Roles
	Resource Manager: Get supplies for your team, and make sure your team cleans up. Call the teacher over for team questions: *"No one has an idea? Should I call the teacher?"*
	Facilitator: Help your team get started by having someone read the task: *"Who wants to read?"* Make sure everyone understands what to do: *"Does anyone know how to get started?"* *"What does the first question mean?"* *"I'm not sure – what are we supposed to do?"* Make sure everyone understands your team's answer before you move on: *"Do we all agree?"* *"I'm not sure I get it yet – can someone explain?"*
	Recorder/Reporter: Share your team's data with the class. Be sure all team members have access to any team diagrams by placing them at the center of the table or desks. Make sure your team agrees about how to show your work: *"How can we write this?"* *"How can we show it on the diagram?"*
	Task Manager: Make sure no one talks outside your team. Help keep your team on task and talking about math: *"Okay, let's get back to work!"* *"Let's keep working."* Listen for statements and reasons: *"Explain how you know that."* *"Can you prove that?"*

Lesson 1.1.2A Resource Page: Team Roles (Option 2)

Student's Name	Team Roles
	Resource Manager:
	Facilitator:
	Recorder/Reporter:
	Task Manager:

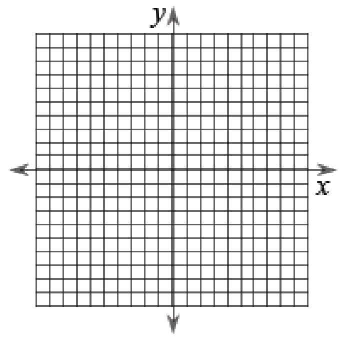
Equation: ________________



Smallest x-value: ____
Largest x-value: _____
Smallest y-value: ____
Largest y-value: _____

Important Points

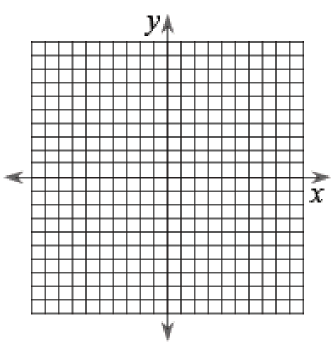
Equation: ________________



Smallest x-value: ____
Largest x-value: _____
Smallest y-value: ____
Largest y-value: _____

Important Points

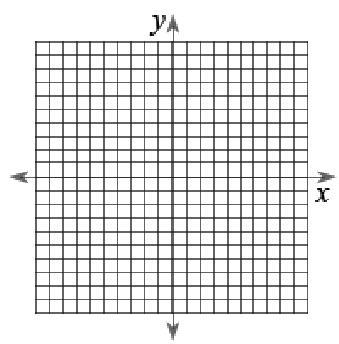
Equation: ________________



Smallest x-value: ____
Largest x-value: _____
Smallest y-value: ____
Largest y-value: _____

Important Points

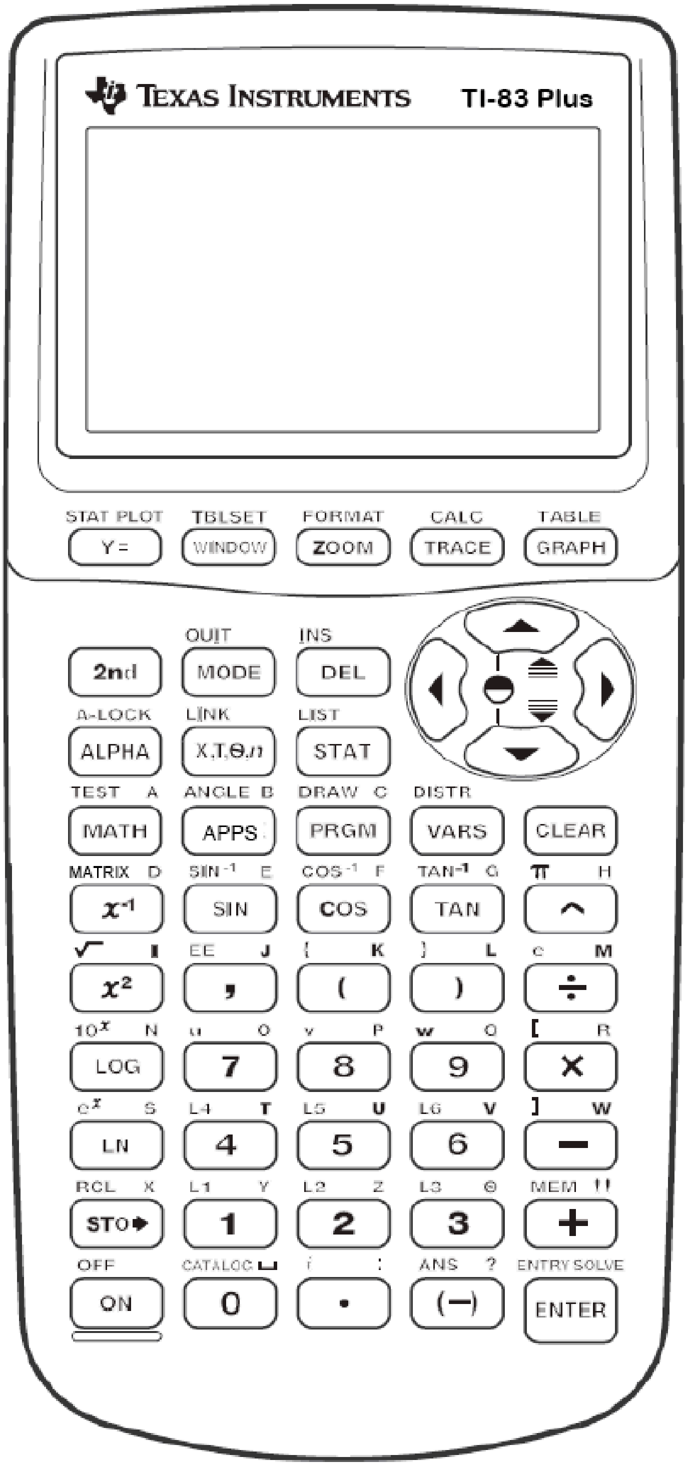
Equation: ________________



Smallest x-value: ____
Largest x-value: _____
Smallest y-value: ____
Largest y-value: _____

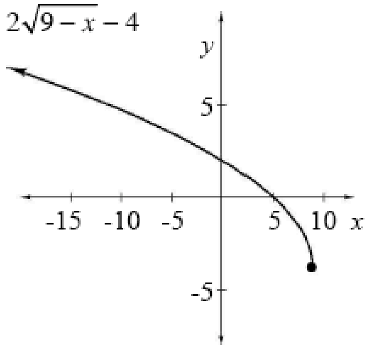
Important Points

Lesson 1.1.2C Resource Page

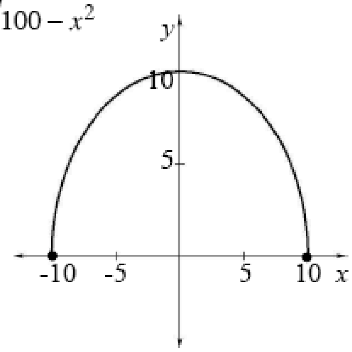


Lesson 1.1.2D Resource Page *Teacher Resource Only*

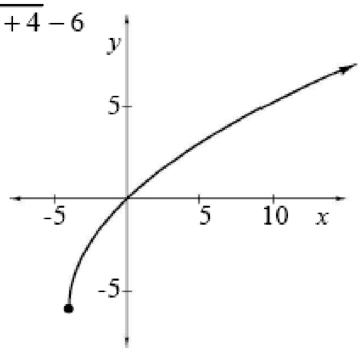
i. $y = 2\sqrt{9 - x} - 4$



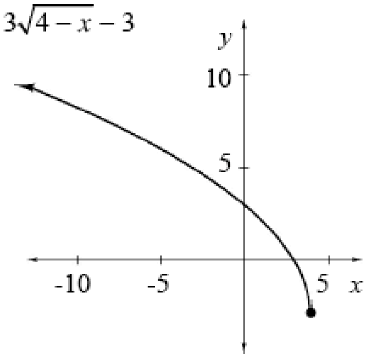
ii. $y = \sqrt{100 - x^2}$



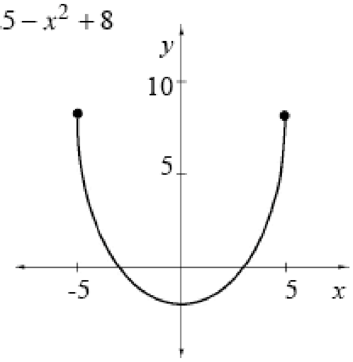
iii. $y = 3\sqrt{x + 4} - 6$



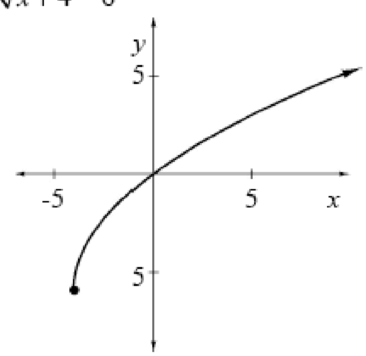
iv. $y = 3\sqrt{4 - x} - 3$



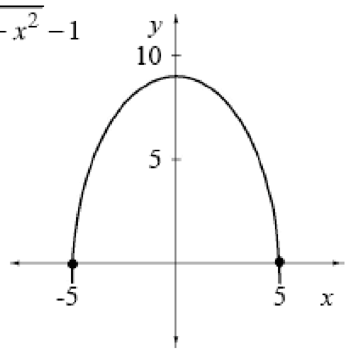
v. $y = -2\sqrt{25 - x^2} + 8$



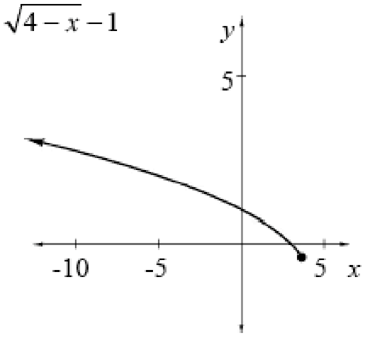
vi. $y = 3\sqrt{x + 4} - 6$



vii. $y = 2\sqrt{25 - x^2} - 1$



viii. $y = \sqrt{4 - x} - 1$



Question 3: ____

Statement 3: ____

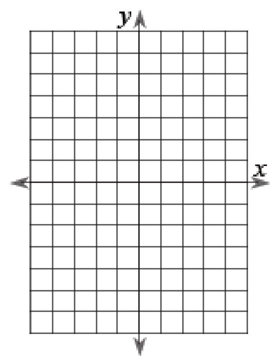
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other:

Question 4: ____

Statement 4: ____

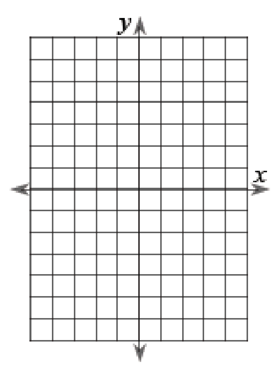
____

Justification:

Table:

x							
y							

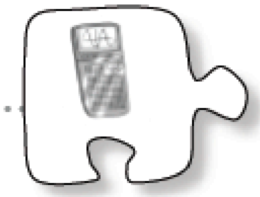
Graph:



Equation:

Other:

1.1.3 Which values are possible?



Domain and Range

In Lesson 1.1.2 you worked with your graphing calculator to see complete graphs of functions and to determine what information was useful to describe those functions completely. In this lesson you will look at more functions, this time thinking about what input and output values are possible. You will also learn about additional tools on your graphing calculator that allow you to see a complete graph. As you work with your team, remember to ask each other questions such as:

What values are possible?

Can we see the complete graph?

What other information can we use to describe the function?

1-27. Jerrod and Sonia were working with their team on ordering the function machines in problem 1-2. The functions are reprinted for you below.

$f(x)=\sqrt{x}$ $\quad$ $g(x)=-(x-2)^2$

$h(x)=2^x-7$ $\quad$ $k(x)=-\frac{x}{2}-1$

a. Jerrod first put an input of 6 into the function $g(x)=-(x-2)^2$ and got an output of -16. He wanted to try $f(x)=\sqrt{x}$ as his next function in the order, but he thinks there might be a problem using -16 as an input. Is there a problem? Explain.

b. Because it is not possible to take the square root of -16, it can be said that -16 is not in the **domain** of the function $f(x)$. The **domain** of a function is the collection of numbers that are possible inputs for that function. With your team, find two other numbers that are *not* part of the domain of $f(x)$. Then describe the domain. In other words, what are all of the numbers that *can* be used as inputs for the function $f(x)$?

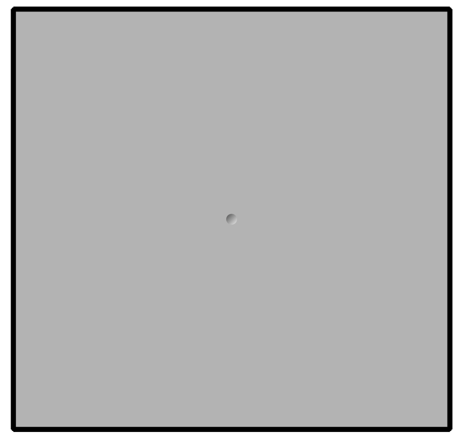
c. Sonia claimed that $g(x)$ could not possibly be the last function in the order for problem 1-2. She **justified** her thinking by saying, *"Our final output has to be 11, which is a positive number. The function $g(x)$ will always make its output negative, so it can't come last in the order."* Discuss this with your team. Does Sonia's logic make sense? How did she know that the output of $g(x)$ would never be positive?

1-28. Use your graphing calculator to help you draw a complete graph of $y = (x+1)(x-9)$.

a. Describe the graph completely.

b. What window settings allow you to see the complete graph?

c. How are the settings related to domain and range?

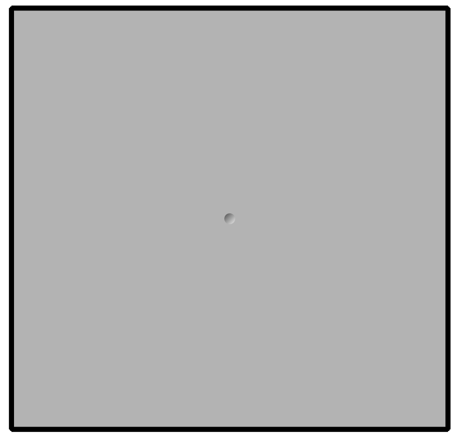


1-29. Draw a complete graph of $y = (x-12)^2 + 11$.

a. What happens when you use the standard window?

b. What window settings did you use to see enough of the graph to help you visualize and draw a complete graph?

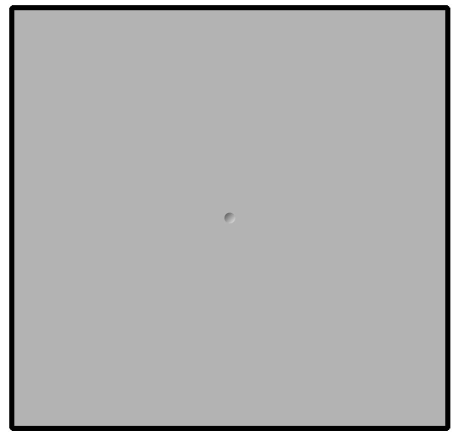
c. What are the domain and range of the function?

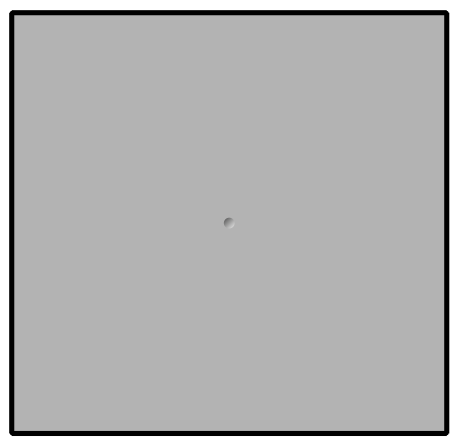


1-30. Now you will **reverse** your thinking to create a graph with a given domain and range.

a. Sketch a relation that has a domain of all numbers between and including -3 and 10 (written $-3 \le x \le 10$) and a range of all numbers between and including -4 and 6 (written $-4 \le y \le 6$). You do not have to write an equation for your relation. Verify your endpoints with your team. Be creative.

b. Sketch a relation with a domain of all real numbers (written $-\infty < x < \infty$) and a range of all numbers greater than or equal to -2 (written $y \ge -2$). (Note: The symbol ∞ means "infinity.")





1-31. How can a graphing calculator help you find the solution to a system of equations? Consider this system:

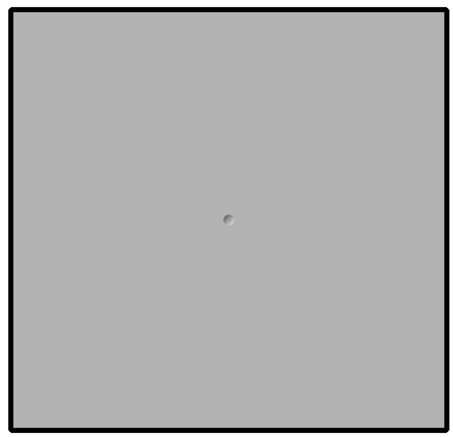
$$5x - y = 35$$
$$3x + y = -3$$

a. First graph the system in a standard window. Can you see the solution on your screen?

b. To find the solution you will need to change the window on your calculator. Discuss with your team what maximum value, minimum value, and scale you should use for the x- and y-axes in order to see the intersection. After you have decided, check your conclusion on the graphing calculator.

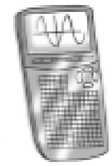
c. Use the $\boxed{\text{TRACE}}$ button to find the solution from the graphs. Then solve the system algebraically.

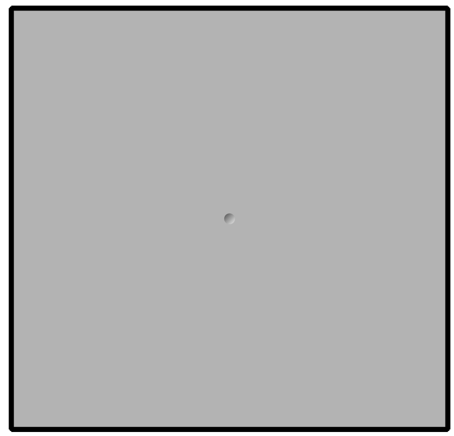
d. Discuss the two methods with your team. Explain which one your team prefers and why.



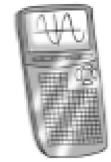
October 24, 2010

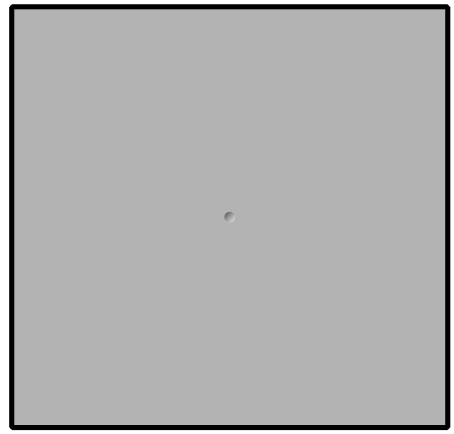
1-32. What does the graph of $y = x + \frac{1}{(x+2)^2} - 3$ look like? Graph the equation on your calculator. Use the trace and/or zoom buttons to find the x- and y-intercepts. What is the domain of this function? What is the range?



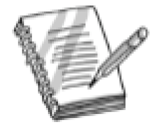


1-33. Use your graphing calculator to help you sketch the graphs of $y=\frac{1}{x}-4$ and $y=\frac{1}{x-4}$. Are the graphs the same? Should they be? Explain why or why not.





1-34. LEARNING LOG



Throughout this course, you will be asked to reflect on your understanding of mathematical concepts in a Learning Log. Your Learning Log will contain explanations and examples to help you remember what you have learned throughout the course, as well as questions you are trying to understand and answer. It is important to write each entry of the Learning Log in your own words so that later you can use your Learning Log as a resource to refresh your memory. Your teacher will tell you where to write your Learning Log entries and how to structure them. Remember to label each entry with a title and a date so you can refer to it later.

In your Learning Log today, describe everything you know about domain and range. Include examples to illustrate your ideas. Title this entry “Domain and Range” and label it with today’s date.

Methods and Meanings

MATH NOTES

Domain and Range

The set of possible values for the input of a function has a special name. It is called the **domain** of the function. This set consists of every input value for x for which the function is defined.

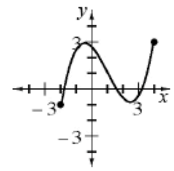
The **range** of a function is the set of possible values of the output. This set contains every y-value that the function can generate.

Domain and **range** are often written with **inequality notation** as shown in the examples below.

If the domain is any number between and including –2 and 7:	$-2 \le x \le 7$
If the range is any number greater than but excluding 4:	$y > 4$ or $4 < y < \infty$
If the domain is all numbers except for –3:	$x \ne -3$

Review & Preview

1-35. Examine $g(x)$ graphed at right.



a. Which x-values have points on the graph? That is, describe the domain of $g(x)$.

b. What are the possible outputs for $g(x)$? That is, what is the range?

c. Ricky thinks the range of $g(x)$ is: $-1, 0, 1, 2$, and 3. Is he correct? Why or why not?

d. Draw a graph for another function with the same domain and range as $g(x)$.

1-36. Consider the functions $f(x) = 3x^2 - 5$ and $g(x) = \sqrt{x-5} + 2$.

a. Find $f(5)$.

b. Find $g(5)$.

c. Find $f(4)$.

d. Find $g(4)$.

e. Find $f(x) + g(x)$.

f. Find $g(x) - f(x)$.

g. Describe the domain of $f(x)$.

h. Describe the domain of $g(x)$.

i. Why is the domain of one of these functions more restrictive than the other?

1-37. Nissos and Chelita were arguing over a math problem. Nissos was trying to explain to Chelita that she had made a mistake in finding the x-intercepts of the function $y = x^2 - 10x + 21$. *"No way!"* Chelita exclaimed. *"I know how to find x-intercepts! You make the y equal to zero and solve for x. I know I did this right!"* Here is Chelita's work:

Step 1: $x^2 - 10x + 21 = 0$, so $(x+7)(x+3) = 0$.

Step 2: Therefore, $x + 7 = 0$ or $x + 3 = 0$.

Step 3: So $x = -7$ or $x = -3$.

Nissos tried to explain to Chelita that she had done something wrong. What is Chelita's error? **Justify** and explain your answer completely.

1-38. As you have found when using a graphing calculator, equations must be solved for y; that is, they must be written in y-form. Rewrite each equation below so that it can be entered into a graphing calculator.

a. $x = 3y + 6$

b. $x = 5y - 10$

c. $x = y^2$

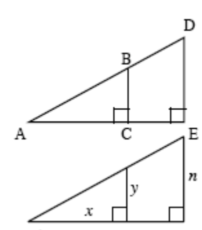
d. $x = 2y^2 - 4$

e. $x = (y-5)^2$

1-39. Write and solve an equation or a system of equations to help you solve the following problem.

A cable 84 meters long is cut into two pieces so that one piece is 18 meters longer than the other. Find the length of each piece of cable.

1-40. Consider triangles ABC and ADE at right. Give a convincing argument why $\Delta ABC \sim \Delta ADE$. Then use what you know about similar triangles to complete each of the following ratios for the triangles shown below right.



a. $\frac{y}{x} = \frac{?}{?}$

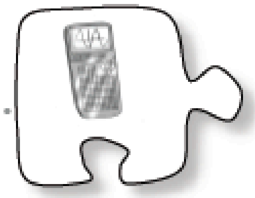
b. $\frac{n}{y} = \frac{?}{?}$

1-41. Solve each of the following equations. Be sure to check your solutions.

a. $4(x-1) - 2(3x+5) = -3x - 1$

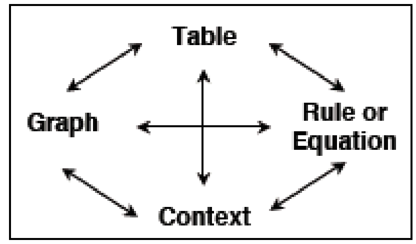
b. $3x - 5 = 2.5x + 3 - (x - 4)$

1.1.4 How can I represent intersections?



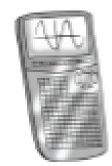
Points of Intersection in Multiple Representations

Throughout this course, you will represent functions and relations in different ways, and you will find connections between these representations. These connections will give you new ways to **investigate** functions and to **justify** your conclusions.



How can these connections help you understand more about systems of equations? In this lesson, you will make connections between ways of representing a system of equations as you use your graphing calculator to find the points of intersection in multiple representations.

1-42. INTERSECTION INVESTIGATION



In Lesson 1.1.3, you used the [TRACE] feature of your graphing calculator to find a point of intersection of two graphs. Can you use other representations as well? What about other **strategies**? Are all **strategies** equally accurate? Which do you prefer?

Your task: Work with your team to find *as many ways as you can* (with *and* without your graphing calculator) to determine the points of intersection of the functions $f(x) = 2x^2 - 5x + 6$ and $g(x) = -2x^2 - x + 30$. Be sure to think about tables, graphs, and equations as you work. Be prepared to teach each of your methods to the class.

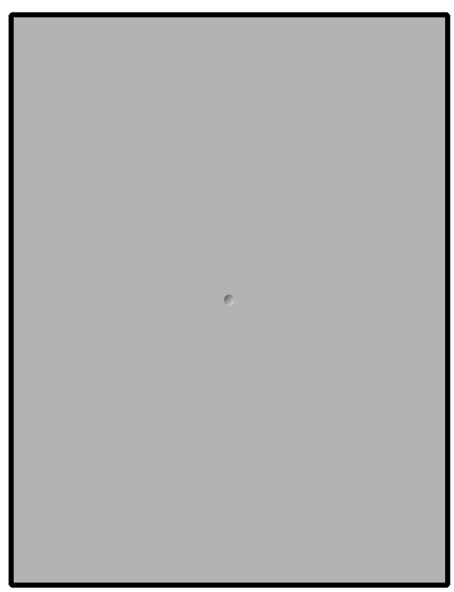
Hint: Explore the [TABLE], [TBLSET], and [CALC] features on your graphing calculator.

Discussion Points

How can we find it using graphs?

How can we find it in tables?

How can we find it using equations?



Further Guidance

1-43. Jason and his team were working on finding the points of intersection of $f(x)=2x^2-5x+6$ and $g(x)=-2x^2-x+30$. He suggested, *"Maybe we could start by looking at the graphs of the functions."*

a. Use your graphing calculator to help you graph $f(x)$ and $g(x)$.

b. Adjust the viewing window so that you can see all of the points of intersection. How accurately can you approximate the coordinates of these points by looking at the graph? Give it a try.

c. Use the $\boxed{\text{TRACE}}$ feature to get a more accurate approximation of each of the points.

d. With your team, explore the [CALC] feature of your graphing calculator. Can you find a way to make the graphing calculator calculate your points of intersection for you? How accurate are your results? Be prepared to teach your method to the class.

1-44. Aria was in Jason's team. She had another idea and asked, *"Can't we find the points of intersection by comparing the tables of our two functions?"*

a. What did Aria mean? How can you find points of intersection by looking at tables?

b. Use your graphing calculator to make tables for $f(x)$ and $g(x)$. To do this, you will need to explore the [TABLE] and [TBLSET] features of your calculator.

c. Find all of the points of intersection in the tables. How accurate are these results?

d. Can you think of any circumstances in which using a table might not be an efficient or accurate **strategy** for finding points of intersection? Explain.

1-45. Delilah had been listening to Jason and Aria explain their ideas. She said, *"I thought of another way! We know a method for using the equations to find points of intersection even without the graphing calculator, don't we?"*

a. What method is Delilah referring to?

b. Use Delilah's method to find the points of intersection of these two functions.

Further Guidance section ends here.

1-46. Rhianna says she can draw different functions that have the same x-intercepts and the same domain and range. Her teammates say, *"No, that's impossible!"* But Rhianna insists, *"It is possible if we just try to sketch the graphs."*

a. What if the x-intercepts are $(-5, 0)$, $(2, 0)$, and $(6, 0)$, the domain is $-5 \le x \le 7$, and the range is $-4 \le y \le 10$? Is more than one function possible? Give examples to help explain why or why not.

b. What if the x-intercepts are $(-4, 0)$ and $(2, 0)$, the domain is all real numbers, and the range is $y \ge -8$? Is there more than one function possible? Give examples of multiple functions or explain why there can be only one.

METHODS AND MEANINGS

MATH NOTES

Solving a Quadratic Equation

In a previous course, you learned how to solve **quadratic equations** (equations that can be written in the form $ax^2 + bx + c = 0$). Review two methods for solving quadratic equations below.

Some quadratic equations can be solved by **factoring** and using the **Zero Product Property**. For example, because $x^2 - 3x - 10 = (x-5)(x+2)$, the quadratic equation $x^2 - 3x - 10 = 0$ can be rewritten as $(x-5)(x+2) = 0$. The Zero Product Property states that if $ab = 0$, then $a = 0$ or $b = 0$. So if $(x-5)(x+2) = 0$, then $x - 5 = 0$ or $x + 2 = 0$. Therefore, $x = 5$ or $x = -2$.

Another method for solving quadratic equations is using the **Quadratic Formula**. This method is particularly helpful for solving quadratic equations that are difficult or impossible to factor. Before using the Quadratic Formula, the quadratic equation you want to solve must be in standard form (that is, written as $ax^2 + bx + c = 0$).

In this form, a is the coefficient of the x^2-term, b is the coefficient of the x-term, and c is the constant term. The Quadratic Formula is stated at right.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

This formula gives two possible answers, shown by the "$\pm$" symbol. This symbol (read as "plus or minus") is shorthand notation that tells you to calculate the formula twice: once using addition and once using subtraction. Therefore, every Quadratic Formula problem must be simplified twice to give:

$$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \quad \text{or} \quad x = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

To solve $x^2 - 3x - 10 = 0$ using the Quadratic Formula, substitute $a = 1$, $b = -3$, and $c = -10$ into the formula, as shown below, then simplify.

$$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4(1)(-10)}}{2(1)} = \frac{3 \pm \sqrt{49}}{2} = \frac{3 \pm 7}{2} \quad \rightarrow \; x = 5 \text{ or } x = -2$$

Review & Preview

1-47. Use any method to find the point of intersection of $f(x) = 3x - 5$ and $g(x) = -4x + 9$.

1-48. Compute for $f(x) = \frac{1}{x}$.

a. $f(\frac{1}{2})$ b. $f(\frac{1}{10})$ c. $f(0.01)$ d. $f(0.007)$

1-49. Solve each of the following quadratic equations. If you need help, refer to the Math Notes box for this lesson.

a. $x^2 - 8x + 15 = 0$ b. $2x^2 - 5x - 6 = 0$

1-50. Consider the points $(-5, 0)$ and $(0, 3)$.

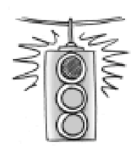
a. Plot the points and find the distance between them. Give your answer both in simplest radical form and as a decimal approximation.

b. Find the slope of the line that passes through both points.

1-51. Sketch a few different equilateral triangles. Create multiple representations ($x \to y$ table, graph, equation) of the function with inputs that are the length of one side of an equilateral triangle and outputs that are its perimeter.

1-52. Find the error in the solution at right. Identify the error and solve the equation correctly.

$$4.1x = 9.5x + 23.7$$
$$-4.1x = -4.1x$$
$$5.4x = 23.7$$
$$\frac{5.4x}{5.4} = \frac{23.7}{5.4}$$
$$x = 4.39$$

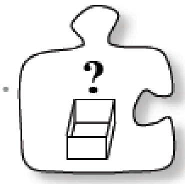


1-53. Solve each of the following equations.

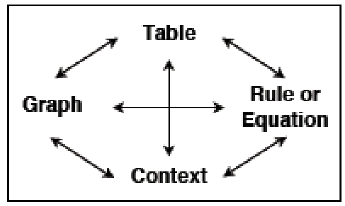
a. $3.9x - 2.1 = 11.2x + 51.7$ b. $\frac{1}{5}x - 2 = \frac{13}{25} - 0.7x$

1.2.1 How can I represent a function?

Modeling a Geometric Relationship



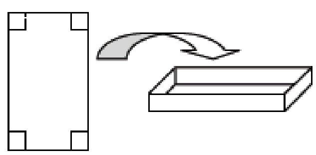
Mathematics can be used to model physical relationships to help us understand them better. Mathematical models can assume the form of a series of diagrams, a context, a table, an equation, or a graph. In this course, you will be given situations to explore in which you gather and interpret data. You will learn to **generalize** your information so that you can make predictions about cases not actually tested. In this lesson, you will analyze a geometric relationship and look for connections among its multiple representations.



1-54. ANALYZING DATA FROM A GEOMETRIC RELATIONSHIP

Each team will make paper boxes using the instructions given below. Based on the physical models, your team will represent the relationship between the height of the box and its volume in multiple ways.

Cut a sheet of centimeter grid paper to match the dimensions that your teacher assigns your team. Cut the same size square out of each corner, and fold the sides up to form a shallow box (with no lid) as shown below.



Dimensions

22 cm × 16 cm	18 cm × 10 cm
22 cm × 14 cm	15 cm × 15 cm
20 cm × 15 cm	15 cm × 10 cm
20 cm × 9 cm	12 cm × 9 cm

Your task: As a team you will **investigate** the relationship between the height of a paper box (the **input**) and its volume (the **output**). You can build as many boxes as necessary to establish this relationship. Be sure to build all of your boxes out of paper of the same size. Record your information using multiple representations—including diagrams, a table, and a graph. Also record any thoughts, observations, and/or general statements that come up in your discussion of the problem.

Discussion Points

How can we collect data for this relationship?

How much data is enough?

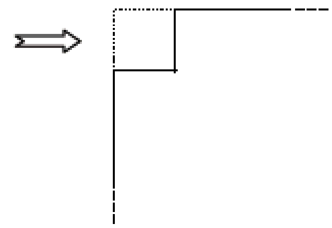
What are all the possible inputs for our function?

How are the different representations related?

Further Guidance

1-55. Begin your **investigation** by building several boxes, taking measurements, and collecting data.

a. As a team, choose a starting input value. Note that this value is the same as the *length of the side of one of the cut-out squares from the corner of your grid paper* and becomes the height of your box. Now make the first box and determine its volume. Label the box with its important information.



Work in the middle of the workspace so that everyone understands what is being measured or calculated, and be sure everyone agrees on the result before recording the information in an input→ output table on your own paper.

b. Each team member should now choose a *different* input value and build a new box or draw a diagram using this new value. Calculate the volume of your box. Share your input and output values with the rest of your team and record everyone's data in your input→ output table.

c. Use the data in your table to create a graph to represent the situation.

Further Guidance section ends here.

1-56. GENERALIZING

Now you will **generalize** your results. **Generalizing** is a mathematical Way of Thinking for this course. A common way to **generalize** using algebra is to write an equation.

a. Draw a diagram of one of your boxes. Since this shape is being used to **generalize**, you want it to represent a relationship between *any* possible input and its output. Therefore, instead of labeling the height with a number, label the height of this box x.

b. Work with your team to calculate the volume (or y-value) for a height of x. It may help you to remember how you calculated the volume when the height was a number and use the same **strategy** for your new input of x.

1-57. LOOKING FOR CONNECTIONS

Put your $x \rightarrow y$ table, graph, and equation in the middle of your workspace. With your team, discuss the questions below.

As you address each question, remember to give reasons when you can. Also, if you make an observation, discuss how that observation relates to your table, graph, and equation.

a. Are there some input values that would not make sense? Why or why not? How can you tell using the graph? The $x \rightarrow y$ table? The equation? The boxes (or diagrams of boxes)?

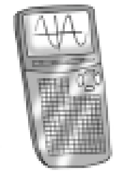
b. What are all of the possible outputs (volumes)? Are there any outputs that would not make sense? Why or why not?

c. Should you connect the points on your graph with a smooth curve? That is, should your graph be *continuous* or *discrete*? Explain.

d. What is different about your graph from others you have seen in previous courses? What special points or features does it have?

e. Work with your team to find as many other connections as you can among your geometric models, your table, your equation, and your graph. How can you show or explain each connection?

1-58. What graph do you get when you use the graphing calculator to draw the graph of your equation? Explain the relationship between this and the graph you made on your own paper.



1-59. Organize your findings into a stand-alone poster that shows everything you have learned about all of the representations of your function as well as the connections between the representations. Use colors, arrows, words, and any other useful tools you can think of to make sure that someone reading your poster can understand all of your thinking.

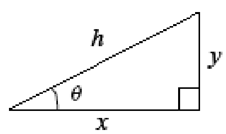
MATH NOTES

METHODS AND MEANINGS

Triangle Trigonometry

There are three **trigonometric ratios** you can use to solve for the missing side lengths and angle measurements in any right triangle: tangent, sine, and cosine.

In the triangle below, when the sides are described relative to the angle θ, the opposite leg is y and the adjacent leg is x. The hypotenuse is h regardless of which acute angle is used.

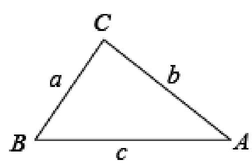


$$\tan\theta = \frac{\text{opposite leg}}{\text{adjacent leg}} = \frac{y}{x}$$

$$\sin\theta = \frac{\text{opposite leg}}{\text{hypotenuse}} = \frac{y}{h}$$

$$\cos\theta = \frac{\text{adjacent leg}}{\text{hypotenuse}} = \frac{x}{h}$$

In general, for any uniquely determined triangle, missing sides and angles can be determined by using the **Law of Sines** or the **Law of Cosines**.



$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

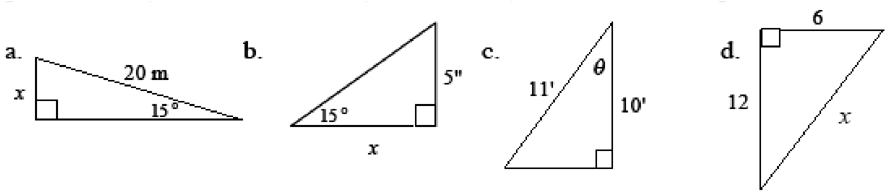
and

$$c^2 = a^2 + b^2 - 2ab\cos C$$

Review & Preview

1-60. Make a table and graph for $h(x) = x^3 - 4$. Find the domain, range, and intercepts.

1-61. For each diagram below, write and solve an equation to find the value of each variable. Give your answer to part (d) in both radical and decimal form. For a reminder of the trigonometry ratios, refer to the Math Notes box for this lesson.

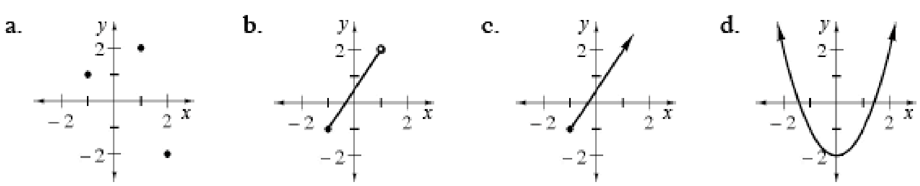


1-62. Consider the points (–2, 5) and (5, 2) as you complete parts (a) and (b) below.

a. Plot the points and find the distance between them. Give your answer both in simplest radical form and as a decimal approximation.

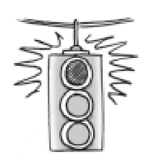
b. Find the slope of the line that goes through the two points.

1-63. Name the domain and range for each of the following functions.



1-64. Find the error in the solution at right. Explain what the error is and solve the equation correctly. Be sure to check your answer.

$$\frac{5}{x} = x - 4$$
$$x \cdot \frac{5}{x} = x - 4$$
$$5 = x - 4$$
$$x = 9$$



1-65. Solve each of the following equations. Be sure to check your answers.

a. $\frac{6}{x} = x - 1$

b. $\frac{9}{x} = x$

1-66. Compute each of the following values for $f(x) = \frac{1}{x-2}$.

a. $f(2.5)$

b. $f(1.75)$

c. $f(2)$

d. **Justify** your answer for part (c).

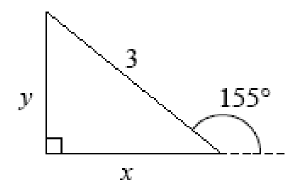
1-67. Graph the following functions and find the x- and y-intercepts.

a. $y = 2x + 3$

b. $f(x) = 2x + 3$

c. How are the functions in (a) and (b) the same? How are they different?

1-68. A 3-foot indoor kiddy slide must meet the ground very gradually and make an angle of 155°, as shown in the diagram at right. Find the height of the slide (y) and the length of the floor it will cover (x).



1-69. Write one or two equations to help you solve the following problem.

A rectangle's length is four times its width. The sum of its two adjacent sides is 22 cm. How long is each side?

1-70. Solve each of the following equations.

a. $\frac{3}{x} + 6 = -45$

b. $\frac{x-2}{5} = \frac{10-x}{8}$

c. $(x+1)(x-3) = 0$

1-71. Consider $f(x) = x^2 - 2x + 6$ and $g(x) = 2x + 11$.

a. Use any method to find the points of intersection of $f(x)$ and $g(x)$.

b. Calculate $f(x) + g(x)$.

c. Calculate $f(x) - g(x)$.

1-72. Rearrange each equation below by solving for x. Write each equation in the form $x =$ ____ . (Note that y will be in your answer).

a. $y = \frac{3}{5}x + 1$ b. $3x + 2y = 6$

c. $y = x^2$ d. $y = x^2 - 100$

1-73. Consider circles of different sizes. Create multiple representations of the function with inputs that are the radius of the circle and outputs that are its area.

1-74. Consider the equation $4x - 6y = 12$.

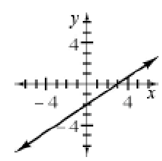
a. Predict what the graph of this equation looks like. **Justify** your answer.

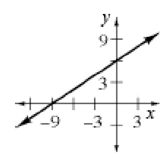
b. Solve the equation for y and graph the equation.

c. Explain clearly how to find the x- and y-intercepts.

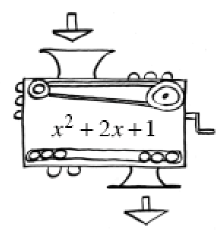
d. Which form of the equation is best for finding intercepts quickly? Why?

e. Find the x- and y-intercepts of $2x - 3y = -18$. Then use the intercepts to sketch a graph quickly.





1-75. If the number 1 is the output for Carmichael's function machine shown at right, how can you find out what number was dropped in? Find the number(s) that could have been dropped in.



1-76. What value of x allows you to find the y-intercept? Where does the graph of each equation below cross the y-axis? Write each answer as an ordered pair.

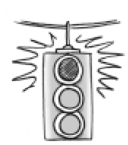
a. $y = 3x + 6$ b. $x = 5y - 10$

c. $y = x^2$ d. $y = 2x^2 - 4$

e. $y = (x-5)^2$ f. $y = 3x^3 - 2x^2 + 13$

1-77. Find the error in the solution at right. Describe the error and solve the equation correctly.

$3x + 2 = 10 - 4(x-1)$
$3x + 2 = 6(x-1)$
$3x + 2 = 6x - 6$
$8 = 3x$ so $x = \frac{8}{3}$



1.2.2 How can I investigate a function?

Function Investigation

What does it mean to describe a function completely? In this lesson you will graph and **investigate** a family of functions with equations of the form $f(x)=\frac{1}{x-h}$. As you work with your team, keep the multiple representations of functions in mind.

1-78. INVESTIGATING A FUNCTION, Part One

Your team will **investigate** functions of the form $f(x)=\frac{1}{x-h}$, where h can be any number.

As a team, choose a value for h between –10 and 10. For example, if $h=7$, then $f(x)=\frac{1}{x-7}$.

Your task: On a piece of graph paper, write down the function you get when you use your h-value. Then make an $x \rightarrow y$ table and draw a complete graph of your function. Is there any more information you need to be sure that you can see the entire shape of your graph? Discuss this question with your team and add any new information you think is necessary.

Discussion Points

How can we be sure that our graph is complete?

How can we get output values that are greater than 1 or less than –1?

Further Guidance

1-79. This function is different from others you have seen in the past. To get a complete graph, you will need to make sure your table includes enough information.

a. Make an $x \rightarrow y$ table with integer x-values from 5 below your value of h to 5 above your value of h. For example, if you are working with $h = 7$, you would start your table at $x = 2$ and end it at $x = 12$. What do you notice about all of your y-values?

b. Is there any x-value that has no y-value for your function? Why does this make sense?

c. Plot all of the points that you have in your table so far.

d. Now you will need to add more values to your table to see what is happening to your function as your input values get close to your h-value. Choose eight input values that are very close to your value of h on either side. For example, if you are working with $h = 7$, you might choose input values such as 6.5, 6.7, 6.9, 6.99, 7.01, 7.1, 7.3, and 7.5. For each new input value, calculate the corresponding output and add the new point to your graph.

e. When you have enough points to be sure that you know the shape of your graph, sketch the curve.

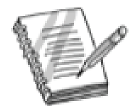
Further Guidance section ends here.

1-80. Now you will continue your **investigation** of $f(x)=\frac{1}{x-h}$.

a. Each team member should choose a different value of h and make a complete $x \to y$ table and graph for your new function.

b. Examine all of your team's functions. Together, generate a list of questions that you could ask about the functions your team created. Be as thorough as possible and be prepared to share your questions with the class.

c. As your teacher records each team's questions, copy them into your Learning Log. Title this entry "Function Investigation Questions" and label it with today's date.



1-81. INVESTIGATING A FUNCTION, Part Two: SUMMARY STATEMENTS

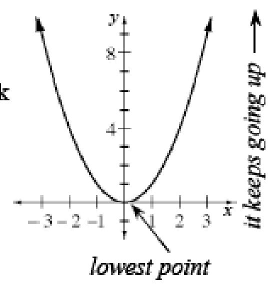
Now you are ready for the most important part of your **investigation**: summary statements! Summary statements are a very important part of this course, so your team will practice making them. A summary statement is a statement about a function *along with thorough justification*. A strong summary statement should be **justified** with multiple representations ($x \rightarrow y$ table, equation, graph, and situation, if applicable).

a. Read the example summary statement below, a summary statement about the range of the function $y = x^2$. Discuss it with your team and decide if it is **justified** completely.

Statement: The function $y = x^2$ has a range of all numbers greater than or equal to zero ($y \geq 0$).

First justification: You can see this when you look at the graph, because you can see that the lowest point on the graph is on the x-axis.

Second justification: Also, you can see this in the table, because none of the y-values are negative.



x	–3	–2	–1	0	1	2	3
y	9	4	1	0	1	4	9

they will keep getting higher ←   *this is the lowest output*   → *they will keep getting higher*

Third justification: It makes sense with the equation, because if you square any number, the answer will be positive. For example, $(-2)^2 = 4$ and $3^2 = 9$.

b. Use your "Function Investigation Questions" Learning Log entry from problem 1-68 to help you make as many summary statements about your functions as you can. Remember to **justify** each summary statement in as many ways as possible.

1-82. SHARING SUMMARY STATEMENTS

With your team, choose one summary statement that you wrote that you find particularly interesting. On an overhead transparency, write the summary statement along with its **justification**. Include sketches of graphs, $x \rightarrow y$ tables, equations, circles, arrows, colors, and any other tools that are helpful.

1-83. What will the graph of $f(x) = \frac{1}{x+25}$ look like?

a. Discuss this question with your team and make a sketch of what you predict the graph will look like. Give as many reasons for your prediction as you can.

b. Use your graphing calculator to graph $f(x) = \frac{1}{x+25}$. Do you see what you expected to see? Why or why not?

c. Adjust the viewing window if needed. When you see the full picture of your graph, make a sketch of the graph on your paper. Label any important points.

d. How close was your prediction?

Review & Preview

1-84. Use any method to find the points of intersection of $f(x)=2x^2-3x+4$ and $g(x)=x^2+5x-3$.

1-85. Solve each equation for x.

a. $-2(x+4)=35-(7-4x)$

b. $\frac{x-4}{7}=\frac{8-3x}{5}$

1-86. Make a complete graph of the function $f(x)=\sqrt{x}-2$, label its x- and y-intercepts, and describe its domain and range.

1-87. Given $f(x)=2x-7$, complete parts (a) through (c) below.

a. Compute $f(0)$.

b. Solve $f(x)=0$.

c. What do the answers to parts (a) and (b) tell you about the graph of $f(x)$?

1-88. Solve each equation below for the indicated variable.

a. $y=mx+b$ (for x)

b. $A=\pi r^2$ (for r)

c. $V=LHW$ (for W)

d. $2x+\frac{1}{y}=3$ (for y)

1-89. What value of y allows you to find the x-intercept? For each of the equations below, find where its graph intersects the x-axis. Write each answer as an ordered pair.

a. $y=3x+6$

b. $x=5y-10$

c. $y=x^2$

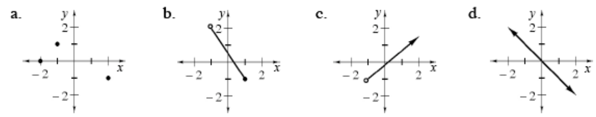
d. $y=2x^2-4$

e. $y=(x-5)^2$

f. $y=x^3-13$

1-90. Make a complete graph of the function $h(x)=2x^2+4x-6$ and describe its domain and range.

1-91. Find the domain and the range for each of the following functions.



1-92. Carlo got a pet snake as a birthday present. On his birthday, the baby snake was just 26 cm long. He has been watching it closely and has noticed that it has been growing 2 cm each week.

a. Create multiple representations of the function for which the inputs are the weeks since Carlo's birthday and the outputs are the length of the snake.

b. If the snake continues to grow at the same rate, when will it be 1 meter (100 cm) long? How can you see this in each representation?

1-93. Create multiple representations of the function $g(x)=\frac{2}{x}$. Then make as many summary statements as you can.

1-94. Suppose you want to find where the lines $y=3x+15$ and $y=3-3x$ cross, and you want to be more accurate than the graphing calculator or graph paper will allow. You can use algebra to find the *point of intersection*.

a. If you remember how to do this, find the point of intersection using algebra and be prepared to explain your method to your team tomorrow in class. If you do not remember, then do parts (b) through (e) below.

b. Since $y=3x+15$ and $y=3-3x$, what must be true about $3x+15$ and $3-3x$ when their y-values are the same?

c. Write an equation that does not contain y and solve it for x.

d. Use the x-value you found in part (c) to find the corresponding y-value.

e. Where do the two lines cross?

1-95. *Salami and More Deli* sells a 5-foot submarine sandwich for parties. It weighs 8 pounds. Assuming that the weight per foot is constant, what would be the length of a 12-pound sandwich?

1-96. If $h(x)=x^2-5$, where does the graph of $h(x)$ cross the x-axis? Make a sketch of the graph.

1-97. Graph the following equations.

a. $y-2x=3$

b. $y-3=x^2$

c. State the x- and y-intercepts for each equation.

d. Where do the two graphs cross? Show how you can find these two points without looking at the graphs.

1-98. Match the laws, rules, or formulas in Column I with the corresponding name from Column II.

Column I	Column II
a. $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$	1. Law of Cosines
b. $\frac{\sin A}{a}=\frac{\sin B}{b}$	2. Law of Sines
c. $c^2=a^2+b^2$	3. Pythagorean Theorem
d. $c^2=a^2+b^2-2ab\cos C$	4. Quadratic Formula

October 24, 2010

1.2.3 What do they have in common?

The Family of Linear Functions

In Lesson 1.2.2, your team **investigated** functions of the form $f(x)=\frac{1}{x-h}$, where h could be any number. You learned that as you changed h, the graph changed, but the basic shape stayed the same. In this lesson, you will think about functions of the form $f(x)=mx+b$.

1-99. Consider functions of the form $y=mx+b$.

a. What do x and y represent in this function? What do m and b represent? Which ones can you change?

b. With the rest of the class, explore the effects of m and b on the function $y=mx+b$. What effect does m have on the graph? What effect does b have on the graph?

c. For this function, m and b are called **parameters** (as h was for $f(x)=\frac{1}{x-h}$), whereas x and y are called **variables**. With your team, explain the difference between a parameter and a variable.

d. What do all of the functions of the form $y=mx+b$ have in common? Since they all have the same basic relationship between x and y, they can be called a **family** of functions.

1-100. With your team, examine each of group of equations below and discuss what you would see if you drew the graphs of the four equations on one set of axes. Write a description of what you imagine you would see. (You do not actually have to draw them.)

a. $x+2y=10$

$y=-\frac{1}{2}x+3$

$-4y=2x+8$

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

b. $5x+y=-3$

$y=-\frac{1}{2}x-3$

$3x-4y=12$

$5y-2x=-15$

1-101. Below, (a) through (f), are six representations of a relationship between an input and an output. With your team, decide whether each relationship is linear and write a clear summary statement **justifying** your decision. If the relationship is linear, graph it and find its equation. If it is not linear, describe the growth.

a.

Pieces of Bread	*Grams of Fiber*
0	0
1	5
2	10
3	15
4	20

b. *Killer Fried Chickens charges $7.00 for a basic bucket of chicken and $0.50 for each additional piece. The input is the number of extra pieces of chicken ordered, and the output is the total cost of the order.*

c.

x	y
10	0
5	5
3	7
2	8
1	9
0	10

d.

x	y
10	1
5	2
4	2.5
2	5
1	10
0.5	20

e. *James planted a bush in his yard. The year he planted it, the bush produced 17 flowers. Each year, the branches of the bush split, so the number of flowers doubles. The input is the year after planting, and the output is the number of flowers.*

f.

x	y
0	–7
2	–2
4	3
6	8
8	13

1-102. Work with your team to create one new table and one new situation that display linear relationships. Be sure to **justify** how you can tell that your table and situation are linear.

1-103. Without using a graph, decide whether the relationship shown in the table at right is linear. Write a clear summary statement **justifying** your ideas. Be prepared to share your ideas with the class.

x	y
1	0.5
4	–7
10	–22
15	–34.5

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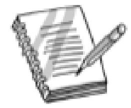
1-104. LEARNING LOG

In your Learning Log, explain how you can recognize a linear relationship in a table or the description of a situation. Be sure to include examples. Title this entry "Recognizing Linear Relationships" and label it with today's date.



Review & Preview

1-105. Find the slope and intercepts of $3x+4y=12$. Sketch a graph.

1-106. Write an equation for the line that passes through the points (2, 0) and (0, –3). Remember that drawing a diagram (in this case, drawing the graph) can be very helpful.

1-107. Solve each equation below. Give solutions in both radical and decimal form.

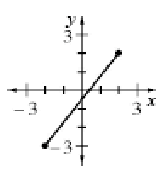
a. $x^2+3x-3=0$ b. $3x^2-7x=12$

1-108. Jason loves to download music. *Downloads R Us* sells songs only in packages of three, and it charges $2.00 for each package of three songs. Jason's favorite group just released their *Greatest Hits* CD, which has 17 songs on it. Jason wants to buy all 17 songs from *Downloads R Us*. How much should Jason expect to pay?

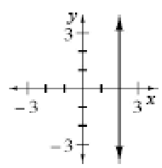
1-109. Make a sketch of a graph showing the relationship between the number of people on your school's campus and the time of day.

1-110. For each graph below, what are the domain and range?

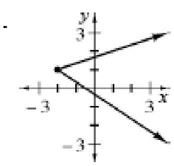
a.



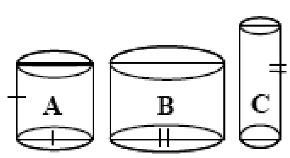
b.

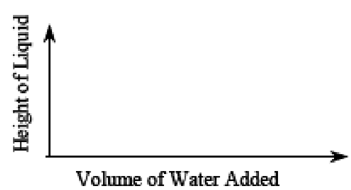


c.



1-111. Imagine that you add water to the beakers shown below (labeled A, B, and C). Sketch a graph for each beaker to show the relationship between the volume of water added and the height of the water in each beaker. Put all three graphs on one set of axes (you may want to use colored pencils to distinguish the graphs). What are the independent and dependent variables?





1.2.4 What can I learn about it?

Function Investigation Challenge

In this lesson, you will have a chance to show off your understanding of **investigation** as you work with a new function.

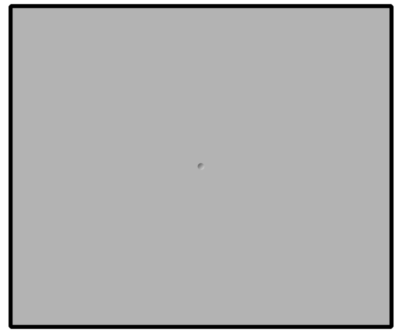
1-112. In this activity you will **investigate** the function $f(x) = \frac{5}{(x^2+1)} - 1$.

a. Take a moment to look over your Learning Log entry entitled "Function Investigation Questions." Are there any questions you should add to your list? Discuss this with your team and make any necessary additions to your Learning Log.

b. Now **investigate** $f(x)$ completely. Be sure to make clear summary statements that are **justified** using multiple representations.

Review & Preview

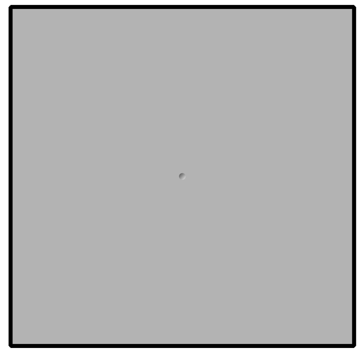
1-113. Recently, Kalani and Lynette took a trip from Vacaville, California to Los Angeles. The graph at right represents their trip.



a. Explain what each line segment in the graph represents.

b. About how many miles is it from Vacaville to Los Angeles? How do you know?

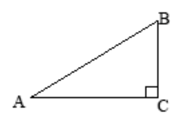
c. Using the graph shown above, sketch a graph that would represent their *speed* while traveling. Take your time to think this through carefully and be sure to label the axes.



1-114. Solve each equation below for x.

a. $10-2(2x+1)=4(x-2)$ b. $5-(2x-3)=-8+2x$

1-115. The right triangle shown at right has a height of 12 cm, and its area is 60 square cm. Find $m\angle B$ and the length of the hypotenuse.



1-116. The longer leg of a right triangle is three inches more than three times the length of the shorter leg. The area of the triangle is 84 square inches. Find the perimeter of the triangle.

1-117. Uyregor has a collection of normal, fair dice. He takes one out to roll it

a. What are all possible outcomes that can come up?

b. What is the probability that a 4 comes up?

c. What is the probability that the number that comes up is less than 5?

1-118. Stacie says to Cory, *"Reach into this standard deck of playing cards and pull out a card at random. If it is the queen of hearts, I'll pay $5.00."* What is the probability that Cory gets Stacie's $5.00? What is the probability that Stacie keeps her $5.00? **Justify** your answers. (Note: A standard deck of playing cards contains 52 cards, each of which is unique.)

1-119. Have you ever wondered why so many equations are written with the variables x and y? Suppose you are reaching into a bag that contains all the letters of the English alphabet, and you pull out one letter at random to use as a variable in equations. What is the probability that you pull out an x? If you got the x, now what is the probability that you pull out a y?

CL 1-120. Given the functions $f(x)=\sqrt{x+4}$ and $g(x)=x^2-x$, find the value of each expression below.

a. $f(5)$

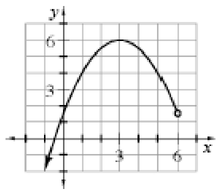
b. $g(-1)$

c. x if $f(x)=10$

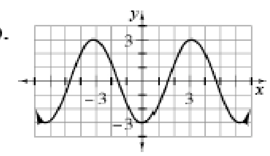
d. x if $g(x)=6$

CL 1-121. Describe the domain and range for each function shown below.

a.



b.



CL 1-122. For each pair of equations below, determine where the graphs intersect.

a. $y=3x+15$
$y=3-3x$

b. $y=x^2-3x-8$
$y=2$

CL 1-123. Graph the function $f(x)=x^2-2x-8$. Identify the domain and range, identify any special points, and describe any symmetry.

CL 1-124. Graph each equation below and find the x- and y-intercepts.

a. $y=-\frac{3}{2}x+8$

b. $2x-3y=-6$

CL 1-125. Find an equation for each line described below.

a. The line that passes through the point (2, 8) and has a slope of –5.

b. The line that passes through the points (–3, 4) and (5, –4).

c. The line that passes through the points (–2, 4) and (4, –5).

CL 1-126. Solve each equation below.

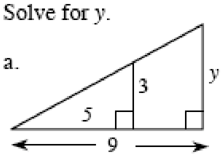
a. $\frac{x+2}{5}=\frac{10-2x}{3}$

b. $\frac{3}{x}-1=8$

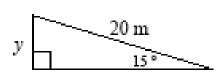
c. $\frac{x}{2}+\frac{x}{3}=7$

CL 1-127. Solve for y.

a.



b.



CL 1-128. Micah was given \$200 for his birthday. Each week he spends \$15 on comic books. In how many weeks will his birthday money be gone?

Create multiple representations ($x \rightarrow y$ table, graph, and equation) for the relationship between the weeks since Micah's birthday and how much money he has left. How does each representation show the solution to the problem?

CL 1-129. Check your answers using the table at the end of this section. Which problems do you feel confident about? Which problems were hard? Have you worked on problems like these in math classes you have taken before? Use the table to make a list of topics with which you need help and a list of topics you need to practice more.

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When I **investigate a function**, I answer each question below with a statement and justification.

Below is my investigation of the function ________________________________

Question 1: ____

Statement 1: ____

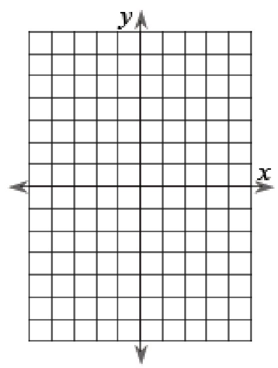
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other:

Question 2: ____

Statement 2: ____

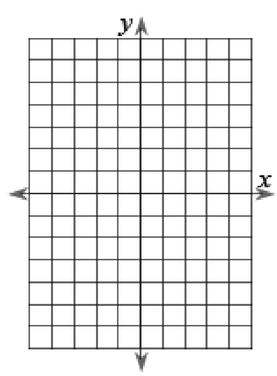
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other:

When I **investigate a function**, I answer each question below with a statement and justification.

Below is my investigation of the function ________________________________

Question 1: ____

Statement 1: ____

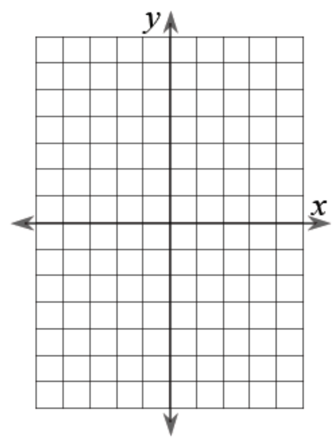
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other:

Question 2: ____

Statement 2: ____

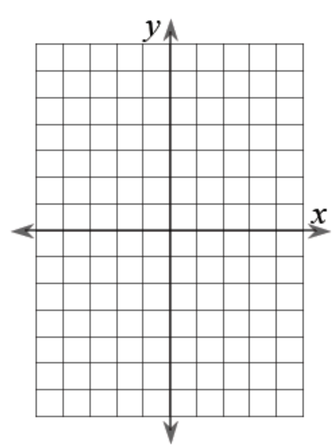
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other:

Question 3: ____

Statement 3: ____

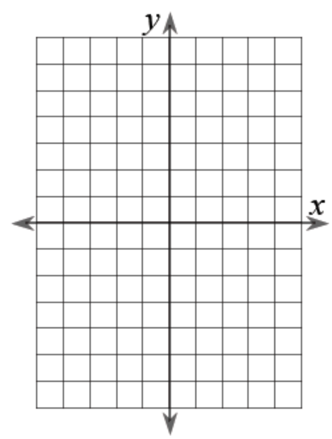
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other:

Question 4: ____

Statement 4: ____

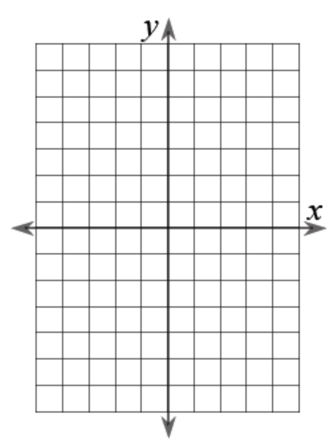
____

Justification:

Table:

x							
y							

Graph:



Equation:

Other: