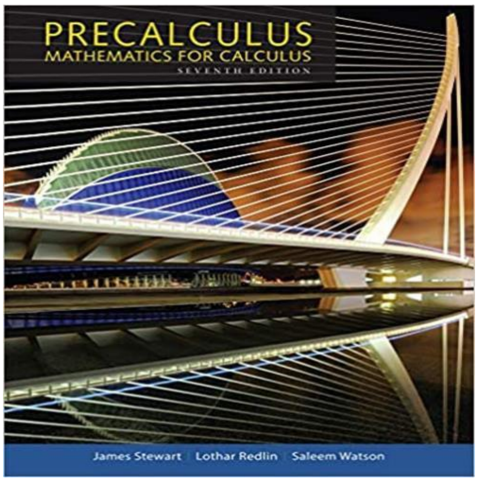
Solution Manual for Precalculus Mathematics for Calculus 7th Edition Stewart Redlin Watson 1305071751 9781305071759



Full link download:
Solution Manual:
https://testbankpack.com/p/solution-manual-for-precalculus-mathematics-for-calculus-7th-edition-stewart-redlin-watson-1305071751-9781305071759/

Test Bank:

https://testbankpack.com/p/test-bank-for-precalculus-mathematics-for-calculus-7th-edition-stewart-redlin-watson-1305071751-9781305071759/

2 FUNCTIONS

2.1 FUNCTIONS

H Suggested Time and Emphasis

$\frac{1}{2}$–1 class. Essential material.

H Points to Stress

1. The idea of function, viewed as the dependence of one quantity on a different quantity.
2. The notation associated with piecewise-defined functions.
3. Domains and ranges from an algebraic perspective.
4. Four different representations of functions (verbally, algebraically, visually, and numerically).

H Sample Questions

- **Text Question:** What is a function?
  Answer: Answers will vary. The hope is that the students will, in their own words, arrive at the idea that a function assigns each element of one set to exactly one element of another set (or the same set).
- **Drill Question:** Let $\square(\square) = \square + \sqrt{\square}$. Find $\square(0)$ and $\square(4)$.
  Answer: $\square(0) = 0$, $\square(4) = 6$

H In-Class Materials

- Discuss the ties between the idea of a function and a calculator key. Keys such as sin, cos, tan, and $\sqrt{\ }$ represent functions. It is easy to compute and graph functions on a calculator. Contrast this with equations such as $\square^3 - \square^3 = 2\square\square$, which have graphs but are not easy to work with, even with a calculator. (Even computer algebra systems have a tough time with some general relations.) Point out that calculators often give approximations to function values—applying the square root function key to the number 2 gives 1.4142136 which is close to, but not equal to, $\sqrt{2}$.
- Most math courses through calculus emphasize functions where both the domain and range sets are numerical. One could give a more abstract definition of function, where $\square$ and $\square$ can be any set. For example, there is a function mapping each student in the class to his or her birthplace. A nice thing about this point of view is that it can be pointed out that the map from each student to his or her telephone number may *not* be a function, because a student may have more than one telephone number, or none at all.
- Function notation can trip students up. Start with a function such as $\square(\square) = \square^2 - \square$ and have your students find $\square(0)$, $\square(1)$, $\square\left(\sqrt{3}\right)$, and $\square(-1)$. Then have them find $\square(\square)$, $\square(\square)$, and (of course) $\square(\square + \square)$. Some

students will invariably, some day, assume that $\square(\square + \square) = \square(\square) + \square(\square)$ for all functions, but this can be minimized if plenty of examples such as $\square(2 + 3)$ are done at the outset.

- Discuss the usual things to look for when trying to find the domain of a function: zero denominators and negative even roots.

  Then discuss the domain and range of $\square(\square) = \begin{cases} \square^2 & \text{if } \square \text{ is an integer} \\ 0 & \text{if } \square \text{ is not an integer} \end{cases}$

  If the class seems interested, perhaps let them think about $\square(\square) = \begin{cases} \square^2 & \text{if } \square \text{ is rational} \\ 0 & \text{if } \square \text{ is irrational} \end{cases}$

- Let $\square(\square) = \dfrac{\square(\square - 2)}{\square - 2}$ and $\square(\square) = \square$. Ask students if the functions are the same function. If they say "yes", ask them to compare the domains, or to compute $\square(2)$ and $\square(2)$. If they say "no", ask them to find a value such that $\square(\square) = \square(\square)$. [This activity assumes that students know the equation of a circle with radius $\square$. If they do not, this may be a good opportunity to introduce the concept.]

H Examples

- Real-world piecewise functions:
  1. The cost of mailing a parcel that weighs □ ounces (see Figure 1 in the text)
  2. The cost of making □ photocopies (given that there is usually a bulk discount)
  3. The cost of printing □ pages from an inkjet printer (at some point the cartridges must be replaced)
- A function with a nontrivial domain: $\sqrt{\dfrac{\square^2 - 5\square + 6}{\square^2 - 2\square + 1}}$ has domain $(-\infty \square\, 1) \cup (1 \square\, 2] \cup [3 \square\, \infty)$.

H Group Work 1: Finding a Formula

Make sure that students know the equation of a circle with radius □, and that they remember the notation for piecewise-defined functions. Divide the class into groups of four. In each group, have half of them work on each problem first, and then have them check each other's work. If students find these problems difficult, have them work together on each problem.

Answers: 1. $\square(\square) = \begin{cases} -\square - 2 & \text{if } \square \le -2 \\ \square + 2 & \text{if } -2 \,\square\, \square \le 0 \\ 2 & \text{if } \square \,\square\, 0 \end{cases}$ **2.** $\square(\square) = \begin{cases} \square + 4 & \text{if } \square \le -2 \\ 2 & \text{if } -2 \,\square\, \square \le 0 \\ \sqrt{4 - \square^2} & \text{if } 0 \,\square\, \square \le 2 \\ \square - 2 & \text{if } \square \,\square\, 2 \end{cases}$

H Group Work 2: Rounding the Bases

On the board, review how to compute the percentage error when estimating □ by $\frac{22}{7}$. (Answer: 0□04%) Have them work on the problem in groups. If a group finishes early, have them look at □(7) and □(10) to see how fast the error grows. Students have not seen exponential functions before, but Problem 3 is a good foreshadowing of Section 4.1.

Answers: 1. 17□811434627, 17, 4□56% **2.** 220□08649875, 201, 8□67% **3.** 45□4314240633, 32, 29□56%

H Homework Problems

Core Exercises: 3, 15, 20, 33, 37, 50, 58, 68, 80, 89, 94

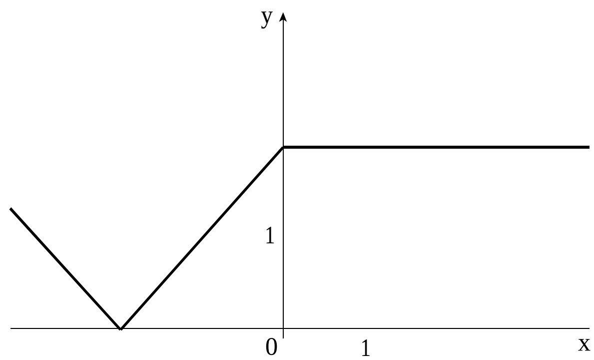
Sample Assignment: 1, 3, 8, 13, 15, 17, 20, 25, 29, 32, 33, 35, 37, 42, 43, 50, 53, 57, 58, 64, 68, 73, 76, 80, 83, 86, 89, 94

GROUP WORK 1, SECTION 2.1

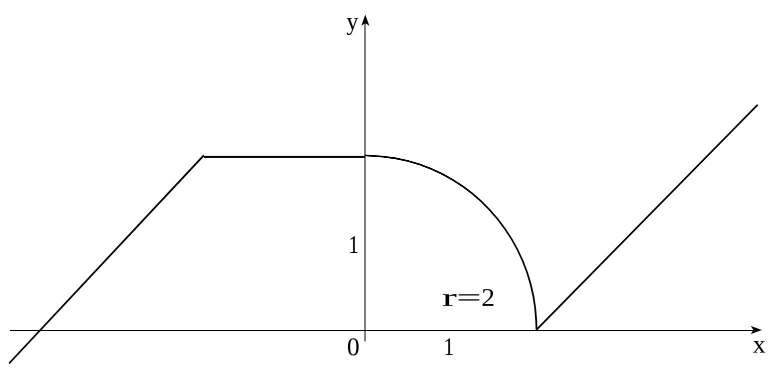
Finding a Formula

Find formulas for the following functions:

1.



2.



GROUP WORK 2, SECTION 2.1

Rounding the Bases

---

1. For computational efficiency and speed, we often round off constants in equations. For example, consider the linear function

$$□(□) = 3□137619523□ + 2□123337012$$

In theory, it is easy and quick to find □(1), □(2), □(3), □(4), and □(5). In practice, most people doing this computation would probably substitute

$$□(□) = 3□ + 2$$

unless a very accurate answer is called for. For example, compute □(5) both ways to see the difference.

The actual value of □(5): __________

The "rounding" estimate: __________

The percentage error: __________

2. Now consider

$$□(□) = 1□12755319□^3 + 3□125694□^2 + 1$$

Again, one is tempted to substitute $□(□) = □^3 + 3□^2 + 1$.

The actual value of □(5): __________

The "rounding" estimate: __________

The percentage error: __________

3. It turns out to be dangerous to similarly round off exponential functions, due to the nature of their growth. For example, let's look at the function

$$□(□) = (2□145217198123)^{□}$$

One may be tempted to substitute $□(□) = 2^{□}$ for this one. Once again, look at the difference between these two functions.

The actual value of □(5): __________

The "rounding" estimate: __________

The percentage error: __________

2.2 GRAPHS OF FUNCTIONS

H Suggested Time and Emphasis

1 class. Essential material.

H Points to Stress

1. The Vertical Line Test.

2. Graphs of piecewise-defined functions.

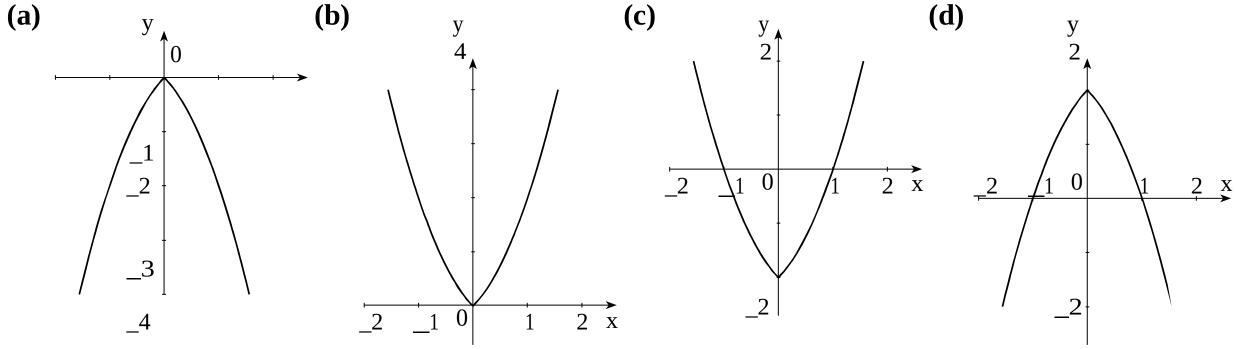
3. The greatest integer function.

H Sample Questions

- **Text Question:** Your text discusses the greatest integer function $[\![\square]\!]$. Compute $[\![2\square 6]\!]$, $[\![2]\!]$, $[\![-2\square 6]\!]$, and $[\![-2]\!]$.

  Answer: $[\![2\square 6]\!] = 2$, $[\![2]\!] = 2$, $[\![-2\square 6]\!] = -3$, $[\![-2]\!] = -2$

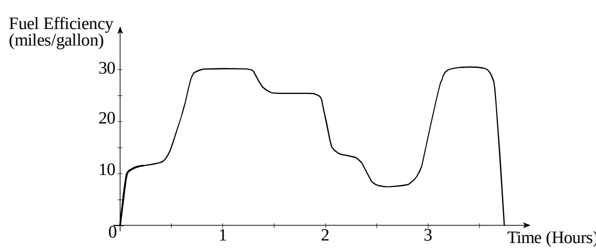
- **Drill Question:** Let $\square(\square) = \square^2 + |\square|$. Which of the following is the graph of $\square$? How do you know?



  Answer: (b) is the graph of $\square$, because $\square(\square) \geq 0$ for all $\square$.

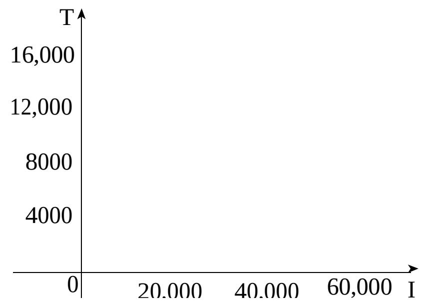
H In-Class Materials

- Draw a graph of fuel efficiency versus time on a trip, such as the one below. Lead a discussion of what could have happened on the trip.



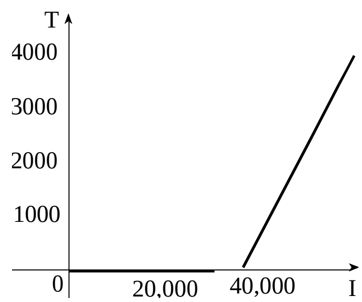
- In 1984, United States President Ronald Reagan proposed a plan to change the personal income tax system. According to his plan, the income tax would be 15% on the first \$19,300 earned, 25% on the next \$18,800, and 35% on all income above and beyond that. Describe this situation to the class, and have them graph tax owed □ as a function of income □ for incomes ranging from \$0 to \$80,000. Then have them try to come up with equations describing this situation.

Answer:



- In the year 2000, Presidential candidate Steve Forbes proposed a "flat tax" model: The first $36,000 of a taxpayer's annual income would not be taxed at all, and the rest would be taxed at a rate of 17%. Have your students do the same analysis they did of Reagan's 1984 plan, and compare the models. As an extension, consider having them look at a current tax table and draw similar graphs.

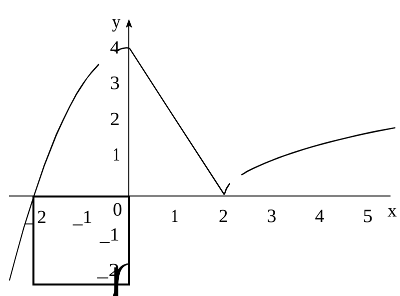
Answer:



- Discuss the shape, symmetries, and general "flatness" near 0 of the power functions x^n for various values of n. Similarly discuss $\sqrt[n]{x}$ for n even and n odd. A blackline master is provided at the end of this section, before the group work handouts.

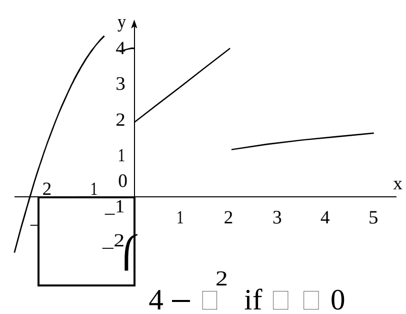
H Examples

- A continuous piecewise-defined function



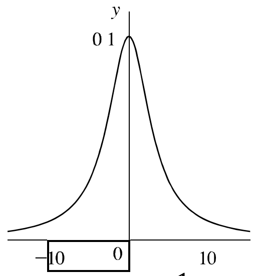
$$f(x) = \begin{cases} 4 - x^2 & \text{if } x < 0 \\ 4 - 2x & \text{if } 0 \le x \le 2 \\ \sqrt{x - 2} & \text{if } x > 2 \end{cases}$$

- A discontinuous piecewise-defined function

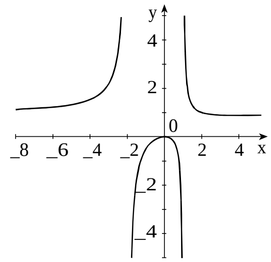


$$f(x) = \begin{cases} 4 - x^2 & \text{if } x < 0 \\ x + 2 & \text{if } 0 \le x \le 2 \\ \sqrt[3]{x} & \text{if } x > 2 \end{cases}$$

- Classic rational functions with interesting graphs



$$\square(\square) = \frac{1}{\square^2 + \square^2}$$



$$\square(\square) = \frac{\square^2}{\square^2 + \square - 2}$$

H Group Work 1: Every Picture Tells a Story

Put students in groups of four, and have them work on the exercise. If there are questions, encourage them to ask each other before asking you. After going through the correct matching with them, have each group tell their story to the class and see if it fits the remaining graph.

Answers:

1. (b) **2.** (a) **3.** (c)

4. The roast was cooked in the morning and put in the refrigerator in the afternoon.

H Group Work 2: Functions in the Classroom

Before starting this one, review the definition of "function". Some of the problems can be answered only by polling the class after they are finished working. Don't forget to take leap years into account for the eighth problem. For an advanced class, anticipate Section 2.8 by quickly defining "one-to-one" and "bijection", then determining which of the functions have these properties.

Answers:

Chairs: Function, one-to-one, bijection (if all chairs are occupied)

Eye color: Function, not one-to-one

Mom & Dad's birthplace: Not a function; mom and dad could have been born in different places

Molecules: Function, one-to-one (with nearly 100% probability); inverse assigns a number of molecules to the appropriate student.

Spleens: Function, one-to-one, bijection. Inverse assigns each spleen to its owner.

Pencils: Not a function; some people may have more than one or (horrors!) none.

Social Security Number: Function, one-to-one; inverse assigns each number to its owner.

February birthday: Not a function; not defined for someone born on February 29.

Birthday: Function, perhaps one-to-one.

Cars: Not a function; some have none, some have more than one.

Cash: Function, perhaps one-to-one.

Middle names: Not a function; some have none, some have more than one.

Identity: Function, one-to-one, bijection. Inverse is the same as the function.

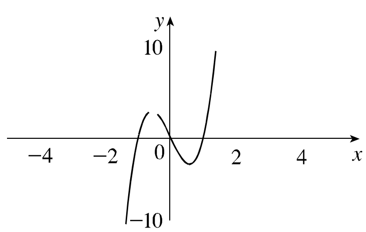
Instructor: Function, not one-to-one.

H Group Work 3: Rational Functions

Remind students of the definition of a rational function as a quotient of polynomials. Students should be able to do this activity by plotting points and looking at domains and ranges.

Answers:

1.

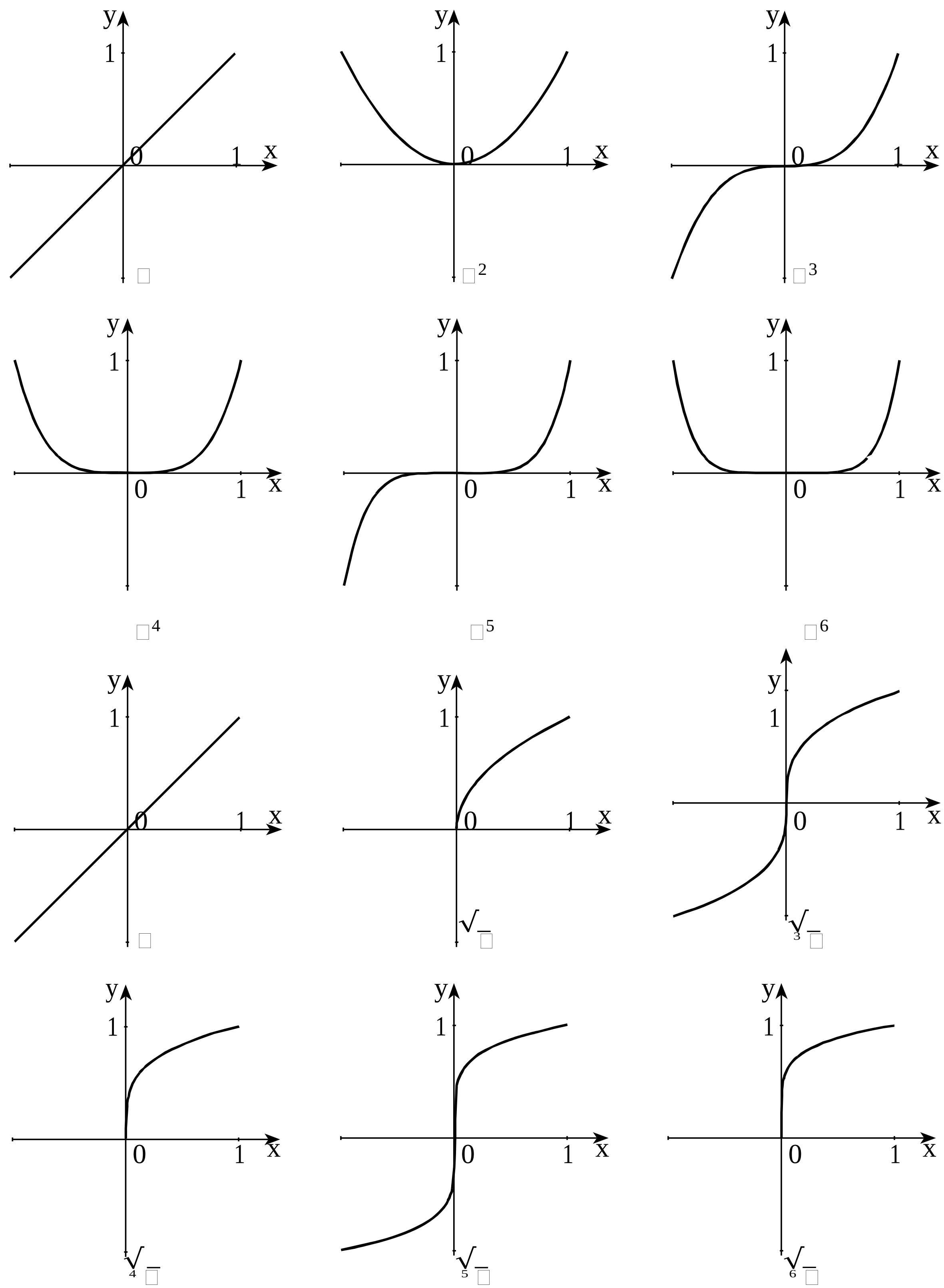


2. (d) **3.** (b) **4.** (e) **5.** (c) **6.** (a)

H Homework Problems

Core Exercises: 3, 7, 22, 34, 42, 47, 52, 60, 70, 78, 83

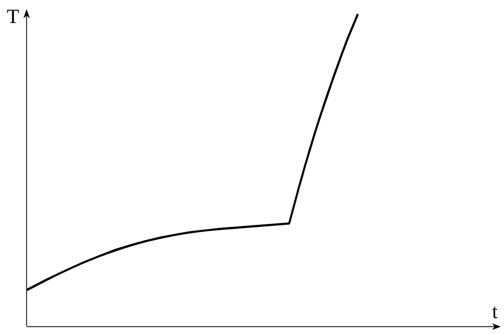
Sample Assignment: 3, 4, 7, 8, 16, 22, 25, 31, 34, 38, 42, 45, 47, 50, 52, 56, 60, 64, 66, 70, 73, 76, 78, 81, 83, 87


y
1
0
1
x
x
x^2
x^3
x^4
x^5
x^6
x
$\sqrt{x}$
$\sqrt[3]{x}$
$\sqrt[4]{x}$
$\sqrt[5]{x}$
$\sqrt[6]{x}$

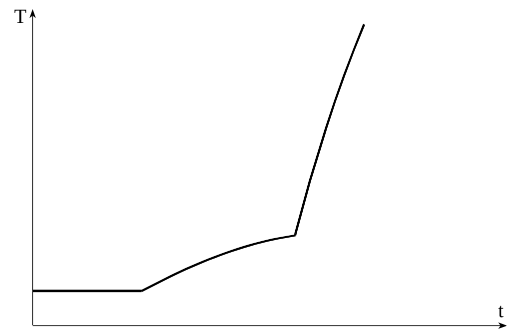
GROUP WORK 1, SECTION 2.2

Every Picture Tells a Story

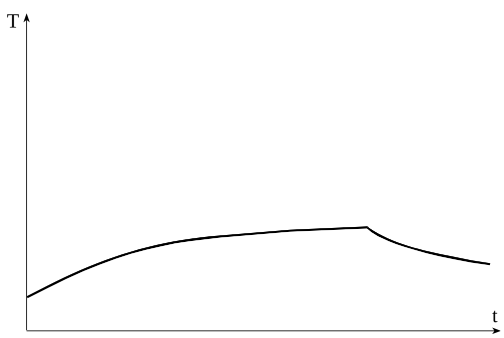
One of the skills you will be learning in this course is the ability to take a description of a real-world occurrence, and translate it into mathematics. Conversely, given a mathematical description of a phenomenon, you will learn how to describe what is happening in plain language. Here follow four graphs of temperature versus time and three stories. Match the stories with the graphs. When finished, write a similar story that would correspond to the final graph.



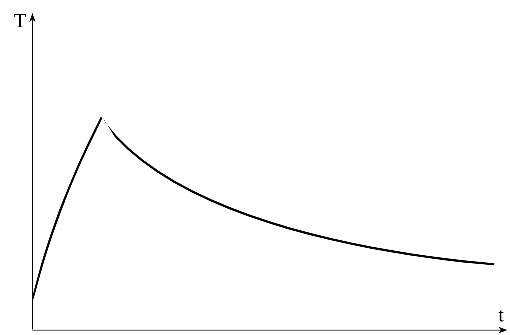
Graph 1



Graph 2



Graph 3



Graph 4

(a) I took my roast out of the freezer at noon, and left it on the counter to thaw. Then I cooked it in the oven when I got home.

(b) I took my roast out of the freezer this morning, and left it on the counter to thaw. Then I cooked it in the oven when I got home.

(c) I took my roast out of the freezer this morning, and left it on the counter to thaw. I forgot about it, and went out for Chinese food on my way home from work. I put it in the refrigerator when I finally got home.

GROUP WORK 2, SECTION 2.2

Functions in the Classroom

Which of the following relations are functions?

Domain	Function Values	Function
All the people in your classroom	Chairs	□ (person) = his or her chair
All the people in your classroom	The set {blue, brown, green, hazel}	□ (person) = his or her eye color
All the people in your classroom	Cities	□ (person) = birthplace of their mom and dad
All the people in your classroom	R, the real numbers	□ (person) = number of molecules in their body
All the people in your classroom	Spleens	□ (person) = his or her own spleen
All the people in your classroom	Pencils	□ (person) = his or her pencil
All the people in the United States	Integers from 0–999999999	□ (person) = his or her Social Security number
All the living people born in February	Days in February, 2019	□ (person) = his or her birthday in February 2019
All the people in your classroom	Days of the year	□ (person) = his or her birthday
All the people in your classroom	Cars	□ (person) = his or her car
All the people in your classroom	R, the real numbers	□ (person) = how much cash he or she has
All the people in your college	Names	□ (person) = his or her middle name
All the people in your classroom	People	□ (person) = himself or herself
All the people in your classroom	People	□ (person) = his or her mathematics instructor

GROUP WORK 3, SECTION 2.2

Rational Functions

The functions below are sad and lonely because they have lost their graphs! Help them out by matching each function with its graph. One function's graph is not pictured here; when you are done matching, go ahead and sketch that function's graph.

1. □^{3} − □ / 0□125

2. □^{2} − 1 / □^{2} − 4

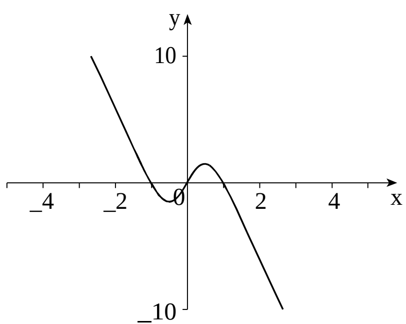
3. □^{2} − 4 / □^{2} − 1

4. □^{2} − 1 / □ + 0□5

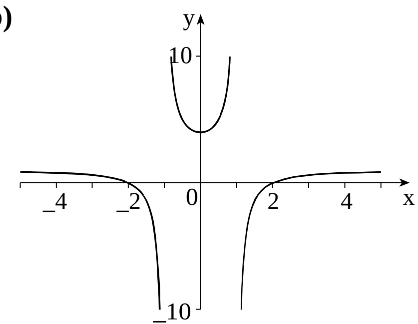
5. 5□ ¡ □^{2} − 1 ¢ / □^{2} + 1

6. 5□ ¡ □^{2} − 1 ¢ / −□^{2} − 1

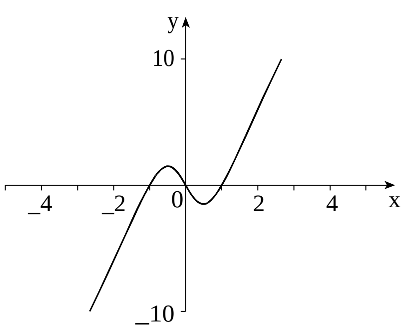
(a)



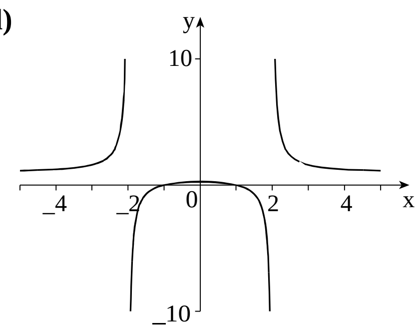
(b)



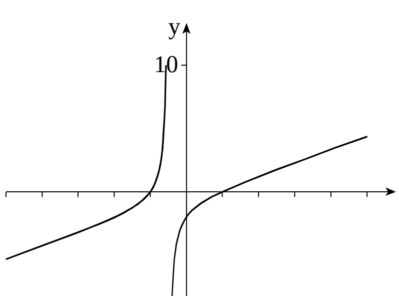
(c)

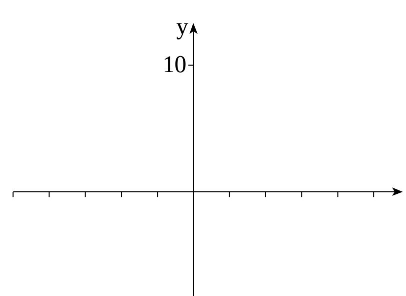


(d)



(e)





_4 _2 0 2 4 x

_10

_4 _2 0 2 4 x

_10

2.3 GETTING INFORMATION FROM THE GRAPH OF A FUNCTION

Suggested Time and Emphasis

$\frac{1}{2}$–1 class. Essential material.

Points to Stress

1. Gaining information about a function from its graph, including finding function values, domain and range.
2. Algebraic and geometric definitions of increasing and decreasing.
3. Finding local extrema of a function from its graph.

Sample Questions

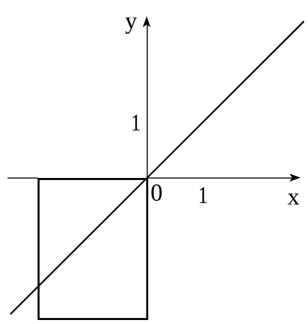
- **Text Question:** Draw a graph of a function with domain $[-10, 10]$ and range $[-2, 2]$. There should be at least one interval where the graph is increasing and at least one interval where the graph is decreasing.

  Answer: Answers will vary.

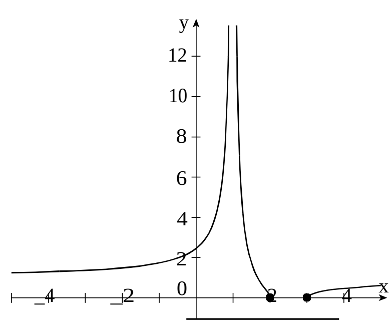
- **Drill Question:** If $f(x) = -x^2 + 9x + 2$, find the extreme value of f. Is it a maximum or a minimum?
  Answer: $f\left(\frac{9}{2}\right) = \frac{89}{4}$ is a maximum.

In-Class Materials

- Explore domain and range with some graphs that have holes, such as the graphs of some of the functions in the previous section.



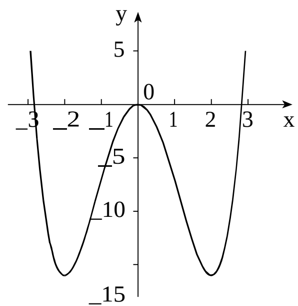
$$f(x) = \frac{x(x-2)}{x-2}$$



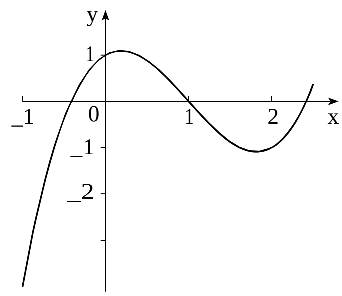
$$f(x) = \frac{x^2 - 5x + 6}{x^2 - 2x + 1}$$

- Draw a graph of electrical power consumption in the classroom versus time on a typical weekday, pointing out important features throughout, and using the vocabulary of this section as much as possible.

- Notice that it is fairly easy to tell where some functions are increasing and decreasing by looking at their graphs. For example, the graph of $f(x) = x^4 - 8x^2$ makes things clear. Note that in this case, the intervals are not immediately apparent from looking at the formula. However, for many functions such as $f(x) = x^3 - 3x^2 + x + 1$, it is difficult to find the exact intervals where the function is increasing/decreasing. In this example, the endpoints of the intervals will occur at precisely $x = 1 \pm \frac{1}{3}\sqrt{6}$.



$f(x) = x^4 - 8x^2$

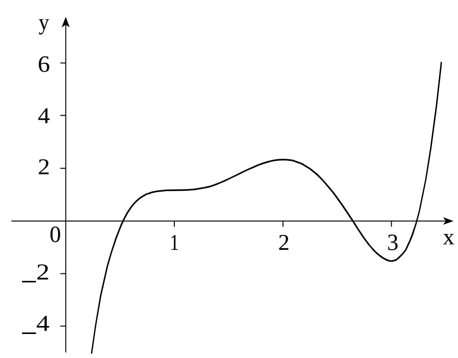


$f(x) = x^3 - 3x^2 + x + 1$

- Examine $f(x) = \begin{cases} x^2 & \text{if } x \text{ is rational} \\ 0 & \text{if } x \text{ is irrational} \end{cases}$ pointing out that it is neither increasing nor decreasing near $x = 0$. Stress that when dealing with new sorts of functions, it becomes important to know the precise mathematical definitions of such terms.

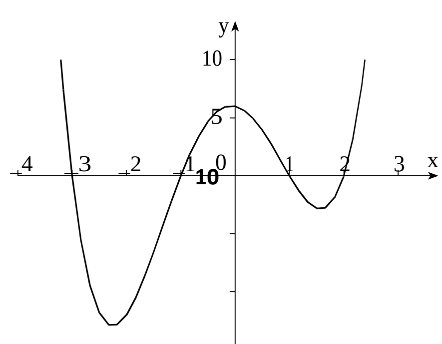
H **Examples**

- A function with two integer turning points and a flat spot:



$\frac{1}{6}\left(12x^5 - 105x^4 + 340x^3 - 510x^2 + 360x - 90\right)$

- A function with several local extrema: $f(x) = x^4 + x^3 - 7x^2 - x + 6 = (x+3)(x+1)(x-1)(x-2)$



_5

_10

_15

The extrema occur at □ ≈ −2□254, □ ≈ −0□0705, and □ ≈ 1□5742.

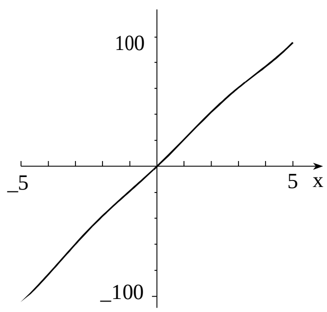
H Group Work 1: Calculator Exploration

This gives students a chance to graph things on their calculator and make conclusions. It will also serve as a warning that relying on calculator graphs without understanding the functions can lead one astray.

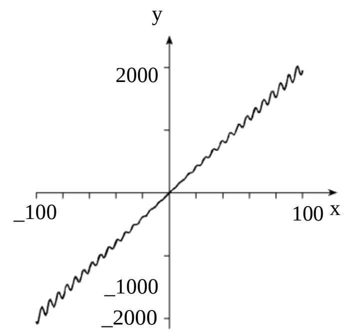
Notice that in calculus, when we say a function is increasing, we are saying it is increasing at every point on its domain. In this context, we are talking about increasing over an interval, which is slightly different. The curve −1□□, for example, is increasing at every point in its domain. Can we say it is decreasing over the interval [−10□ 1]? No, because it is not defined in that interval. So the curve −1□□ is increasing over every interval for which it is defined.

Answers:

1. (c) **2.** (a) **3.** (a) (assuming positive intervals) **4.** (c) **5.** (c) **6.** (a) **7.** (b) **8.** (a) **9.** (c) **10.** (c)



□ (□) = 20□ + □ sin □



□ (□) = 20□ + □ sin □

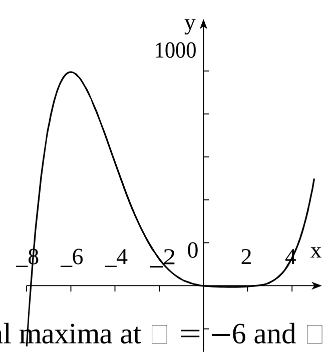
H Group Work 2: The Little Dip

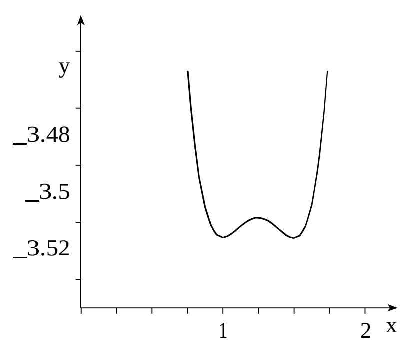
In this exercise students analyze a function with some subtle local extrema. After they have tried, reveal that there are two local maxima and two local minima.

After students have found the extrema, point out that if they take calculus, they will learn a relatively simple way to find the exact coordinates of the extrema.

Answers:

1.





2. There are local maxima at □ = −6 and □ = $\frac{5}{4}$, and local minima at □ = 1 and □ = $\frac{3}{2}$.

H Homework Problems

Core Exercises: 3, 8, 13, 22, 32, 37, 45, 48, 52, 59, 66, 67

Sample Assignment: 1, 3, 7, 8, 9, 13, 15, 20, 22, 32, 34, 36, 37, 41, 44, 45, 48, 52, 56, 57, 59, 62, 65, 66, 67, 69

GROUP WORK 1, SECTION 2.3

Calculator Exploration

Graph the following curves on your calculator. For each curve specify which of the following applies.

(a) The graph of $\square$ is increasing over every interval (assuming the curve is defined everywhere in that interval).

(b) The graph of $\square$ is decreasing over every interval (assuming the curve is defined everywhere in that interval).

(c) The graph of $\square$ is increasing over some intervals and decreasing over others.

1. $\square(\square) = \square^2$

2. $\square(\square) = \square^3$

3. $\square(\square) = \sqrt{\square}$

4. $\square(\square) = \sin \square$

5. $\square(\square) = \cos \square$

6. $\square(\square) = \tan \square$

7. $\square(\square) = \square^{-\square}$

8. $\square(\square) = \ln \square$

9. $\square(\square) = 5\square^4 - 1\square01^{\square}$

10. $\square(\square) = 20\square + \square \sin \square$

GROUP WORK 2, SECTION 2.3

The Little Dip

Consider $f(x) = \frac{1}{5}x^5 + \frac{9}{16}x^4 - \frac{143}{24}x^3 + \frac{207}{16}x^2 - \frac{45}{4}x$.

1. Draw a graph of f.

2. Estimate the x-values of all local extrema. Make sure your estimates are accurate to three decimal places.

2.4 AVERAGE RATE OF CHANGE OF A FUNCTION

H Suggested Time and Emphasis

$\frac{1}{2}$–1 class. Essential material.

H Points to Stress

1. Average rate of change.

H Sample Questions

- **Text Question:**

  Let □ (□) = 3□ + 2.

  (a) What is the average rate of change of □ from □ = 1 to □ = 3? **(b)** What is the average rate of change of □ from □ = 1 to □ = □? **Answer: (a)** 3 **(b)** 3

- **Drill Question:** If □ (□) = □^{2} − |3□| , what is the average rate of change between □ = −3 and □ = −1?

  Answer: 1

- Students should see the geometry of the average rate of change — that the average rate of change from □ = □ to □ = □ is the slope of the line from (□□ □ (□)) to (□□ □ (□)). Armed with this knowledge, students now have a way of estimating average rate of change: graph the function (making sure that the □- and □-scales are the same), plot the relevant points, and then estimate the slope of the line between them.
- It is possible, at this point, to foreshadow calculus nicely. Take a simple function such as □ (□) = □^{2} and look at the average rate of change from □ = 1 to □ = 2. Then look at the average rate of change from □ = 1 to □ = $\frac{3}{2}$. If students work in parallel, it won't take them long to fill in the following table:

From	To	Average Rate of Change
□ = 1	2	3
□ = 1	1□5	2□
□ = 1	1□25	2□2
□ = 1	1□1	2□
□ = 1	1□01	2□0
□ = 1	1□001	2□00

  Note that these numbers seem to be approaching 2. This idea is pursued further in the group work.
- Assume that a car drove for two hours and traversed 120 miles. The average rate of change is clearly 60 miles per hour. Ask the students if it was possible for the car to have gone over 60 mph at some point in the interval, and explain how. Ask the students if it was possible for the car to have stayed under 60 mph the whole time. Ask the students if it was possible for the car never to have gone exactly 60 mph. Their intuition will probably say that the car had to have had traveled exactly 60 mph at one point, but it will be hard for them to justify. The truth of this statement is an example of the Mean Value Theorem from calculus.

Examples

If $f(x) = x^3 - x$, the average rate of change from $x = 1$ to $x = 4$ is

$$\frac{f(4) - f(1)}{4 - 1} = \frac{\left(4^3 - 4\right) - \left(1^3 - 1\right)}{3} = \frac{(64 - 4) - (1 - 1)}{3} = \frac{60}{3} = 20$$

Group Work: Small Intervals

If you have the time, and really wish to foreshadow calculus, have the students find the limit starting with $x = 1$ and then again with $x = 3$. Then see if they can find the pattern, and discover that the average value is going to approach $3x^2$ if we start at x.

Students won't remember every detail of this problem in a year, obviously. So when you close, try to convey the main idea that as we narrow the interval, the average values approach a single number, and that everything blows up if we make the interval consist of a single point. You may want to mention that exploring this phenomenon is a major part of the first semester of calculus.

Answers:

1. 19 **2.** 15.25 **3.** 12.61 **4.** 12.0601 **5.** 12.006001 **6.** 11.9401 **7.** 12 **8.** You get $\frac{0}{0}$, which is undefined.

Homework Problems

Core Exercises: 3, 10, 16, 24, 31, 36, 40

Sample Assignment: 3, 4, 8, 10, 11, 15, 16, 22, 24, 26, 29, 31, 33, 36, 38, 40

GROUP WORK, SECTION 2.4

Small Intervals

Let us consider the curve □ = □^{3}. Assume I am interested only in what is happening near □ = 2. It is clear that the function is getting larger there, but my question is, how quickly is it increasing? One way to find out is to compute average rates of change.

1. Find the average rate of change between □ = 2 and □ = 3.

2. The number 2□5 is even closer to the number 2. Remember, I only really care about what is happening very close to □ = 2. So compute the average rate of change between □ = 2 and □ = 2□5.

3. We can get closer still. Compute the average rate of change between □ = 2 and □ = 2□1.

4. Can we get closer? Sure! Compute the average rate of change between □ = 2 and □ = 2□01.

5. Compute the average rate of change between □ = 2 and □ = 2□001.

6. We can also approach 2 from the other side. Compute the average rate of change between □ = 2 and □ = 1□99.

7. Your answers should be approaching some particular number as we get closer and closer to 2. What is that number?

8. Hey, the closest number to 2 is 2 itself, right? So go ahead and compute the average rate of change between □ = 2 and □ = 2. What happens?

2.5 LINEAR FUNCTIONS AND MODELS

Suggested Time and Emphasis

$\frac{1}{2}$–1 class. Essential material.

Points to Stress

1. Definition of a linear function.

2. The relationship between slope and rate of change, including units.

3. Creating linear models in an applied context.

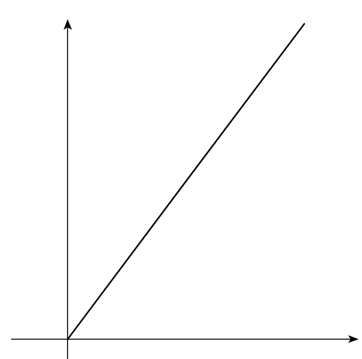
Sample Questions

- **Text Question:** What is the difference between "slope" and "rate of change?"
  Answer: The text describes this as a difference in points of view. Any response that gets at the idea of a slope being a property of a graph and a rate of change being a property of a physical situation should be given full credit.

- **Drill Question:** Which of the following, if any, are linear functions?
  (a) $f(x) = 3x + \sqrt{2}$ **(b)** $f(x) = 3x - 2 + x$ **(c)** $f(x) = \pi x$ **(d)** $f(x) = \sqrt{3x} - 4$ **(e)** $f(x) = -\frac{\sqrt{5}}{2}x - \frac{\sqrt{3}}{4}$
  Answer: (a), (b), (c), (e)

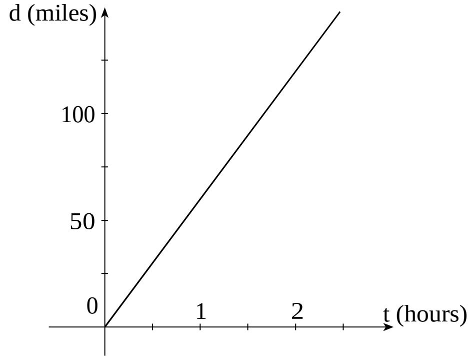
In-Class Materials

- It is important to guide students from the perspective of Section 1.10 (Lines) to the more applied perspective of this section. Start by asking the students to graph $f(x) = 60x$. You should see graphs that look like the one below.



As you know, students tend not to label their axes, and if the □- and □-axis scales are equal, the slope of the line is nowhere near 60. Ask them for the slope and □-intercept of their line.

Now show them this graph of the distance a car travels as a function of time over a two hour trip.

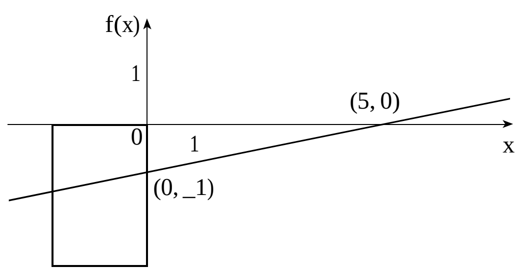


Point out that this graph looks the same as theirs, but now the slope has both units and meaning—the car travelled at 60 miles per hour. The fact that the graph is linear means the car traveled at a constant speed.

- One nice aspect of linear functions is interpolation. For example, assume that between 2012 and 2016, a tree grew at a constant rate. Assume it was 10 feet tall in 2012 and 20 feet tall in 2016. Now we can use this model to figure out how tall it was in 2015: 15 feet. We also can extrapolate to predict its height in 2040, but we should always be careful when we extrapolate. Just because the growth rate was constant between 2012 and 2016, we cannot necessarily assume it will be constant through 2040.
- In many applications, complicated functions are approximated by linear functions. The group work for this section will explore that concept further.

Examples

- A linear function with nice intercepts: $f(x) = \frac{1}{5}x - 1$



- A real-world example of a linear model: The force exerted by a spring increases linearly as it is stretched. When it is at rest (not stretched at all), it exerts no force. Now assume that when you stretch it 3 inches, it exerts $\frac{1}{10}$ lb of force on your hand. How much will it exert if you stretch it only 1 inch?

  Answer $\frac{1}{30}$ lb

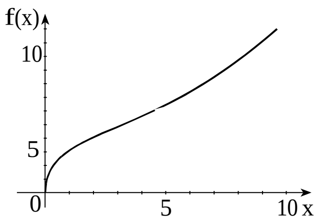
Group Work: Approximating Using Linear Models

This activity introduces the idea of linear approximation from both geometric and algebraic perspectives, and assumes the students are using graphing technology. These ideas show up again in first semester calculus.

For the second question, if the students are not feeling playful, give each student a different x-value in the interval $[0, 10]$ to zoom in on.

Answers:

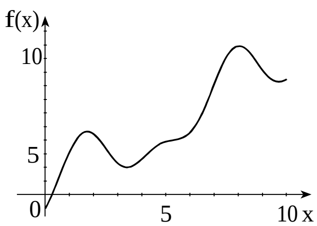
1.(a)



(b) It looks linear.

(c) It looks linear.

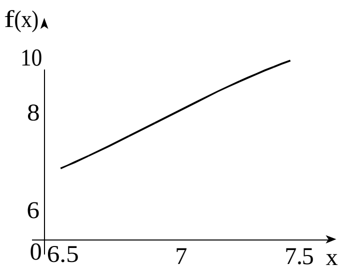
2.(a)



(b) It looks linear.

(c) It looks linear.

3.(a)



(b) □ (6□5) = □ (7□5) = □ (□)

= 4□11□ − 20□31

(c) They are close.

H Homework Problems

Core Exercises: 3, 9, 14, 17, 21, 29, 35, 42, 46, 52

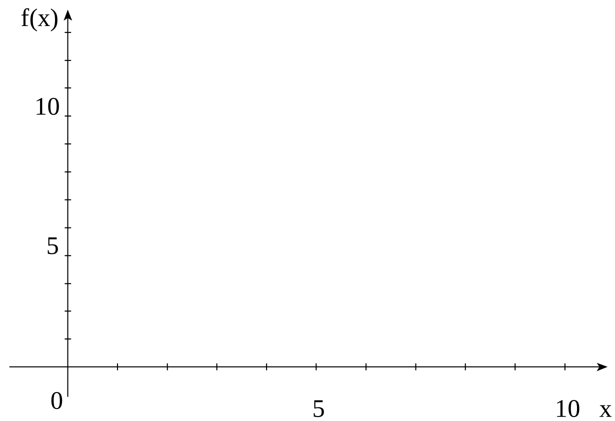
Sample Assignment: 1, 3, 5, 7, 9, 13, 14, 15, 17, 18, 21, 22, 25, 27, 29, 32, 35, 36, 38, 42, 43, 45, 46, 49, 52

GROUP WORK, SECTION 2.5

Approximating Using Linear Models

1. Consider the rather nasty function $f(x) = \frac{x^2}{10} - x + 4\sqrt{x}$.

(a) Sketch this function on the interval $[0, 10]$.

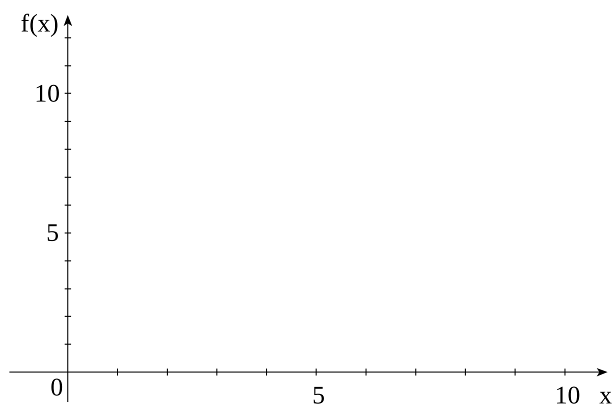


(b) f is clearly not a linear function. But notice that between $x = 8$ and $x = 9$ it looks almost linear. Plot this function on your calculator on the interval $[8, 9]$. Does it look linear?

(c) Now look at your original graph near $x = \frac{1}{2}$. It is clearly curved there. But look what happens when you plot it on the interval $[0.4, 0.6]$. Does it look linear?

2. Let's play with a kind of function you may never have seen yet: $f(x) = x + 2\sin x - \cos 2x$.

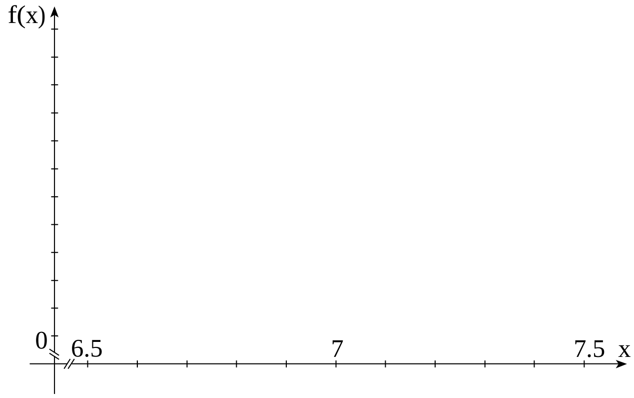
(a) Sketch this function on the interval $[0, 10]$.



(b) Notice how this function is even wigglier than the previous one! But something interesting happens when you zoom in. Pick any value of x and zoom in on it repeatedly. Does it eventually look linear?

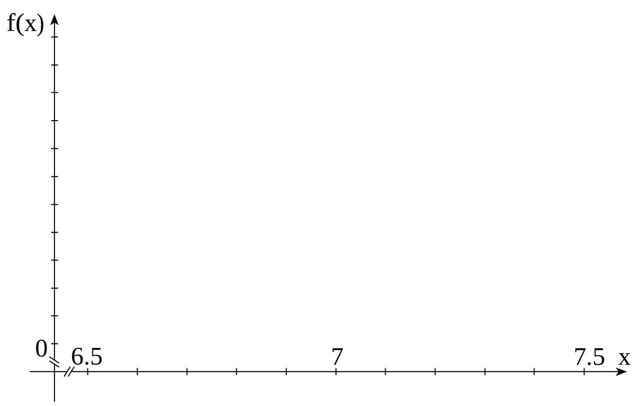
3. This is a key idea that is used in many real-world applications. If a function is "smooth" (that is, its graph has no breaks or sharp corners) then no matter how twisty it is, if you zoom in close enough, it looks linear.

(a) Graph f, the function from Part 2, on the interval $[6.5, 7.5]$.



(b) Compute $f(6.5)$ and $f(7.5)$, and use this information to find the equation of a straight line that intersects the graph of f at $x = 6.5$ and at $x = 7.5$.

(c) Graph f and your line on the same axes. Are they close?



2.6 TRANSFORMATIONS OF FUNCTIONS

Suggested Time and Emphasis

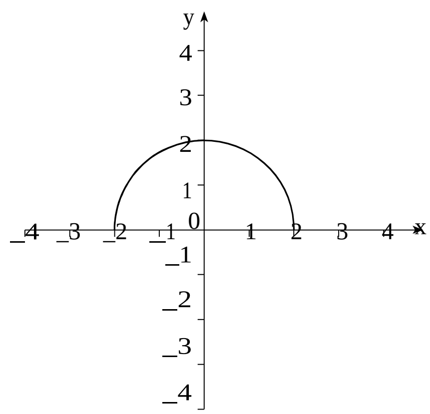
1 class. Essential material.

Points to Stress

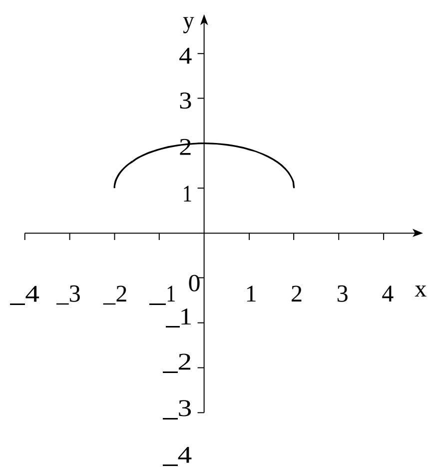
1. Transforming a given function to a different one by shifting, stretching, and reflection.
2. Using the technique of reflection to better understand the concepts of even and odd functions.

Sample Questions

- **Text Question:** What is the difference between a vertical stretch and a vertical shift?
  Answer: A vertical stretch extends the graph in the vertical direction, changing its shape. A vertical shift moves the graph in the vertical direction, preserving its shape.
- **Drill Question:** Given the graph of $f(x)$ below, sketch the graph of $\frac{1}{2}f(x)+1$.



Answer:



In-Class Materials

- Students will often view this section as a process of memorizing eight similar formulas. Although it doesn't hurt to memorize how to shift, reflect, or stretch a graph, emphasize to students the importance of understanding what they are doing when they transform a graph. The group work "Discovering the Shift" (in Section 1.9) should help students understand and internalize. Tell students that if worse comes to worst, they can always plot a few points if they forget in which direction the graphs should move.

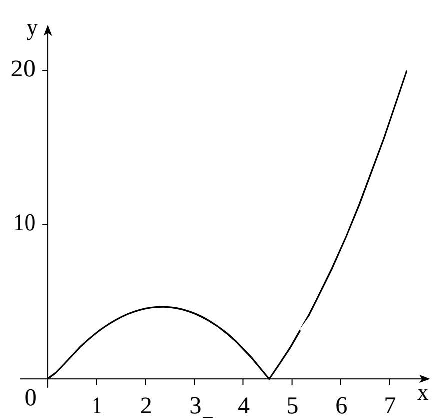
- Show the class a function they have not learned about yet, such as $f(x) = \sin x$. (If students know about sin, then show them arctan or e^{-x^2}—any function with which they are unfamiliar.) Point out that even though they don't know a lot about $\sin x$, once they've seen the graph, they can graph $\sin x + 3$, $\sin(x - 1)$, $2\sin x$, $-\sin x$, etc.

- Graph $f(x) = x^2$ with the class. Then anticipate Section 3.2by having students graph $(x - 2)^2 - 3$ and $(x + 1)^2 + 2$, finally working up to $f(x) = (x - h)^2 + k$. If you point out that any equation of the form $f(x) = ax^2 + bx + c$ can be written in this so-called *standard form*, students will have a good start on the next section in addition to learning this one.

- This is a good time to start discussing parameters. Ask your students to imagine a scientist who knows that a given function will be shaped like a stretched parabola, but has to do some more measurements to find out exactly what the stretching factor is. In other words, she can write $f(x) = -ax^2$, noting that she will have to figure out the a experimentally. The a is not a variable, it is a parameter. Similarly, if we are going to do a bunch of calculations with the function $f(x) = \sqrt[3]{x + 2}$, and then do the same calculations with $\sqrt[3]{x + 3}$, $\sqrt[3]{x - \pi}$, and $\sqrt[3]{x - \frac{2}{3}}$, it is faster and easier to do the set of calculations just once, with the function $f(x) = \sqrt[3]{x + a}$, and then fill in the different values for a at the end. Again, this letter a is called a parameter. Ask the class how, in the expression $f(x) = x + 3a$, they can tell which is the variable, and which is the parameter—the answer may encourage them to use careful notation.

Examples

A distinctive-looking, asymmetric curve that can be stretched, shifted and reflected:



$f(x) = \sqrt{x^2 - 5x +}$

Group Work 1: Label Label Label, I Made It Out of Clay

Some of these transformations are not covered in the book. If the students are urged not to give up, and to use the process of elimination and testing individual points, they should be able to successfully complete this activity.

Answers: 1. (d) **2.** (a) **3.** (f) **4.** (e) **5.** (i) **6.** (j) **7.** (b) **8.** (c) **9.** (g) **10.** (h)

H Group Work 2: Which is the Original?

The second problem has a subtle difficulty: the function is defined for all □, so some graphs show much more of the behavior of □ (□)than others do.

Answers: 1. 2□ (□ + 2), 2□ (□), □ (2□), □ (□ + 2), □ (□) **2.** 2□ (□), □ (□), □ (□ + 2), □ (2□), 2□ (□ + 2)

H Homework Problems

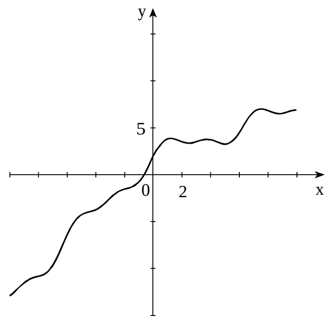
Core Exercises: 3, 9, 14, 17, 21, 29, 35, 42, 46, 52

Sample Assignment: 1, 3, 5, 7, 9, 13, 14, 15, 17, 18, 21, 22, 25, 27, 29, 32, 35, 36, 38, 42, 43, 45, 46, 49, 52

GROUP WORK 1, SECTION 2.6

Label Label Label, I Made it Out of Clay

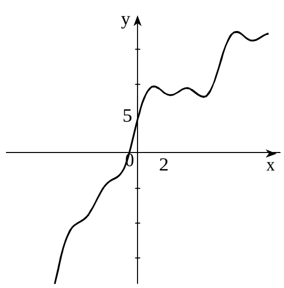
This is a graph of the function □ (□):



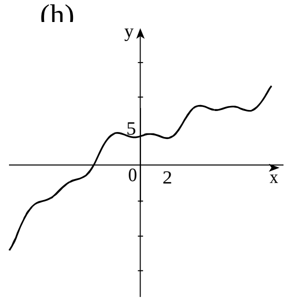
Give each graph below the correct label from the following:

(a) □ (□ + 3)   (b) □ (□ − 3)   (c) □ (2□)   (d) 2□ (□)   (e) |□ (□)|

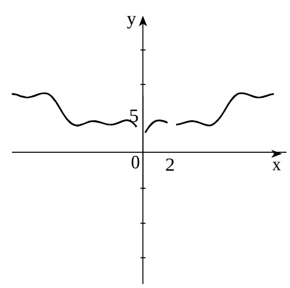
(f) □ (|□|)   (g) 2□ (□) − 1   (h) □ (2□) + 2   (i) □ (□) − □   (j) 1□□ (□)



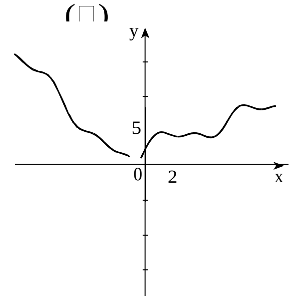
Graph 1



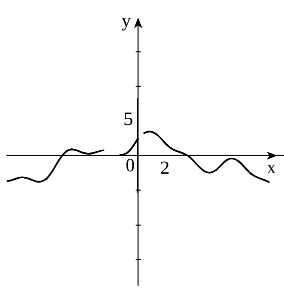
Graph 2



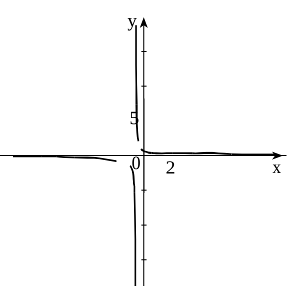
Graph 3



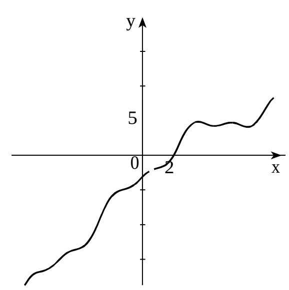
Graph 4



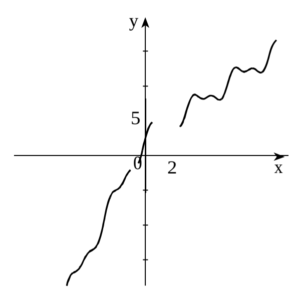
Graph 5



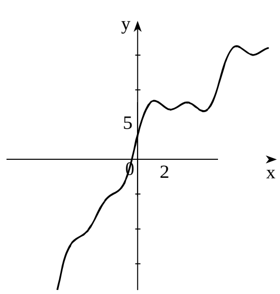
Graph 6



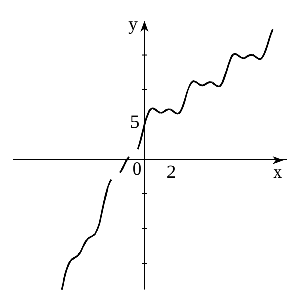
Graph 7



Graph 8



Graph 9



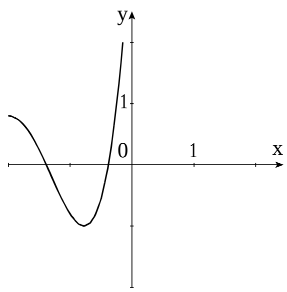
Graph 10

GROUP WORK 2, SECTION 2.6

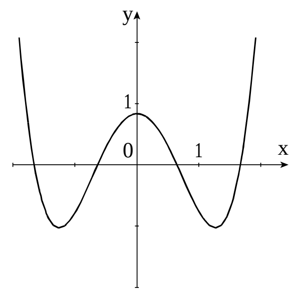
Which is the Original?

Below are five graphs. One is the graph of a function $f(x)$ and the others include the graphs of $2f(x)$, $f(2x)$, $f(x+2)$, and $2f(x+2)$. Determine which is the graph of $f(x)$ and match the other functions with their graphs.

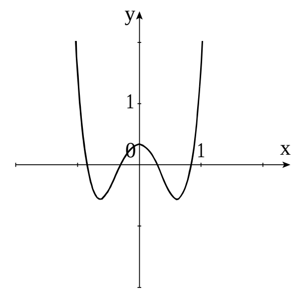
1.



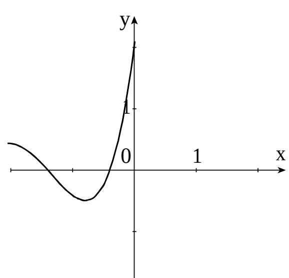
Graph 1



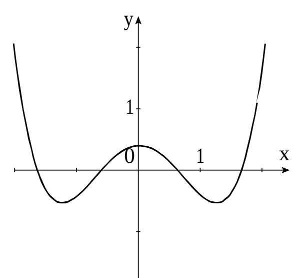
Graph 2



Graph 3

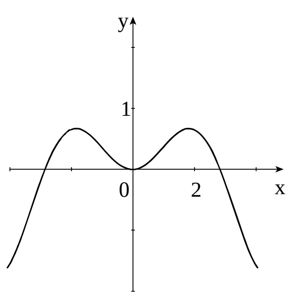


Graph 4

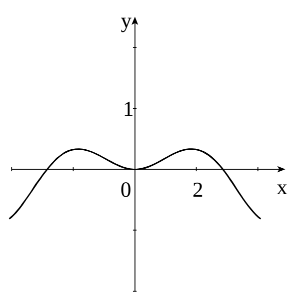


Graph 5

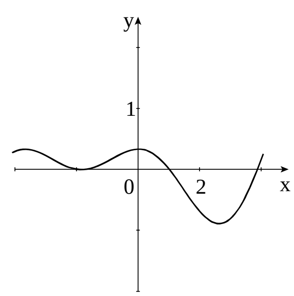
2.



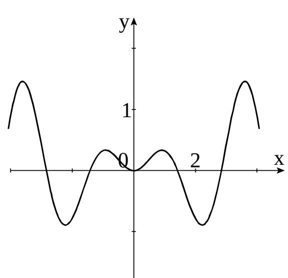
Graph 1



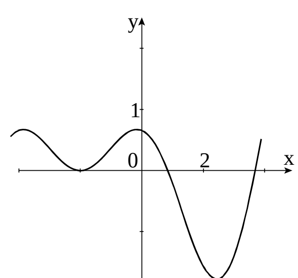
Graph 2



Graph 3



Graph 4



Graph 5

2.7 COMBINING FUNCTIONS

H Suggested Time and Emphasis

$\frac{1}{2}$–1 class. Essential material.

H Points to Stress

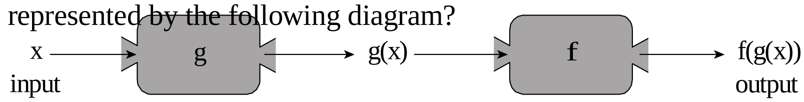
1. Addition, subtraction, multiplication, and division of functions.

2. Composition of functions.

3. Finding the domain of a function based on analysis of the domain of its components.

H Sample Questions

- **Text Question:** The text describes addition, multiplication, division, and composition of functions. Which of these operations is represented by the following diagram?



Answer: Composition

- **Drill Question:** Let $\square(\square) = 4\square$ and $\square(\square) = \square^3 + \square$.

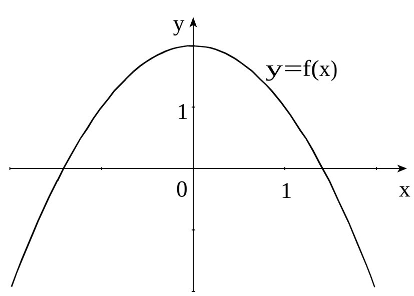
(a) Compute $(\square \circ \square)(\square)$.

(b) Compute $(\square \circ \square)(\square)$.

Answer: **(a)** $4\left(\square^3 + \square\right) = 4\square^3 + 4\square$ **(b)** $(4\square)^3 + 4\square = 64\square^3 + 4\square$

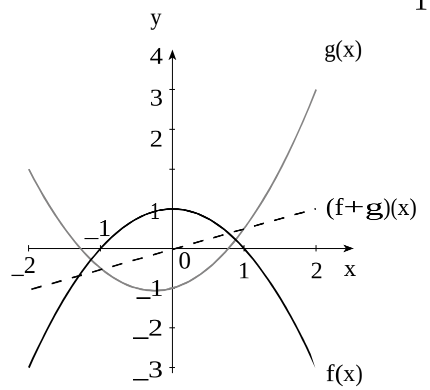
H In-Class Materials

- Do the following problem with the class:



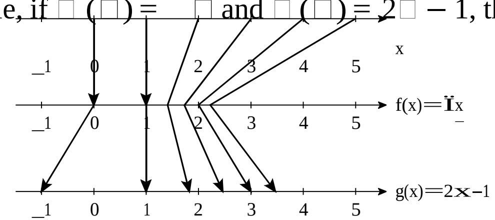
From the graph of $\square = \square(\square) = -\square^2 + 2$ shown above, compute $\square \circ \square$ at $\square = -1$, 0, and 1. First do it graphically, then algebraically.

- Show the tie between algebraic addition of functions and graphical addition. For example, let $f(x) = 1 - x^2$ and $g(x) = x^2 + \frac{1}{2}x - 1$. First add the functions graphically, as shown below, and then show how this result can be obtained algebraically: $\left(1 - x^2\right) + \left(x^2 + \frac{1}{2}x - 1\right) = \frac{1}{2}x$.



- Point out that it is important to keep track of domains, especially when doing algebraic simplification. For example, if $f(x) = x + \sqrt{x}$ and $g(x) = 3x^2 + \sqrt{x}$, even though $(f - g)(x) = x - 3x^2$, its domain is not $\mathbb{R}$ but $\{x \mid x \geq 0\}$.

- Function maps are a nice way to explain composition of functions. To demonstrate $g \circ f(x)$, draw three number lines labeled x, $f(x)$, and $g(x)$, and then indicate how each number x goes to $f(x)$ which then goes to $g(f(x))$. For example, if $f(x) = \sqrt{x}$ and $g(x) = 2x - 1$, the diagram looks like this:



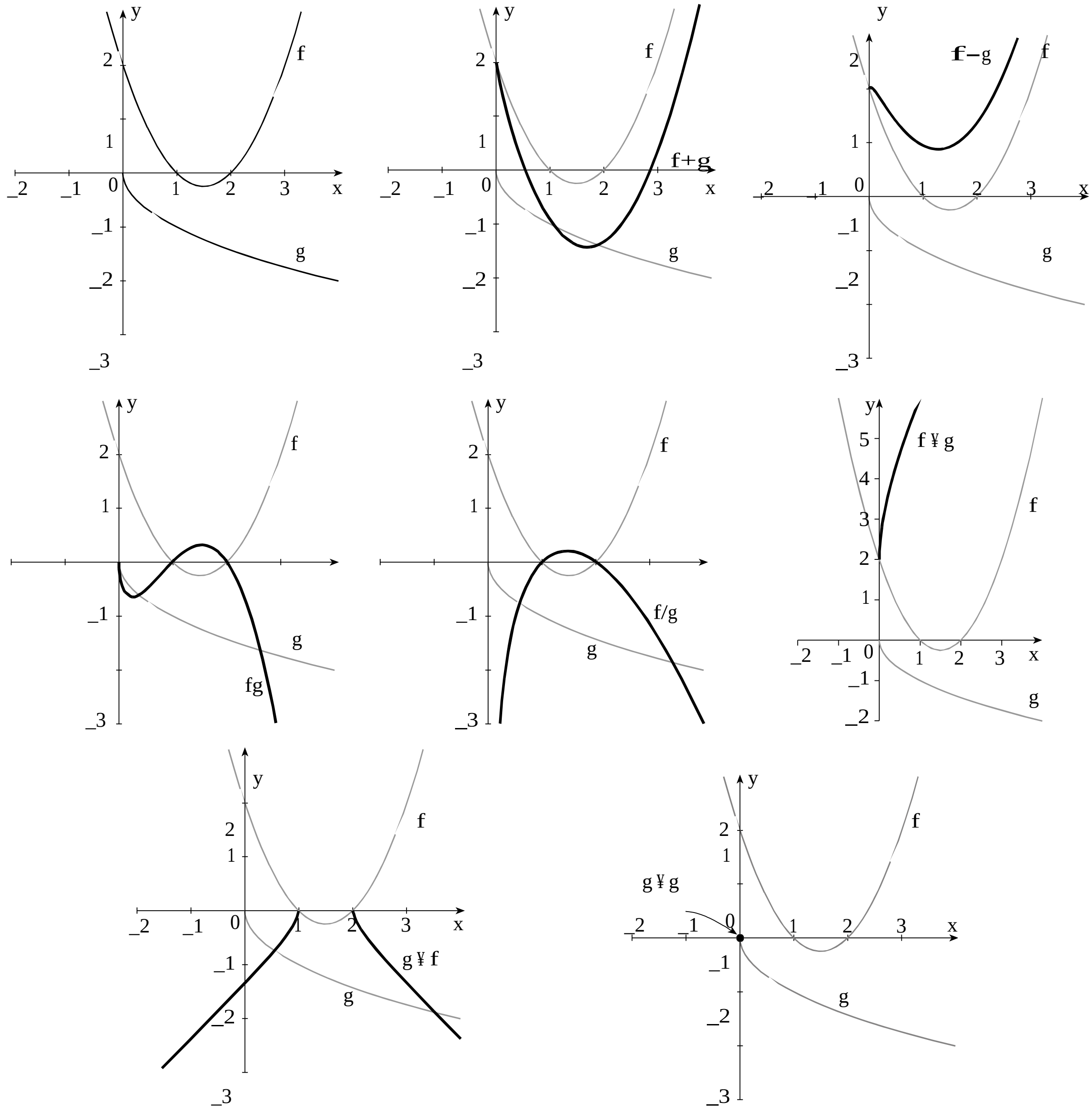
- After doing a few basic examples of composition, it is possible to foreshadow the idea of inverses, which will be covered in the next section. Let $f(x) = 2x^3 + 3$ and $g(x) = x^2 - x$. Compute $f \circ g$ and $g \circ f$ for your students. Then ask them to come up with a function $h(x)$ with the property that $(f \circ h)(x) = x$. They may not be used to the idea of coming up with examples for themselves, so the main hints they will need might be "don't give up," "when in doubt, just try something and see what happens," and

“I’m not expecting you to get it in fifteen seconds.” If the class is really stuck, have them try $\square(\square) = 2\square^3$ to get a

feel for how the game is played. Once they have determined that $\square(\square) = \sqrt[3]{\frac{\square - 3}{2}}$, have them compute $(\square \circ \square)(\square)$ and have them conjecture whether, in general, if $(\square \circ \square)(\square) = \square$ then $(\square \circ \square)(\square)$ must also equal $\square$.

H Examples

Combined functions with graphs: Let $f(x) = x^2 - 3x + 2$ and $g(x) = -\sqrt{x}$.



H Group Work 1: Transformation of Plane Figures

This tries to remove the composition idea from the numerical context, and introduces the notion of symmetry groups. It is a longer activity than it seems, and can lead to an interesting class discussion of this topic.

Answers:

1. (a) □ µ ¶ = **(b)** □ µ ¶ = □ **(c)** □ µ µ ¶¶ = □ **(d)** □ µ µ ¶¶ =

2. This is false. For example, (□ ∘ □) µ ¶ = , but (□ ∘ □) µ ¶ = .

3. It is true: reversing something thrice in a mirror gives the same result as reversing it once.

4. It rotates the shape 270° clockwise or, equivalently, 90° counterclockwise.

H Group Work 2: Odds and Evens

This is an extension of Exercise 102 in the text. Students may find the third problem difficult to start. You may want to give selected table entries on the board first, before handing the activity out, to make sure students understand what they are trying to do.

Answers:

1.

□	□	□ + □
even	even	even
odd	even	odd
even	odd	odd
odd	odd	even

2.

□	□	□ · □
even	even	even
odd	even	even
even	odd	even
odd	odd	odd

3.

□	□	□ + □	□	□ ∘ □	□ ∘ □
even	even	even	even	even	even
even	odd	neither	odd	even	even
odd	even	neither	odd	even	even
odd	odd	odd	even	odd	odd
neither	neither	unknown	unknown	unknown	unknown

H Group Work 3: It's More Fun to Compute

Each group gets one copy of the graph. During each round, one representative from each group stands, and one of the questions below is asked. The representatives write their answer down, and all display their answers at the same time. Each representative has the choice of consulting with their group or not. A correct solo answer is worth two points, and a correct answer after a consult is worth one point.

1. (□ ∘ □) (5)

2. (□ ∘ □) (5)

3. (□ ∘ □) (0)

4. (□ ∘ □) (5)

5. (□ ∘ □) (5)

6. (□ ∘ □) (−3)

7. (□ ∘ □) (−1)

8. (□ ∘ □) (1)

9. (□ ∘ □) (1)

10. (□ ∘ □ ∘ □) (4)

11. (□ ∘ □ ∘ □) (4)

12. (□ ∘ □ ∘ □) (4)

Answers: **1.** 0 **2.** 0 **3.** 1 **4.** 5 **5.** 1 **6.** 1 **7.** 1 **8.** 0 **9.** 2 **10.** 1 **11.** 1 **12.** 1

H Homework Problems

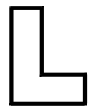
Core Exercises: 4, 10, 15, 20, 26, 34, 38, 49, 57, 64, 71, 75, 79, 86, 92, 104

Sample Assignment: 2, 4, 6, 7, 10, 13, 15, 20, 22, 24, 26, 27, 29, 34, 36, 38, 45, 49, 52, 55, 57, 61, 64, 67, 69, 71, 73, 75, 77, 79, 82, 85, 86, 92, 93, 95, 98, 104

GROUP WORK 1, SECTION 2.7

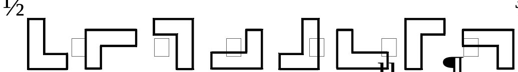
Transformation of Plane Figures

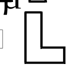
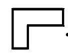
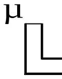
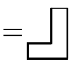
So far, when we have been talking about functions, we have been assuming that their domains and ranges have been sets of numbers. This is not necessarily the case. For example, look at this figure:



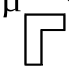
Let's let our domain be all the different ways we can move this figure around, including flipping it over:

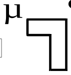
½ ¾

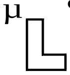
□ =  □

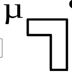
Now let □ be the function that rotates the shape 90° clockwise: □ µ  ¶ = . Let □ be the function that flips the shape over a vertical line drawn through the center: □ µ  ¶ = 

1. Find the following:

(a) □ µ  ¶

(b) □ µ  ¶

(c) □ □ µ µ  ¶¶

(d) □ □ µ µ  ¶¶

2. Is it true that □ ◦ □ = □ ◦ □? Why or why not?

3. Is it true that □ ◦ □ ◦ □ = □? Why or why not?

4. Write, in words, what the function □ ◦ □ ◦ □ does to a shape.

GROUP WORK 2, SECTION 2.7

Odds and Evens

1. Let $\square$ be an odd number, and $\square$ be an even number. Fill in the following table (the first row is done for you).

$\square$	$\square$	$\square + \square$
even	even	even
odd	even	
even	odd	
odd	odd	

2. We can also multiply numbers together. Fill in the corresponding multiplication table:

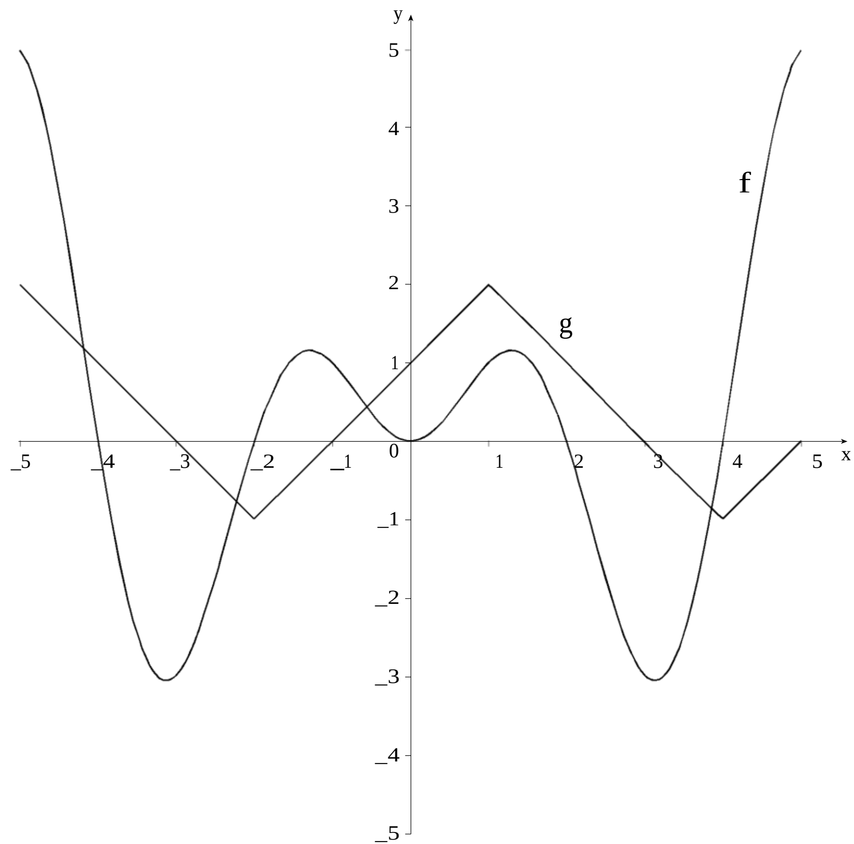
$\square$	$\square$	$\square \cdot \square$
even	even	
odd	even	
even	odd	
odd	odd	

3. Now we let $\square$ and $\square$ be (nonzero) functions, not numbers. We are going to think about what happens when we combine these functions. When you fill in the table, you can write "unknown" if the result can be odd *or* even, depending on the functions. You can solve this problem by drawing some pictures, or by using the definition of odd and even functions.

$\square$	$\square$	$\square + \square$	$\square\square$	$\square \circ \square$	$\square \circ \square$
even	even				
even	odd				
odd	even				
odd	odd				
neither	neither				

GROUP WORK 3, SECTION 2.7

It's More Fun to Compute



2.8 ONE-TO-ONE FUNCTIONS AND THEIR INVERSES

Suggested Time and Emphasis

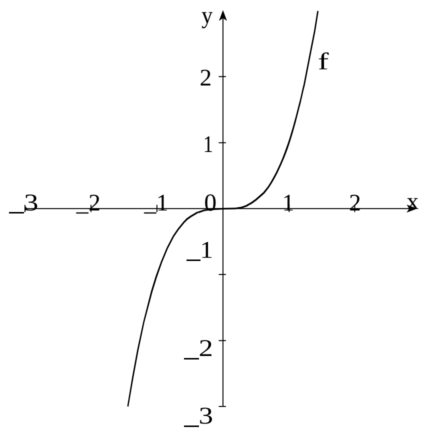
1–2 classes. Essential material.

Points to Stress

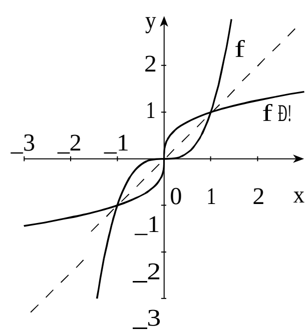
1. One-to-one functions: their definition and the Horizontal Line Test.
2. Algebraic and geometric properties of inverse functions.
3. Finding inverse functions.

Sample Questions

- **Text Question:** The function f is graphed below. Sketch f^{-1}, the inverse function of f.



Answer:



- **Drill Question:** If $f(-2) = 4$, $f(-1) = 3$, $f(0) = 2$, $f(1) = 1$ and $f(2) = 3$, what is $f^{-1}(2)$?
  Answer: 0

In-Class Materials

- Make sure students understand the notation: f^{-1} is not the same thing as $\frac{1}{f}$.
- Starting with $f(x) = \sqrt[3]{x-4}$, compute $f^{-1}(-2)$ and $f^{-1}(0)$. Then use algebra to find a formula for $f^{-1}(x)$. Have the class try to repeat the process with $f(x) = x^3 + x - 2$. Note that facts such as

$\square^{-1}(-2) = 0$, $\square^{-1}(0) = 1$, and and $\square^{-1}(8) = 2$ can be found by looking at a table of values for $\square(\square)$ but that algebra fails to give us a general formula for $\square^{-1}(\square)$. Finally, draw graphs of $\square$, $\square^{-1}$, $\square$, and $\square^{-1}$.

- Pose the question: If □ is always increasing, is $□^{-1}$ always increasing? Give students time to try prove their answer.

  Answer: This is true. Proofs may involve diagrams and reflections about $□ = □$, or you may try to get them to be more rigorous. This is an excellent opportunity to discuss concavity, noting that if □ is concave up and increasing, then $□^{-1}$ is concave down and increasing.

- Point out that the idea of "reversing input and output" permeates the idea of inverse functions, in all four representations of "function". When finding inverse functions algebraically, we explicitly reverse □ and □. When drawing the inverse function of a graph, by reflecting across the line $□ = □$ we are reversing the □- and □-axes. If $□(□)$ is the cost (in dollars) to make □ fruit roll-ups, then $□^{-1}(□)$ is the number of fruit roll-ups that could be made for □ dollars—again reversing the input and the output. Finally, show the class how to find the inverse of a function given a numeric data table, and note that again the inputs and outputs
are reversed.

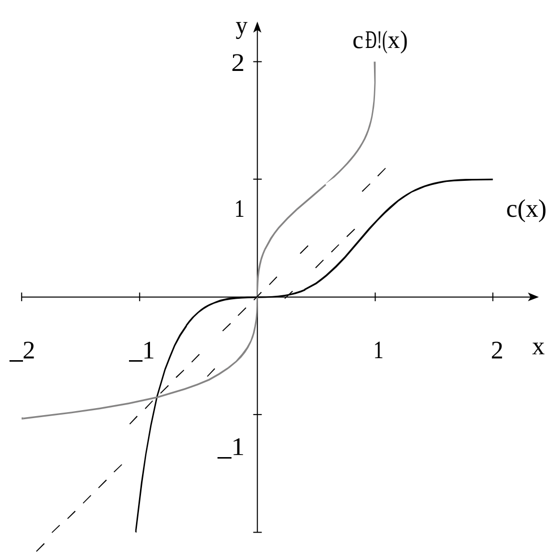
□	□ (□)
1	3
2	4□
3	5□
4	8

□	$□^{-1}(□)$
3	1
4□2	2
5□7	3
8	4

- Make sure to discuss units carefully: when comparing $□ = □(□)$ to $□ = □^{-1}(□)$, the units of □ and □ trade places.

H Examples

- The graph of a complicated function and its inverse:



H **Group Work 1: Inverse Functions: Domains and Ranges**

While discussing the domains and ranges of inverse functions, this exercise foreshadows later excursions into the maximum and minimum values of functions.

If a group finishes early, ask them this question:

"Now consider the graph of □ (□) = $\sqrt{2□ - 3} + 2$. What are the domain and range of □ (□)? Try to figure out the domain and range of $□^{-1}$ (□) by looking at the graph of □. In general, what information do you need to be able to compute the domain and range of $□^{-1}$ (□) from the graph of a function □?"

Answers:

1. It is one-to-one, because the problem says it climbs steadily.
2. $□^{-1}$ is the time in minutes at which the plane achieves a given altitude.
3. Reverse the data columns in the given table to get the table for the inverse function. The domain and range of □ are $0 \le □ \le 30$ and $0 \le □ \le 29{,}000$, so the domain and range of $□^{-1}$ are $0 \le □ \le 29{,}000$ and
   $0 \le □^{-1} \le 30$.
4. You can expect to turn on your computer after about 8□5 minutes.
5. □ is no longer 1-1, because heights are now achieved more than once.

Bonus The domain of $□^{-1}$ is the set of all □-values on the graph of □, and the range of $□^{-1}$ is the set of all
□-values on the graph of □.

H **Group Work 2: The Column of Liquid**

If the students need a hint, you can mention that the liquid in the mystery device was mercury.

Answers **1.** The liquid is 1 cm high when the temperature is 32 °F. **2.** The liquid is 2 cm high when the temperature is 212 °F **3.** The inverse function takes a height in cm, and gives the temperature. So it is a device for measuring temperature. **4.** A thermometer

H **Group Work 3: Functions in the Classroom Revisited**

This activity starts the same as "Functions in the Classroom" from Section 2.2. At this point, students have learned about one-to-one functions, and they are able to explore this activity in more depth.

Answers

Chairs: Function, one-to-one, bijection (if all chairs are occupied). If one-to-one, the inverse assigns a chair to a person.

Eye color: Function, not one-to-one

Mom & Dad's birthplace: Not a function; mom and dad could have been born in different places

Molecules: Function, one-to-one (with nearly 100% probability); inverse assigns a number of molecules to the appropriate student.

Spleens: Function, one-to-one, bijection. Inverse assigns each spleen to its owner.

Pencils: Not a function; some people may have more than one or (horrors!) none.

Social Security Number: Function, one-to-one; inverse assigns each number to its owner.

February birthday: Not a function; not defined for someone born on February 29.

Birthday: Function, perhaps one-to-one. If one-to-one, the inverse assigns a day to a person.

Cars: Not a function; some have none, some have more than one.

Cash: Function, perhaps one-to-one. If one-to-one, the inverse assigns an amount of money to a person.

Middle names: Not a function; some have none, some have more than one.

Identity: Function, one-to-one, bijection. Inverse is the same as the function.

Instructor: Function, not one-to-one.

H Homework Problems

Core Exercises: 3, 8, 14, 20, 24, 35, 48, 54, 57, 64, 67, 79, 71

Sample Assignment: 1, 3, 8, 10, 14, 15, 18, 20, 22, 24, 25, 29, 31, 35, 38, 41, 46, 47, 48, 54, 56, 57, 60, 64, 66, 67, 70, 71, 73, 77, 79, 81, 82

GROUP WORK 1, SECTION 2.8

Inverse Functions: Domains and Ranges

Let □ (□) be the altitude in feet of a plane that climbs steadily from takeoff until it reaches its cruising altitude after 30 minutes. We don't have a formula for □, but extensive research has given us the following table of

values:

□	□ (□)
0□1	50
0□	150
5	500
1	2000
3	8000
7	12,000
10	21,000
20	27,000
25	29,000

1. Is □ (□) a one-to-one function? How do you know?

2. What does the function $□^{-1}$ measure in real terms? Your answer should be descriptive, similar to the way □ (□) was described above.

3. We are interested in computing values of $\square^{-1}$. Fill in the following table for as many values of $\square$ as you can. What quantity does $\square$ represent?

$\square$	$\square^{-1}(\square)$

What are the domain and range of $\square$? What are the domain and range of $\square^{-1}$?

4. You are allowed to turn on electronic equipment after the plane has reached 10,000 feet. Approximately when can you expect to turn on your laptop computer after taking off?

5. Suppose we consider $\square(\square)$ from the time of takeoff to the time of touchdown. Is $\square(\square)$ still one-to-one?

GROUP WORK 2, SECTION 2.8

The Column of Liquid

It is a fact that if you take a tube and fill it partway with liquid, the liquid will rise and fall based on the temperature. Assume that we have a tube of liquid, and we have a function $\square(\square)$, where $\square$ is the height of the liquid in cm at temperature $\square$ in $^\circ$F.

1. It is true that $\square(32) = 1$. What does that mean in physical terms?

2. It is true that $\square(212) = 10$. What does that mean in physical terms?

3. Describe the inverse function $\square^{-1}$. What are its inputs? What are its outputs? What does it measure?

4. Hospitals used to use a device that measured the function $\square^{-1}$. Some people used to have such a device in their homes. What is the name of this device?

GROUP WORK 3, SECTION 2.8

Functions in the Classroom Revisited

Which of the following are functions? Of the ones that are functions, which are one-to-one functions? Describe what the inverses tell you.

Domain	Function Values	Function
All the people in your classroom	Chairs	□ (person) = his or her chair
All the people in your classroom	The set {blue, brown, green, hazel}	□ (person) = his or her eye color
All the people in your classroom	Cities	□ (person) = birthplace of their mom and dad
All the people in your classroom	R, the real numbers	□ (person) = number of molecules in their body
All the people in your classroom	Spleens	□ (person) = his or her own spleen
All the people in your classroom	Pencils	□ (person) = his or her pencil
All the people in the United States	Integers from 0–999999999	□ (person) = his or her Social Security number
All the living people born in February	Days in February, 2019	□ (person) = his or her birthday in February 2019
All the people in your classroom	Days of the year	□ (person) = his or her birthday
All the people in your classroom	Cars	□ (person) = his or her car
All the people in your classroom	R, the real numbers	□ (person) = how much cash he or she has
All the people in your college	Names	□ (person) = his or her middle name
All the people in your classroom	People	□ (person) = himself or herself
All the people in your classroom	People	□ (person) = his or her instructor