Lesson 17
Parent Functions

NAME:

Start by navigating to the Online Lesson for instructions.

Objectives

- Name a parent function given the graph or equation: linear, absolute value, square root, cube root, quadratic, cubic, reciprocal.
- Name the domain and range of parent functions.
- Graph/Sketch a parent function given the equation: linear, absolute value, square root, cube root, quadratic, cubic, reciprocal.
- Describe the end behavior of parent functions.

Why?

Understanding parent graphs is an important foundation in Algebra. Every transformed graph can be traced back to its most basic form, the parent graph.

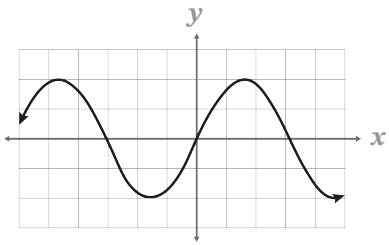
Warm Up

Name the domain and range. Then determine if a function exists.

1)

x	y
−3	5
0	5
0.5	5
8	5

2)



To continue, return to the Online Lesson.

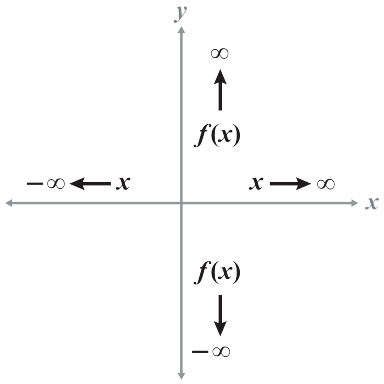
Explore

End Behavior of Functions

Fill in the notes as you watch the video in the Online Lesson.

- _____ is an important feature of a graph because it shows trends.
- The end behavior of a graph is a trend in the $f(x)$ values when x approaches _____ and when x approaches _____.
- Another way to think about end behavior is to ask yourself:
  - As _____ gets bigger, what happens to _____?

    AND
  - As _____ gets smaller, what happens to _____?
- The notation for end behavior is written as:



The notation for end behavior is said as:

"As x approaches positive infinity, the function approaches [blank], and as x approaches negative infinity, the function approaches [blank]."

- The blanks are determined by what the _____ looks like.
- The _____ on the end(s) of a graph on the coordinate plane demonstrate the direction of the end behavior of a graph.
- When a function is written in standard form, use the leading _____ and the _____ of the function (rather than the graph) to determine the end behavior.
- Recall that _____ is the value of the largest exponent.

To continue, return to the Online Lesson.

Example 1

Complete the example as you watch the video in the Online Lesson.

Name the end behavior of the odd degree graph.

Plan

Find and circle the ends of the graph.

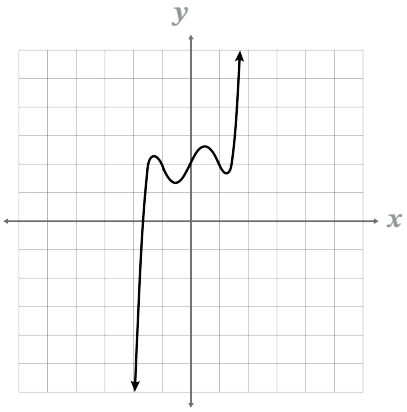
As x increases and decreases, determine what happens to the y-values.

Explain

Written notation:

As $x \to +\infty, f(x) \to +\infty$, and as $x \to -\infty$, _____

Implement



Spoken word:

As x approaches _____ infinity, the y (or $f(x)$) approaches

_____ infinity.

And, as x approaches _____ infinity, the y (or $f(x)$) approaches

_____ infinity.

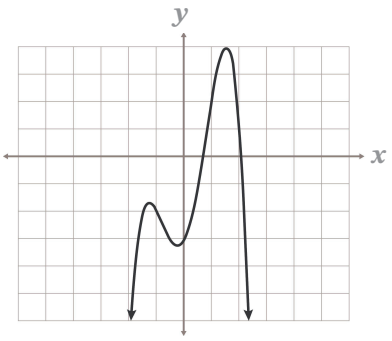
Example 2

Complete the example as you watch the video in the Online Lesson.

Name the end behavior of the even degree graph.

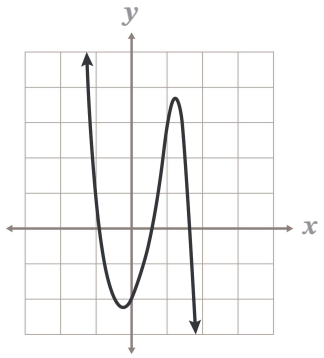
As $x \to +\infty$, _____ and

as $x \to -\infty$, _____



☑ Checkpoint: End Behavior of Functions

Name the end behavior of the graph.



To continue, return to the Online Lesson.

Polynomial Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

- The _____ function is the simplest form of any function.
- Polynomial parent functions are named by the _____ of the polynomial.
- Looking at the graphs of parent functions will help you notice _____ in the end behavior as well as the domain and range.
  - The domain is the set of all _____ values, or x-coordinates.
  - The range is the set of all _____ values, or y-coordinates ($f(x)$ in function notation).
- The domain and range can be written using _____ notation or _____ notation.
  - Interval notation is one way to express _____ of the domain or range.
    - Use parentheses ( ) for _____ points or _____ numbers like infinity ∞.
    - Use brackets [ ] for _____ points or _____ numbers.
  - Set-builder notation uses _____ to define all values of the domain and range.

All equations of functions can be written using function notation $f(x)$ or y.

Linear Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Polynomial Parent Functions

Type	Linear	Quadratic	Cubic
Parent equation	$y = x$		
Degree			
Domain and Range			
Quadrants			
Because	the x- and y-coordinates will _____ have the _____ value		
Other Characteristics	slope _____		
Intersects graph	Polynomial parent functions intersect the coordinate plane at the origin:		

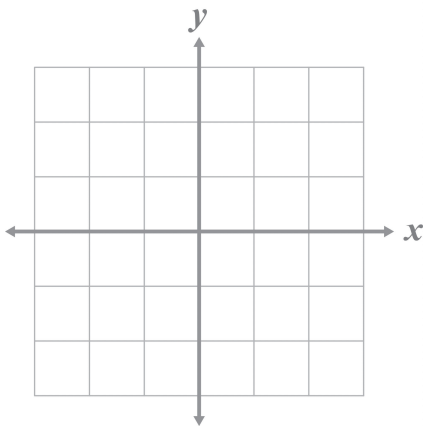
Example 3

Complete the example as you watch the video in the Online Lesson.

Graph the linear parent function. Name the domain and range in interval and set-builder notation. Then name the end behavior of the graph.

$y = x$

x	y
−2	−2
−1	−1
0	0
1	1
2	2



Interval notation

domain: $(-\infty, \infty)$

range:

Set-builder notation

End behavior

As $x \to +\infty, f(x) \to$ _____ and as $x \to -\infty$, _____

Quadratic Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Polynomial Parent Functions

Type	Linear	Quadratic	Cubic
Parent equation	$y = x$	$y = x^2$	
Degree	1		
Domain and Range	$\text{domain: } \{x \mid x \in \mathbb{R}\}$ $\text{range: } \{y \mid y \in \mathbb{R}\}$		
Quadrants	Q1 and Q3		
Because	the x- and y-coordinates will always have the same value	the y-coordinates will _____, because any number squared is positive	
Other Characteristics	slope $m = 1$	_____, u-shaped symmetric graph Axis of symmetry is _____, the y-axis	
Intersects graph	Polynomial parent functions intersect the coordinate plane at the origin:		

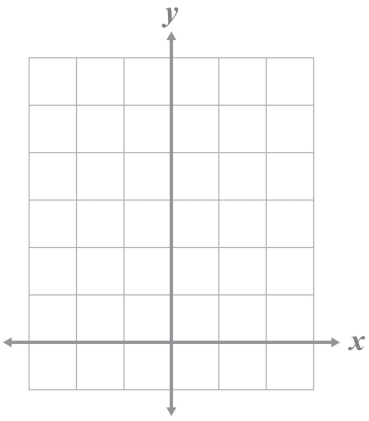
Example 4

Complete the example as you watch the video in the Online Lesson.

Graph the quadratic parent function. Name the domain and range in interval and set-builder notation. Then name the end behavior of the graph.

$y = x^2$

x	y
−2	4
−1	1
0	0
1	1
2	4



Interval notation

domain: $(-\infty, \infty)$

range: $[0, \infty)$

Set-builder notation

End behavior

As $x \to +\infty, f(x) \to$ _____ and as $x \to -\infty$, _____

Cubic Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Polynomial Parent Functions

Type	Linear	Quadratic	Cubic
Parent equation	$y = x$	$y = x^2$	$y = x^3$
Degree	1	2	
Domain and Range	domain: $\{x \mid x \in \mathbb{R}\}$ range: $\{y \mid y \in \mathbb{R}\}$	domain: $\{x \mid x \in \mathbb{R}\}$ range: $\{y \mid y \in \mathbb{R}, y \geq 0\}$	
Quadrants	Q1 and Q3	Q1 and Q2	
Because	the x- and y-coordinates will always have the same value	the y-coordinates will always be positive, because any number squared is positive	when the x-value is positive, the y-value is _____ , and when the x-value is negative, the y-value is _____
Other Characteristics	slope $m = 1$	parabola, u-shaped symmetric graph Axis of symmetry is $x = 0$, the y-axis	
Intersects graph	Polynomial parent functions intersect the coordinate plane at the origin:		

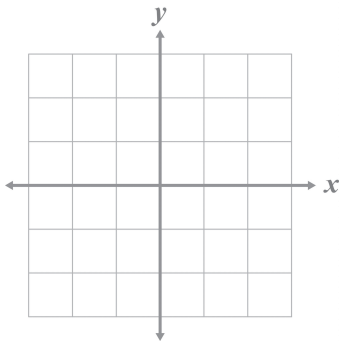
Example 5

Complete the example as you watch the video in the Online Lesson.

Graph the cubic parent function. Name the domain and range in interval and set-builder notation. Then name the end behavior of the graph.

$y = x^3$

x	y
−2	−8
−1	−1
0	0
1	1
2	8



Interval notation

domain: $(-\infty, \infty)$

range:

Set-builder notation

End behavior

Checkpoint: Polynomial Parent Functions

Explain the differences between the end behavior of a linear and cubic parent graph compared to quadratic parent graph.

To continue, return to the Online Lesson.

Non-Polynomial Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

- Non-polynomial parent functions are named by their _____ rather than their degree.
- Many of these graphs are _____ of the polynomial parent functions.

Absolute Value Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Non-Polynomial Parent Functions

Type	Absolute Value	Square Root	Cube Root	Reciprocal
Parent equation	$y = \lvert x \rvert$			
Degree	does not apply			
Domain and Range				
Quadrants				
Because	y-coordinates will always be _____ because _____			
Other Characteristics	v-shaped, symmetric Axis of symmetry is $x = 0$, the y-axis			
Intersects graph	vertex at origin, changes directions at origin			

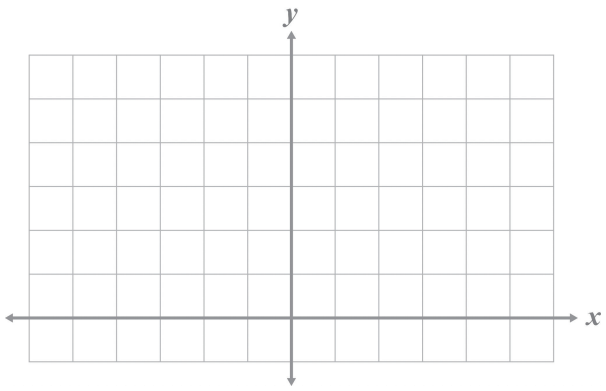
Example 6

Complete the example as you watch the video in the Online Lesson.

Graph the absolute value parent function. Name the domain and range in interval and set-builder notation. Then name the end behavior of the graph.

$y = |x|$

x	y
-2	2
-1	1
0	0
1	1
2	2



Interval notation

domain: $(-\infty, \infty)$

range: $[0, \infty)$

Set-builder notation

domain: $\{x \mid x \in \mathbb{R}\}$

range:

End behavior

As $x \to +\infty, f(x) \to$ _____ and as $x \to -\infty$, _____

Square Root Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Non-Polynomial Parent Functions

Type	Absolute Value	Square Root	Cube Root	Reciprocal
Parent equation	$y = \lvert x \rvert$	$y = \sqrt{x}$		
Degree	does not apply			
Domain and Range	$\text{domain: } \{x \mid x \in \mathbb{R}\}$ $\text{range: } \{y \mid y \in \mathbb{R},\ y \geq 0\}$			
Quadrants	Q1 and Q2			
Because	y-coordinates will always be positive because $\lvert \text{term} \rvert = +\ \text{term}$	only _____ are being graphed, so the x- and y-values will be _____		
Other Characteristics	v-shaped, symmetric Axis of symmetry is $x = 0$, the y-axis	partial inverse of the _____ function		
Intersects graph	vertex at origin, changes directions at origin	_____ start and end point at the origin		

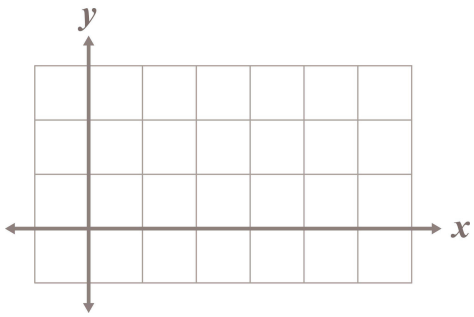
Example 7

Complete the example as you watch the video in the Online Lesson.

Graph the square root parent function. Name the domain and range in interval and set-builder notation. Then name the end behavior of the graph.

$y = \sqrt{x}$

x	y
–1	undefined
0	0
1	1
2	1.4142136
3	1.7320508
4	2



Interval notation

Set-builder notation

domain: $\{x \mid x \in \mathbb{R}, x \geq 0\}$

range: $\{y \mid y \in \mathbb{R}, y \geq 0\}$

End behavior

As $x \to +\infty, f(x) \to$ _____ and as $x \to 0,$ _____

Cube Root Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Non-Polynomial Parent Functions

Type	Absolute Value	Square Root	Cube Root	Reciprocal
Parent equation	$y = \lvert x \rvert$	$y = \sqrt{x}$	$y = \sqrt[3]{x}$	
Degree	does not apply	$\frac{1}{2}$		
Domain and Range	$\text{domain: } \{x \mid x \in \mathbb{R}\}$ $\text{range: } \{y \mid y \in \mathbb{R},\ y \geq 0\}$	$\text{domain: } \{x \mid x \in \mathbb{R},\ x \geq 0\}$ $\text{range: } \{y \mid y \in \mathbb{R},\ y \geq 0\}$		
Quadrants	Q1 and Q2	Q1		
Because	y-coordinates will always be positive because $\lvert \text{term} \rvert = + \text{ term}$	Only $\mathbb{R}$ are being graphed, so the x- and y-values will be ≥ zero	cube root of a number can be ____, so there are _____ for domain and range	
Other Characteristics	v-shaped, symmetric Axis of symmetry is $x = 0$, the y-axis	partial inverse of the quadratic function	inverse of the _____ parent function	
Intersects graph	vertex at origin, changes directions at origin	defined start and end point at the origin	_____ the coordinate plane at the origin	

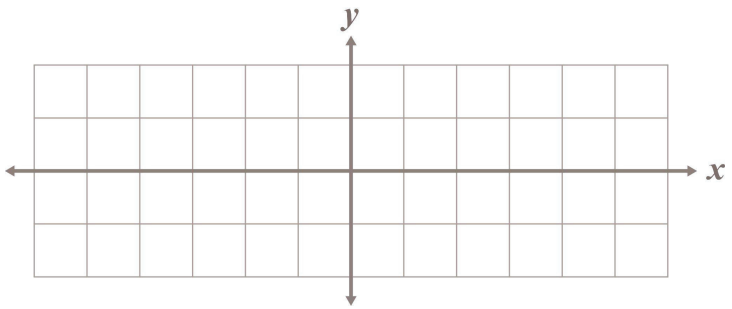
Example 8

Complete the example as you watch the video in the Online Lesson.

Graph the cube root parent function. Name the domain and range in interval and set-builder notation. Then name the end behavior of the graph.

$y = \sqrt[3]{x}$

x	y
–8	–2
–2	–1.259921
–1	–1
0	0
1	1
2	1.259921
8	2



Interval notation

Set-builder notation

End behavior

Reciprocal Parent Functions

Fill in the notes as you watch the video in the Online Lesson.

Non-Polynomial Parent Functions

Type	Absolute Value	Square Root	Cube Root	Reciprocal
Parent equation	$y = \lvert x \rvert$	$y = \sqrt{x}$	$y = \sqrt[3]{x}$	$y = \frac{1}{x}, x \neq 0$
Degree	does not apply	$\frac{1}{2}$	$\frac{1}{3}$	
Domain and Range	$\text{domain}: \{x \mid x \in \mathbb{R}\}$ $\text{range}: \{y \mid y \in \mathbb{R}, y \geq 0\}$	$\text{domain}: \{x \mid x \in \mathbb{R}, x \geq 0\}$ $\text{range}: \{y \mid y \in \mathbb{R}, y \geq 0\}$	$\text{domain}: \{x \mid x \in \mathbb{R}\}$ $\text{range}: \{y \mid y \in \mathbb{R}\}$	
Quadrants	Q1 and Q2	Q1	Q1 and Q3	Q1 and Q3
Because	y-coordinates will always be positive because $\lvert \text{term} \rvert = +\text{ term}$	only $\mathbb{R}$ are being graphed, so the x- and y-values will be ≥ zero	cube root of a number can be ±, so there are no restrictions for domain and range	1 divided by a positive value will give a positive value _____; 1 divided by a negative value will give a negative value _____
Other Characteristics	v-shaped, symmetric Axis of symmetry is $x = 0$, the y-axis	partial inverse of the quadratic function	inverse of the cubic parent function	has asymptotes denominator _____
Intersects graph	vertex at origin, changes directions at origin	defined start and end point at the origin	crosses the coordinate plane at the origin	continues across the coordinate plane in _____ with four end behavior statements (not two)

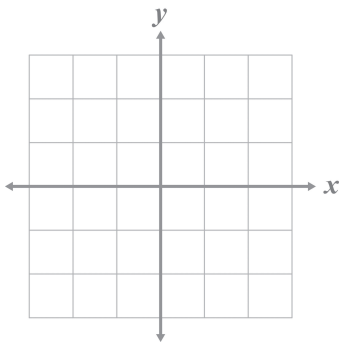
Example 9

Complete the example as you watch the video in the Online Lesson.

Graph the rational parent function. Name the domain and range set-builder notation. Then name the end behavior of the graph.

$y = \frac{1}{x}, x \neq 0$

x	y
–2	–0.5
–1	–1
0	undefined
1	1
2	0.5



Set-builder notation

End behavior

Quadrant I
As $x \to +\infty, f(x) \to 0$, and as $x \to 0^+, f(x) \to +\infty$

Quadrant III
As $x \to -\infty, f(x) \to 0$, and as $x \to 0^-, f(x) \to -\infty$

The direction as x approaches zero is noted here because the rational parent function is in two quadrants.

☑ Checkpoint: Non-Polynomial Parent Functions

Explain why the domain values for a cube root parent function are all real numbers, but for the square root parent function the domain is numbers greater than or equal to zero.

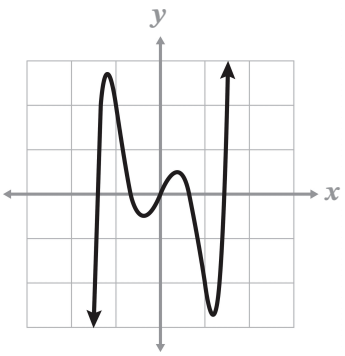
To continue, return to the Online Lesson.

Practice 1

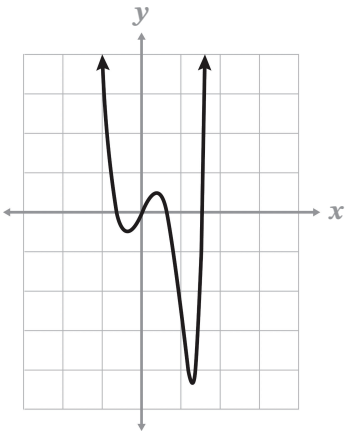
Complete problems on a separate sheet of paper.

Determine the end behavior for the graph.

1)



2)



Match the given graph to its end behavior. Choices may be used more than once.

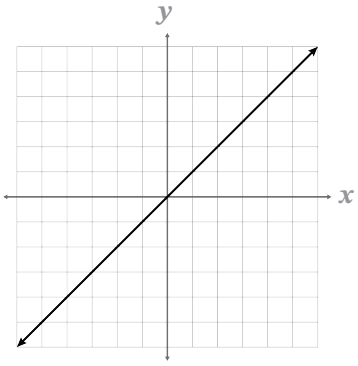
A) As $x \to +\infty, f(x) \to +\infty$, and as $x \to -\infty, f(x) \to -\infty$

B) As $x \to +\infty, f(x) \to +\infty$, and as $x \to 0, f(x) \to 0$

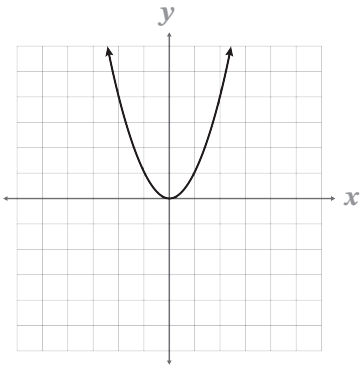
C) As $x \to +\infty, f(x) \to +\infty$, and as $x \to -\infty, f(x) \to +\infty$

D) Quadrant I: As $x \to +\infty, f(x) \to 0$, and as $x \to 0, f(x) \to +\infty$
Quadrant III: As $x \to -\infty, f(x) \to 0$, and as $x \to 0, f(x) \to -\infty$

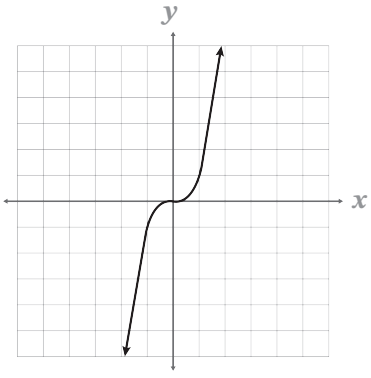
____ 3)



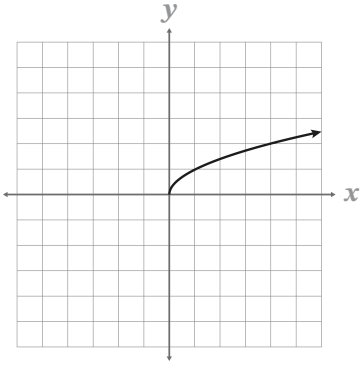
____ 4)



____ 5)



____ 6)



Name the parent function in the given graphs. Then name the domain and range.

7) Graph of problem 3

8) Graph of problem 4

9) Graph of problem 5

10) Graph of problem 6

Given the equation of the parent function, sketch the graph. Then name the end behavior.

11) square root

12) cube root

13) rational

14) absolute value

15) Explain end behavior in your own words.

16) How do the domain and range relate to the end behavior?

To continue, return to the Online Lesson.

Mastery Check

Show What You Know

A) Sort the parent functions by like domain and range.

absolute value
cube root
cubic
linear
quadratic
rational
square root

Group 1	Group 2	Group 3
domain: $\{x \mid x \in \mathbb{R}\}$ range: $\{y \mid y \in \mathbb{R}\}$	domain: $\{x \mid x \in \mathbb{R}\}$ range: $\{y \mid y \in \mathbb{R}, y \geq 0\}$	other

B) Name the quadrants and end behavior for the parent functions in Group 1.

C) Name the quadrants and end behavior for the parent functions in Group 2.

D) Name the domain and range in set-builder notation as well as the end behavior for the parent functions in Group 3.

Say What You Know

In your own words, talk about what you have learned using the objectives for this part of the lesson and your work on this page.

To continue, return to the Online Lesson.

Practice 2

Complete problems on a separate sheet of paper.

Match the given graph to its end behavior. Choices may be used more than once.

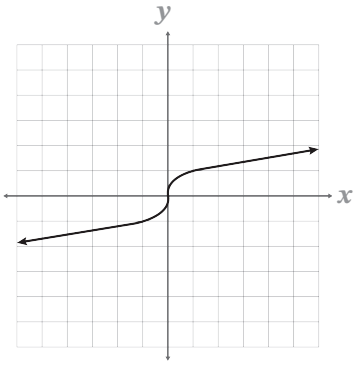
A) As $x \to +\infty, f(x) \to +\infty$, and as $x \to -\infty, f(x) \to -\infty$

B) As $x \to +\infty, f(x) \to +\infty$, and as $x \to 0, f(x) \to 0$

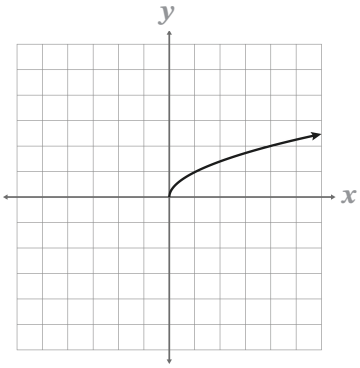
C) As $x \to +\infty, f(x) \to +\infty$, and as $x \to -\infty, f(x) \to +\infty$

D) Quadrant I: As $x \to +\infty, f(x) \to 0$, and as $x \to 0, f(x) \to +\infty$
Quadrant III: As $x \to -\infty, f(x) \to 0$, and as $x \to 0, f(x) \to -\infty$

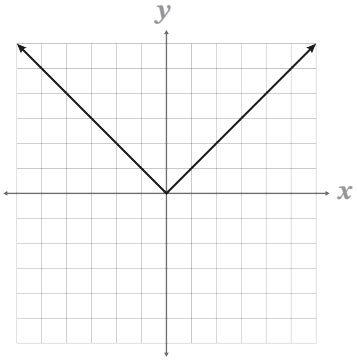
____ 1)



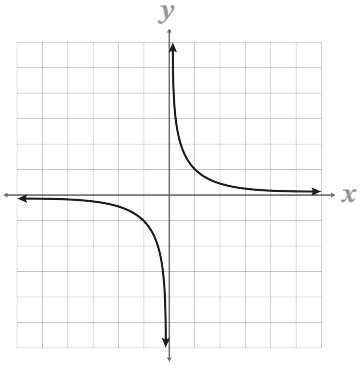
____ 2)



____ 3)



____ 4)



Name the parent function in given graphs. Then name the domain and range.

5) Graph of problem 1

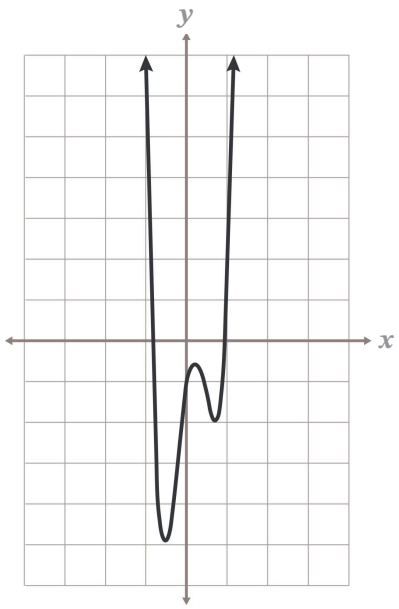
6) Graph of problem 2

7) Graph of problem 3

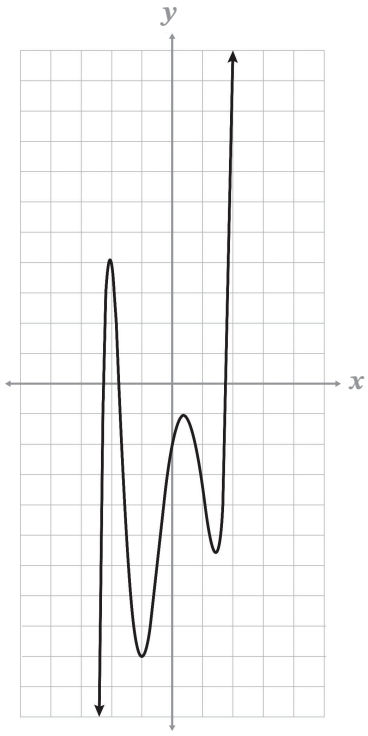
8) Graph of problem 4

Determine the end behavior for the graph.

9)



10)



Given the equation of the parent function, sketch the graph. Then name the end behavior.

11) quadratic

12) cubic

13) linear

14) Describe the end behavior of a polynomial parent function when the degree is odd and when the degree is even.

To continue, return to the Online Lesson.

Targeted Review

Complete items on a separate sheet of paper.

Simplify. Rationalize denominators.

1) $\dfrac{6}{\sqrt[3]{5x^2y}}$

2) $\left(i^{18}\right)\left(i^{5}\right)$

3) $\dfrac{2-\sqrt{3}}{6+\sqrt{3}}$

4) $\dfrac{8ab}{\sqrt[4]{3a^2b}}$

5) $\dfrac{3}{2-5i}$

Solve.

6) $\sqrt{x+10}=4-\sqrt{x+2}$

7) $(3x+2)^{\frac{1}{4}}=3$

8) $\sqrt{4x-7}>\sqrt{x-1}$

Multiple Choice

____ 9) The __ test can be used to determine if a graph represents a function.

A) horizontal line

B) vertical line

C) domain

D) range

____ 10) Solve: $5+\sqrt{2x-6}>8$

A)

B)

C)

D)

____ 11) Simplify: $(3-i)^2+4i^3(-i)$

A) 4

B) 6

C) $4-6i$

D) $8-7i$

12) Select all classifications for the expression $8-3i^2$

- ☐ Real numbers
- ☐ Rational Numbers
- ☐ Imaginary Numbers
- ☐ Complex Numbers

Problem	1	2	3	4	5	6	7	8	9	10	11	12
Origin	L11	L15	L12	L12	L16	L13	L13	L14	A1	L14	L16	L16

L = Lesson in this level, A1 = Algebra 1: Principles of Secondary Mathematics, FD = Foundational Knowledge

To continue, return to the Online Lesson.