

Day 6 ~

Increasing/Decreasing , and Extrema

A Graphical Approach

Warm Up ~ Day 6

$$1) \quad f(x) = \frac{x - 4}{x^2 - 7x + 12}$$

Find the a) domain b) x & y intercepts
c) range d) discontinuities
e) end behavior using limit notation

$$2) \quad g(x) = \sqrt{3x^2 + 7x - 6}$$

Find the a) domain b) x & y intercepts
c) range

Warm Up ~ Day 6 ANSWERS

$$1) \quad f(x) = \frac{x-4}{x^2-7x+12}$$

Find the

- a) domain $D: (-\infty, 3) \cup (3, 4) \cup (4, \infty)$
- b) x & y intercepts $x\text{-int}: \text{none}$ $y\text{-int}: (0, -\frac{1}{3})$
- c) range $R: (-\infty, 0) \cup (0, 1) \cup (1, \infty)$
- d) discontinuities $\text{Hole (Removable Disc.) at } (4, 1)$
 $\text{V.A. (NonRemovable Disc.) at } x=3$
- e) end behavior using limit notation

$$\lim_{x \rightarrow \infty} f(x) = 0$$

$$\lim_{x \rightarrow -\infty} f(x) = 0$$

Warm Up ~ Day 6 ANSWERS

$$2) \quad g(x) = \sqrt{3x^2 + 7x - 6}$$

Find the

- a) domain *Domain* : $(-\infty, -3] \cup [\frac{2}{3}, \infty)$
- b) x & y intercepts *x-int* : $(-3, 0)$ and $(\frac{2}{3}, 0)$
y-int : *none*
- c) range *Range* : $[0, \infty)$

Warm Up ~ Day 6

$$1) f(x) = \frac{x-4}{x^2-7x+12}$$

Find the a) domain b) x & y intercepts

c) range d) discontinuities

e) end behavior using limit notation

Day 6 - Inc Dec Extrema S19

Warm Up ~ Day 6

$$f(x) = \frac{x-4}{(x-4)(x-3)}$$

1) $f(x) = \frac{x-4}{x^2-7x+12}$

Find the a) domain b) x & y intercepts
c) range d) discontinuities
e) end behavior using limit notation

$x \neq 4, x \neq 3$

$(-\infty, 3) \cup (3, 4) \cup (4, \infty)$

x-int
 $0 = x - 4$
 $4 = x$
no x-int.

y-int.
 $\frac{1}{0-3}$
 $Y = -\frac{1}{3}$

$(0, -\frac{1}{3})$

Day 6 - Inc Dec Extrema S19

Warm Up ~ Day 6

$$f(x) = \frac{x-4}{(x-4)(x-3)}$$

1) $f(x) = \frac{x-4}{x^2-7x+12}$

Find the a) domain b) x & y intercepts
c) range d) discontinuities
e) end behavior using limit notation

hole at (4,1)

V.A. $x=3$

Warm Up ~ Day 6

$$2) g(x) = \sqrt{3x^2 + 7x - 6}$$

Find the a) domain b) x & y intercepts
c) range

The screenshot shows a presentation slide titled "Warm Up ~ Day 6" with handwritten solutions in blue and red ink. The solutions are as follows:

- Factorization: $(x+3)(3x-2)=0$
- X-intercepts: $x=-3, x=\frac{2}{3}$
- Domain: $(-\infty, -3] \cup [\frac{2}{3}, \infty)$
- X-intercept: $x\text{-int. } (-3, 0)$

The slide also includes a graph of the function $g(x) = \sqrt{3x^2 + 7x - 6}$ on the right side, showing the domain and x-intercepts marked on the x-axis.

Announcements

Tonight's Homework

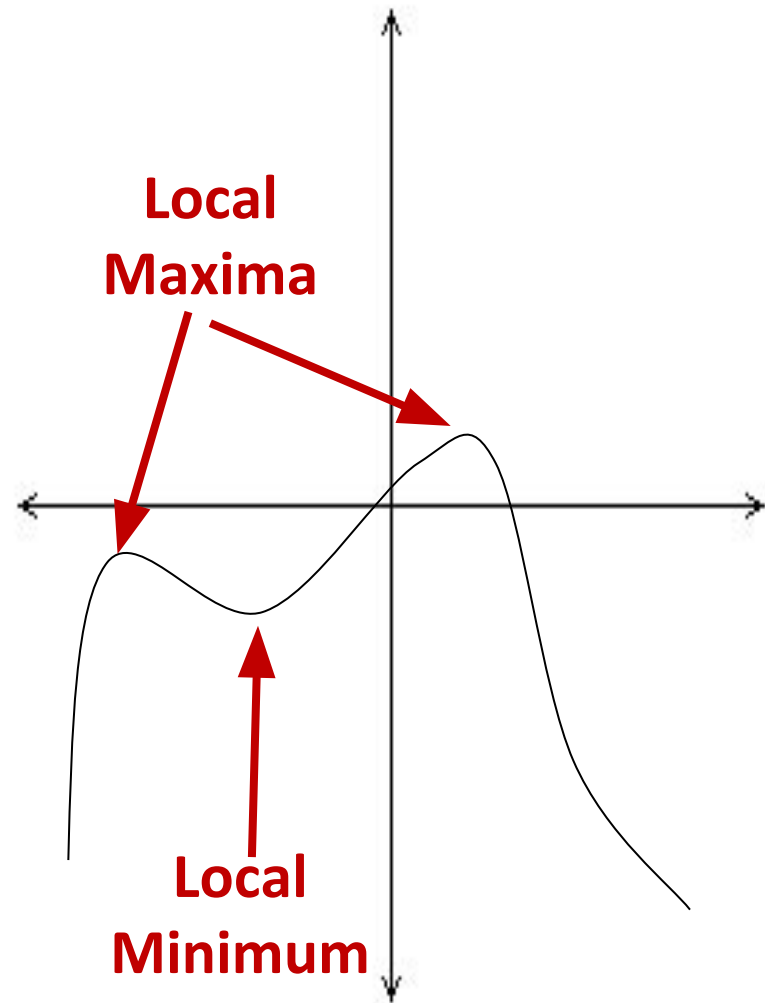
Packet p. 7-8

Notes Day 6

Part 1 – Increasing, Decreasing, Max and Min

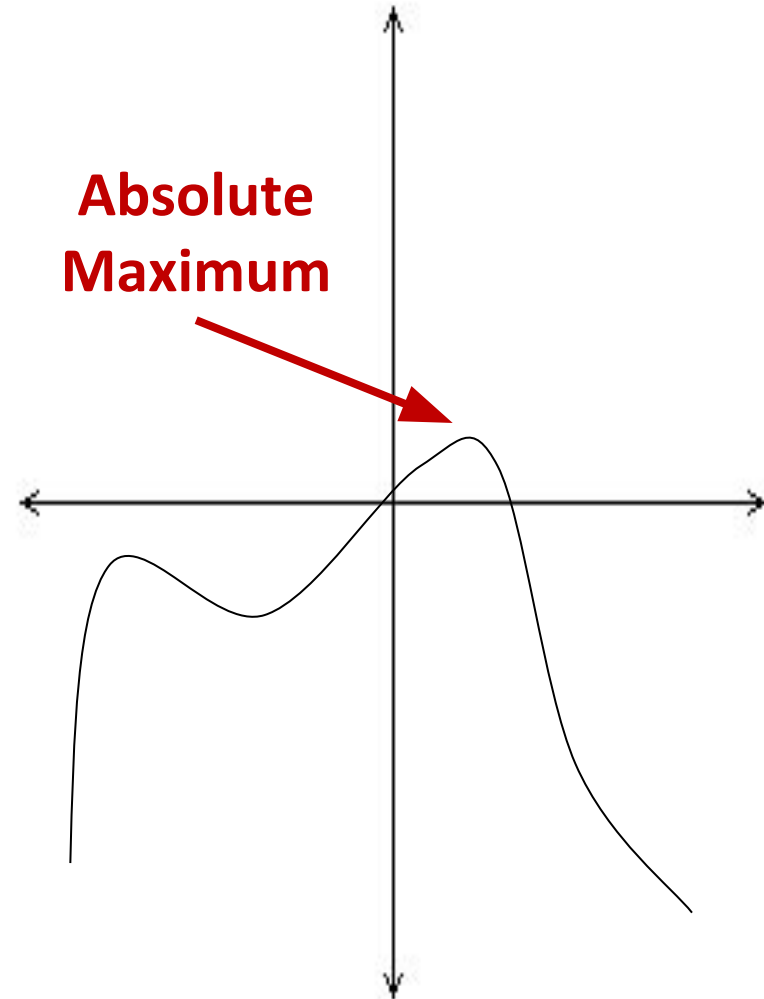
Local/Relative Extrema

- Local Maximum – the maximum **y-value** of a function on some small interval
- Local Minimum – the minimum **y-value** of a function on some small interval
- Local Extrema are also called “relative” extrema



Absolute Extrem

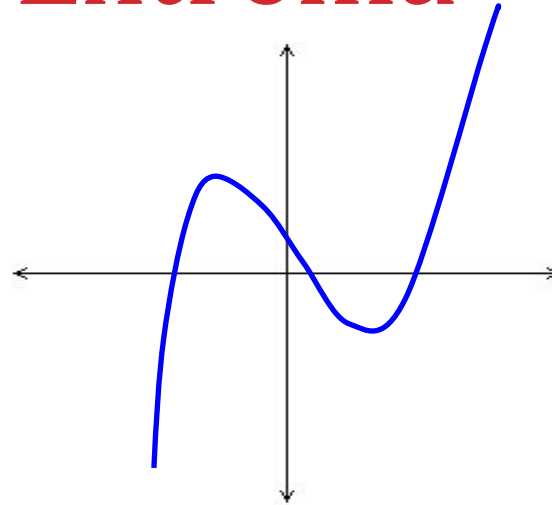
- **Absolute** extrema are the maximum and minimum of **all** range values.
- Report all extrema (local or absolute) as:
 - ***Max/Min y-value**
occurs at x-value*
- Occurs when y-values change from increasing to decreasing



Absolute Max Example:
Maximum 3 occurs at $x = 4$

Local & Absolute Extrema

- What are the local extrema of: $g(x) = x^3 - 4x + 1$



Remember, report all extrema (local or absolute) as:

Max: 4.08 occurs at $x = -1.15$
Min: -2.08 occurs at $x = 1.15$

- Max/Min is #, occurs at #
- **Max/Min is y-value, Occurs at x-value**
Remember, if given a function, you can use your calculator to find max's and min's!

Day 6 - Inc Dec Extrema S19

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Local & Absolute Extrema

What are the local extrema of $g(x) = x^3 - 4x + 1$

Remember, report all extrema (local or absolute) as:

- Max/Min is #, occurs at #
- **Max/Min is y-value, Occurs at x-value**

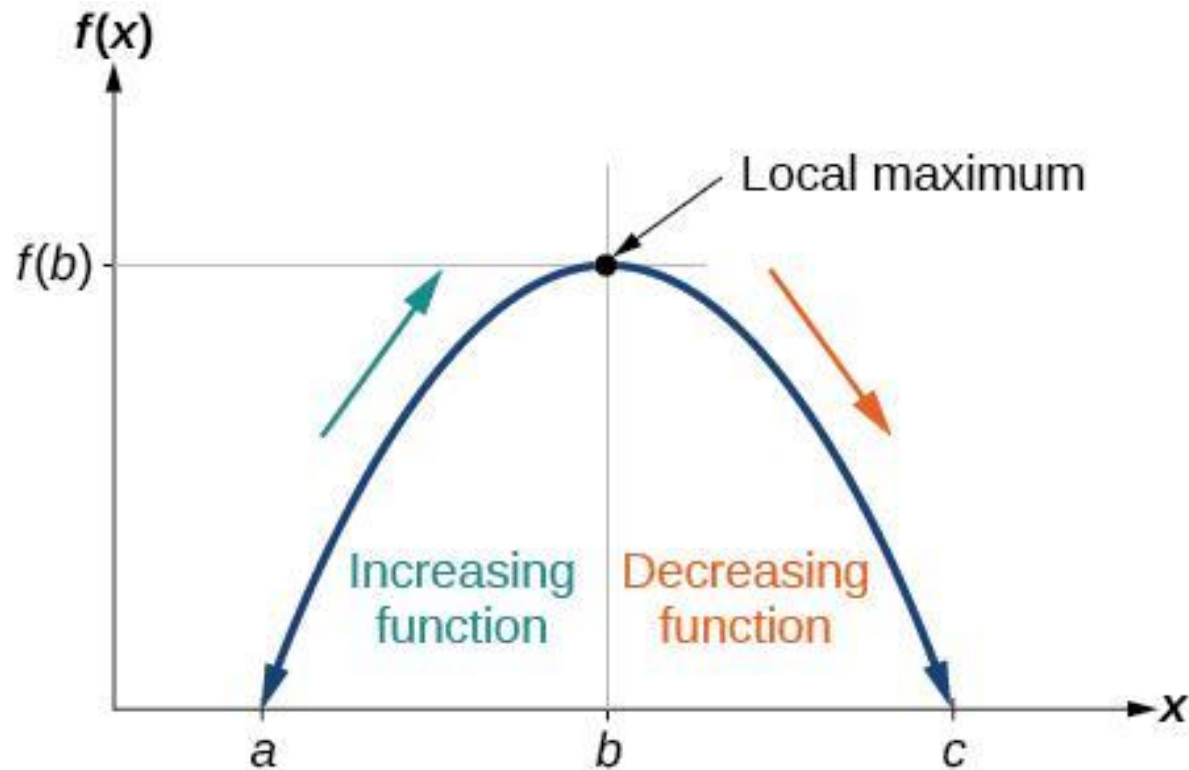
Remember, if given a function, you can use your calculator to find max's and min's!

Max: 4.08 occurs at $x = -1.15$
Min: -2.08 occurs at $x = 1.15$

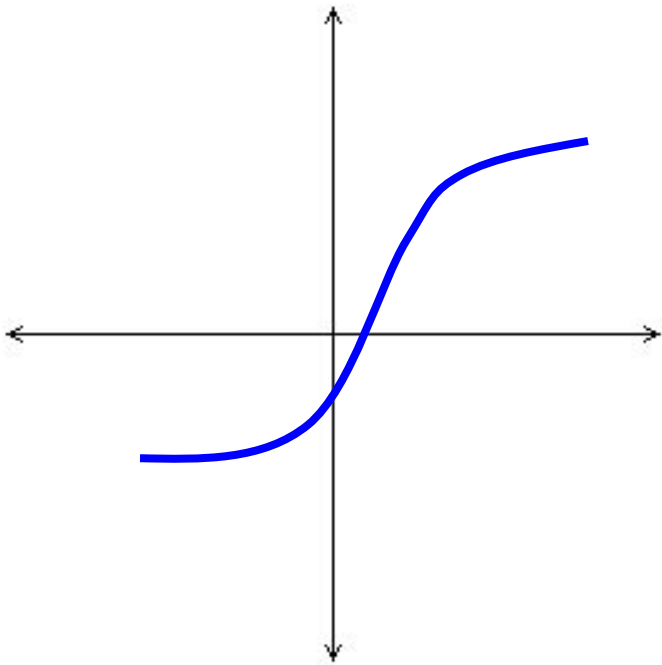
2nd, trace
min -3
max -4
left bound
enter

Local & Absolute Extrema

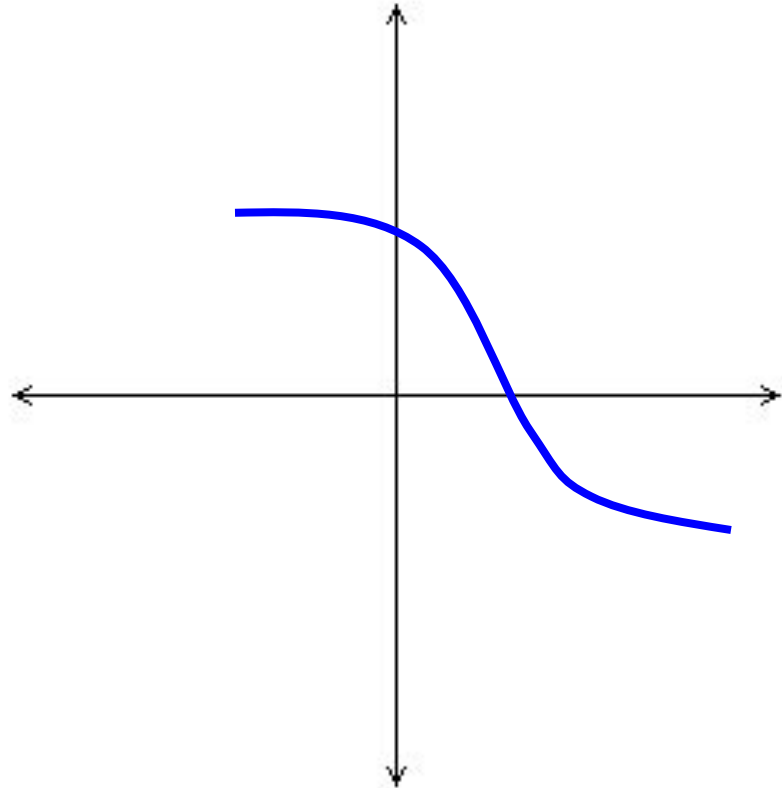
- Note that local and absolute extrema occur when y-values change from increasing to decreasing or vice versa



Increasing and Decreasing

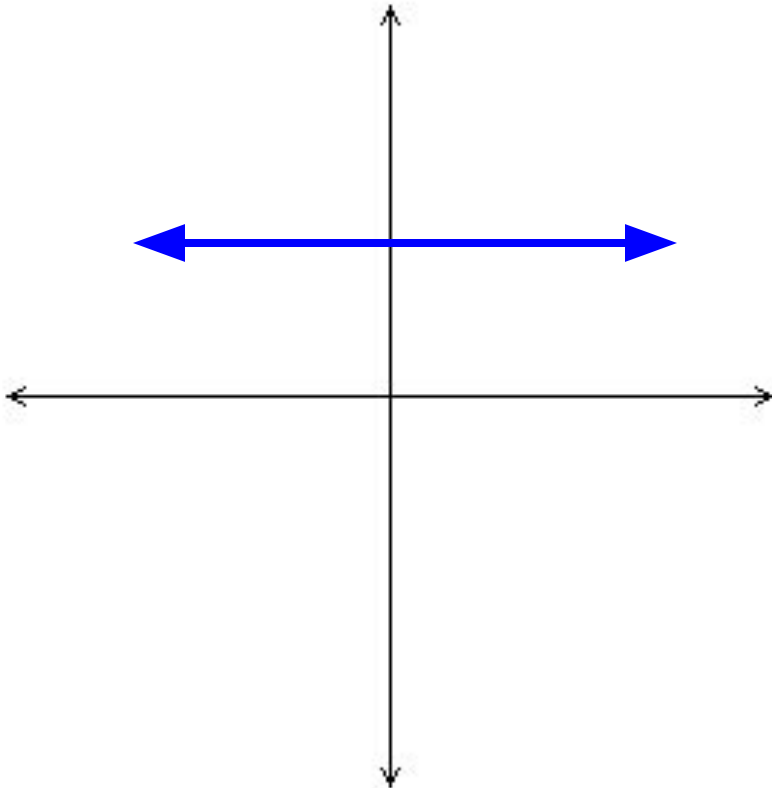


Increasing

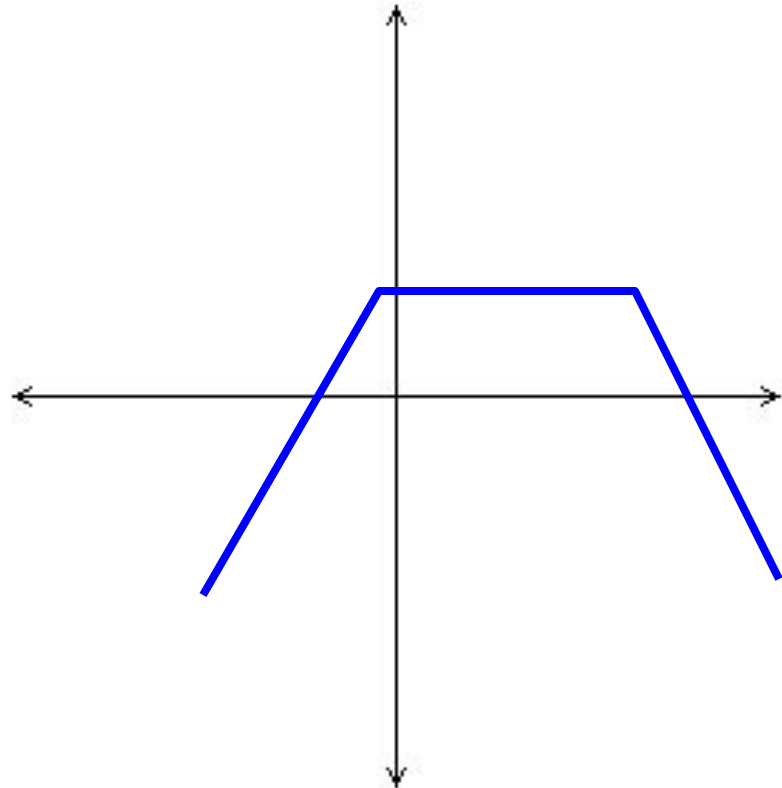


Decreasing

Constant and Mixed Intervals



Constant



Mixed

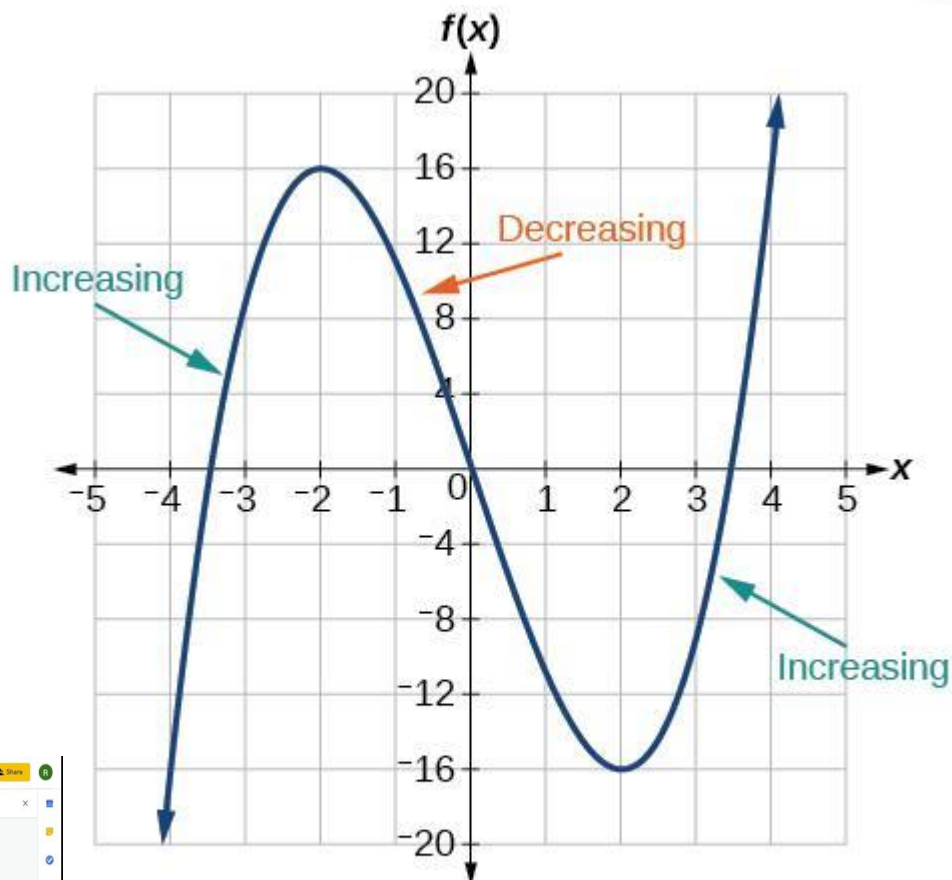
Increase, Decrease, and

Constant

Always use **x-values** to report increasing, decreasing, and constant intervals!

Increasing?

Decreasing?



$$f(b) > f(a) \\ \text{where } b > a$$

$$f(b) < f(a) \\ \text{where } b > a$$

$$f(b) > f(a) \\ \text{where } b > a$$

Day 6 - Inc Dec Extrema 519

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Format options

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Increase, Decrease, and Constant

Always use **x-values** to report increasing, decreasing, and constant intervals!

$(-\infty, -2) \cup (2, \infty)$

Increasing?

Decreasing?

$(-\infty, -2)$ $(2, \infty)$

$(-2, 2)$

$(-2, 16)$ $(2, -16)$

$f(b) > f(a)$ where $b > a$ $f(b) < f(a)$ where $b > a$ $f(b) > f(a)$ where $b > a$

Increase and Decrease

ANSWERS

Always use **x-values** to report increasing, decreasing, and constant intervals!

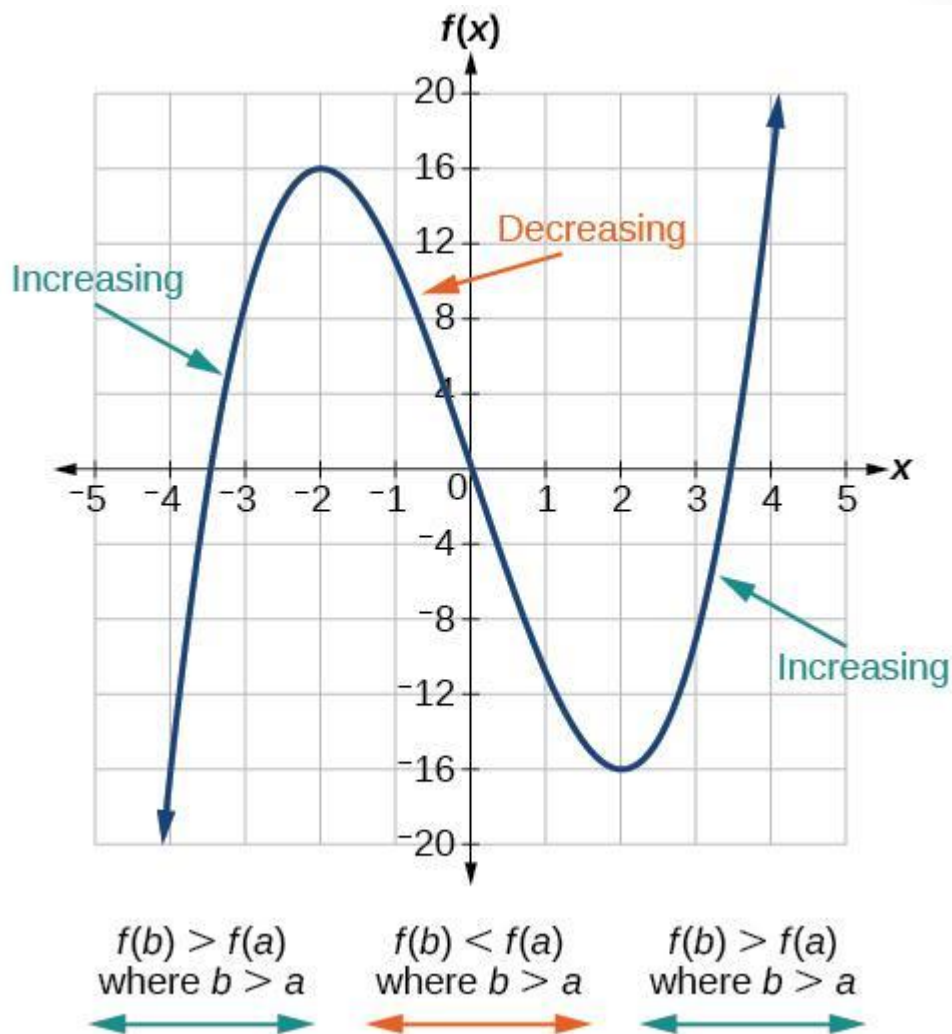
Mixed

Increasing?

$$(-\infty, -2) \cup (2, \infty)$$

Decreasing?

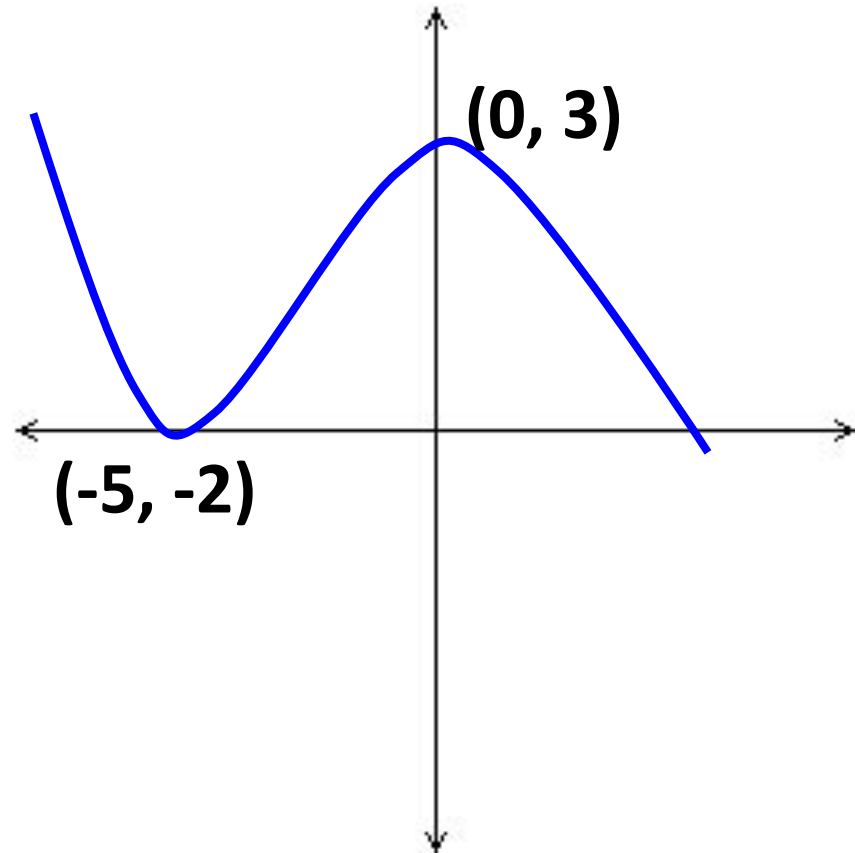
$$(-2, 2)$$



Increase, Decrease, and Constant

Always use **x-values** to report increasing/decreasing/constant intervals!

Mixed



Increasing?

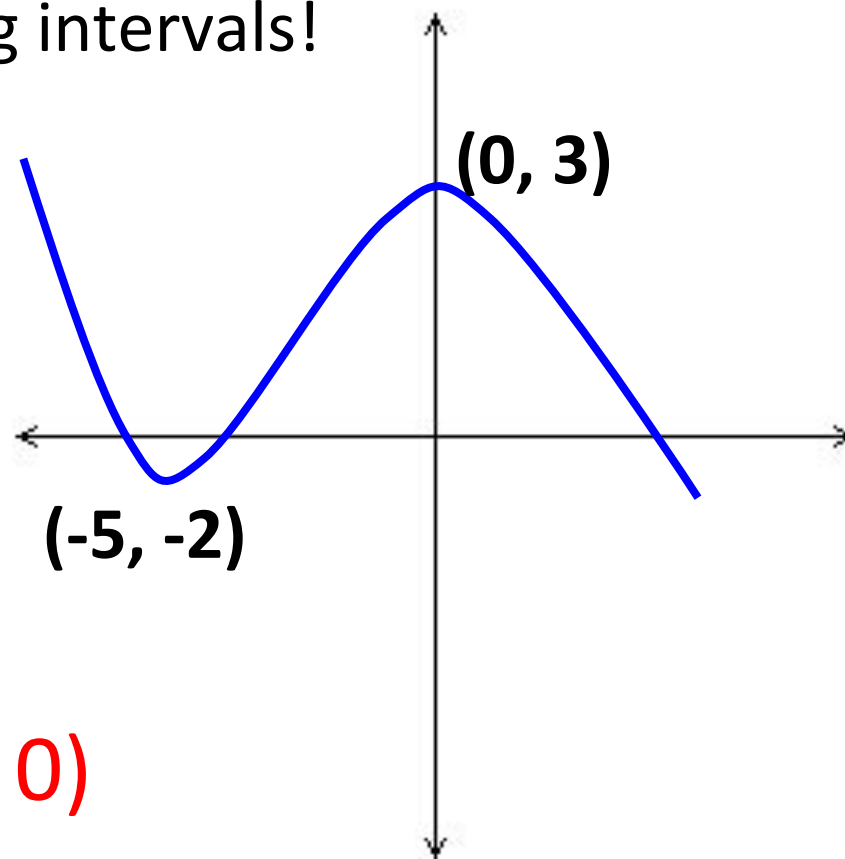
Decreasing?

Increase and Decrease

ANSWERS

Always use **x-values** to report increasing/decreasing intervals!

Mixed



Increasing? $(-5, 0)$

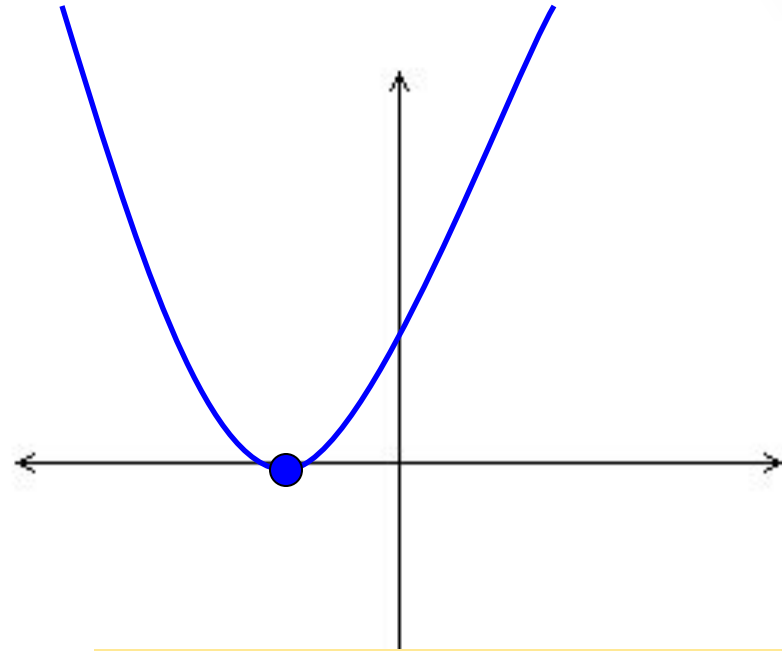
Decreasing? $(-\infty, -5) \cup (0, \infty)$

Increasing/Decreasing (Algebraic Models)

• Ex:

$$f(x) = (x + 2)^2$$

- What is the interval when this function is:
 - Increasing
 - Decreasing



HINT: 1st Get any Max and/or Min Values in Calculator OR with Algebra!

Increasing/Decreasing (Algebraic Models)

ANSWERS

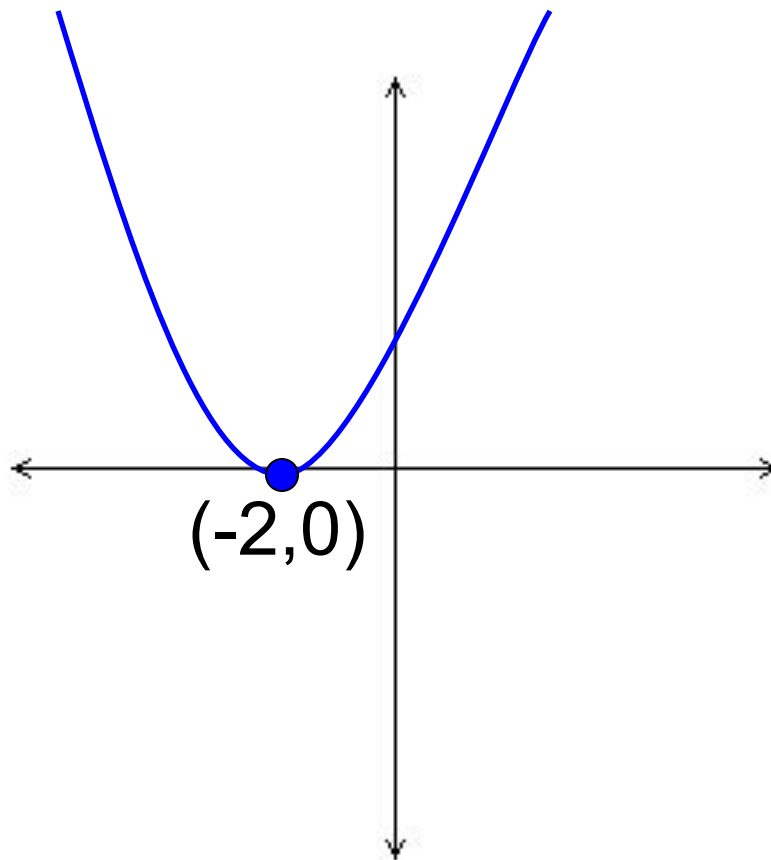
• Ex:

$$f(x) = (x + 2)^2$$

• What is the interval when this function is:

• Increasing $(-2, \infty)$

• Decreasing $(-\infty, -2)$



Always use x values!

You Try!

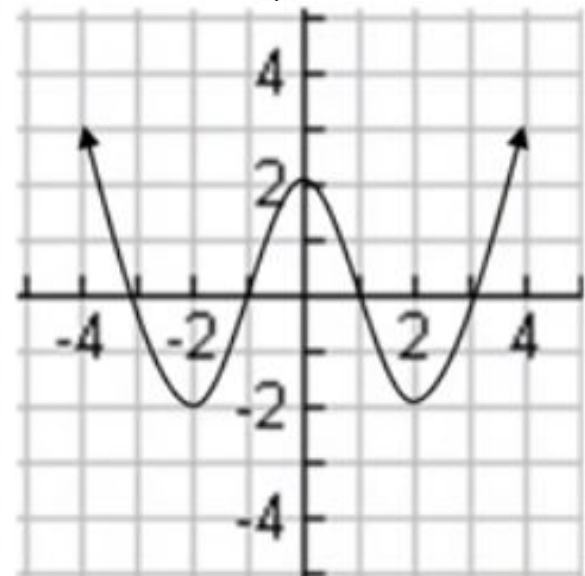
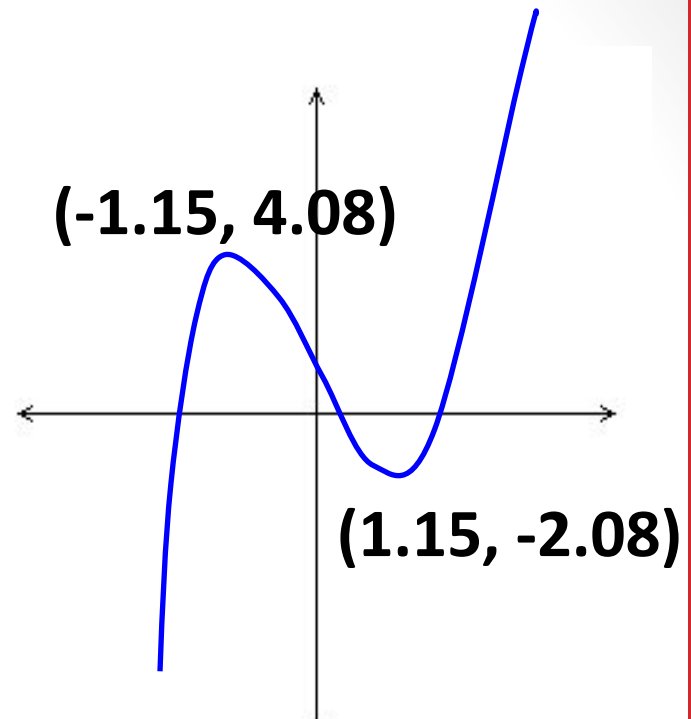
1) Back to this example...

$$g(x) = x^3 - 4x + 1$$

- When is the function increasing?
- When is the function decreasing?

2) Using the graph shown to the right,

- When is the function increasing?
- When is the function decreasing?



You Try!...ANSWERS

1) We found the extrema:

Max: 4.08 occurs at $x = -1.1$

Min: -2.08 occurs at $x = 1.1$

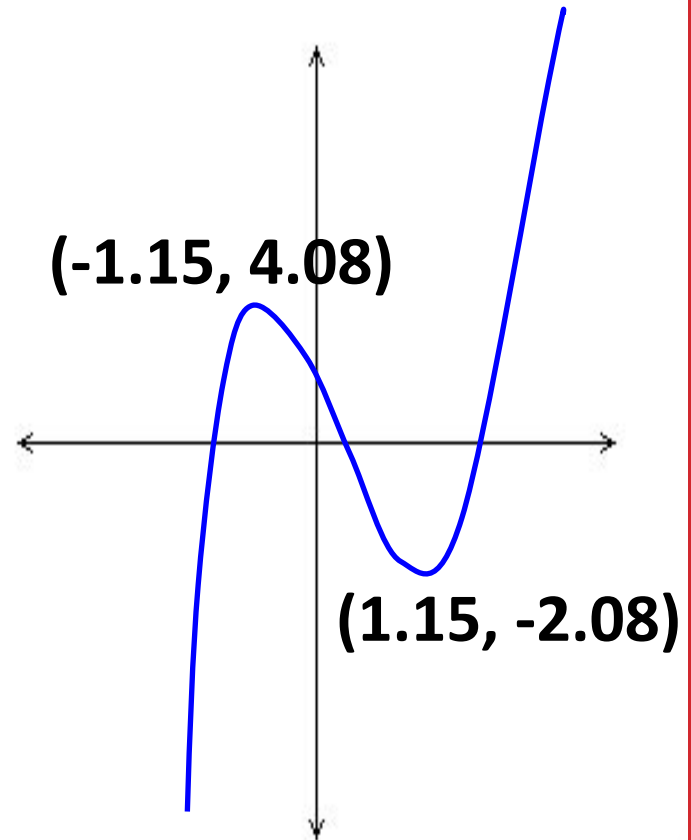
$$g(x) = x^3 - 4x + 1$$

• When is the function increasing?

$$(-\infty, -1.15) \cup (1.15, \infty)$$

• When is the function decreasing?

$$(-1.15, 1.15)$$



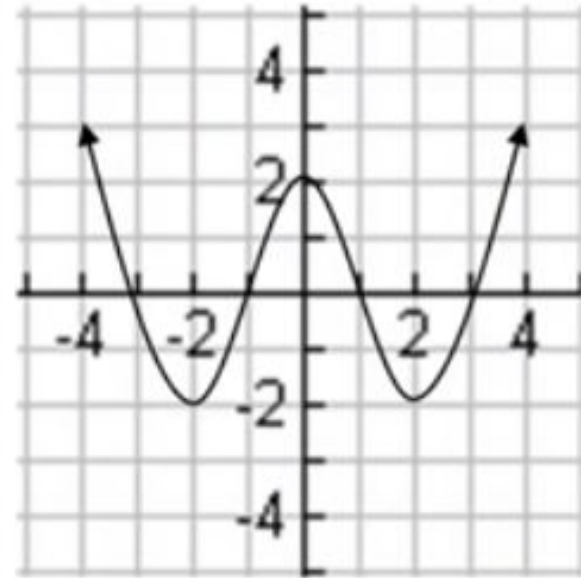
You Try!

2) Using the graph shown to the right,

First, find the extrema

Max: 2 occurs at $x = 0$

Min: -2 occurs at $x = -2$ and 2



- When is the function increasing?

$(-2, 0) \cup (2, \infty)$

- When is the function decreasing?

$(-\infty, -2) \cup (0, 2)$

Student Practice

- Find the intervals increasing/decreasing.
- State the domain and range.

• A) $g(x) = \frac{x^2}{x^2 - 1}$

Increasing:

Decreasing:

Domain:

Range:

• B) $h(x) = |x - 4| + 5$

Increasing:

Decreasing:

Domain:

Range:

The screenshot shows a presentation slide titled "Student Practice" for problem A. The slide contains the function $g(x) = \frac{x^2}{x^2 - 1}$ and asks for intervals of increasing/decreasing and domain/range. Handwritten notes in red and orange include: $x = -1, x = 1$ (vertical asymptotes), $HA y = 1$ (horizontal asymptote), and domain $(-\infty, -1) \cup (1, \infty)$. The graph shows a hyperbola with two branches, one in the upper-left and one in the lower-right, with arrows indicating increasing and decreasing intervals.

The screenshot shows a presentation slide titled "Student Practice" for problem B. The slide contains the function $h(x) = |x - 4| + 5$ and asks for intervals of increasing/decreasing and domain/range. The graph shows a V-shaped absolute value function opening upwards with its vertex at $(4, 5)$.

Student Practice ANSWERS

- Find the intervals increasing/decreasing.
- State the domain and range.

• A) $g(x) = \frac{x^2}{x^2 - 1}$

Increasing: $(-\infty, -1) \cup (-1, 0)$

Decreasing: $(0, 1) \cup (1, \infty)$

Domain: $(-\infty, -1) \cup (-1, 1) \cup (1, \infty)$

Range: $(-\infty, 0] \cup (1, \infty)$

• B) $h(x) = |x - 4| + 5$

Increasing: $(4, \infty)$

Decreasing: $(-\infty, 4)$

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

Range: $[5, \infty)$

Practice! What is the EQUATION of the horizontal asymptote for the following functions? Then write the end behavior using limits.

$$g(x) = -\frac{2x^5}{5x^4 + 6}$$

$$f(x) = \frac{2x^3 + 7}{5x - 7x^3 + 15}$$

$$h(x) = \frac{3x + 14}{9x^2}$$

Bottom > Top
y=0
Same = ratio
Top > Bottom
O ↑ No HA.
N ↑

Practice! What is the EQUATION of the horizontal asymptote for the following functions? Then write the end behavior using limits.

$$g(x) = -\frac{2x^5}{5x^4 + 6}$$

H.A. : none

$$\lim_{x \rightarrow \infty} g(x) = -\infty$$

$$\lim_{x \rightarrow -\infty} g(x) = \infty$$

Bottom > Top
 $y=0$
 Same = ratio
 Top > Bottom
 O ↑ No HA.
 N ↑

$$f(x) = \frac{2x^3 + 7}{5x - 7x^3 + 15}$$

H.A. : $y = -\frac{2}{7}$

$$\lim_{x \rightarrow \infty} f(x) = -\frac{2}{7}$$

$$\lim_{x \rightarrow -\infty} f(x) = -\frac{2}{7}$$

$$h(x) = \frac{3x + 14}{9x^2}$$

$$\lim_{x \rightarrow \infty} h(x) = 0$$

$$\lim_{x \rightarrow -\infty} h(x) = 0$$

H.A. : $y = 0$

More Practice: Increasing/Decreasing

$$f(x) = |x + 1| + |x - 1| - 3$$

$$h(x) = \frac{1}{2}(x + 2)^2 - 1$$

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

The screenshot shows a presentation slide titled "Day 6 - Inc Dec Extrema S19". The slide content includes:

- Graphs of $f(x) = |x+1| + |x-1| - 3$ and $h(x) = \frac{1}{2}(x+2)^2 - 1$ with handwritten points $(-1, -1)$ and $(1, -1)$ for the first graph, and $(-2, -1)$ for the second.
- Graphs of $f(x) = x^3 - x^2 - 2x$ with handwritten points $(-0.55, 0.63)$ and $(1.22, -2.11)$.
- Handwritten text: "More Practice: Increasing/Decreasing", "inc. $(-\infty, -0.55)$ ", and "dec. $(-0.55, 1.22)$ ".

The slide also features a navigation menu on the left with slide numbers 29, 30, and 31, and a footer with the text "Click to add speaker notes".

More Practice ANSWERS: Increasing/Decreasing

• 30. $f(x) = |x + 1| + |x - 1| - 3$

inc. $(1, \infty)$ dec. $(-\infty, 1)$

• 32. $h(x) = \frac{1}{2}(x + 2)^2 - 1$

inc. $(-2, \infty)$ dec. $(-\infty, -2)$

• 34. $f(x) = x^3 - x^2 - 2x$

inc. $(-\infty, -0.55) \cup (1.22, \infty)$

dec. $(-0.55, 1.22)$

Practice

Find the a) domain b) x & y intercepts c) range
d) discontinuities e) end behavior using limit notation

- 1)
$$h(x) = \frac{7x + 15}{2x^2}$$

- 2)
$$g(x) = \frac{4x^3}{5x^2 + 9}$$

Practice ANSWERS

- Find the a) domain b) x & y intercepts c) range
d) discontinuities e) end behavior using limit notation

• 1)

$$h(x) = \frac{7x + 15}{2x^2}$$

$$D: (-\infty, 0) \cup (0, \infty) \quad R: [-0.4, \infty)$$

$$x\text{-int} : \left(-\frac{15}{7}, 0\right) \quad y\text{-int} : \text{none}$$

$$\lim_{x \rightarrow \infty} f(x) = 0$$

$$\lim_{x \rightarrow -\infty} f(x) = 0$$

• 2)

$$g(x) = \frac{4x^3}{5x^2 + 9}$$

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

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

$$x\text{-int} : (0, 0)$$

$$y\text{-int} : (0, 0)$$

$$\lim_{x \rightarrow \infty} g(x) = \infty$$

$$\lim_{x \rightarrow -\infty} g(x) = -\infty$$