SET NOTATION

1.1 Functions and Their Key Features

A **relation** is a {set} of ordered pairs (x,y). {(1,9) (2,8) (3,7)}.

The **domain** of a relation is the {set} of all X-values. {1,2,3} x is the Independent Variable.

The **range** of a relation is the {set} of all y-values. {9,8,7} y is the Dependent Variable.

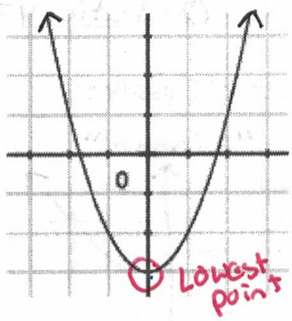
What makes a relation a FUNCTION? For every x-value there is one and only one y-value.

*To be a FUNCTION, x-values CANNOT REPEAT! *

If given the graph of a relation, we can tell if it is a function by using the Vertical Line Test (VLT).

Example 1: Determine if the following relations are functions using the vertical line test. Then state the domain and range using interval notation. (,), [,], $-\infty$, ∞, numbers *Smallest # to biggest #*

a.)



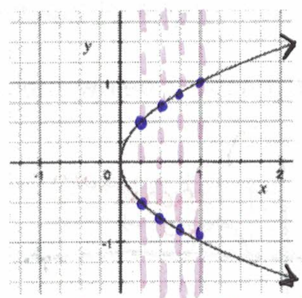
READ L to R
READ Bottom to Top

Function: yes or no

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

Y Range: $[-3,\infty)$

b.)



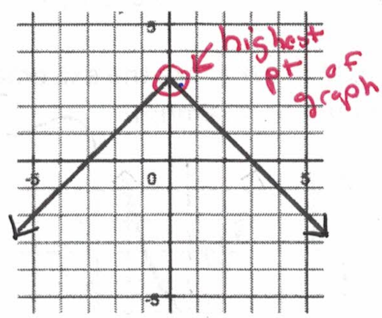
DOES NOT PASS VLT

Function: yes or no

X Domain: $[0,\infty)$

Y Range: $(-\infty,\infty)$

c.)



Function: yes or no

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

Y Range: $(-\infty,3]$

Function Notation: We represent functions with a symbol such as *f(x)*. We read this as "f of x" and interpret it as the value of the function *f* at *x*. Every function can be evaluated for each value in its domain.

x is the INPUT and f(x) is the OUTPUT. (y; x → y)

That means f(x) is the same as the y-value!!! We can always replace f(x) with y to turn a function into an equation.

Evaluating Functions: To evaluate a function means to find the y-value given a certain x-value. All we have to do is plug the x-value given into all "x's" and the evaluate the expression.

Example 2: Given $f(x)=2x+1$, evaluate the function at the given values for *x*.

a.) Find $\boxed{f(1)}$: → x=1 ("f" evaluated at 1.)

(1,3) f(1) = 2(1)+1
= 2+1
f(1) = 3

b.) Find f(-2): ← x=-2 (-2,-3)

f(-2) = 2(-2)+1
= -4+1
f(-2) = -3

c.) Find f(0): (0,1)

f(0) = 2(0)+1
= 0+1
f(0) = 1

Example 3: Given $h(x) = x^2 + 2x + 1$, evaluate the function at the given values of x.

a.) Find h(1):

$h(1) = (1)^2 + 2(1) + 1$

$= 1 + 2 + 1$

$h(1) = 4$

b.) Find h(-2):

$h(-2) = (-2)^2 + 2(-2) + 1$

$= 4 - 4 + 1$

$h(-2) = 1$

c.) Find h(b):

$h(b) = (b)^2 + 2(b) + 1$

$h(b) = b^2 + 2b + 1$

Key Features of Functions

1. Extreme Values (highs and lows) * Turning points for graphs. *

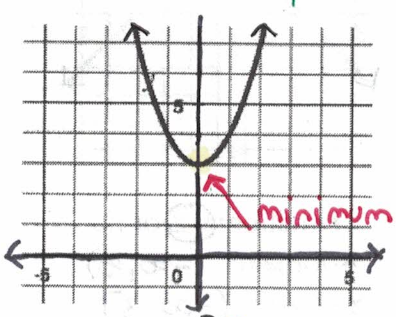
The highest (maximum) and lowest (minimum) points of a function are called extrema, or extreme values. It is important to know that extreme values refer to the y-value of the ordered pair. Can you think of a function you have learned about in the past that has an extreme value? Quadratic $y = x^2$

Example 4: What are the extreme values of the functions below and where do they occur? Classify as maximum or minimum.

Quadratic

"Linear"

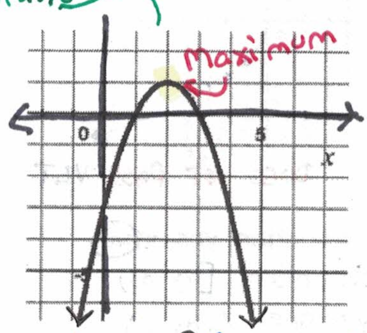
1.



minimum of 3 at x=0

(0,3)

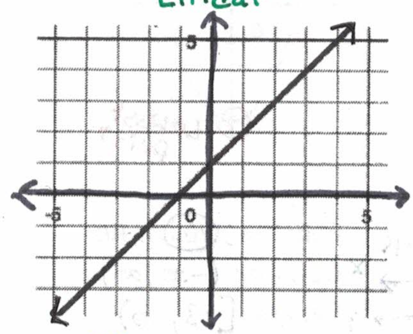
2.



maximum of 1 at x=2

(2,1)

3.



NO EXTREMA

2. Intervals of Increase and Decrease

A function is said to be increasing if the function RISES (Increase) from left to right, [redacted]. across a set of x-values.

A function is said to be decreasing if the function FALLS (Decrease) from left to right, [redacted]. across a set of x-values.

Example 5: Using the examples above, describe where each function is increasing or decreasing using interval notation.

1. Increasing: $[0, \infty)$

   Decreasing: $(-\infty, 0]$

2. Increasing: $(-\infty, 2]$

   Decreasing: $[2, \infty)$

3. Increasing: $(-\infty, \infty)$

   Decreasing: NONE

3. Intercepts

The x-intercept(s) of a function is where the function CROSSES the x-axis.

What does this tell you about the y-value of the function? $y=0 \rightarrow (\#,0)$

The y-intercept of a function is where the function CROSSES the y-axis.

What does this tell you about the x-value of the function? $x=0 \rightarrow (0,\#)$

Example 6: Using the examples above, state the x and y-intercepts of each function.

1. x-intercept: NONE
   y-intercept: $(0,3)$
2. x-intercept: $(1,0)$ and $(3,0)$
   y-intercept: $(0,-3)$
3. x-intercept: $(-1,0)$
   y-intercept: $(0,1)$

4. End Behavior

The End Behavior of a function describes where the function's values tend to as x-values decrease in the negative direction and increase in the positive direction. "What are the ends of my graph doing?"

Notation: $x \rightarrow -\infty, f(x) \rightarrow \pm\infty$ or $\#$

Read "as X approaches" $X \rightarrow$

*MUST HAVE BOTH DIRECTIONS

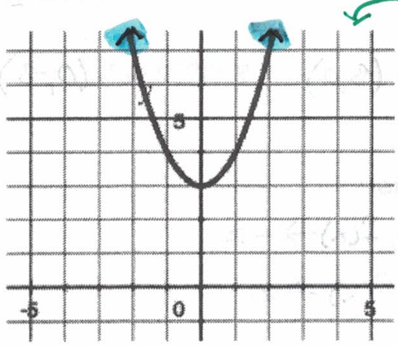
$x \rightarrow \infty, f(x) \rightarrow \pm\infty$ or $\#$

Example 7: State the end behavior.

Quadratics degree 2

"Linear" degree 1

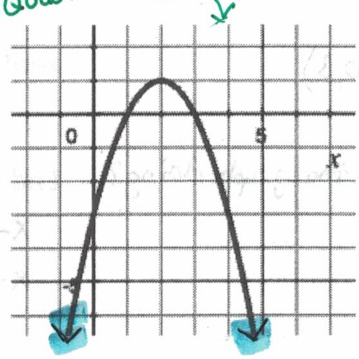
1.



$X \rightarrow -\infty, f(x) \rightarrow \infty$

$x \rightarrow \infty, f(x) \rightarrow \infty$

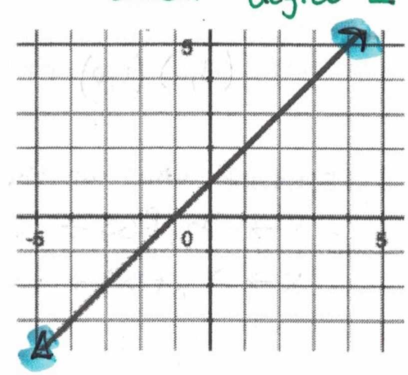
2.



$X \rightarrow -\infty, f(x) \rightarrow -\infty$

$X \rightarrow \infty, f(x) \rightarrow -\infty$

3.



$X \rightarrow -\infty, f(x) \rightarrow -\infty$

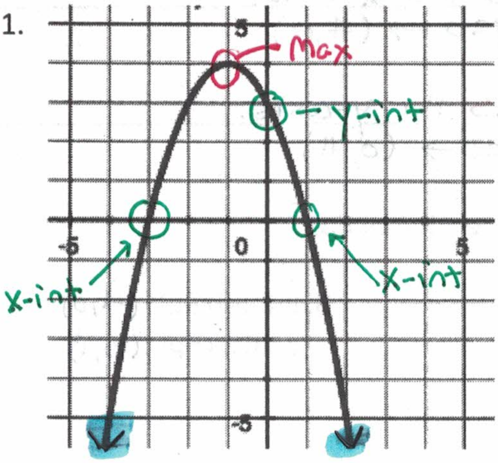
$X \rightarrow \infty, f(x) \rightarrow \infty$

Even Degree functions have end behavior that goes the SAME direction.

ODD Degree functions have end behavior that goes the opposite direction.

Example 8: For the functions below, list all key features.

1.



Domain: $(-\infty, \infty)$ ← "Read left to right" →

Range: $(-\infty, 4]$ ← "Read bottom to top" →

Extrema: Max of 4 at $x = -1$
$(-1, 4)$

Increasing: $(-\infty, -1]$

* Turning points and x-values decide this! *

Decreasing: $[-1, \infty)$

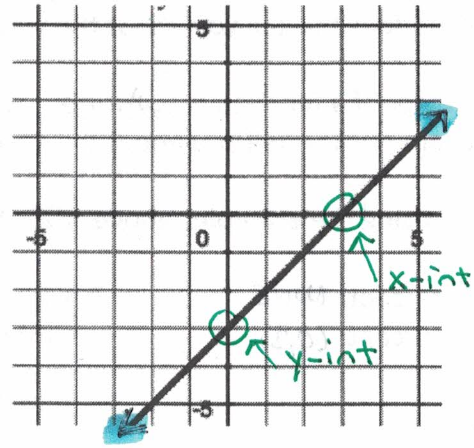
x-intercept: $(-3,0)$ $(1,0)$ y-intercept: $(0,3)$

End Behavior: What are the ends of the graph doing?

$x \to -\infty, f(x) \to -\infty$

$x \to \infty, f(x) \to -\infty$

2.



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

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

Extrema: NONE

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

Decreasing: NONE

x-intercept: $(3,0)$ y-intercept: $(0,-3)$

End Behavior:

$x \to -\infty, f(x) \to -\infty$

$x \to \infty, f(x) \to \infty$