

3.2 Base Functions

Base functions are used as building blocks for more complicated functions. The list of base functions that you are **responsible** for are listed below.

$$f(x) = x$$

$$g(x) = x^2$$

$$q(x) = x^3$$

$$p(x) = 2^x$$

$$r(x) = |x|$$

$$h(x) = \frac{1}{x}$$

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

In this lesson we are going to investigate the properties of these base functions.

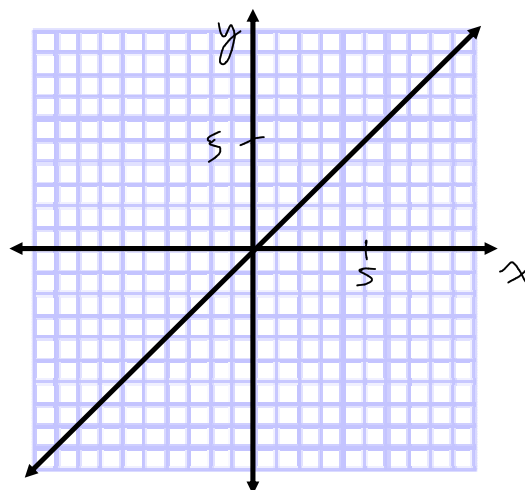
Key properties of the base functions :

| | |
|---|---|
| <p>Domain:</p> <p>Range:</p> <p>Left to Right {</p> <p>Increasing:</p> <p>Decreasing:</p> <p>Asymptotes:</p> <p>y-intercept:</p> <p>Finite Differences:</p> | <p>possible values of x (input)</p> <p>possible values of y (output)</p> <p>intervals in the domain, where y increases as x increases</p> <p>intervals in the domain, where y decreases as x increases.</p> <p>a line that the function approaches but never crosses</p> <p>the point where the relation crosses the y-axis ($x=0$)</p> <p>the difference of the yvalue for consecutive xvalues</p> |
|---|---|

- Recall: ★ first differences Constant? Linear
- ★ second differences Constant? Quadratic
- ★ third differences Constant? Cubic

$$y = x$$

Linear Function



Domain: $\{x \in \mathbb{R}\}$
 Range: $\{y \in \mathbb{R}\}$
 Increasing: $\{x \in \mathbb{R}\}$
 Decreasing: never

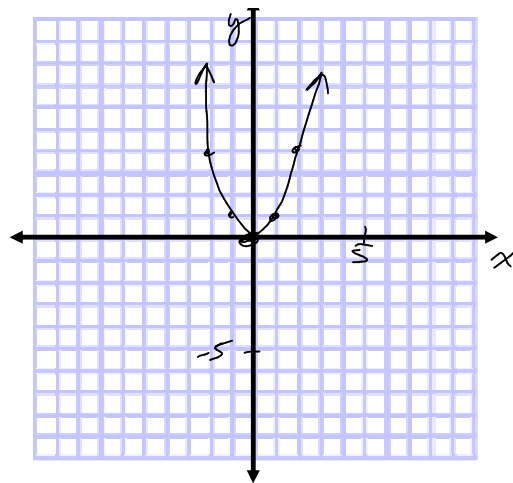
Asymptotes: none
 y-intercept: 0
 Finite Differences:

| x | y | | |
|----|----|---|---|
| -1 | -1 | > | 1 |
| 0 | 0 | > | 1 |
| 1 | 1 | > | 1 |
| 2 | 2 | > | 1 |
| 3 | 3 | > | 1 |

Constant

$$y = x^2$$

Quadratic Function
Parabola



Domain: $\{x \in \mathbb{R}\}$
 Range: $\{y \in \mathbb{R} / y \geq 0\}$
 Increasing: $x > 0$
 Decreasing: $x < 0$

Don't include
turning point

Asymptotes: None

y-intercept: 0

Finite Differences: Constant 2nd diff of 2

| x | y | 1 st | 2 nd |
|----|---|-----------------|-----------------|
| -2 | 4 | | |
| -1 | 1 | > -3 | |
| 0 | 0 | > -1 | > 2 |
| 1 | 1 | > 1 | > 2 |
| 2 | 4 | > 3 | > 2 |

↑
Constant

∴ Quad.

$$y = \sqrt{x}$$

Root Function

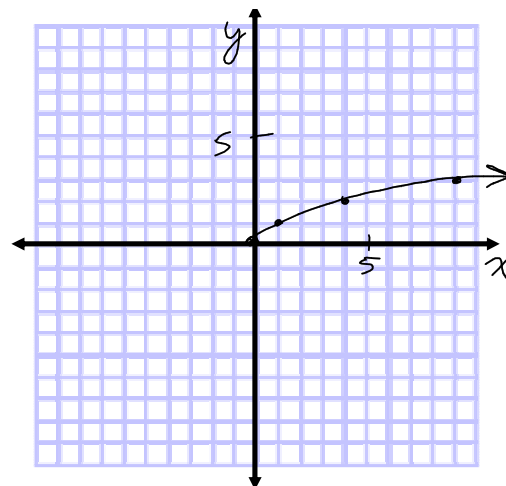
| x | y |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 4 | 2 |
| 9 | 3 |

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

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

Increasing: $x \geq 0$

Decreasing: never



Asymptotes: none

y-intercept: 0

Finite Differences:

$$y = 2^x$$

Exponential Function

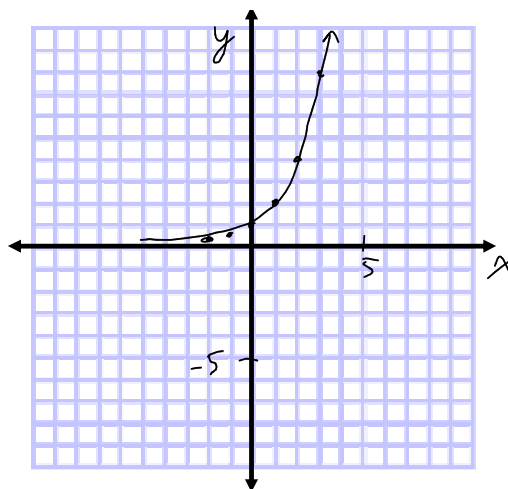
| x | y |
|----|---------------|
| -2 | $\frac{1}{4}$ |
| -1 | $\frac{1}{2}$ |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |
| 3 | 8 |

Domain: $\{x \in \mathbb{R}\}$

Range: $\{y \in \mathbb{R} \mid y > 0\}$

Increasing: $\{x \in \mathbb{R}\}$

Decreasing: never



Asymptotes: horz. @ $y=0$

y-intercept: 1

Finite Differences:

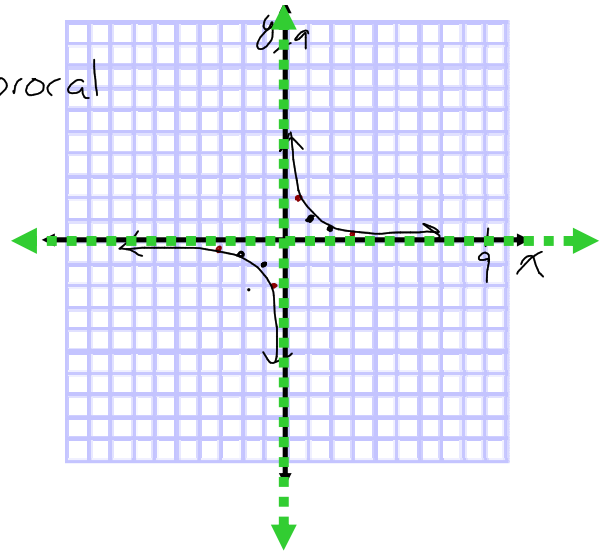
Common ratio of 2

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

Rational / Reciprocal Function

| x | y |
|----|----------------|
| -2 | $-\frac{1}{2}$ |
| -1 | -1 |
| 0 | Undef. |
| 1 | 1 |
| 2 | $\frac{1}{2}$ |

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



Domain: $\{x \in \mathbb{R} \mid x \neq 0\}$

Range: $\{y \in \mathbb{R} \mid y \neq 0\}$

Increasing: never

Decreasing: $\{x \in \mathbb{R} \mid x \neq 0\}$

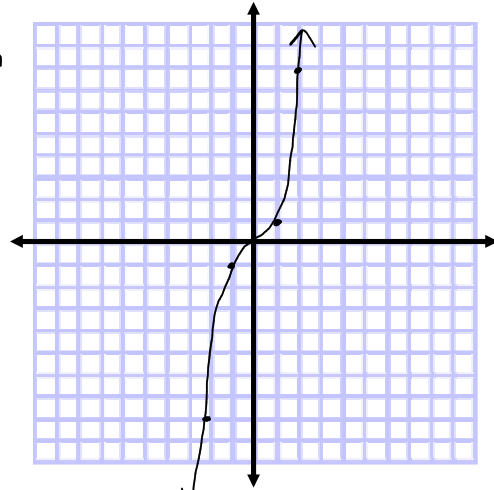
Asymptotes: Horiz @ $y=0$
Vert. @ $x=0$

y-intercept: none

Finite Differences:

$y = x^3$ Cubic Function

| x | y | <u>1st</u> | <u>2nd</u> | <u>3rd</u> |
|-----|-----|-----------------------|-----------------------|-----------------------|
| -3 | -27 | | | |
| -2 | -8 | > 19 | > -12 | > 6 |
| -1 | -1 | > 7 | > -6 | > 6 |
| 0 | 0 | > 1 | > 0 | > 6 |
| 1 | 1 | > 1 | > 0 | > 6 |
| 2 | 8 | > 7 | > 6 | > 6 |
| 3 | 27 | > 19 | > 12 | > 6 |



Domain: $\{x \in \mathbb{R}\}$
 Range: $\{y \in \mathbb{R}\}$
 Increasing: $\{x \in \mathbb{R}\}$
 Decreasing: never

Asymptotes: none

y-intercept: 0

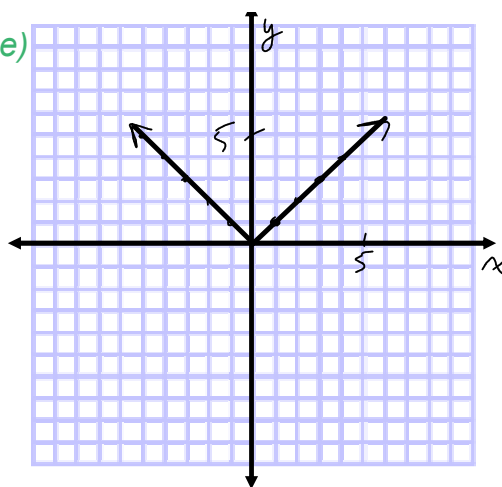
Finite Differences: Constant 3rd Diff = 6

\therefore Cubic

$$y = |x|$$

absolute value (take positive value)

| x | y |
|----|---|
| -3 | 3 |
| -2 | 2 |
| -1 | 1 |
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |



Domain: $\{x \in \mathbb{R}\}$

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

Increasing: $x > 0$

Decreasing: $x < 0$

Asymptotes: none

y-intercept: 0

Finite Differences: 1st Diff.

$$x < 0 = -1$$

$$x > 0 = 1$$

Homework

****Memorize Base Functions****

use Desmos to explore transformations

& take-home QUIZ

