# Algebra 2

## Unit 1: Characteristics of Functions

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Welcome to Algebra 2!

If you Practice, you will be Successful.

So ... do your Practice Problems!

Ms. Forbes
**Graphing Calculator Keystrokes**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Keystrokes</th>
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<tr>
<td>Reset the Memory</td>
<td><code>2^{nd}</code>, +, 7, 1, 2</td>
</tr>
<tr>
<td>Get back to the Home Screen</td>
<td><code>2^{nd}</code>, MODE</td>
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<td>Enter an equation</td>
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<tr>
<td>See the graph</td>
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<tr>
<td>Table of Values (X/Y Chart)</td>
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</tr>
<tr>
<td>Fraction Boxes</td>
<td><code>ALPHA, Y =</code>, ENTER</td>
</tr>
<tr>
<td>Decimal to Fraction</td>
<td><code>MATH</code>, ENTER, ENTER</td>
</tr>
<tr>
<td>Decimal to Mixed Number (ex: 1 ( \frac{3}{4} ))</td>
<td><code>ALPHA, Y=</code>, (option) 3</td>
</tr>
<tr>
<td>Standard Graphing Window</td>
<td><code>ZOOM, 6</code></td>
</tr>
<tr>
<td>Maximum / Minimum</td>
<td><code>2^{nd}</code>, TRACE</td>
</tr>
</tbody>
</table>
Characteristics of Functions

Functions, Domain, and Range

Key Words
Domain / Range
Element
Set / Interval Notation
Soft / Hard bracket
Function
Continuous / Discontinuous
Relation
Inverse
Vertical Line Test

What is a function?
A function relates an input (x-value) to an output (y-value).

What is a relation?
A set of ordered pairs, or (x, y) pairs.

Vertical Line Test: why does it work?
In order to make predictions using your function, every input can only have one output.

Think about it this way:

Ms. Forbes
### Domain
- Describes the **x**-values.
- Read it from **left** to **right**.

Determine the domain of the function from the graph.

| Set notation \{ \} | \{x | -4 ≤ x < ∞\} |
|----------------------|------------------|
| Interval notation \[\] and ( ) | \([-4, ∞)\) or ∞ |

( ) Soft Brackets mean ... either the point is not included or ∞

[ ] Hard Brackets mean ... the point IS included (closed circle or endpoint)

### Range
- Describes the **y**-values.
- Read it from **bottom** to **top**.

Determine the range of the function from the graph.

| Set notation \{ \} | \{y | -1 ≤ y ≤ 1\} |
|----------------------|------------------|
| Interval notation \[\] and ( ) | \([-1, 1]\) |

( ) Soft Brackets mean ... < or >

[ ] Hard Brackets mean ... ≤ or ≥
Characteristics of Functions

Domain: \(-2, \infty\)
Range: \([0, 4]\)

L \rightarrow R

Domain: \([-2, 6]\)
Range: \([0, 4]\)

L \rightarrow R

Domain: \((-\infty, \infty)\)
Range: \((-\infty, 4]\)

B \rightarrow T

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

Discontinuity

Domain (L \rightarrow R)

\([-4, 4]\)

Range (B \rightarrow T)

\([-2, 4] \text{ except } \pm 2 \text{ and } 0, 2\]

\([-2, 0] \leq [2, 4] \leq [0, 4]

\{y | -2 \leq y \leq 0 \text{ and } 2 \leq y \leq 4\}

\(f(x) = \frac{3}{x-2}\)

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Step Function

**Domain (L - R):**

\([-3, 3]\]

\(\{x | -3 \leq x \leq 3\}\)

**Range (B - T):**

Have to set \(\{\}\) \(\{\}\)

\(y \in \{-3, -2, -1, 0, 1, 2, 3\}\)

\((-2, -2.999)\)

---

**What is the domain of this function?**

**What is the range of this function?**

**D: left to right**

\([-9, 1]\]

**R: bottom to top**

\([1, \infty]\)

Each graph has various ways that it can end.
What is the domain of this function?
What is the range of this function?

This one goes on forever

D: \((-\infty, \infty)\) or TR
R: \((-\infty, \infty)\) or TR

What is the domain of this function?
What is the range of this function?

They can be continuous and smooth.

D: \((-\infty, \infty)\) or TR
R: TR
**Characteristics of Functions**

**What is the domain of this function?**

- Domain: \( \mathbb{R}, x \neq -2 \)

**What is the range of this function?**

- Range: \( \mathbb{R}, y \neq 1 \)

- This hole means an input of 2 for \( x \) would create an undefined equation (denom of zero).

**What is the domain of this function?**

- Domain: \([0, 12]\)

**What is the range of this function?**

- Range: \(\{0, 1, 2, 3, 4, 5\}\)

- Or they can be discontinuous.

**They can look like steps.**

- It may help to list the points to find the range.

- \( (0, 0), (1, 1), (2, 2), (3, 3), (4, 4), (5, 5) \)
**Characteristics of Functions**

What is the domain of this function?
What is the range of this function?

D: \( L \rightarrow R \)
\((-9, 9)\)
R: \( B \uparrow T \)
\((-4, 5)\)

What is the domain of this function?
What is the range of this function?

D: \( \{ -8, -7, -4, -2, 2 \} \)
R: \( \{ 1, 2, 2, 3, 3 \} \)

**Hint:** Label the points to get x and y values for domain and range.
Determine if each graph is or is not a function.

*If it is not, draw in the vertical line where the graph fails to be a function.*
State the domain and range for the following functions.

<table>
<thead>
<tr>
<th>Function</th>
<th>Domain in interval notation</th>
<th>Domain in set notation</th>
<th>Range in interval notation</th>
<th>Range in set notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Image 1]</td>
<td>$[-6, 6]$</td>
<td>${x \mid -6 \leq x \leq 6}$</td>
<td>$[0, 6]$</td>
<td>${y \mid 0 \leq y \leq 6}$</td>
</tr>
<tr>
<td>[Image 2]</td>
<td>$[-4, 2]$</td>
<td>${x \mid -4 \leq x \leq 2}$</td>
<td>$[-2, 4]$</td>
<td>${y \mid -2 \leq y \leq 4}$</td>
</tr>
<tr>
<td>[Image 3]</td>
<td>$(-\infty, \infty)$</td>
<td>$\mathbb{R}$</td>
<td>$[0, \infty)$</td>
<td>${y \mid y \geq 0}$</td>
</tr>
</tbody>
</table>

Continued on next page
State the domain and range for the following functions.

<table>
<thead>
<tr>
<th>Domain in interval notation:</th>
<th>Domain in interval notation:</th>
<th>Domain in interval notation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(-\infty, \infty)$</td>
<td>$R$</td>
<td>$(-\infty, \infty)$</td>
</tr>
<tr>
<td>$\mathbb{R}$</td>
<td>$R$</td>
<td>$\mathbb{R}$</td>
</tr>
<tr>
<td>Range in interval notation:</td>
<td>Range in interval notation:</td>
<td>Range in interval notation:</td>
</tr>
<tr>
<td>$(-\infty, \infty)$</td>
<td>$R$</td>
<td>$(0, \infty)$</td>
</tr>
<tr>
<td>$\mathbb{R}$</td>
<td>$R$</td>
<td>${y</td>
</tr>
<tr>
<td>Range in set notation:</td>
<td>Range in set notation:</td>
<td>Range in set notation:</td>
</tr>
<tr>
<td>$\mathbb{R}$</td>
<td>$\mathbb{R}$</td>
<td>${y</td>
</tr>
</tbody>
</table>

$\mathbb{R}$
Characteristics of Functions

**Algebra 2 Notes**

**Intercepts, Function Notation, and Inverses**

**Key Words**

- **Intercepts**
- **Solutions**
- **Zeros**
- **Roots**
- **Function Notation:** \( f(x) = y \)
- **Y-intercept** \((b)\)
- **Slope** \((m)\)

List any differences you see between the two functions:

<table>
<thead>
<tr>
<th>( y = -2x + 3 ) ( {x \mid -3 &lt; x &lt; 4} )</th>
<th>( y = \frac{2}{3}x - 1 ) ( {y \mid -3 &lt; y &lt; 4} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slope:</strong> (-2)</td>
<td><strong>Slope:</strong> ( m = \frac{2}{3} )</td>
</tr>
<tr>
<td><strong>B-intercept:</strong> (3) <strong>decreasing</strong></td>
<td><strong>Intercept:</strong> ( b = -1 ) <strong>increasing</strong></td>
</tr>
<tr>
<td>Limits on domain &quot;cut off&quot; graph (L-R)</td>
<td>Limits on range &quot;cut off&quot; graph bottom to top</td>
</tr>
</tbody>
</table>

Sketch the graphs:

- \(-2x + 3\)
- \(\frac{2}{3}x - 1\)
Intercepts/Zeros/Roots/Solutions

- **X-intercepts**: Points where the graph intercepts/crosses the x-axis
  → Value of x where y = 0

  \[ f(x) = -x^5 + x^4 \ldots + 0.75 \]

- **Y-intercept**: Where the graph crosses the y-axis
  → Where x = 0

\[ f(x) = -x + 3 \]

- **Y-intercept**: (0, 3)
- **X-intercept**: (3, 0)
Remember Function Notation?

\[ f(x) = y \]

We read this as "\( f \) of \( x \) equals \( y \)."

It is the same as: \( y = \) ______

And, the \( x \) and \( y \) represent an ordered pair \( (x, y) \).

Think of it this way: The function \( f \) of putting in a value for \( x \) is to get a value for \( y \).
Use the graph below to find the indicated value.

Remember:
\[ f(x) = y \]
...the x- and y-values are the (x, y) point.

Function notation
\[ f(x) = y \]

- \( f(2) = 0 \)
- \( f(-9) = 0 \)
- \( f(-7) = \frac{5}{4} \)
- \( f(-2) = 1 \)
- \( f(0) = 0 \)
- \( f(4) = -2 \)
- \( f(8) = -1 \)
- \( f(11) \)
Without the graph, the given x-value determines which function to use to find the correct output.

\[
\begin{align*}
y &= \begin{cases} 
2x + 3, & \text{when } x < 4 \\
3, & \text{when } x = 4 \\
-x, & \text{when } x > 4 
\end{cases} \\
y &= \begin{cases} 
6, & \text{when } x < 5 \\
-x + 1, & \text{when } x \geq 5 
\end{cases} \\
y &= \begin{cases} 
3x - 1, & \text{when } x \leq 0 \\
x, & \text{when } 0 < x \leq 3 \\
x + 1, & \text{when } x > 3 
\end{cases}
\]

\[
\begin{align*}
x &= -1 \\
f(-2) &= \frac{5}{2} \Rightarrow 2(-2) + 3 = -1 \\
f(0) &= -3 \\
f(4) &= 3 \\
f(5) &= -5 \\
f(x) &= y \\
f(-2) &= 0 \\
f(0) &= 6 \\
f(4) &= 6 \\
f(5) &= -4 \\
f(-2) &= \frac{-7}{3} \\
f(0) &= \frac{-1}{3} \\
f(1) &= 1 \\
f(3) &= 3 \\
-x+1 &= 5 \\
-x &= 4 \\
x &= -4 \\
-x+1 &= -4 \\
-x &= -5 \\
x &= 5 \\
-x+1 &= 6 \\
-x &= 5 \\
x &= -5 \\
-x+1 &= 7 \\
-x &= 6 \\
x &= -6
\end{align*}
\]
Characteristics of Functions

- Find the Inverse given \( a(n) \) ...

Inverse of a Function

\[ f^{-1}(x) \quad \text{"f inverse of } x \text{"} \]

Table

\[
\begin{array}{c|c|c|c|c}
X & 1 & 2 & 3 & 4 \\
Y & 1 & 9 & 6 & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c}
X & 1 & 9 & 6 & 7 \\
Y & 1 & 2 & 3 & 4 \\
\end{array}
\]

Ordered Pair

\[
\begin{array}{c|c}
(2, 3) & (3, 2) \\
(8, 4) & (4, 8) \\
(-9, 0) & (9, -9) \\
(-4, -2) & (-2, -4) \\
\end{array}
\]

Function Notation

\[
f(x) = y \quad f^{-1}(y) = x
\]

| \( f(3) = 2 \) | \( f^{-1}(2) = 3 \) |
| \( f(-6) = 7 \) | \( f^{-1}(-6) = -6 \) |
| \( f(4) = 4 \) | \( f^{-1}(4) = 4 \) |
| \( f(-5) = 9 \) | \( f^{-1}(-5) = -5 \) |
| \( f(324) = \frac{12}{59} \) | \( f^{-1}\left(\frac{12}{59}\right) = 324 \) |
| \( f(0.73) = -8.91 \) | \( f^{-1}(-8.91) = 0.73 \) |

Graph

Make an \( x - y \) chart and flip the points.

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Characteristics of Functions

Graph the inverse in 3 steps:

1. Pick the points
   2. Flip the points
   3. Plot new coordinate pairs

Graph the inverse
### Characteristics of Functions

---

**Practice Problems 1.2**

**Intercepts, Function Notation, and Inverses**

<table>
<thead>
<tr>
<th>Given $f(x)$:</th>
<th>Given $g(x)$:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x) = y$</td>
<td>$g(x)$</td>
</tr>
<tr>
<td>$x = -1, y = ?$</td>
<td>$x = -1, y = ?$</td>
</tr>
<tr>
<td>$f(-1) = y$</td>
<td>$g(-1) = 2$</td>
</tr>
<tr>
<td>For what value(s) of $x$ does $f(x) = 3$? $x = 1$</td>
<td>For what value(s) of $x$ does $g(x) = -4$? $x = 4$</td>
</tr>
<tr>
<td>$y = 3, x = ?$</td>
<td>$f(1) = 3$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Given $h(x)$:</th>
<th>Given $g(x)$:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h(x) = y$</td>
<td>$g(x)$</td>
</tr>
<tr>
<td>$y = ?$</td>
<td>$x = 0, y = ?$</td>
</tr>
<tr>
<td>$h(2) = 2$</td>
<td>$g(0) = 15$</td>
</tr>
<tr>
<td>$y = 2$</td>
<td></td>
</tr>
<tr>
<td>For what value(s) of $x$ does $h(x) = 4$? $x = 4$</td>
<td>For what value(s) of $x$ does $g(x) = -10$? $x = 10, 20$</td>
</tr>
<tr>
<td>$y = 4, x = ?$</td>
<td>$h(4) = 4$</td>
</tr>
</tbody>
</table>

*Ms. Forbes*
Use the graph to find the information for each function.

**Given \( f(x) \):**

Find \( f(2) \):
\[ f(2) = 3 \]

For what value(s) does \( f(x) = -3 \)?
\[ y = -3, \quad x = ? \quad x = 7 \]

What is the domain of \( f(x) \)?
\[-\infty, \infty \] or \( TR \)

What is the range of \( f(x) \)?
\( TR \)

Find the y-intercept(s):
- **Point** \((0, 7)\)

Find the x-intercept(s):
- **Point** \((0, 0)\)

What are the zeros of the function?
\[ f(x) = 0, \quad x = 6 \]

---

**Given \( g(x) \):**

Find \( g(-1) \):
\[ g(-1) = 0 \]

For what value(s) does \( g(x) = 3 \)?
\[ x? \quad y = 3 \quad x = -4, 6 \]

What is the domain of \( g(x) \)?
\([-4, 6]\)

What is the range of \( g(x) \)?
\([-2, 3]\)

Find the y-intercept(s):
- \((0, 0)\)

Find the x-intercept(s):
- \((-1, 0)\) \((3, 0)\)

What are the zeros of the function?
\[ x = -1, 3 \]

Solutions?
\[ x = -1, 3 \]
Use the graph to find the information for each function.

\[
\begin{align*}
\text{h}(x) &= y \\
\text{x} &= 2, \text{y} = 0 \\
\text{y} &= 10 \\
\end{align*}
\]

For what value(s) does \( h(x) = 0 \)?
\[
\begin{align*}
x &= ? \\
y &= 0 \\
x &= -10, 5, 25
\end{align*}
\]

What is the domain of \( h(x) \)?
\([-10, 30]\)

What is the range of \( h(x) \)?
\([-15, 25]\)

Find the \( y \)-intercept(s):
\((0, 15)\)

Find the \( x \)-intercept(s):
\((-10, 0), (5, 0), (25, 0)\)

What are the zeros of the function?
\(x = -10, 5, 25\)

Find the inverse of the relation. Graph both the original and its inverse. Label your graph appropriately.

\[
\begin{array}{c|c|c|c|c|c}
\text{x} & -2 & -1 & 0 & 1 & 2 \\
\hline
\text{y} & -4 & 3 & 4 & 5 & 12 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c|c|c}
\text{x} & -4 & 3 & 4 & 5 & 12 \\
\hline
\text{y} & -2 & -1 & 0 & 1 & 2 \\
\end{array}
\]
**End Behavior, Intervals, & Maximums / Minimums**

**Key Words**
- Maximum / Minimum
- Even / Odd Function
- End Behavior
- Leading Coefficient
- Points of Inflection
- Increasing / Decreasing Intervals
- Asymptote
- Properties of Real Numbers

**End Behavior**
The end behavior of a function is the behavior of the graph \( f(x) \) as \( x \) approaches positive or negative infinity. By looking at the end behavior of the function, we can determine if the function is even or odd (degree) and if the leading coefficient is positive or negative.

\[ \begin{align*}
\text{odd} & \quad x^n = n \text{ is an odd} \\
& \quad \rightarrow \text{negative} \\
& \quad \rightarrow \text{leading coefficient} = -TR
dromary\n
\text{even} & \quad x^n = n \text{ is an even} \\
& \quad \rightarrow \text{positive} \\
& \quad \rightarrow \text{leading coefficient} = +TR
\end{align*} \]

**Intervals**
Graphs may increase or decrease. We call these sections interval. We always describe the increasing or decreasing intervals using ONLY the \( x \)-values, or the domain.
Characteristics of Functions

State the end behavior
Label local max and min
State the intervals of increase and decrease

Increasing
\([-\infty, -7]\]
\([-7, -1.5]\]
\([-1.5, 5]\]
\([5, \infty]\)

Decreasing

\((-, +)\)

\((-\infty, -\infty)\)

\((-1.5, -3.25)\)

\((-1.5, 3.25)\)

\((5, 3)\)

\((+, -)\)

State the end behavior
Label local max and min
State the intervals of increase and decrease

\([-\infty, -15]\]
\([-15, -11.5]\]
\([-11.5, -8]\]
\([-8, -3.5]\]
\([-3.5, \infty]\)

\([x, \infty]\]

\((+, +)\)

\((\infty, \infty)\)

\((\infty, \infty)\)

\((-\infty, -\infty)\)

\((-\infty, -\infty)\)

EVEN POSITIVE

INCR

\\(-15, -11.5]
[\(-11.5, -8]\)
[\(-8, -3.5]\)
[\(-3.5, \infty]\)

DECRR

INCR

\([-15, -11.5]\)
[\(-11.5, -8]\)
[\(-8, -3.5]\)
[\(-3.5, \infty]\)

\([-\infty, -\infty]\)

\([-\infty, -\infty]\)

\([x, \infty]\)

\([x, \infty]\)

\((+, +)\)

\((+, +)\)

\((x, \infty)\)

\((x, \infty)\)

\((y, \infty)\)

\((y, \infty)\)

\((x, \infty)\)

\((x, \infty)\)

\((y, \infty)\)

\((y, \infty)\)

\(x \rightarrow -\infty\)

\(y \rightarrow \infty\)

\(x \rightarrow \infty\)

\(y \rightarrow \infty\)
Complete the table for each graph.

<table>
<thead>
<tr>
<th>Label the Local Max and Min (if there is one)</th>
<th>Label the Local Max and Min (if there is one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinates for max/min: (1, 4) (3, 0)</td>
<td>Coordinates for max/min: (1.5, -1.5) (-2, -5) (2.5, -1.75)</td>
</tr>
<tr>
<td>Increasing interval(s): (-\infty, 1] [3, \infty)</td>
<td>Increasing interval(s): [-2, -5] [2.5, \infty)</td>
</tr>
<tr>
<td>Decreasing interval(s): [1, 3]</td>
<td>Decreasing interval(s): (-\infty, -2] [4.5, 1.25]</td>
</tr>
<tr>
<td>End Behavior: (x \to \infty ) (f(x) \to \infty)</td>
<td>End Behavior: (x \to \infty ) (f(x) \to \infty)</td>
</tr>
<tr>
<td>Leading coefficient: Positive / Negative</td>
<td>Leading coefficient: Positive / Negative</td>
</tr>
<tr>
<td>Function: Even / Odd / Neither</td>
<td>Function: Even / Odd / Neither</td>
</tr>
</tbody>
</table>

Keep going!

\[f(x) = x^n, \quad n = \text{even} \neq\]
Complete the table for each graph.

<table>
<thead>
<tr>
<th>Coordinates for max/min:</th>
<th>Coordinates for max/min:</th>
</tr>
</thead>
<tbody>
<tr>
<td>((-3, 4)) ((1.5, -3))</td>
<td>((0, 4)) ((-1.5, -4))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Increasing interval(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>((-\infty, -3]) ([0, 1.5])</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decreasing interval(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>([-3, 0]) ([1.5, \infty))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End Behavior:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x \to \infty) (f(x) \to -\infty)</td>
</tr>
<tr>
<td>(x \to -\infty) (f(x) \to -\infty)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leading coefficient: Positive/ Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
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<table>
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<th>Function: Even/Odd/Neither</th>
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<th>End Behavior:</th>
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<tbody>
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<td>(x \to \infty) (f(x) \to -\infty)</td>
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<tr>
<td>(x \to -\infty) (f(x) \to \infty)</td>
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<table>
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### Characteristics of Functions

**Glossary of Key Terms**

These are the Key Terms, Phrases, and/or Concepts in this unit. You may choose to write definitions or explanations here to help you study; however, it is not required.

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