10.1 Graph \( y = ax^2 + c \)

**Introduction to the Parent Quadratic Function (Q.F.)**

- Graph \( y = x^2 \) with the domain -2, -1, 0, 1, 2
- Create table and plot the graph

\[
egin{array}{c|c|c}
 x & y & \text{mentally} \\
-2 & 4 & (2)^2 \\
-1 & 1 & (-1)^2 \\
0 & 0 & 0^2 \\
1 & 1 & 1^2 \\
2 & 4 & 2^2 \\
\end{array}
\]

Add \( \rightarrow \) 3 \( \rightarrow \) 9

**Parent Quadratic Function**

The most basic quadratic function in the family of quadratic functions, called the **Parent function**.

The equation is:

\[
y = x^2 \quad \text{or} \quad f(x) = x^2
\]

The lowest or highest point on the parabola is the **vertex**. It is a point with the coordinates \((x, y)\).

The vertex of the graph of \( y = x^2 \) is: \((0, 0)\)

The line that passes through the vertex and divides the parabola into two symmetric parts is called the **axis of symmetry (A.S.)**. It is a vertical line.

Since there is no \( b \) term, the A.S. is the \( y \) axis with the equation: \( x = 0 \)

**The \( x \)-intercept(s) are** \((0, 0)\) \((x, 0)\)

**The \( y \)-intercept is** \((0, 0)\) \((0, y)\)
VOCABULARY

1. **Degree:** THE HIGHEST EXPONENT FOR EQUATIONS WITH 1 VARIABLE.
   - Quadratic Functions always have a degree of 2.

2. **Standard Form of a Quadratic Equation:** \[Ax^2 + Bx + C = 0\]
   where \(A, B, C\) are real numbers \(A \neq 0\).

3. **Parabola:** IS A U-SHAPE GRAPH AND THIS IS THE SHAPE OF ALL QUADRATIC EQUATIONS.

4. **Shape Quadratic Equation:** IS BASED ON THE "A" COEFFICIENT
   
   \[+A\]
   
   \[-A\]

5. **Y-intercept:** IS BASED ON THE CONSTANT TERM "C"
   
   \(y\)-intercept is a point \((0, C)\)

6. **Vertex:** IS THE HIGHEST OR LOWEST POINT ON THE PARABOLA \((x, y)\)

7. **Axis of Symmetry:** IS A VERTICAL LINE THAT PASSES THROUGH THE VERTEX AND DIVIDES THE PARABOLA INTO 2 SYMMETRIC HALVES.
   
   \(\text{The equation of the line is: } A.S. : x = -\frac{B}{2A}\)

   \(\text{When the } B\text{-term is missing, the } A.S. \text{ is the } y\text{-axis } x=0\)

8. **X-intercepts:** ARE THE POINTS THAT CROSS THE X-AXIS \((x, 0)\)

\[\text{X-intercepts = solutions = zeros = roots}\]
Graph $y = ax^2$ where $|a| < 1$

Step 1: Make a table of values for $y = \frac{1}{2}x^2$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>-4</th>
<th>2</th>
<th>0</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

**State and Label:**
- Shape: opens up b/c $a = \frac{1}{2}$
- Y-intercept: $(0,0)$ b/c $c = 0$
- Vertex: $(0,0)$ b/c lowest point
- A.S.: $x = 0$ b/c $b = 0$
- X-intercepts: $(0,0)$

**Checkpoint** Graph the function.

1. $y = -\frac{1}{4}x^2$ with domain: $-8, -4, 0, 4, 8$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>-8</th>
<th>-4</th>
<th>0</th>
<th>4</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>-16</td>
<td>-4</td>
<td>0</td>
<td>-4</td>
<td>-16</td>
</tr>
</tbody>
</table>

**State:**
- Shape: open down b/c $a = -\frac{1}{4}$
- Y-intercept: $(0,0)$ b/c $c = 0$
- Vertex: $(0,0)$
- A.S.: $x = 0$
- X-intercepts: $(0,0)$
Example 2: Graph \( y = x^2 + c \)

Graph \( y = x^2 - 2 \).

Step 1: Make a table of values for \( y = x^2 - 2 \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>2</td>
<td>-1</td>
<td>-2</td>
<td>-1</td>
<td>2</td>
</tr>
</tbody>
</table>

**State and label:**
- **Shape:** Opens up \( b/c \) \( A = 1 \)
- **Y-intercept:** \((0, -2)\) \( b/c \) \( C = -2 \)
- **Vertex:** \((0, -2)\)
- **A.S.:** \( x = 0 \)
- **X-intercepts:** \((-1, 0), (1, 0)\)

**Tip:** To set up a table to graph a Q.F., you need 5 points. When \( A \) is NOT a fraction, set up table below.

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Example 3: Graph \( y = ax^2 + c \)

Graph \( y = -3x^2 + 3 \).

Step 1: Make a table of values for \( y = -3x^2 + 3 \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>-9</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>-9</td>
</tr>
</tbody>
</table>

**State and label:**
- **Shape:** Opens down \( b/c \) \( A = -3 \)
- **Y-intercept:** \((0, 3)\) \( b/c \) \( C = 3 \)
- **Vertex:** \((0, 3)\)
- **A.S.:** \( x = 0 \)
- **X-intercepts:** \((-1, 0), (1, 0)\)

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**Solve:**

\[-3x^2 + 3 = 0\]

Factor:

\[-3(x^2 - 1) = 0\]

\[-3(x+1)(x-1) = 0\]

**X-intercepts:** \(-1, 1\)

**Notice these solutions are the X-intercepts**