**Quadratic Functions in Standard Form**

A **quadratic function** is a function that is a degree 2 polynomial.

Ex : $f\left(x\right)=3x^{2}-5x+1$
 $g\left(x\right)=-\frac{1}{2}x^{2}+5$

**I – The Reference quadratic function :** $y=x^{2}$

Table of values :

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

Graph :



Axis of symmetry : $x=0$

Vertex : $(0,0)$

Opening upwards

Domain : $\{x\in R\}$

Range : $\{y\in R, y\geq 0\}$

This type of graph is called a **PARABOLA**.

**II – Quadratic Functions in Standard Form :** $y=ax^{2}+bx+c$

Ex : $y=3x^{2}+x-6$ 🡪 $a=$ , $b= $, $c=$

 $y=-x^{2}+x+6$ 🡪 $a= $, $b= $, $c=$

The graph of any quadratic function is a **parabola** which can open upwards or downwards:

To graph a quadratic function, you need to determine the coordinates of its vertex, the direction of opening and the “speed” of its opening (or “width of opening”).

* **Direction of opening** : The sign of coefficient *a* tells us if the parabola opens upwards or downwards.
* **Coordinates of the vertex** : The calculation $\frac{-b}{2a}$ gives the *x-*coordinate of the vertex $\left(\frac{-b}{2a}, \right)$
Then, you just need to replace *x* by that value to find the corresponding *y* value.

Example : $y=x^{2}-4x+2$

**Note** : The *y*-intercept is the value of *y* when $x=0$.

 In Standard form, it always is the value of coefficient $c$.
 Ex : for $y=x^{2}-4x+2$ the *y*-intercept is 2.

To finish graphing the parabola, you can either create a table of values (by hand of with a graphing calculator) or use the reference function.

Example 1 : Using a table of values.

$y=x^{2}-4x+2$

We already figured out that the parabola opens upwards, that its vertex is $(2,-2)$ and its *y*-intercept is 2.

We also know that parabolas have a vertical axis of symmetry that goes through the vertex (here $x=2)$. Therefore, if we can find some points on one side of the vertex, we can position the “same” points on the other side easily. We will fill a table of values with *x* values only on one side of the vertex…

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *x* | 2 | 3 | 4 | 5 |
| *y* | -2 |  |  |  |

Domain :

Range :



We can notice that the parabola opens at the same “speed” as the reference function … that’s because they have the same $a$ coefficient.

Your turn : $y=2x^{2}+6x-1$

Example 2 : Using the « speed of opening » of the reference function.

$y=3x^{2}-12x+5$

Opening

Vertex :

Opening 3 times faster than the reference function



Domain :

Range :

Your turn : $y=-x^{2}+4x+5$

**Note** : In « real life » situations, domain might have to be restricted for all values to make sense…

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