MBF3C: Mathematics of Personal Finance Day 3: Quadratic Relation $y=a x^{2}$

Date:
Unit 4: Quadratics I

A parabola in standard position.

| $x$ | $y=x^{2}$ | $(x, y)$ |
| :---: | :--- | :--- |
| -4 | $=(-4)^{2}=16$ | $(-4,16)$ |
| -3 | $=(-3)^{2}=9$ | $(-3,9)$ |
| -2 | $=(-2)^{2}=4$ | $(-2,4)$ |
| -1 | $=(-1)^{2}=1$ | $(-1,1)$ |
| 0 | $=(0)^{2}=0$ | $(0,0)$ |
| 1 | $=(1)^{2}=1$ | $(1,1)$ |
| 2 | $=(2)^{2}=4$ | $(2,4)$ |
| 3 | $=(3)^{2}=9$ | $(3,9)$ |
| 4 | $=(4)^{2}=16$ | $(4,16)$ |

## INVESTIGATION 1



Graphing $y=a x^{2}$, when ' $\mathbf{a}$ ' is positive
Complete each table of values. Use a different colour to sketch a graph of each parabola on the axes above.o. 5

| $y=\left(\frac{1}{2}\right) x^{2}=0.3 x$ |  |
| :---: | :--- |
| $x$ | $(x, y)$ |
| -4 | $0.5(-4)^{2}=8$ |
| -3 | $0.5(-3)^{2}=4.5$ |
| -2 | $0.5(-2)^{2}=2$ |
| -1 | $0.5(-1)^{2}=0.5$ |
| 0 | $0.5(0)^{2}=0$ |
| 1 | $0.5(1)^{2}=0.5$ |
| 2 | $0.5(2)^{2}=2$ |
| 3 | $0.5(3)^{2}=4.5$ |
| 4 | $0.5(4)^{2}=8$ |


| $y=\frac{1}{4} x^{2}=0.25$ |  |
| :---: | :--- |
| $x$ | $(x, y)$ |
| -4 | $0.25(-4)^{2}=4$ |
| -3 | $0.25(-3)^{2}=2.25$ |
| -2 | $0.25(-2)^{2}=1$ |
| -1 | $0.25(-1)^{2}=0.25$ |
| 0 | $0.25(0)^{2}=0$ |
| 1 | $0.25(1)^{2}=0.25$ |
| 2 | $0.25(2)^{2}=1$ |
| 3 | $0.25(3)^{2}=2.25$ |
| 4 | $0.25(4)^{2}=4$ |


| $y=2 x^{2}$ |  |
| :---: | :--- |
| $x$ | $(x, y)$ |
| -4 | $2(-4)^{2}=32$ |
| -3 | $2(-3)^{2}=18$ |
| -2 | $2(-2)^{2}=8$ |
| -1 | $2(-1)^{2}=2$ |
| 0 | $2(0)^{2}=0$ |
| 1 | $2(1)^{2}=2$ |
| 2 | $2(2)^{2}=8$ |
| 3 | $2(3)^{2}=18$ |
| 4 | $2(4)^{2}=32$ |


| $y=3 x^{2}$ |  |
| :---: | :--- |
| $x$ | $(x, y)$ |
| -4 | $3(-4)^{2}=48$ |
| -3 | $3(-3)^{2}=27$ |
| -2 | $3(-2)^{2}=12$ |
| -1 | $3(-1)^{2}=3$ |
| 0 | $3(0)^{2}=0$ |
| 1 | $3(1)^{2}=3$ |
| 2 | $3(2)^{2}=12$ |
| 3 | $3(3)^{2}=27$ |
| 4 | $3(4)^{2}=48$ |

When ' $\alpha$ ' is positive and $|a|<1$, the parabola opens UP and is vertically compressed When 'a is positive and $|a|>1$, the parabola opens up and is verticolly stretched This type of transformation is called a Vertical compression/stretch

## INVESTIGATION 2

Graphing $y=a x^{2}$, when ' $\mathbf{a}$ ' is negative
Complete the table of values for parabola $y=-x^{2}$

| $x$ | $y=-x^{2}$ | $(x, y)$ |
| :---: | :--- | :--- |
| -4 | $-(-4)^{2}=-16$ | $(-4,-16)$ |
| -3 | $-(-3)^{2}=-9$ | $(-3,-9)$ |
| -2 | $-(-2)^{2}=-4$ | $(-2,-4)$ |
| -1 | $-(-1)^{2}=-1$ | $(-1,-1)$ |
| 0 | $-(0)^{2}=0$ | $(0,0)$ |
| 1 | $-(1)^{2}=-1$ | $(1,-1)$ |
| 2 | $-(2)^{2}=-4$ | $(2,-4)$ |
| 3 | $-(3)^{2}=-9$ | $(3,-9)$ |
| 4 | $-(4)^{2}=-16$ | $(4,-16)$ |



Complete each table of values. Use a different colour to sketch a graph of each parabola on the axes above.


When ' $a$ ' is negative and $|a|<1$, the parabola opens down and is compressed When ' $a$ ' is negative and $|a|>1$, the parabola opens dow $\cap$ and is stretched When ' $a$ ' is negative, this type of transformation is called a reflection in the $x$-axis (oflip)

## Quadratic $y=\mathbf{a} x^{2}$ Practice

1. In each picture, the graph of $y=x^{2}$ is shown as a dotted parabola (standard position).

The solid parabola is the graph of a quadratic relation of the form $y=a x^{2}$.
For each solid parabola, is the value of $a$ :

- less than -1
- between -1 and 0
- between 0 and 1
- greater than 1?

Explain your answer.

$a$ is between
-1 and $-1 k 0$
b/c graph io
compressed
and flipped
2. On the same axis graph the following functions:

| (1) | $y=2 x^{2}$ |
| :--- | :--- |
| -2 | $2(-2)^{2}=8$ |
| -1 | $2(-1)^{2}=2$ |
| 0 | 0 |
| 1 | $2(1)^{2}=2$ |
| 2 | $2(2)^{2}=8$ |


| (2) | $y=3 x^{2}$ |
| :--- | :--- |
| -2 | $3(-2)^{2}=12$ |
| -1 | $3(-1)^{2}=3$ |
| 0 | 0 |
| 1 | $3(1)^{2}=3$ |
| 2 | $3(2)^{2}=12$ |

How are the graphs the same?

## open up/porabola/, stretched

How are the graphs different?
(2) stretched more than (1) (norrowe)
Does this function have a minimum or a maximum? min
If $a>1$, the graph is vertically $\frac{\text { stretched }}{\text { (stretched / compressed) }}$
and it looks $\qquad$ .

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3. On the same axis graph the following functions:

| $(1)$ | $y=1 / 2 x^{2}=0.5(x)^{2}$ |
| :--- | :--- |
| -2 | $=0.5(-2)^{2}=2$ |
| -1 | $=0.5(-1)^{2}=0.5$ |
| 0 | $=0$ |
| 1 | $=0.5(1)^{2}=0.5$ |
| 2 | $=0.5(2)^{2}=2$ |


| (2) | $y=1 / 4 x^{2}=0.25 x^{2}$ |
| :---: | :--- |
| -2 | $0.25(-2)^{2}=1$ |
| -1 | $0.25(-1)^{2}=0.25$ |
| 0 | 0 |
| 1 | 0.25 |
| 2 | 1 |

How are the graphs the same? open up/parabola/compressed vert.
How are the graphs different?
(2) is wider than
(1)


Does this function have a minimum or a maximum? min
If $1>a>0$, the graph is vertically $\frac{\text { compressed }}{\text { (stretched / compressed) }}$ and it looks $\frac{\text { wider }}{\text { (narrower /wider) }}$.
4. On the same axis graph the following functions:

| (1) $y=-3 x^{2}$ |  |
| :--- | :--- |
| -2 | $-3(-2)^{2}=-12$ |
| -1 | $-3(-1)^{2}=-3$ |
| 0 | 0 |
| 1 | -3 |
| 2 | -12 |


| (2) $y=-1 / 4 x^{2}=-0.25 x^{2}$ |  |
| :--- | :--- |
| -2 | $=-1$ |
| -1 | $=0.25$ |
| 0 | $=0$ |
| 1 | $=-0.25$ |
| 2 | $=-1$ |

How are the graphs the same? open down/parobols / flipped How are the graphs different?

> (1) is stretched (2) compressed

Does this function have a minimum or a maximum? min
 If the value of ' $a$ ' is positive the parabola opens $\qquad$
If the value of ' $\alpha$ ' is negative then parabola opens $\qquad$
This is called a reflection in the $X$ - axis.

