# 2.4 A Graphing in Vertex Form

**Recall:** Equation of a parabola in vertex form is

$$y = a(x-h)^2 + k$$

We saw yesterday how **a**, **h**, and **k** changed the graph of $y = x^2$

**a:** stretch factor, if $a>1$ stretch $0>a>1$ compression
if neg, opens down

**h:** Left/Right shift, ex. $(x-3)^2$ means → RIGHT 3

**k:** UP/down shift. ex: .... +3 means ↑ UP 3

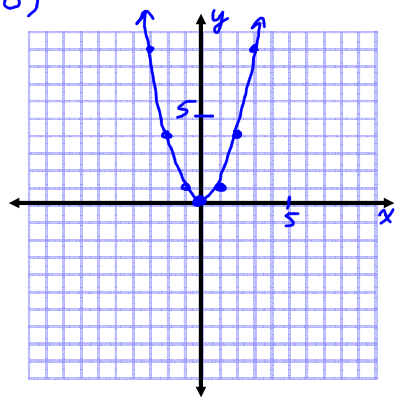
Graphing Quadratic Equations – **The Pattern Method**

Consider $y=x^2$

Vertex(0,0)

| X | Y |
|---|---|
| -3 | 9 |
| -2 | 4 |
| -1 | 1 |
| 0 | 0 |
| 1 | 1 |
| 2 | 4 |
| 3 | 9 |

Matching heights and distances: symmetry!




From vertex get the pattern:

| x | | | y |
|---|---|---|---|
| over | 1 | up | 1 |
| over | 2 | up | 4 |
| over | 3 | up | 9 |

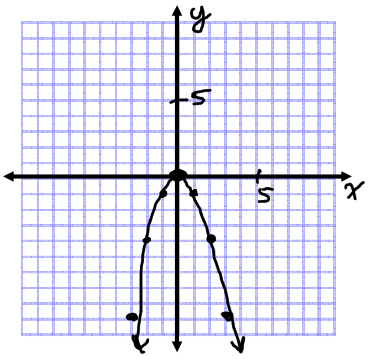
How to Graph Using the Pattern Method

1. Identify and plot the vertex (h, k)
2. Determine the step Pattern ( → 1 ↑ 1...)
3. Graph the step points
4. Reflect each point across the axis of symmetry
5. Draw a smooth curve between points

Ex 1: Sketch $y= -x^2$

- vertex at (0,0) start here
- a= -1, opens down

Reflection in x-axis




Use the STEP Pattern from the **vertex**

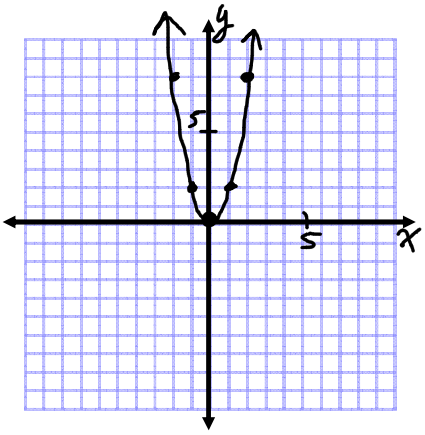
| x | | | y | multiply by "a" |
|---|---|---|---|---|
| over | 1 | down | 1x-1 = -1 | |
| over | 2 | down | 4x-1 = -4 | |
| over | 3 | down | 9x-1 = -9 | |

## Ex 2: Vertical Stretches

Sketch
a) $y=2x^2$

vertex: (0,0)
opens: UP

- makes graph "skinnier"
- vertical stretch by 2



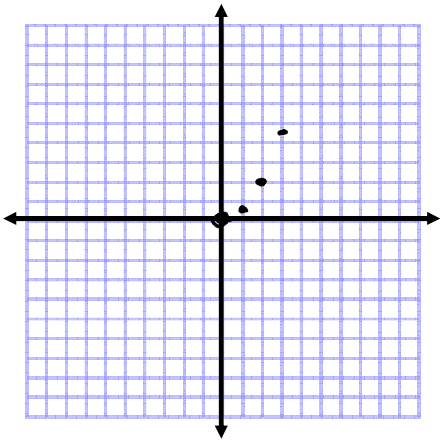

The Step Pattern From the vertex:

| | x | | y | |
|---|---|---|---|---|
| over | 1 | up | $1(2)=2$ | multiply by "a" |
| over | 2 | up | $4(2)=8$ | |
| over | 3 | up | $9(2)=18$ | |

b) $y=\frac{1}{2}x^2$

vertex: (0,0)
opens: UP

- makes graph "wider"
- vertical squish by $\frac{1}{2}$



The Step Pattern From the vertex:

| | x | | y | |
|---|---|---|---|---|
| over | 1 | up | $1\left(\frac{1}{2}\right)=\frac{1}{2}$ | multiply by "a" |
| over | 2 | up | $4\left(\frac{1}{2}\right)=2$ | |
| over | 3 | up | $9\left(\frac{1}{2}\right)=\frac{9}{2}=4.5$ | |

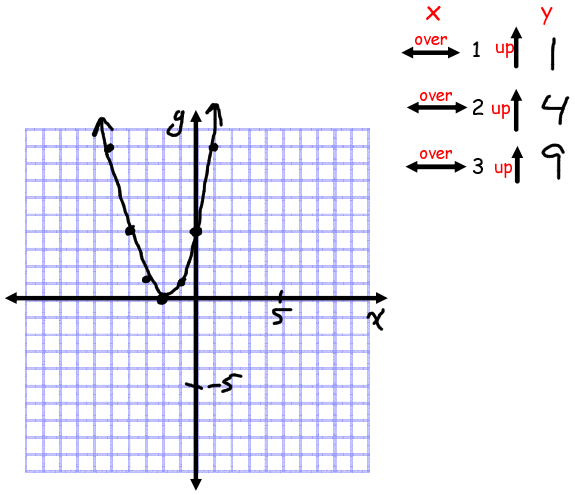
## Ex 3: Horizontal Translations (Moves left or right)

$y=a(x-h)^2+k$

Sketch

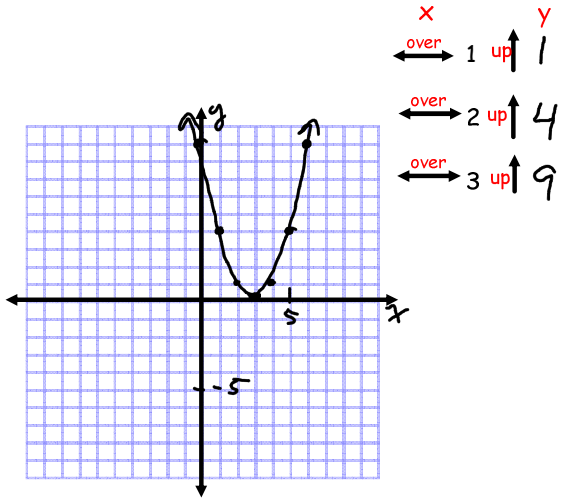
a) $y=(x+2)^2$ vertex: $(-2,0)$ opens: UP

h = - 2 so move **left** 2 units.




b) $y=(x-3)^2$ vertex: $(3,0)$ opens: UP

h = 3 move **right** 3 units.

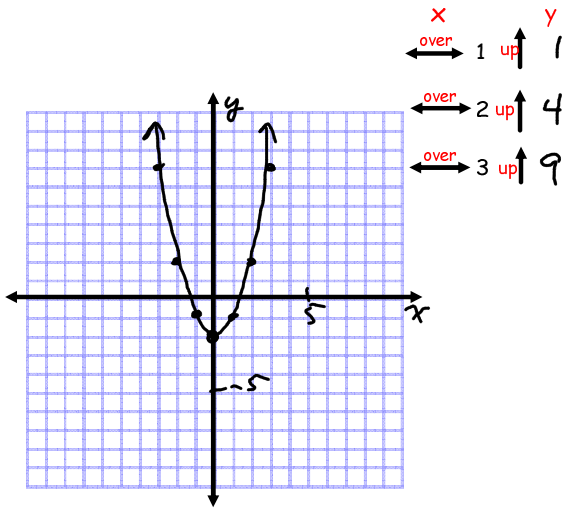



## Ex 4: Vertical Translations (Move up or down)

Sketch

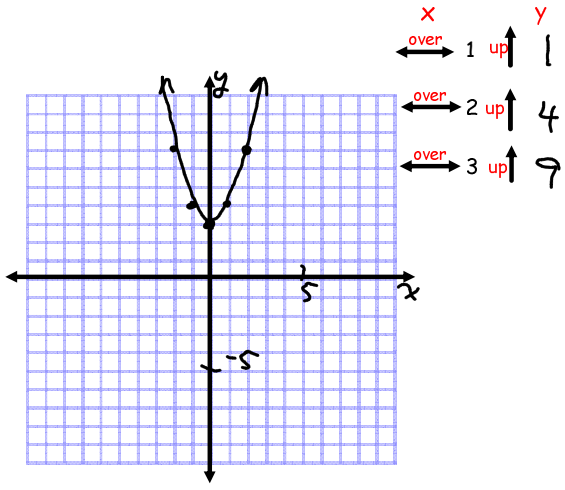
a) $y=x^2-2$ vertex: $(0,-2)$ opens: UP

k = - 2 move **down** 2 units.




b) $y=x^2+3$ vertex: $(0,3)$ opens: UP

k = 3 move **up** 3 units.

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## Ex. 5 For each relation

i) State the vertex (h,k)

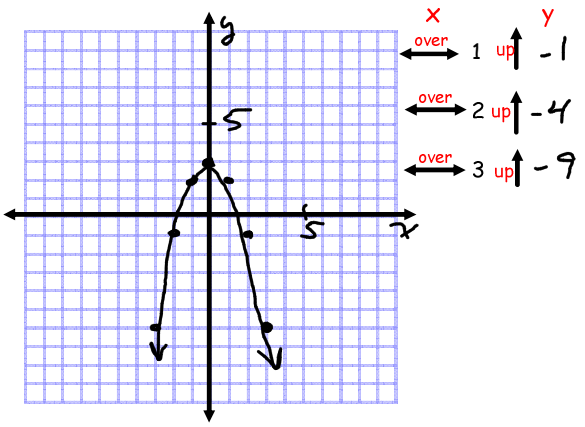
ii) State the direction of opening (a)

iii) Graph the relation

a) $y=-x^2+3$

vertex (h,k): (0, 3)

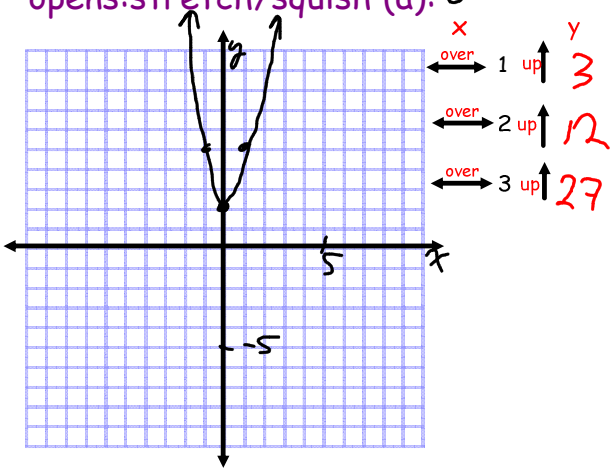
opens:stretch/squish (a): Down




b) $y = 3(x - 2)^2$

vertex (h,k): ( 2 , 0 )

opens:stretch/squish (a): UP a=3




c) $y = 2(x+3)^2-4$

vertex (h,k): (-3, -4)

opens:stretch/squish (a): UP

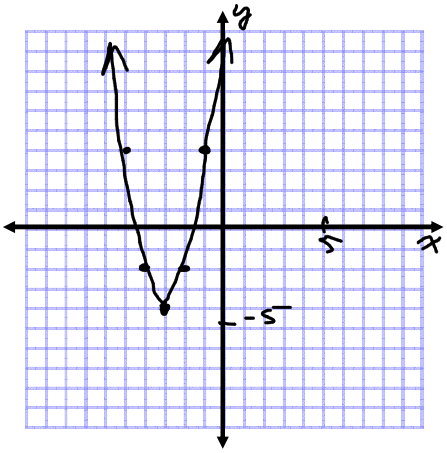
a = 2

x y

over 1 up 1(2) = 2

over 2 up 4(2) = 8

over 3 up 9(2) = 18



**When StatingTransformations**

Order matters

1st (multiplying operations)

- Stretching
- Reflecting

2nd (adding/subtracting operations)

- Translations (left/right; up/down)

State the transformations (in order)

$y = -5(x+7)^2-10$

- stretch by 5
- reflected
- vertical shift of -10
- horizontal shift of -7

Practice
3.4A Handout

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