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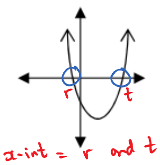
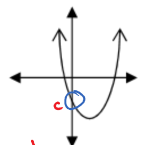
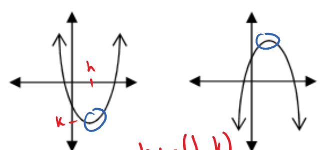
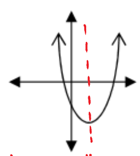
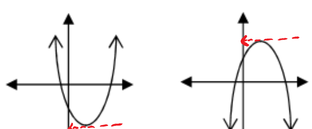
Changing Quadratic Relations: The Value of 'a'

Quadratic Vocabulary:

A quadratic relation is modeled by a smooth symmetrical curve, known as a ________________.

The **key features** of a parabola are:

zeros	 OR $(r,0)$ $(t,0)$ record: x-int = r and t	the x-intercepts (where graph crosses x-axis)
y-intercept	 OR $(0,c)$ record: y-int = c	where graph crosses the y-axis
vertex	 record: vertex = (h,k)	the lowest / highest point of parabola
axis of symmetry	 record: $x = \#$	an imaginary line of symmetry that runs vertically through vertex
optimal value	 record: $y = \#$ (MAX or MIN)	how low/ high vertex reaches in terms of y-value MIN when parabola opens up MAX when parabola opens down

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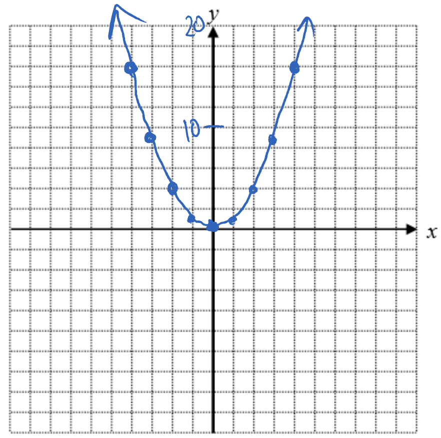
The Basic Parabola:

1. Complete the table of values for the relation $y = x^2$, including finite differences.

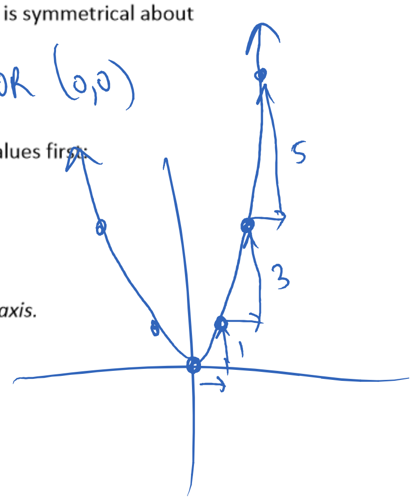
x	x^2	y	1st	2nd
-4	$(-4)^2$	16	-7	+2
-3	$(-3)^2$	9	-5	2
-2		4	-3	2
-1		1	-1	2
0		0	+1	2
1		1	+3	2
2		4	+5	2
3		9	+7	
4		16		

2. Plot the data on the coordinate grid. Draw a curve of best fit.



Summarize the properties of the basic quadratic relation $y = x^2$.

1. The vertex is (0,0) and is also known as the origin.
2. The optimum value is y=0 and it is a MIN because parabola opens up.
3. The axis of symmetry is x=0. The graph is symmetrical about y-axis.
4. The zeros of the relation are x-int=0 only OR (0,0)
5. To graph the basic parabola without creating a table of values first:
   - Start at the vertex: $(0,0)$.
   - Go right 1 and up 1, plot a point.
     Go right 1 and up 3, plot a point.
     Go right 1 and up 5, plot a point.
     These points are located on the right side of the y-axis.
   - Find the points on the left side using symmetry.
     OR repeat the pattern going left rather than right.
   - Draw a curve of best fit.



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I n v e s t i g a t e $y = ax^2$

Function	Value of a in $y = ax^2$	Direction of Opening	Vertex	Axis of Symmetry	Same shape as $y = ax^2$?
a. $y = x^2$	1	up	(0, 0)	$x = 0$	
b. $y = 2x^2$	2	up	(0,0)	$x=0$	skinnier
c. $y = 0.5x^2$	0.5	up	(0,0)	$x=0$	wider
d. $y = -2x^2$	−2	down	(0,0)	$x=0$	skinnier + reflected
e. $y = -0.5x^2$	−0.5	down	(0,0)	$x=0$	wider + reflected

How does the value of *a* affect the basic parabola?

The **sign** of *a* indicates the direction of opening of the parabola:

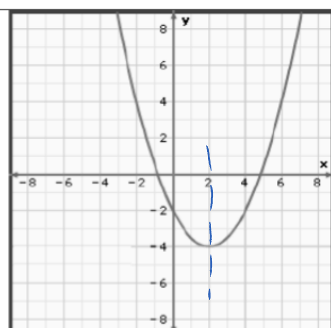
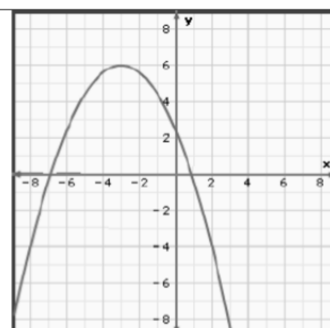
- when *a* is positive, the parabola opens up and has a MINIMUM
- when *a* is negative, the parabola opens down and has a MAXIMUM; this is known as a reflection

The **value** of *a* describes the shape of the parabola:

- when *a* is between 0 and 1, the parabola is wider than $y = x^2$; known as a vertical compression
- when *a* is greater than 1, the parabola is narrower than $y = x^2$, known as a vertical stretch

Example 1

State the key features of each graph. *(Round answers to the nearest 0.5.)*

		
zeros	(−1,0) and (5,0)	(−7,0) and (1,0)
y-intercept	(0,−2)	(0,2.5)
vertex	(2,−4)	(−3,6)
axis of symmetry	$x=2$	$x=-3$
optimal value	$y=-4$ MIN	$y=6$ MAX

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Example 2

For each of the following, (i) state the transformations, and (ii) graph the parabola.

	$y = -2x^2$	$y = {}^{1}/{}_{4}x^2$ $= 0.25x^2$
(I) TRANSFORMATIONS	reflected vertically stretched step: $(1, 3, 5) \times -2 = -2, -6, -10$	vertically compressed step: $(1, 3, 5) \times 0.25$ $= 0.25, 0.75, 1.25$
(II) GRAPH