4.1 Investigate Non-Linear Relations
4.2 Quadratic Relations

A Finite Differences

Finite differences is a method of investigating relationships (tables of values).

Example 1. Find the *first order differences* for the following *linear* relation $y = -2x + 3$.

x	$y = -2x + 3$	First Order Differences Change in the y-variable
-2		
-1		
0		
1		
2		

What can you conclude about the first order differences of a *linear* relation?

Example 2. Find the *first and second order differences* for the following *quadratic* relation $y = -3x^2 + 2x - 5$.

x	$y = -3x^2 + 2x - 5$	First Order Differences	Second Order Differences
-2			
-1			
0			
1			
2			

What can you conclude about the second order differences of a *quadratic* relation?

Example 3. Find the *first, second and third order differences* for the following *cubic* relation $y = x^3 - 2x^2$.

x	$y = x^3 - 2x^2$	First Order Differences	Second Order Differences	Third Order Differences
-2				
-1				
0				
1				
2				

Conclusion:

B Classify Relations by using Finite Differences

- ✓ If a relation is *constant*, then all *y-values* are constant (same value).
- ✓ If a relation is *linear*, then all *first order* differences are constant (same value).
- ✓ If a relation is *quadratic*, then all *second order* differences are constant (same value).
- ✓ If a relation is *cubic*, then all *third order* differences are constant (same value).

Example 4. Classify the following relation as constant, linear, quadratic, cubic, or neither.

x	y	First Order Differences	Second Order Differences	Third Order Differences
0	2			
1	2			
2	2			
3	2			
4	2			

Conclusion:

Example 5. Classify the following relation as constant, linear, quadratic, cubic, or neither.

x	y	First Order Differences	Second Order Differences	Third Order Differences
0	3			
1	5			
2	7			
3	9			
4	11			

Conclusion:

Example 6. Classify the following relation as constant, linear, quadratic, cubic, or neither.

x	y	First Order Differences	Second Order Differences	Third Order Differences
0	0			
1	1			
2	4			
3	9			
4	16			

Conclusion:

Example 7. Classify the following relation as constant, linear, quadratic, cubic, or neither.

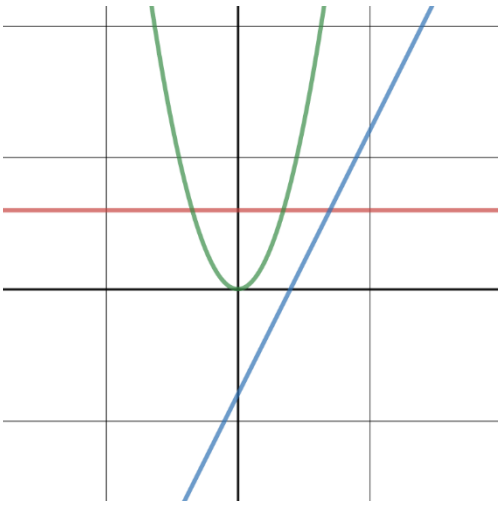
x	y	First Order Differences	Second Order Differences	Third Order Differences
0	1			
1	3			
2	9			
3	27			
4	81			

Conclusion:

C Classify Relations by using Formulas or Graphs

- ✓ A *constant* relation is described by $y = a$ and its graph is a *horizontal line*.
- ✓ A *linear* relation is described by $y = ax + b$ and its graph is an *oblique (slant) line*.
- ✓ A *quadratic* relation is described by $y = ax^2 + bx + c$ and its graph is called *parabola*.

Example 8. Classify each relation on the right figure.



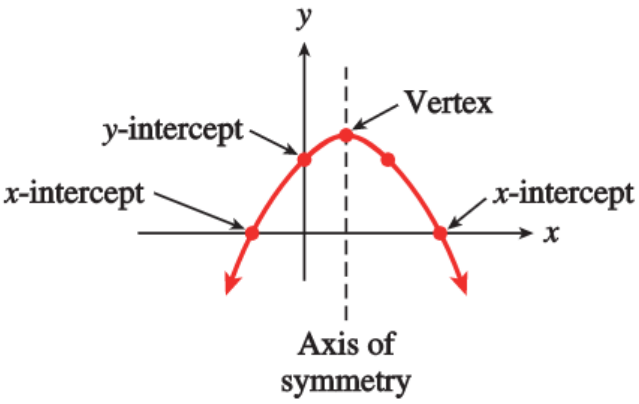
Example 9. Classify each relation as constant, linear, quadratic, or neither.

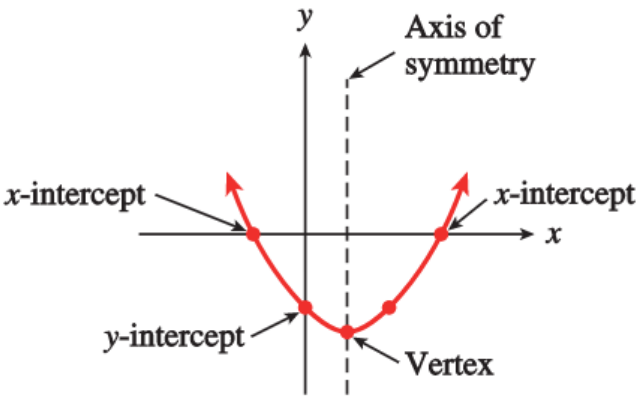
a) $y = x^2 + 5x + 6$ b) $y = 5$ c) $y = 2^x$ d) $y = 5 - 3x$

e) $y = (x - 2)(x + 3)$ f) $y = (x - 1)^2$ g) $y = \sqrt{x}$ f) $y = 10 - (x - 5)^2$

D Parabola

The graph of a quadratic relation $y = ax^2 + bx + c$ is called *parabola*.

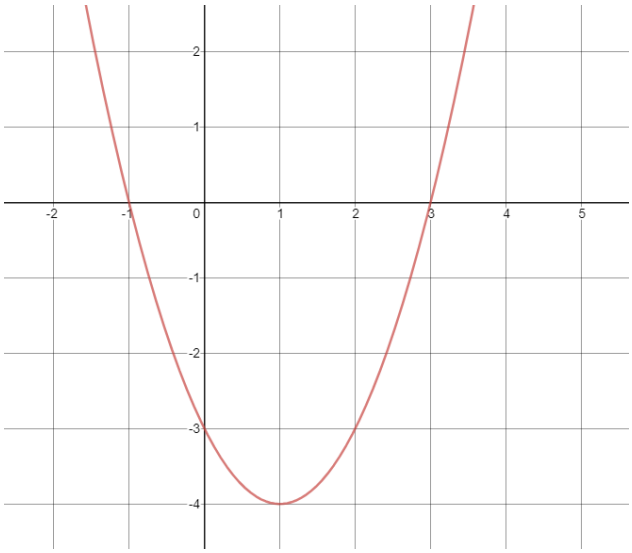




Characteristics:

- ✓ Parabola has a *vertex point*.
- ✓ The *vertex point* is either a *minimum* or a *maximum* point.
- ✓ If $a > 0$, parabola opens *up(ward)*.
- ✓ If $a < 0$, parabola opens *down(ward)*.
- ✓ Parabola is symmetrical with respect to the *axis of symmetry*.
- ✓ The *axis of symmetry* passes through the *vertex point*.

Example 9. Describe the following parabola.



Vertex Point:

Minimum or Maximum Point:

Equation of the axis of symmetry:

Direction of opening (up/down):

Is $a > 0$ or $a < 0$?

x-intercepts points:

y-intercept point:

Example 10. Use Desmos to graph the following quadratic relation $y = -2x^2 + 8x$. Describe the parabola.

Notes: Textbook Pages 164-166, 168-171
Homework: Textbook Page 171 #3, 5 (Use Desmos), 9 (Use Desmos)