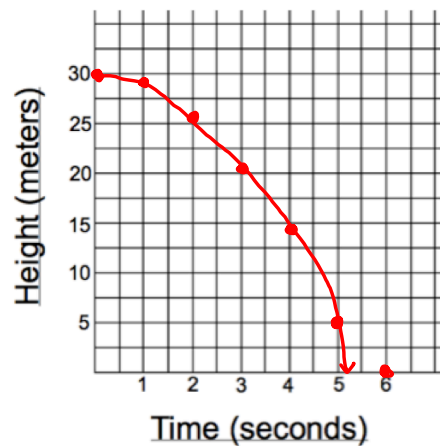# 5.5 First Differences

DO IT NOW

If a tennis ball falls out of the third story window of a building will its motion be linear? The height of the ball over time is recorded in the following table.

Graph the relation and determine if it represents linear motion.

Time (seconds)	Height (meters)
0	30
1	29
2	26
3	21
4	14
5	5
6	0

NOT LINEAR.
Rate of change is not costant.

Part 1:Recall

We know from graphing lines that **if the slope (rise and the run) is constant** then the relation will **form a straight line**.

$$slope = m = \frac{rise}{run} = \frac{\Delta x}{\Delta y}$$

Therefore, we need to determine if the changes in x and y are constant in a table to determine if a relation is linear.

Part 2: What are First differences

First differences are the differences between consecutive y-values in tables of values with evenly spaced x-values.

If the first differences of a relation are <u>constant</u>, the relation is ___LINEAR___

If the first differences of a relation are <u>not constant</u>, the relation is ___NON-LINEAR___

Notice that the x-values change by a constant amount. This is a requirement to work with first differences!

Notice that the differences between consecutive y-values are constant! This means it is a linear relation

x	y
0	0
1	3
2	6
3	9
4	12

First Differences

3-0 = 3

6-3 = 3

9-6 = 3

12-9 = 3

Part 3: Calculating First Differences

Complete a table of values for each equation given. Then determine if the first differences are constant and state whether the relation is linear or non linear.

Example 1:

$y = -2x + 7$

x	y	First Differences
0	7	
1	5	5-7 = -2
2	3	3-5 = -2
3	1	1-3 = -2
4	-1	-1-1 = -2

Conclusion:
the first differences are

__Constant__

therefore the relationship is

__Linear__

Example 2:

$y = x^2$

x	y	First Differences
0	0	
1	1	1-0 = 1
2	4	4-1 = 3
3	9	9-4 = 5
4	16	16-9 = 7

Conclusion:
the first differences are

__Not Constant__

therefore the relationship is

__Non-Linear__

Example 3:

$y = 2^x$

x	y	First Differences
0	1	
1	2	2-1 =1
2	4	4-2=2
3	8	8-4=4
4	16	16-8=8

Conclusion:
the first differences are

<u>Not Constant</u>

therefore the relationship is

<u>Non Linear</u>

Part 4: Check Your Understanding

Use first differences to determine which of these relations are linear and which are non linear.

Example 4:

x	y	First Differences
0	7	
1	3	3-7=-4
2	-1	-1-3=-4
3	-5	-5-(-1) =-4
4	-9	-9-(-5) =-4

Type of relation:<u>Linear</u>

Example 5:

x	y
2	-5
3	10
4	25
5	40
6	55

First Differences

$$10-(-5)=15$$
$$25-10=15$$
$$40-25=15$$
$$55-40=15$$

Type of relation: <u>Linear</u>

Example 6:

x	y
-2	-10
-1	-2
0	0
1	2
2	10

First Differences

$$-2-(-10)=8$$
$$0-(-2)=2$$
$$2-0=2$$
$$10-2=8$$

Type of relation: <u>Non-linear</u>