First Differences – Linear or Non-Linear

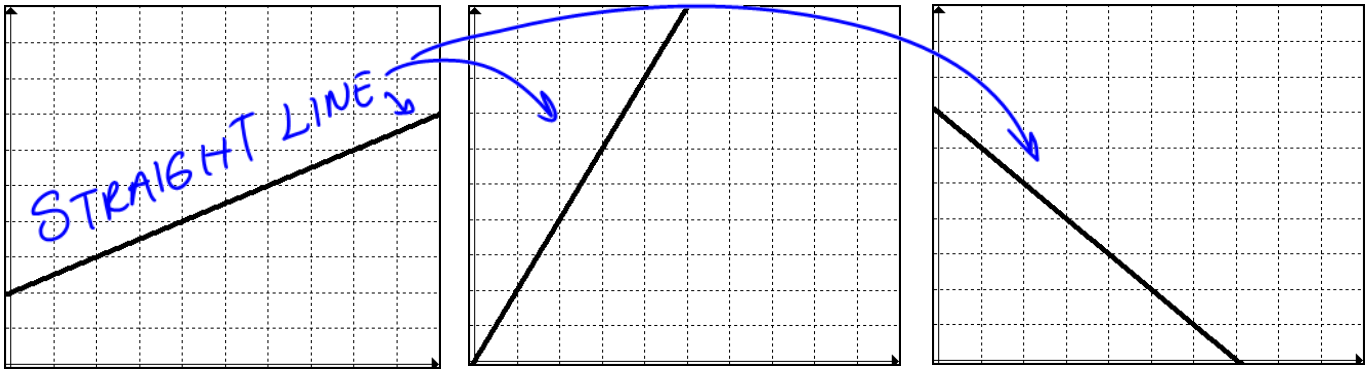
Whether a relationship is linear or non-linear can be determined by:

- Looking at the graph
- Using the table of values
- Looking at the equation

We will focus on the first two and investigate the third one next unit.

The first and most obvious is by looking at the graph. When the plotted points are connected, it they make a straight line, it is a linear relationship.

Example:



FIRST DIFFERENCES – Finding linearity in a table of values.

		First Differences
0	10	
1	13	13-10=3
2	16	16-13=3
3	19	19-16=3
4	22	22-19=3
5	25	25-22=3
6	28	28 - 25 = 3

+3

What do you notice in the first column?

x values increase by the same amount

they've to increase " "

This pattern must be evident in order to calculate the first differences.

To calculate the first differences, we use the second column (dependent variable) and, starting at the bottom, subtract the number above from the bottom number. The first is done for you. Continue the pattern to complete the first differences column.

What do you notice about the first differences?

They're all the SAME

This tells us that this relationship IS LINEAR!

First Differences – The Tile Factory - Perimeter

P of Square = 4s

Jody works at a factory that produces square tiles for bathrooms and kitchens. She helps determine shipping costs by calculating the perimeter of each tile.

Calculate the perimeter and record your observations in column 2.

Side Length (cm) X	Perimeter (cm) y	First Differences
1	4·1 = 4	8-4 = 4
2	4·2 = 8	12-8 = 4
3	4·3 = 12	16-12 = 4
4	4·4 = 16	20-16 = 4
5	4·5 = 20	

Construct a graph of the perimeter of a tile vs. the side length of the tile.

a) Which variable is the independent variable?

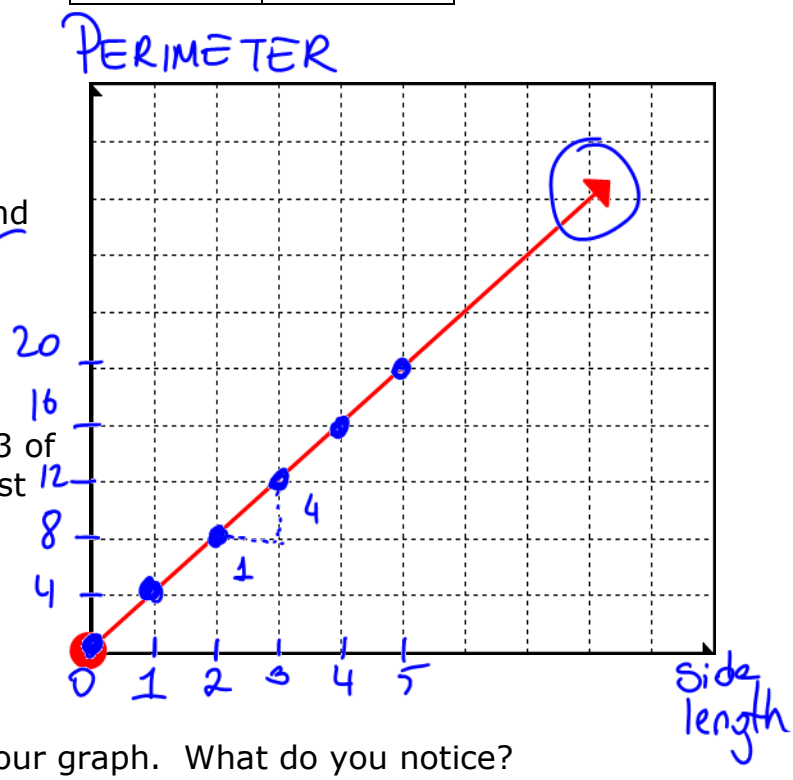
Side length

b) Which variable is the dependent variable?

Perimeter depends on the side length

c) Use the graph to describe the relationship between the perimeter and side length of a tile.

For 1 cm increase in length, the Perimeter increases by 4.



d) Calculate the first differences in column 3 of the table. What do you notice about the first differences? What does this tell us?

They're all the same; therefore, the relationship is linear.

e) Calculate the rate of change (slope) of your graph. What do you notice?

Slope = 4 1st differences = 4

"Slope will be equal to 1st differences if the "x" values increase by 1."

First Differences – The Tile Factory - PAYDAY

Jody is paid $8.50 per hour (slope) to calculate perimeters. Calculate her pay and record your observations in column 2.

Create an expression

$P = 8.50h$

Number of Hours	Pay ($)	First Differences (RISE)
0	0	
5	8.5(5)=42.5	42.5
10	85	42.5
15	127.5	127.5-85=42.5
20	170	170-127.5=42.5

Construct a graph of the number of hours vs. her pay.

a) Which variable is the independent variable?

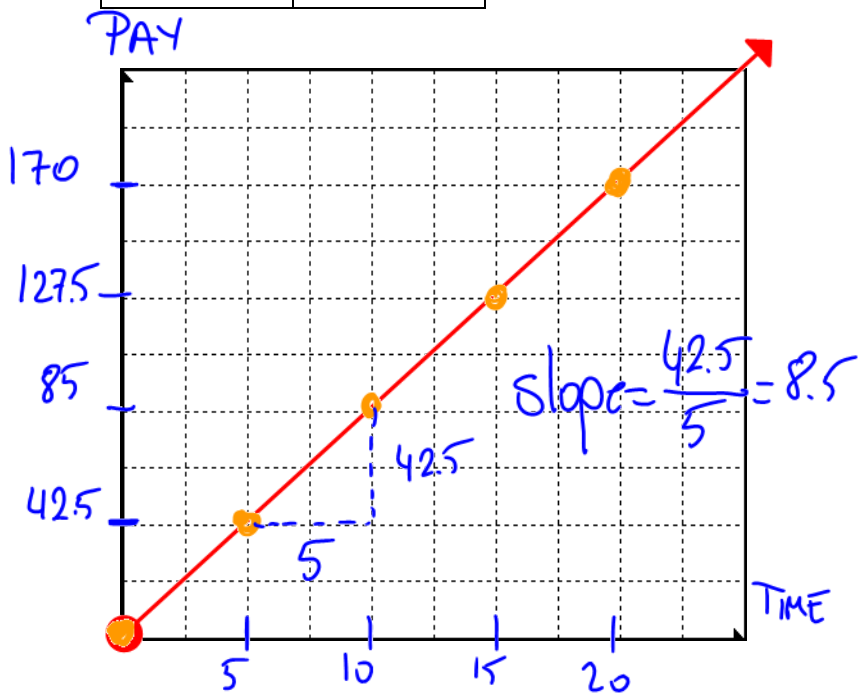
TIME

b) Which variable is the dependent variable?

PAY

c) Use the graph to describe the relationship between the number of hours worked and Jody's pay.

for every 5 hours she makes $42.50



d) Calculate the first differences in column 3 of the table. What do you notice about the first differences? What does this tell us?

ALL EQUAL
∴ LINEAR

e) Calculate the rate of change (slope) of your graph. How is this different than the last example?

$\text{Slope} = \frac{42.5}{5} = 8.5$

1st differences do not tell us the slope b/c "x" values increase by 5.

First differences – The Tile Factory - Area

$A = s^2$

Raj, another employee at the factory, also works with the tiles. He helps to determine the shipping costs by calculating the area of each tile and recording his calculations in the table. Calculate the area and record your observations in column 2.

Length of Side (cm)	Area (cm^2)	First Differences
1	1x1=1	
2	2x2=4	4-1=3
3	3x3=9	9-4=5
4	4x4=16	16-9=7
5	5x5=25	25-16=9

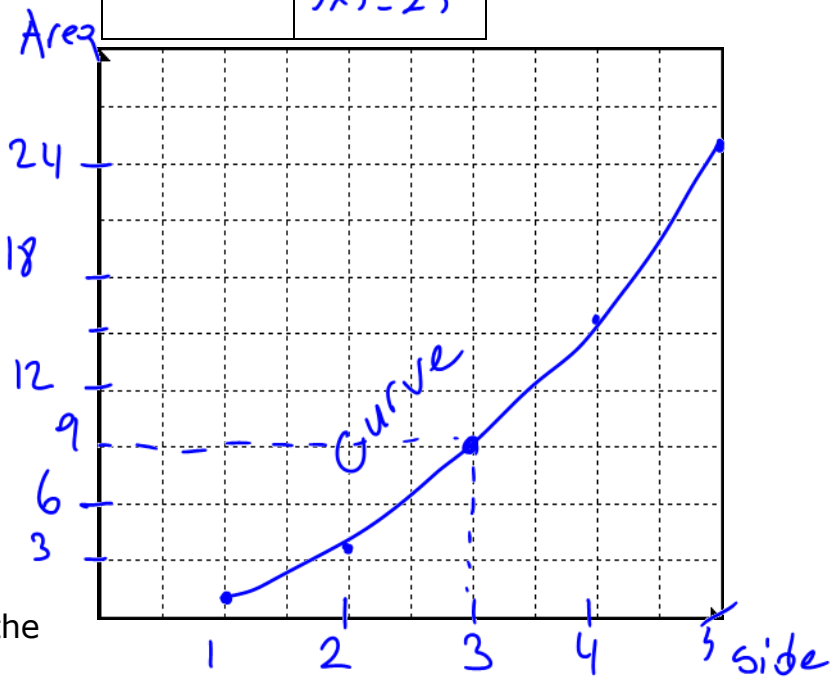
Construct a graph of the length of side vs. area of the tile.

a) Which variable is the independent variable?

SIDE

b) Which variable is the dependent variable?

AREA



c) Use the graph to describe the relationship between the length of the side and the area.

The area is the square of each side

d) Calculate the first differences in column 3 of the table. What do you notice about the first differences? What does this tell us?

UNEQUAL; therefore, it's a non-linear relation.