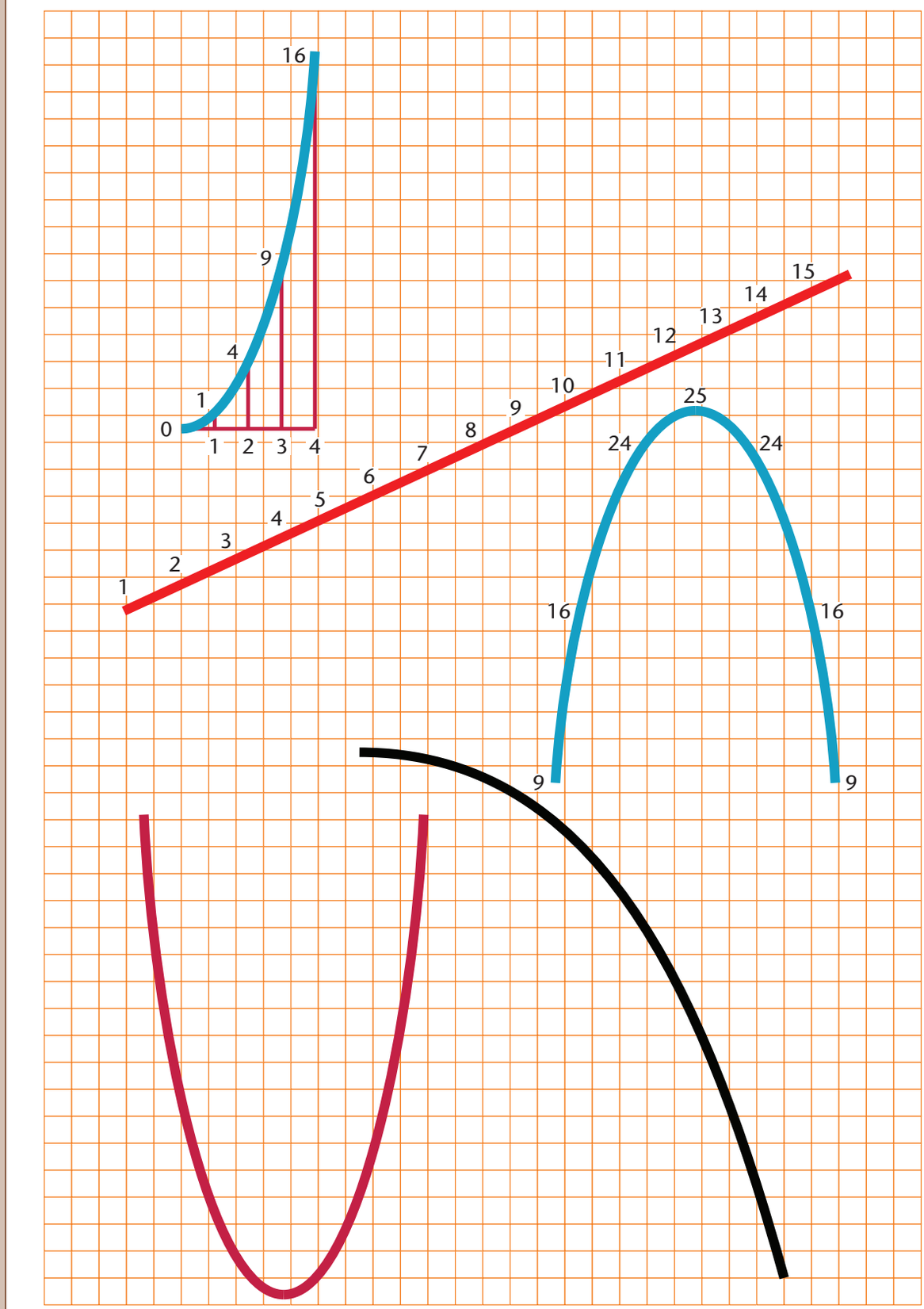
Chapter 11
Graphs

In this chapter, you will specifically deal with global graphs. These graphs show visually how variables vary, focusing on trends rather than detailed readings.

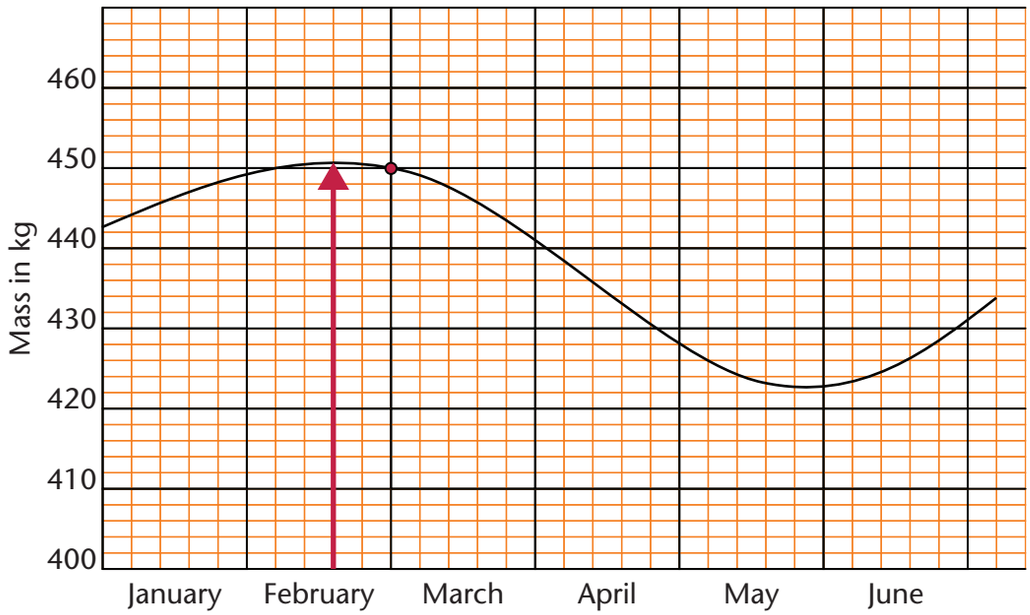


11 Graphs

11.1 What we can tell with graphs

INTERPRETING GRAPHS

1. Mrs Maleka is a dairy farmer. She cares for her cows and weighs all of them daily. Here is a graph of one cow's mass in kilograms over a period of 6 months. At the end of February, the mass of the cow was 450 kg, as shown by the red dot.



(a) The mass of the cow reached a maximum a few days after the middle of February, as shown by the red arrow on the graph. When, in the period shown on the graph, did the cow's mass reach a minimum?

.....

(b) During most of February the cow weighed slightly more than 450 kg. During which month did the cow weigh less than 430 kg, for the whole month?

.....

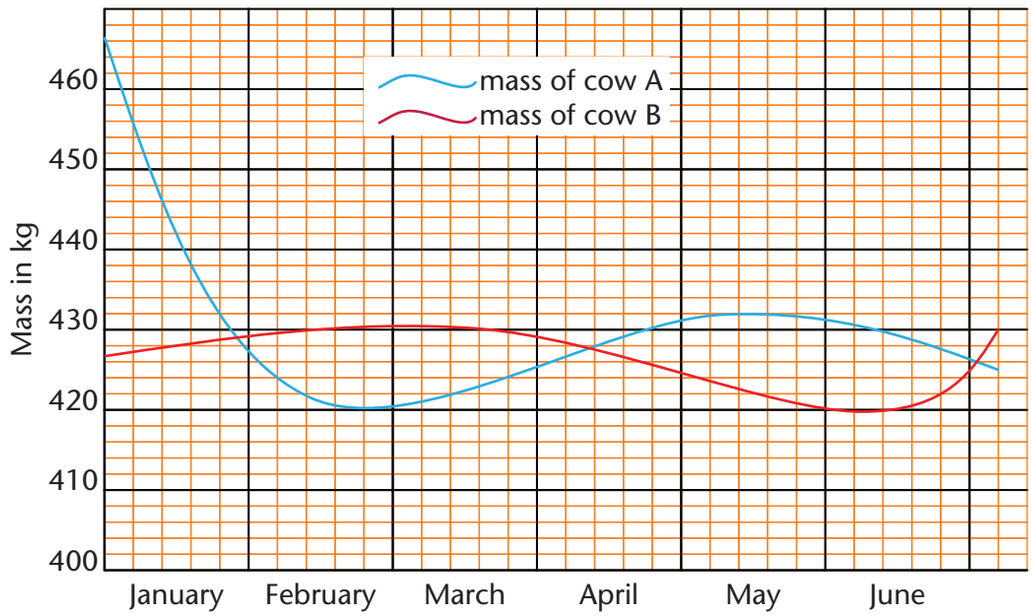
(c) All through the month of June, the mass of the cow increased. During which other month did the mass of the cow also increase, right through the month?

.....

(d) During which months did the mass of the cow decrease right through the month?

.....

2. The blue and red curves below are graphs that show how the mass of two cows varied over the same period of time.



(a) Which cow was the heaviest at the end of February? .....

(b) When was cow B heavier than cow A?

.....

(c) During which months did the mass of cow A decrease for the whole month?

.....

(d) When did cow A's mass start to increase again?

.....

(e) During what month did cow B's mass begin to decrease while cow A's mass increased for that whole month?

.....

(f) When did cow A's mass catch up with cow B's mass again?

.....

(g) When did cow A stop gaining weight and start losing weight again?

.....

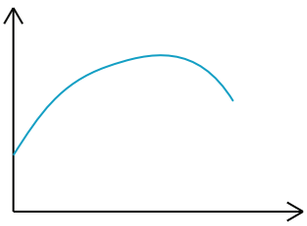
(h) When did cow B's mass catch up with cow A's mass again?

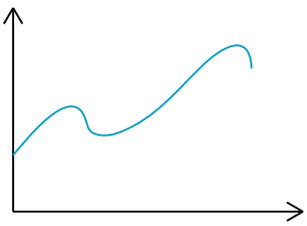
.....

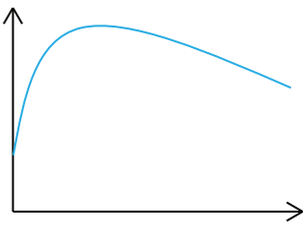
3. A traffic department keeps track of the traffic density on different roads. Two traffic officers are posted somewhere along each main road and they count and record the number of cars that pass in each direction during each 15 minute interval. They use tally marks to do this, as you can see in the example below.

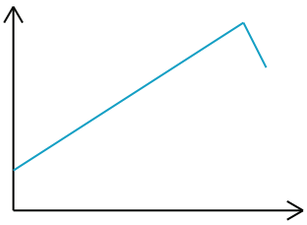
	//// ///// ///// /////	/// ///// ///// ///// /////	///// // ///// ///// ///// /////	///// //// ///// ///// ///// ///// /////	/ ///// ///// ///// ///// ///// ///// /////	///// /// ///// ///// ///// ///// ///// /////
Time	06:00 to 06:15	06:15 to 06:30	06:30 to 06:45	06:45 to 07:00	07:00 to 07:15	07:15 to 07:30
Cars	14	23	37	59	71	48

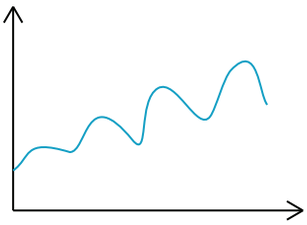
Which of the graphs below do you think is the best representation of the above data on traffic flow?

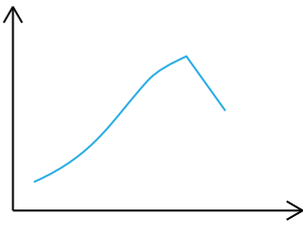
A 

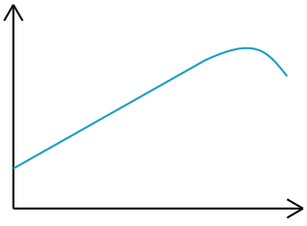
B 

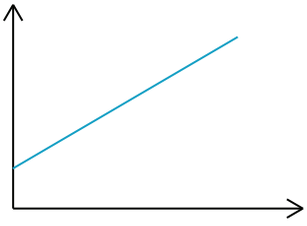
C 

D 

E 

F 

G 

H 

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4. Which of the graphs on the previous page is the best representation of each of these traffic flow reports?

(a)

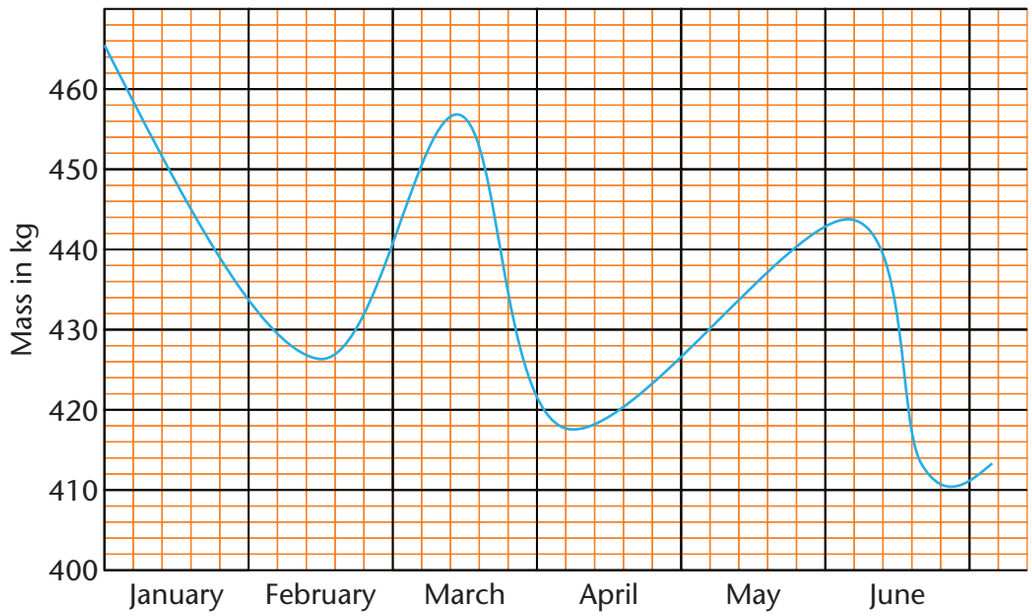
Time	06:00 to 06:15	06:15 to 06:30	06:30 to 06:45	06:45 to 07:00	07:00 to 07:15	07:15 to 07:30
Cars	42	53	64	75	86	75

(b)

Time	06:00 to 06:15	06:15 to 06:30	06:30 to 06:45	06:45 to 07:00	07:00 to 07:15	07:15 to 07:30
Cars	42	123	158	147	136	124

.....

5. Study this graph for another cow.



(a) During which periods did the cow lose weight?

.....

(b) During which of these periods did the cow lose weight more slowly?

.....

(c) During which of the periods did the cow lose weight most rapidly?

.....

(d) Compare the two periods when the cow gained weight.

.....

.....

(e) Is there anything else about the graph that may indicate that this cow has health problems?

.....

.....

.....

HOW GRAPHS SHOW INCREASES AND DECREASES

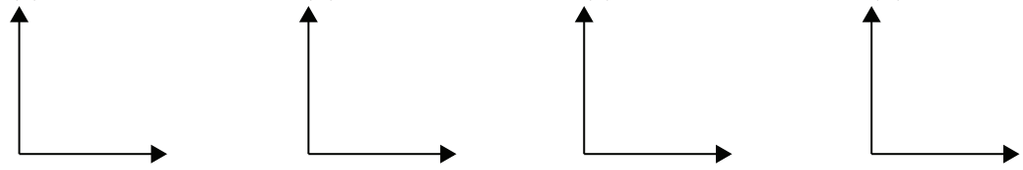
A graph on a system of coordinates shows the way in which one quantity (called the dependent variable) changes when another quantity (called the independent variable) increases. A quantity can change in different ways:

- It can increase or decrease.
- It can increase at a constant rate, for example the total amount saved if the same amount is saved every week or month.
- It can decrease at a constant rate, for example the length of a burning candle.
- It can increase (or decrease) at a varying rate, for example the increase in the area of a square as the side length increases.

When a quantity increases or decreases at a **constant rate**, it is called **linear** change or variation, and the graph is a **straight line**. When the rate of change is **not constant**, it is called **non-linear** change, and the graph is **curved**. If there is no change in the output variable, the graph is a horizontal straight line.

1. Draw a graph to match each of the following descriptions.
   (a) The quantity increases, and increases more rapidly as time progresses.
   (b) The quantity first increases slowly at a constant rate, and then increases at a faster constant rate.
   (c) The quantity decreases faster and faster.
   (d) The quantity increases, and the rate of increase gradually diminishes.

(a) (b) (c) (d)



2. Statements and graphs about patterns of change in the petrol price per litre over a period are given below. Match each statement with the appropriate graph given below. Time is represented on the horizontal axis in all these graphs, and petrol price on the vertical axis.

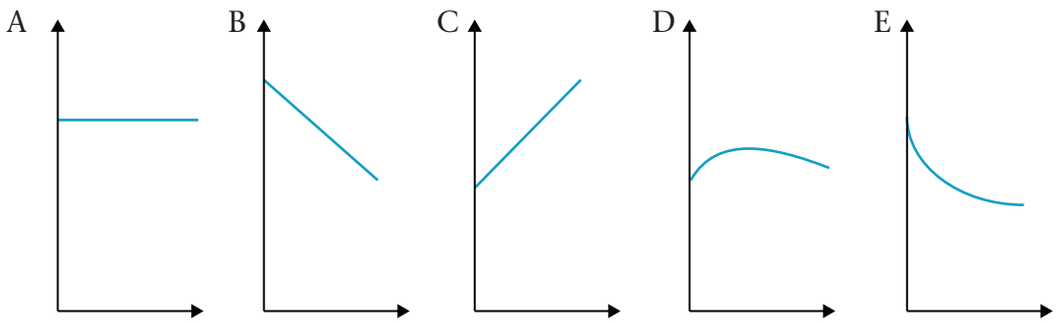
   (a) The price did not change. .....

   (b) The price rose at a constant rate. .....

   (c) The price decreased at a constant rate. .....

   (d) The price dropped very fast at first and then at a slower rate. .....

   (e) The price rose at a decreasing rate up to a point and then started to drop at an increasing rate. .....



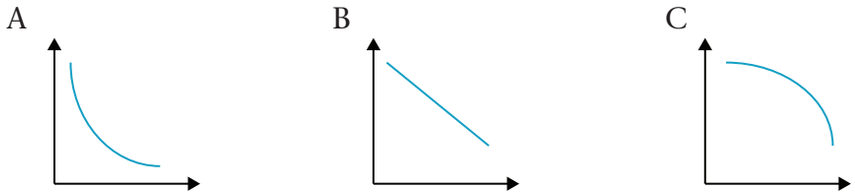
3. Complete the table below in respect of the graphs in question 2.

Graph	Represents a linear or non-linear relation	Reason
A		
B		
C		
D		
E		

4. (a) Which graph below represents a quantity that decreases at a constant rate? .....

   (b) Which graph represents a quantity that decreases at an increasing rate? .....

   (c) Which graph represents a quantity that decreases at a decreasing rate? .....



11.2 More features of graphs

LOCAL MAXIMUM AND MINIMUM VALUES

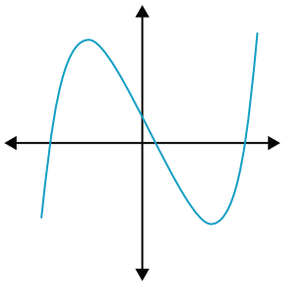
A graph has a **maximum value** when it changes from increasing to decreasing.

A graph has a **minimum value** when it changes from decreasing to increasing.

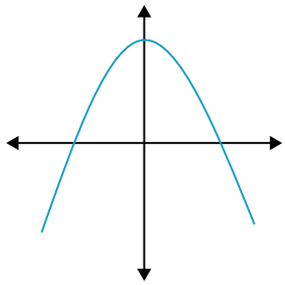
A graph can have more than one minimum or maximum value.

1. Consider the graphs below. Describe how the dependent variable behaves in each case by indicating which graph corresponds to which description.
   (a) The variable has a maximum value because it changes from increasing to decreasing. .....
   (b) The variable has a minimum value because it changes from decreasing to increasing. .....
   (c) The variable has a maximum value as well as a minimum value because it changes from increasing to decreasing and then from decreasing to increasing. .....

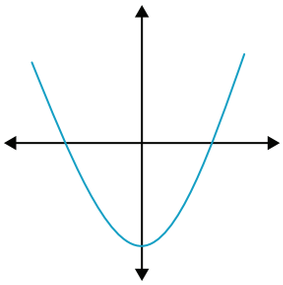
Graph 1



Graph 2



Graph 3



2. On the next page, draw graphs that match the descriptions given below.
   (a) A quantity changes in non-linear fashion, at one stage switching from decreasing to increasing and then to decreasing again.
   (b) A quantity changes from increasing at a constant rate to decreasing at a constant rate and then becomes constant.

(a) (b)

DISCRETE OR "CONTINUOUS"

1. Which of the items in the list provided can you count, and which quantities need to be measured?

Quantities can be counted, measured or calculated.

(a) Number of bags of cement sold

(b) Heights of learners in Grade 8

(c) Times taken for athletes to complete a 400 m hurdles race during the Olympics

(d) The number of sweets in various 500 g bags

(e) The distance travelled by learners to school

(f) Cars passing at a scholar patrol crossing

(g) The cost of an exercise book in rands and cents

(h) Temperature

Write your answers in the table.

Can only be counted	Can only be measured

2. Say whether the following make sense. Explain.
   (a) 501,3 learners attended a rugby match played by the senior team.

   .....

   (b) The distance from school to the nearest shopping mall is 10,75 km.

   .....

   (c) 2 004,75 cans of cola were sold during a fundraising event.

   .....

Quantitative data is numerical data such as your marks in a Mathematics test. Quantities that can be counted are sometimes said to be **discrete**: they do not allow values in between any two consecutive values. You cannot have 2,6 people for example. Quantities that allow many values between any two values are sometimes said to be **continuous**.

The terms "discrete" and "continuous" are used in different meanings than these in formal mathematics.

11.3 Drawing graphs

DRAWING GLOBAL GRAPHS

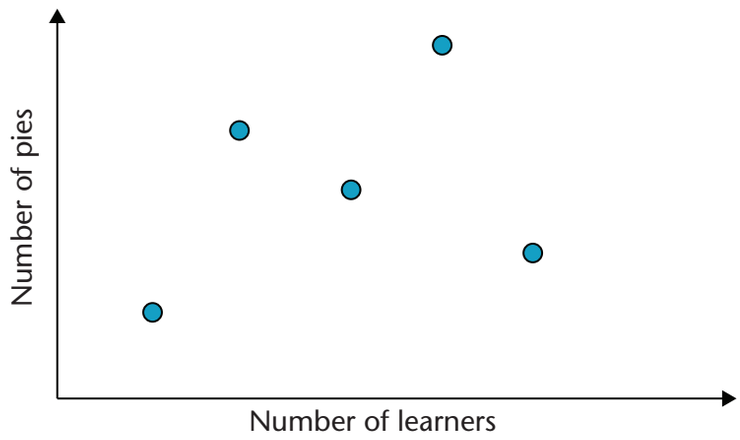
When we draw a graph of continuous data, it is a solid line or curve.

The graph of discrete data is a set of distinct points.

Consider the situations below.

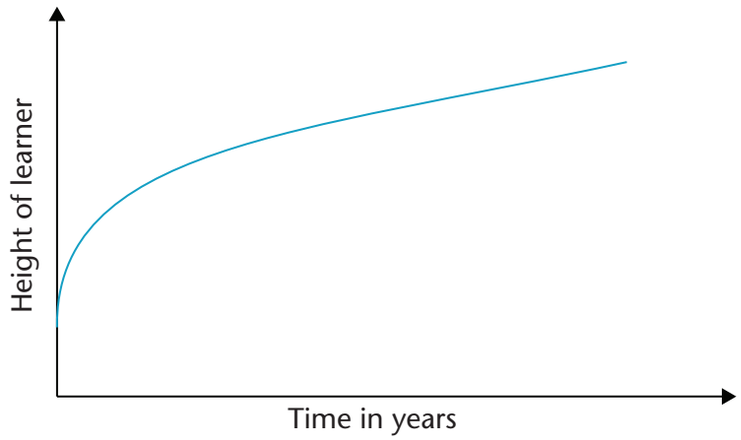
Situation 1

Number of pies bought by learners during a school week



Situation 2

Graph showing the height of a learner over a period of time



1. (a) What type of data is graphed in situation 1?

   .....

   (b) What type of data is graphed in situation 2?

   .....

   (c) Why do you think the graph in situation 2 is a solid line?

   .....

   (d) Why are the points in situation 1 not joined?

   .....

2. Draw a rough graph for each of these situations. Use the spaces below and on the next page.
   (a) The height of a young tree and its age
   (b) The level of water in a dam over a period without any rain
   (c) The temperature under a tree over a period of 24 hours

   (a)

(b)

(c)

GRAPHS OF ORDERED PAIRS

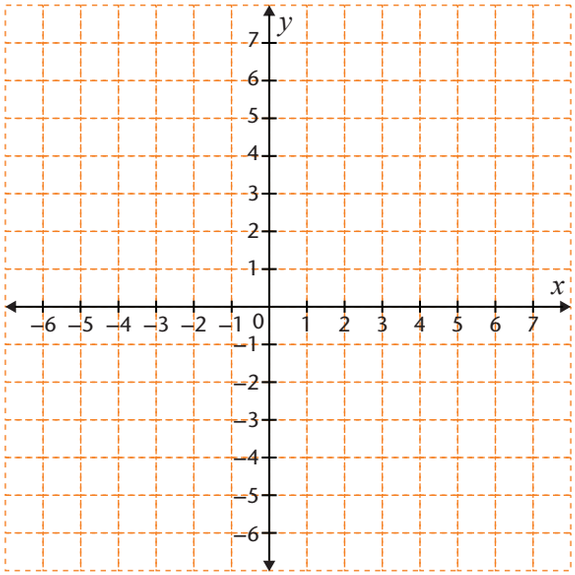
Input and output values can be written as a pair. The first number in a pair represents the input number and the second number represents the output number. We therefore say that the pair of numbers is ordered.

Making a graph of **ordered pairs** is another way to show how the input and output values are related.

When drawing a graph of ordered pairs, work as follows:

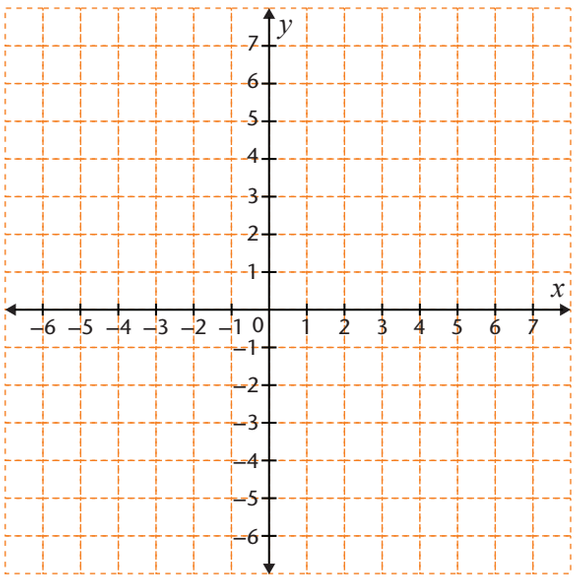
- First identify the input values (x) and output values (y). In most cases the input values will be given and the output values are calculated using the formula given.
- The output values are written on the y-axis (the vertical axis) and the input values are written on the x-axis (the horizontal axis).
- Plot the ordered pair. Suppose the ordered pair is (3; 6). To plot this pair put your finger on the number 3 on the x-axis and another finger on the number 6 on the y-axis. Move the finger on the number 3 in a line straight up and move the finger on the number 6 straight across. Where your two fingers meet, make a point. You can describe this point with the ordered pair (3; 6).

1. Plot the ordered pairs given below:
   (a) A(0; 3)
   (b) B(3; 0)
   (c) C(–2; 1)
   (d) D(4; –4)
   (e) E(–3; –2)



2. (a) Complete the table below for $y = x + 3$.

x	y	$(x; y)$
–4		
–3		
–2	1	(–2; 1)
–1		
0		
1	4	(1; 4)
2		
3		
4		

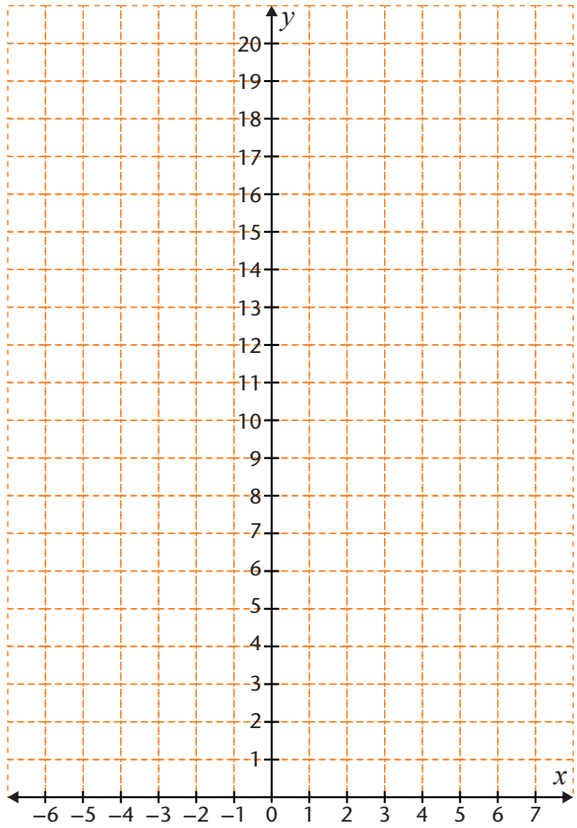


   (b) Plot the ordered pairs on the given coordinate system.
   (c) Join the points to form a graph.
   (d) The ordered pair (1; 6) is not on the graph because when we substitute the value of x ($x = 1$) in the formula $y = x + 3$ we get 4 instead of 6. [$y = 1 + 3 = 4$]
   Is the ordered pair (100; 103) on the graph? Explain.

. . . . . .

3. (a) Complete the table below for the formula $y = x^2 + 3$.

x	y	$(x; y)$
–4		
–3		
–2	7	(–2; 7)
–1		
0		
1	4	(1; 4)
2		
3		
4		



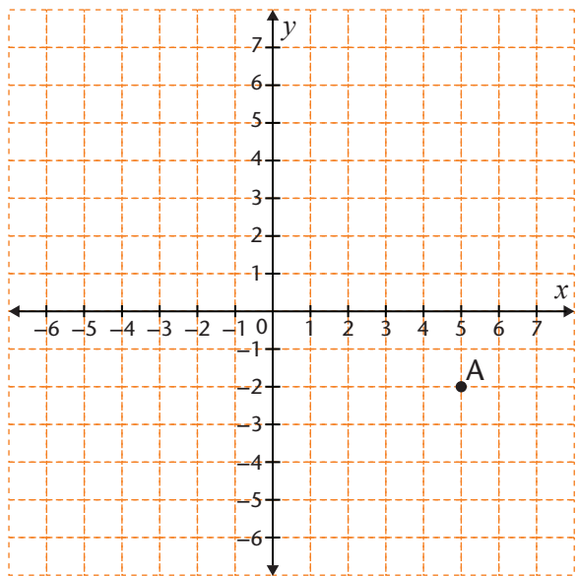
(b) Plot the coordinates on the axis system on the right. Join the points to form a graph.

(c) Is the point (10; 103) on the graph? Explain.

.....

4. (a) Complete the table below for the formula $y = -x + 3$.

x	y	$(x; y)$
–4		
–3		
–2	5	(–2; 5)
–1		
0		
1	2	(1; 2)
2		
3		
4		



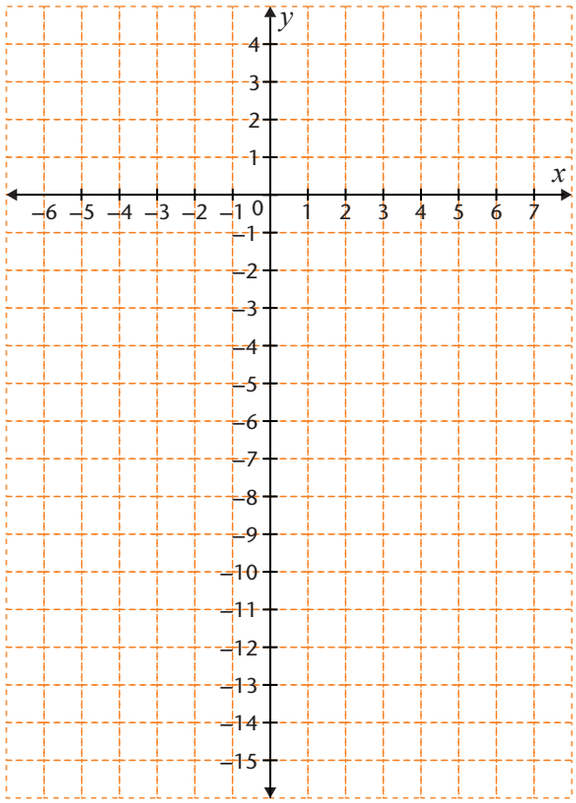
(b) Plot the ordered pairs on the axis system.

(c) Join the points to form a graph.

(d) What are the values of the ordered pair A on the graph? .....

5. (a) Complete the table below for the formula $y = -x^2 + 3$.

x	y	$(x; y)$
–4		
–3		
–2	–1	(–2; –1)
–1		
0		
1	2	(1; 2)
2		
3		
4		

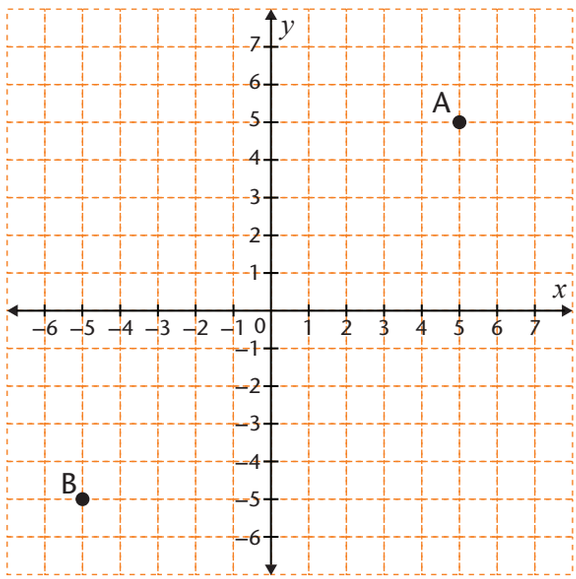


(b) Plot the ordered pairs on the axis system.

(c) Join the points to form a graph.

6. (a) Complete the table below for the formula $y = x$.

x	y	$(x; y)$
–4		
–3		
–2	–2	(–2; –2)
–1		
0		
1	1	(1; 1)
2		
3		
4		



(b) Plot the ordered pairs on the axis system.

(c) Join the points to form a graph.

(d) Write down the values of the ordered pairs A and B on the graph.

. . . . . .