Module 1
Exponential Functions

What this module is about

This module is about Exponential Functions. You will learn how to classify relations which deals on Interest on bank accounts, radioactive decay, biological growth, and the spread of infectious diseases. These are examples by which the amount of change depends on the amount of materials present. You will also develop skills in graphing different types of exponential functions.

What you are expected to learn

This module is designed for you to:

1. Identify certain relationships in real life which are exponential (e.g. population, growth over time, growth of bacteria over time, etc.)

2. Given a table of ordered pairs, state whether the trend is exponential or not.

3. Draw the graph of an exponential function $f(x) = a^x$ and describe some properties of the function or its graph.

    - $a > 1$
    - $0 < a < 1$

4. Given the graph of an exponential function determine the :

    - domain
    - range
    - intercepts
    - trend
    - asymptote

5. Draw the graph of an exponential function $f(x) = Ba^x$ and $f(x) = a^x + c$ and compare it to the graph of $f(x) = a^x$

How much do you know

Answer the following:

1. Which of the statements is best modeled by an exponential growth?
   a. The cost of pencils as a function of the number of pencils.
   b. The distance when a stone is dropped as a function of time.
   c. The distance of a swinging pendulum bob from the center as a function of time.
   d. The compound interest of an amount as a function of time.

2. Identify the relation which describes an exponential relation from among the given table of values.

   a.

x	-2	-1	0	1	2
y	1	3	5	7	9

   b.

x	-2	-1	0	1	2
y	5	2	1	2	5

   c.

x	1	2	3	4	5
y	2	4	9	16	25

   d.

x	0	1	2	3	4
y	1	3	9	27	81

3. The graph of a function of the form $y = a^x$ passes through which of the following points?
   a. (-l, 0)
   b. (1,0)
   c. (0,1)
   d. (0,-1)

Given the function $y = 3(4^x) – 2$, what is the:

4. y-intercept
5. Trend of the graph
6. Asymptote

7. Which of the following functions has a steeper graph?
   a. $y = 2^x$
   b. $y = -2^x$
   c. $y = \left(\frac{1}{2}\right)^x$
   d. $y = 3^x$

8. Which of the following is a decreasing function?
   a. $y = 4^x + 2$
   b. $y = 3(2^x)$
   c. $y = 3\left(\frac{4}{3}^x\right)$

d. $y = 2(\frac{1}{3}^x)$

9. What is the range of $f(x) = 2^x - 3$?
   a. $y > -3$
   b. $y \geq -3$
   c. $y < -3$
   d. $y \leq -3$

10. In function $y = 2(4^x) - 3$, the graph is asymptotic to
   a. $y > 2$
   b. x –axis
   c. $y = -3$
   d. $y < -3$

What you will do

Lesson 1

Identify Relationships in Real Life Which are Exponential in Nature

A rabbit at maturity gives birth to two rabbits. If a rabbit gives birth to 2 rabbits, and two rabbits in turn gives birth to two rabbits each, how many rabbits will there be after four rabbits give birth?

Let's see this in a table:

No. of births	1	2	3	4
No. of rabbits	2	4	8	16

This example is exponential in nature and is said to be an *increasing function or an exponential growth .*

Relational statements such as mass of a 200 gram sample of an element being reduced to 100 grams after 10 years is an example of a *decreasing function or an exponential decay*. The period where this occurs is called half-life.

You will encounter terms such as appreciate and growth for increase, and terms such as depreciate, half-life or decay for decrease in the discussions on exponential functions.

Try this out

Tell whether the following statements describes an exponential growth or decay.

1. The population of Kuhala Island doubles every 3 decades.
2. The amount of radioactive isotope of carbon has a half-life of 5500 years.
3. A colony of bacteria grows by 20% every half hour.
4. An amount deposited by Jessie in a bank earns a compound interest of 6% yearly.
5. The value of a car depreciates 10% of its amount every year.
6. A person deciding to go on a diet for 3 months loses $\frac{1}{8}$ kg of his weight every month.
7. A chain letter where each persons sends 3 letters to 3 persons.
8. A radioactive substance decays after a certain time t.
9. The value of a jewelry appreciates 8% every 5 years.
10. A certain culture of bacteria grows from 500 to 400 bacteria every 1.5 hours.

Lesson 2

Given a Table of Ordered Pairs, State Whether the Trend is Exponential or Not

A relation which exhibits an exponential change can be described by a set of values in a table. In your study of the table of values of linear and quadratic functions, you get a constant value in the first differences in y in a linear functions while a constant in the second differences in a quadratic function.

Examples:

a. $y = 3x + 2$

x	-2	-1	0	1	2	3	4
y = f(x)	-4	-1	2	5	8	11	14

3 3 3 3 3 3 *First differences in y*

Notice that a constant value of 3 was obtained in the **first differences in y**. The relation y = 3x + 2 is a **linear function**.

b. $f(x) = -2x^2 + 5$

x	-3	-1	1	3	5	7	9
y = f(x)	-13	3	3	-13	-45	-93	-157

16 0 -16 -32 -48 -64 *First differences in y*

-16 -16 -16 -16 -16 *Second differences in y*

Notice that a constant value of -16 was obtained in the **second differences in y**. The relation $f(x) = -2x^2 + 5$ is a **quadratic function**.

You have seen the behavior of the values of y in the two functions for equal differences in x. Now it is time for you to us study the behavior of the values of y for equal differences in x in the third function.

c. $y = 2^x$

x	0	1	2	3	4	5
y = f(x)	1	2	4	8	16	32

2 2 2 2 2 Equal ratios in *y*

When you **divide the consecutive values of y** you get equal ratios.

This type of relation where a constant ratio between two consecutive values for y for equal differences in x is what we call an **exponential function**.

Try this out

Tell whether the following table of values describe a linear, quadratic or exponential function.

1.

x	1	2	3	4	5	6
y = f(x)	1	3	6	10	15	21

2.

x	0	1	2	3	4	5
y = f(x)	1	3	9	27	81	243

3.

x	0	1	2	3	4	5
y = f(x)	1	5	9	13	17	21

4.

x	0	1	2	3	4	5
y = f(x)	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$

5.

x	0	1	2	3	4	5
y = f(x)	4	8	16	32	64	128

6.

x	0	1	2	3	4	5
y = f(x)	5	7	9	11	13	15

7.

x	-3	-2	-1	0	1	2
y = f(x)	1	6	9	10	9	6

8.

x	1	2	3	4	5	6
y = f(x)	4	8	16	32	64	128

9.

x	0	1	2	3	4	5
y = f(x)	-3	-1	1	3	5	7

10.

x	0	1	2	3	4	5
y = f(x)	-2	-1	1	5	13	29

Lesson 3

Draw the graph of an exponential function $f(x) = a^x$, where a >1

An exponential function of the form $y = a^x$ where a >1. To understand fully exponential function of this form , let us complete the table of values, plot the points and graph the function.

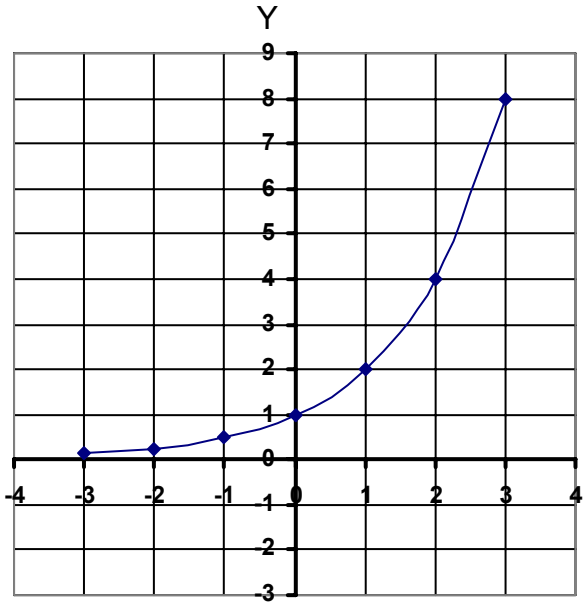
Examples:

1. Construct a table of values for $f(x) = 2^x$ and graph in the coordinate plane.

   Table of values

x	-3	-2	-1	0	1	2	3
y = f(x)	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8

   The graph of $f(x) = 2^x$

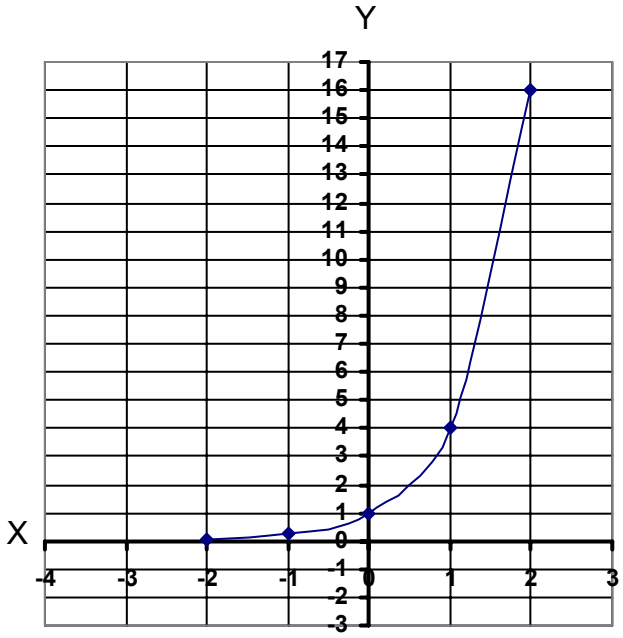


One property of the graph is that it passes the point (0, 1) or the graph has its y – intercept = 1.

2. Construct a table of values for $f(x) = 4^x$ and graph in the coordinate plane.

x	-3	-2	-1	0	1	2	3
y = f(x)	$\frac{1}{64}$	$\frac{1}{8}$	$\frac{1}{4}$	1	4	16	64

The graph of $f(x) = 4^x$



Like the graph of $f(x) = 2^x$, the graph passes (0, 1) and its **y – Intercept = 1**.

To further explore the properties of the graphs, let us plot the points of $f(x) = 2^x$ and $f(x) = 4^x$ on one coordinate plane.

Now let us compare the table of values of the two functions.

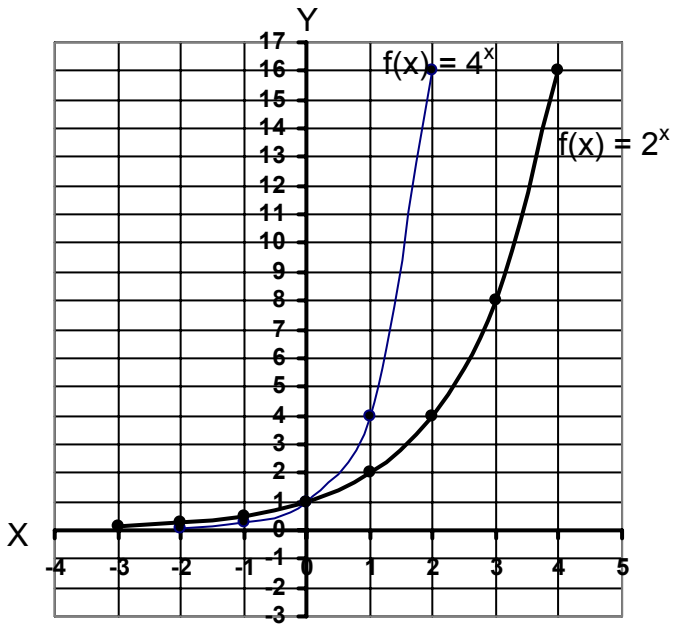
x	$f(x) = 2^x$	$f(x) = 4^x$
-3	$\frac{1}{8}$	$\frac{1}{64}$
-2	$\frac{1}{4}$	$\frac{1}{16}$
-1	$\frac{1}{2}$	$\frac{1}{4}$
0	1	1
1	2	4
2	4	16
3	8	64

What have you noticed?

The set of values for y in $f(x) = 4^x$ tends to be greater than that of $f(x) = 2^x$ as x increases and tends too become much smaller as x decreases.

As x becomes smaller, y also becomes too small that it tends to approach zero. But will a value of x give us a value of 0 for y? Think by analyzing the values of y. Yes, you are right it will never give us a zero value for y.

Compare too the graphs of $f(x) = 2^x$ and $f(x) = 4^x$



What have you noticed?

The graph of $f(x) = 2^x$ is wider compared to the graph of $f(x) = 4^x$, meaning the graph of $f(x) = 4^x$ is **steeper**.

Now you can draw a conclusion for this. The base of the two functions are 4 and 2. This illustrates that the bigger is the base, the steeper is the graph.

Notice also that the graph approaches zero as the value of x becomes smaller. From the table of values, it will never get a zero value for y. Meaning, the graph will not touch the x – axis or the line y = 0. We shall now call this line the **asymptote**.

Let us draw more properties by observing the two graphs. We shall see the **trend of the graph**. Always start from the left side of the graph. See that the graphs increases from left to right. The trend of the graphs of the two functions is therefore increasing. This two functions are increasing functions.

The **domain** (values of x) of an exponential function is the set of real numbers. The range can be observed from the graph. The graph approaches zero but never touches it. Let us make then zero the boundary or the graph is from $y > 0$ going up. Therefore, the **range** is the set of all y's greater than 0 or $\{y/y > 0\}$.

Summarizing the properties in a table.

Function	Domain	Range	Y - intercept	Asymptote	Trend
$f(x) = 2^x$	{x/x ϵ R}	{y/y > 0}	y = 1	y = 0	increasing
$f(x) = 4^x$	{x/x ϵ R}	{y/y > 0}	y = 1	y = 0	increasing

You can now conclude that exponential functions of the form $f(x) = a^x$, where a >1 have these properties.

Now it is your turn to try your skills in constructing tables, graphing and analyzing properties of exponential functions of the form you have learned.

Try this out

A. Fill the table of values below. Sketch the graph the functions in one coordinate plane. Analyze and arrange the properties in the table provided.

1. $y = 1.5^x$
2. $y = 2.5^x$
3. $y = 3^x$

Table of values

x	$y = 1.5^x$	$y = 2.5^x$	$y = 3^x$
-3			
-2			
-1			
0			
1			
2			
3			

The Properties

Function	Domain	Range	Y - intercept	Asymptote	Trend
1. $y = 1.5^x$					
2. $y = 2.5^x$					
3. $y = 3^x$					

B. For each pair of functions, which has a steeper graph?

1. $y = 1.5^x$ and $y = 3^x$
2. $y = 2^x$ and $y = 2.5^x$
3. $y = 3^x$ and $y = 3.5^x$
4. $y = 4^x$ and $y = 3^x$
5. $y = 4.2^x$ and $y = 4^x$
6. $y = 7^x$ and $y = 9^x$
7. $y = 5^x$ and $y = 1.5^x$
8. $y = 3^x$ and $y = 8^x$
9. $y = 6^x$ and $y = .6^x$
10. $y = 4^x$ and $y = 5^x$

Lesson 4

Draw the graph of an exponential function $f(x) = a^x$, where $0 < a < 1$.

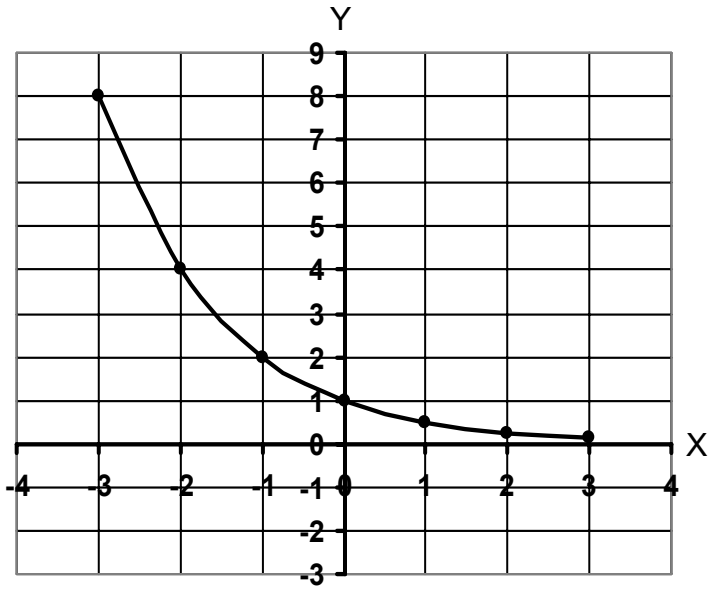
Now let us try graphing exponential functions of the form $f(x) = a^x$, where is $0 < a < 1$. They simply are the base that are fractions between 0 and 1. See how the graphs differ with that of the previous lesson.

Example: Graph $y = \left(\frac{1}{2}\right)^x$

Table of values

x	$y = \left(\frac{1}{2}\right)^x$
-3	8
-2	4
-1	2
0	1
1	$\frac{1}{2}$
2	$\frac{1}{4}$
3	$\frac{1}{8}$

The graph



Properties of $y = \left(\frac{1}{2}\right)^x$

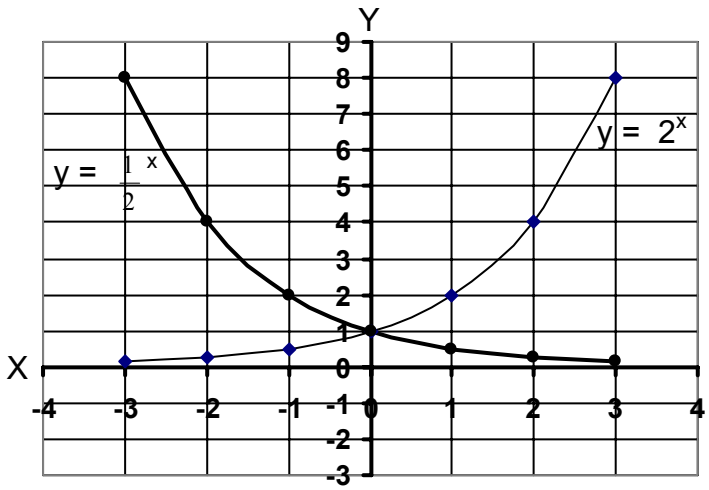
Function	Domain	Range	Y - intercept	Asymptote	Trend
$y = \left(\frac{1}{2}\right)^x$	{x/x ϵ R}	{y/y > 0}	y = 1	y = 0	decreasing

Now, compare the graphs of $y = 2^x$ and $y = \left(\frac{1}{2}\right)^x$

Table of values

x	$y = 2^x$	$y = \left(\frac{1}{2}\right)^x$
-3	$\frac{1}{8}$	8
-2	$\frac{1}{4}$	4
-1	$\frac{1}{2}$	2
0	1	1
1	2	$\frac{1}{2}$
2	4	$\frac{1}{4}$
3	8	$\frac{1}{8}$

The graphs of $y = 2^x$ and $y = \left(\frac{1}{2}\right)^x$



The graph of $y = \left(\frac{1}{2}\right)^x$ is the mirror image of $y = 2^x$ with respect to the y - axis.

The properties of the two functions:

Function	Domain	Range	Y - intercept	Asymptote	Trend
$y = 2^x$	{x/x ϵ R}	{y/y > 0}	y = 1	y = 0	increasing
$y = \left(\frac{1}{2}\right)^x$	{x/x ϵ R}	{y/y > 0}	y = 1	y = 0	decreasing

Note: $f(x) = \left(\frac{1}{2}\right)^x$ and $f(x)=2^{-x}$ are the same.

Try this out

A. Complete the table of values. Sketch the graph of each pair of functions in one coordinate plane.

1. If $y = 3^x$ and $y = \left(\frac{1}{3}\right)^x$

Table of values

x	$y = 3^x$	$y = \left(\frac{1}{3}\right)^x$
-3		
-2		
-1		
0		
1		
2		
3		

2. If $y = 4^x$ and $y = \left(\frac{1}{4}\right)^x$

Table of values

x	$y = 4^x$	$y = \left(\frac{1}{4}\right)^x$
-3		
-2		
-1		
0		
1		
2		
3		

B. Tell which of the following is an increasing or decreasing function.

1. $y = 6^x$
2. $y = 4^{-x}$
3. $y = 3.5^x$
4. $y = 10^x$
5. $y = 8^{-x}$
6. $y = 7^{-x}$
7. $y = 9^x$
8. $y = 8^x$
9. $y = 12^x$
10. $y = 12^{-x}$

C. Write the properties of the functions in the table:

Function	Domain	Range	y-intercept	Asymptote	Trend
1. $f(x)= 7^{-x}$					
2. $f(x) = 7^x$					
3. $f(x) = \left(\frac{1}{5}\right)^x$					
4. $f(x) = 5^{-x}$					
5. $f(x) = \left(\frac{4}{3}\right)^x$					
6. $f(x) = \left(\frac{2}{3}\right)^x$					
7. $f(x) = 9^x$					
8. $f(x) = 9^{-x}$					
9. $f(x) = \left(\frac{3}{2}\right)^x$					
10. $f(x) = \left(\frac{3}{2}\right)^{-x}$					

Lesson 5

Draw the graph of an exponential function $f(x) = Ba^x$ and $f(x) = a^x + c$, and compare it to the graph of $f(x) = a^x$

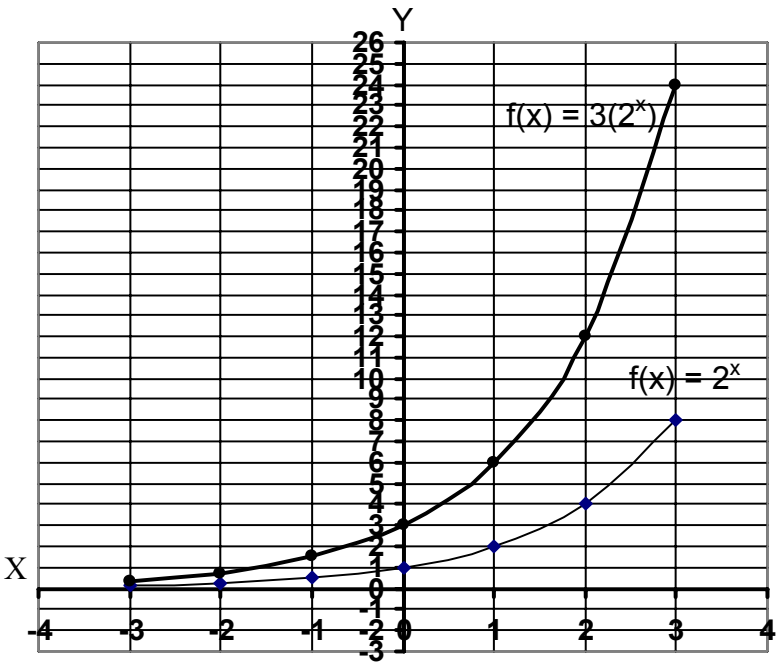
If the function is multiplied or added to a constant, how will it affect the reference function $f(x) = a^x$? Let's find out. Consider the following examples.

Example: Sketch the graph of $f(x) = 3(2^x)$ and $f(x) = 2^x$

Table of values

x	$f(x) = 2^x$	$f(x) = 3(2^x)$
-3	$\frac{1}{8}$	$\frac{3}{8}$
-2	$\frac{1}{4}$	$\frac{3}{4}$
-1	$\frac{1}{2}$	$\frac{3}{2}$
0	1	3
1	2	6
2	4	12
3	8	24

The graph of $f(x) = 3(2^x)$ and $f(x) = 2^x$



Check the table of values. You will notice that the values of $f(x) = 3(2^x)$ is 3 times the values of $f(x) = 2^x$. The graph of $f(x) = 3(2^x)$ is translated 3 units vertically upwards from the graph of $f(x) = 2^x$. In this case, the y – intercept of $f(x) = 3(2^x)$ is 3.

Let's summarize the properties of the two graphs.

Function	Domain	Range	Y - intercept	Asymptote	Trend
$f(x) = 2^x$	$\{x/x \in R\}$	$\{y/y > 0\}$	y = 1	y = 0	increasing
$f(x) = 3(2^x)$	$\{x/x \in R\}$	$\{y/y > 0\}$	y = 3	y = 0	increasing

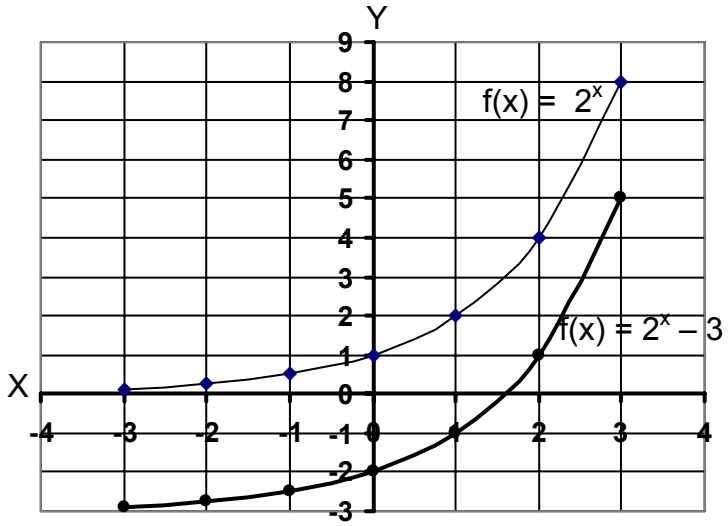
If a constant *c* is added to $f(x) = a^x$ to be transformed into $f(x) = a^x + c$, what will happen to the function? You can find out by doing the same procedure as we did in the first example.

Example: Graph $f(x) = 2^x$ and $f(x) = 2^x - 3$

Table of values

x	$f(x) = 2^x$	$f(x) = 2^x - 3$
-3	$\frac{1}{8}$	$-\frac{23}{8}$
-2	$\frac{1}{4}$	$-\frac{11}{4}$
-1	$\frac{1}{2}$	$-\frac{5}{2}$
0	1	-2
1	2	-1
2	4	1
3	8	5

The graph



Check the table of values. You will notice that the values of $f(x) = 2^x - 3$ is 3 units less than the values of $f(x) = 2^x$. The graph of $f(x) = 2^x - 3$ is translated 3 units vertically downwards from the graph of $f(x) = 2^x$. In this case, the asymptote of $f(x) = 2^x - 3$ is -3.

Let's summarize the properties.

Function	Domain	Range	Y - intercept	Asymptote	Trend
1. $f(x) = 2^x$	$\{x/x \epsilon R\}$	$\{y/y > 0\}$	y = 1	y = 0	increasing
2. $f(x) = 2^x - 3$	$\{x/x \epsilon R\}$	$\{y/y > 0\}$	y = 2	y = -3	decreasing

Try this out

A. Complete the table of values and graph of the following functions.

1. $y = 2(2^x)$

x	$y = 2(2^x)$
-3	
-2	
-1	
0	
1	
2	
3	

2. $f(x) = 3^x - 4$

x	$f(x) = 3^x - 4$
-3	
-2	
-1	
0	
1	
2	
3	

B. Without graphing determine the y-intercept of each function.

1. $y = 8^x$
2. $y = 5^{-x}$
3. $y = 2(6^{-x})$

4. $y = 3(2^x)$
5. $y = 5(\frac{1}{5}^x)$
6. $f(x) = 3(3^x) - 1$
7. $f(x) = 2(3^x) + 2$
8. $f(x) = 5(\frac{2}{5}^x) + 3$
9. $f(x) = 2^x + 3$
10. $f(x) = 2(3^x) - 4$

C. Without graphing determine the asymptote of each function.

1. $f(x) = 9^x$
2. $y = 3(2^x)$
3. $y = 2(7^{-x})$
4. $f(x) = 8^{-x}$
5. $y = \frac{1}{5}^x$
6. $y = 5(2^x) - 2$
7. $f(x) = 2(3^x) + 3$
8. $y = 6(\frac{1}{2}^x) - 5$
9. $y = 3(\frac{2}{3}^x) + 2$
10. $f(x) = 2(5^x) - 3$

Let's Summarize

1. For functions of the form $y = a^x$, where $a > 1$

   - $y = a^x$ is an increasing function
   - The asymptote of the curve is the x-axis or line y = 0.
   - The domain is the set of real number.
   - The range is y /y > 0.
   - The greater is the base the steeper is the graph.

2. For functions of the form $y = a^x$, where $0 < a < 1$

   - $y = a^x$ is a decreasing function
   - The asymptote is the x-axis or line y =0.
   - The domain is the set of real number
   - The range is y/y > 0.

- The smaller is the base the steeper is the graph.

3. For $f(x) = B(a^x)$, the y – Intercept of the graph is multiplied B times and the asymptote is the line y = 0 or the x - axis.

4. For $f(x) = B(a^x) + c$, c is the asymptote of the curve and the y – intercept is translated c units from $f(x) = B(a^x)$.

What have you Learned

Answer the following:

1. Which of the following statements describes an exponential growth?

   a. A population grows 5% every year.
   b. The cost of an apple per kilogram.
   c. The area of a square of side s.
   d. The height of a person with respect to his age.

2. Which of the following table of values describes an exponential function?

a.

x	-2	-1	0	1	2
y	9	6	5	6	9

b.

x	-2	-1	0	1	2
y	$\frac{1}{9}$	$\frac{1}{3}$	1	3	9

c.

x	1	2	3	4	5
y	1	3	5	7	9

d.

x	0	1	2	3	4
y	2	5	8	11	14

3. In the function $y = 4(3^x) – 1$, the graph is asymptotic to

   a. y = 1
   b. y-axis
   c. y = -1
   d. x - axis

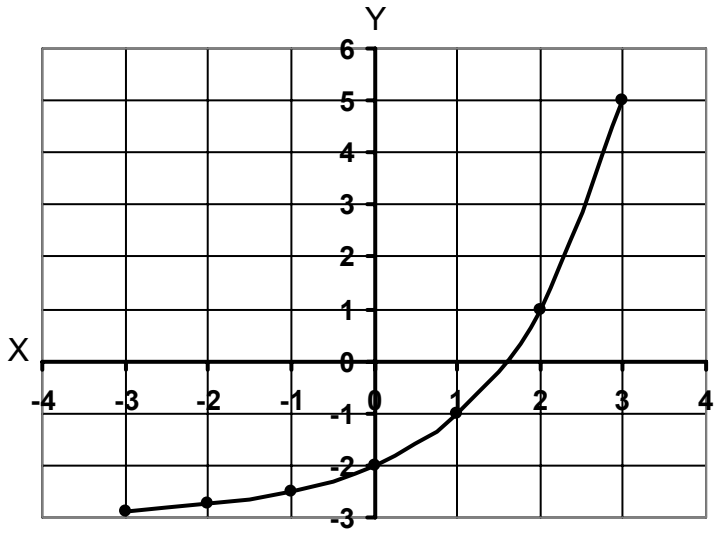
4. Which function is increasing?

   a. $y = -2^x$
   b. $y = 2(\frac{1}{2}^x)$
   c. $y = 3(4^{-x})$
   d. $y = -4(2^{-x})$

5. What is the y-intercept of the function $y = 4(2^x) – 2$?

   a. 2
   b. –2
   c. 4
   d. 1

From the graph,



determine the:

6. y-intercept
7. asymptote
8. Trend of the graph

9. Which is a decreasing function?

   a. $y = 7^x – 2$
   b. $y = 7^{-x} + 2$
   c. $y = 3(5^x) – 5$
   d. $y = 5(3^x) + 3$

10. What function is the reflection of $y = 10^x$ with respect to the y-axis?

Answer key

How much do you know

1. d
2. d
3. c
4. 1
5. increasing
6. -2
7. d
8. d
9. a
10. c

Try this out

Lesson 1

1. Exponential growth
2. Exponential decay
3. Exponential growth
4. Exponential growth
5. Exponential decay
6. Exponential decay
7. Exponential growth
8. Exponential decay
9. Exponential growth
10. Exponential growth

Lesson 2

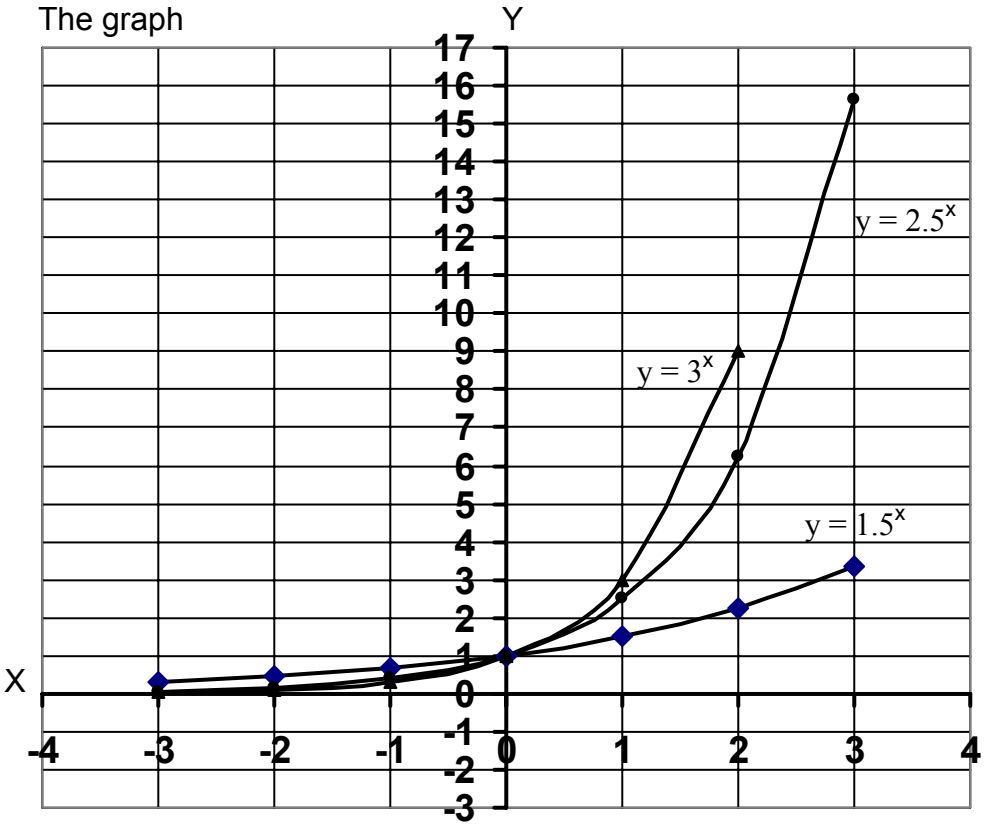
1. Quadratic
2. Exponential
3. Linear
4. Exponential
5. Exponential
6. Linear
7. Quadratic
8. Exponential
9. Linear
10. Exponential

Lesson 3

1. Table of values

x	$y = 1.5^x$	$y = 2.5^x$	$y = 3^x$
-3	.296	.064	.037
-2	.444	.16	.111
-1	.667	.4	.33
0	1	1	1
1	1.5	2.5	3
2	2.25	6.25	9
3	3.375	15.625	27

The graph



The Properties

Function	Domain	Range	Y - intercept	Asymptote	Trend
1. $y = 1.5^x$	Set of Real nos.	y/y > 0	I	x – axis or line y = 0	Increasing
2. $y = 2.5^x$	Set of Real nos.	y/y > 0	1	x – axis or line y = 0	Increasing
3. $y = 3^x$	Set of Real nos.	y/y > 0	1	x – axis or line y = 0	Increasing

B.

1. $y = 3^x$
2. $y = 2.5^x$
3. $y = 3.5^x$
4. $y = 4^x$
5. $y = 4.2^x$
6. $y = 9^x$
7. $y = 5^x$
8. $y = 8^x$
9. $y = 6^x$
10. $y = 5^x$

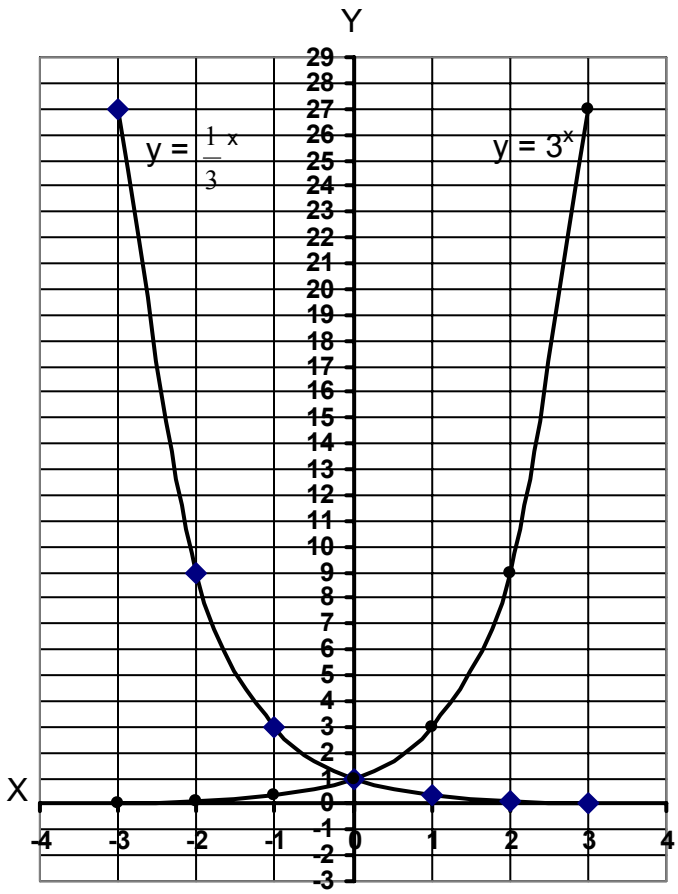
Lesson 4

A.

1. $y = 3^x$ and $y = \frac{1}{3}^x$

Table of Values

x	$y = 3^x$	$y = \frac{1}{3}^x$
-3	$\frac{1}{27}$	27
-2	$\frac{1}{9}$	9
-1	$\frac{1}{3}$	3
0	1	1
1	3	$\frac{1}{3}$
2	9	$\frac{1}{9}$
3	27	$\frac{1}{27}$

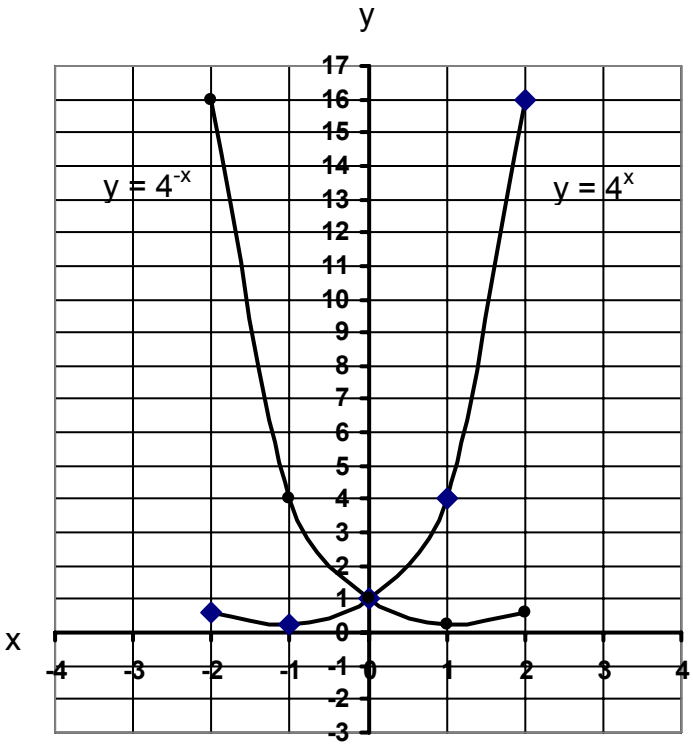


2. If $y = 4^x$ and $y = 4^{-x}$

Table of values

x	-3	-2	-1	0	1	2	3
$y = 4^x$	.015	.62	.25	1	4	16	64
$y = 4^{-x}$	64	16	4	1	.25	.62	.015

The graph



B.

1. increasing
2. decreasing
3. increasing
4. increasing
5. decreasing
6. decreasing
7. increasing
8. increasing
9. increasing
10. decreasing

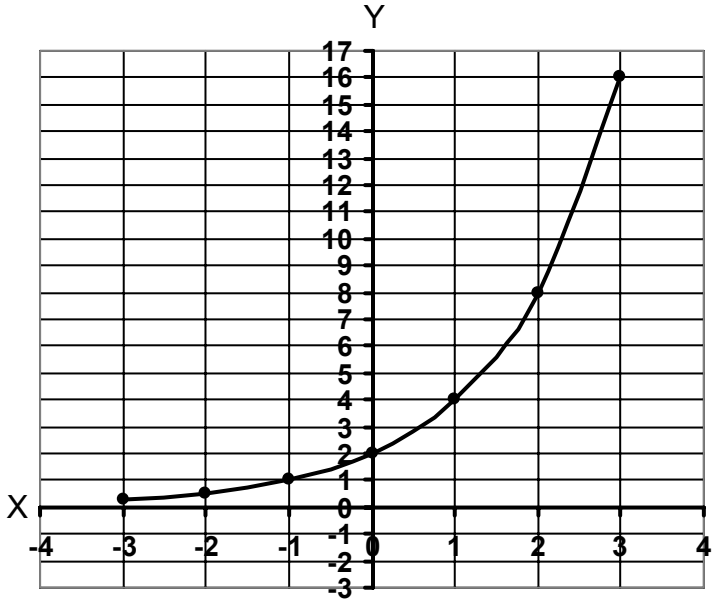
C.

Function	Domain	Range	y-intercept	Asymptote	Trend
1. $f(x)= 7^{-x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	decreasing
2. $f(x) = 7^{x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	Increasing
3. $f(x) = \frac{1}{5}^{x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	decreasing
4. $f(x) = 5^{-x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	decreasing
5. $f(x) = \frac{4}{3}^{x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	Increasing
6. $f(x) = \frac{2}{3}^{x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	decreasing
7. $f(x) = 9^{x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	Increasing
8. $f(x) = 9^{-x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	decreasing
9. $f(x) = \frac{3}{2}^{x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	Increasing
10. $f(x) = \frac{3}{2}^{-x}$	Set of Real Nos.	y/y > 0	1	y =0 or the x - axis	decreasing

Lesson 5

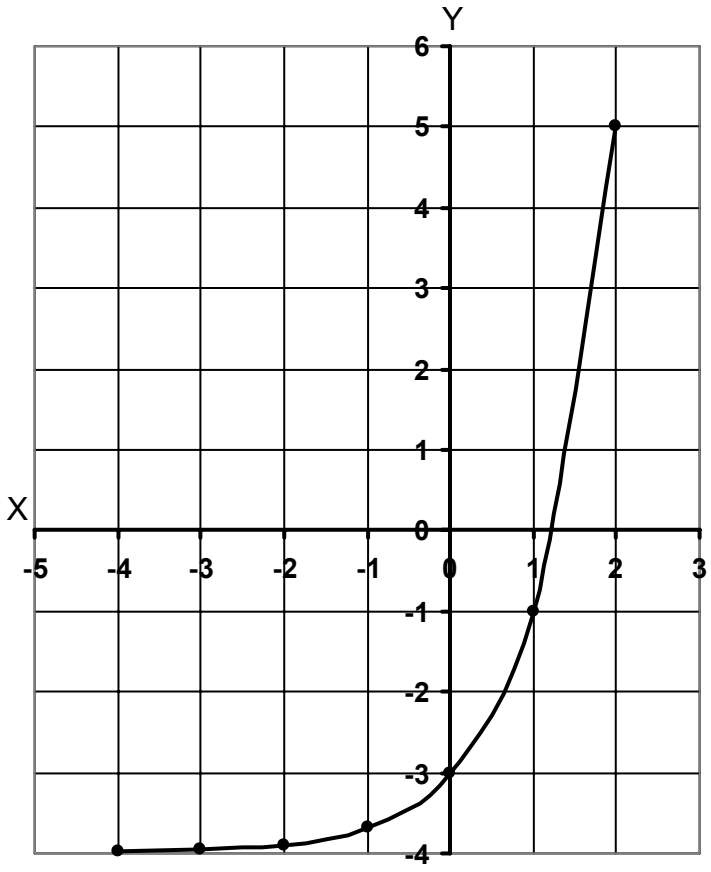
1. $y = 2(2^{x})$

x	$y = 2(2^{x})$
-3	0.25
-2	0.5
-1	1
0	2
1	4
2	8
3	16



2. $y = 3^x - 4$

x	$y = 3^x - 4$
-3	-3.96
-2	-3.89
-1	-3.67
0	-3
1	-1
2	5
3	23



B.

1. 1
2. 1
3. 2
4. 3
5. 5
6. 2
7. 4
8. 8
9. 4
10. -2

C.

1. y = 0
2. y = 0
3. y = 0
4. y = 0
5. y = o
6. -2
7. 3
8. -5
9. 2
10. -3

What have you Learned

1. a
2. b
3. c
4. b
5. 2
6. -2
7. y = -3
8. increasing
9. b
10. $y = 10^{-x}$