11

General Mathematics

Quarter 1 – Module 6:
Exponential Functions

SELF-LEARNING MODULE

SLM

DEPARTMENT OF EDUCATION - SOCCSKSARGEN

General Mathematics – Grade 11
Self-Learning Module (SLM)
Quarter 1 – Module 6: Exponential Functions
First Edition, 2020

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre test are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module, or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teachers are also provided to the facilitators and parents for strategies and reminders on how they can best help you on your home based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. Read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you master the concept of exponential functions. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

This module consists of one lesson. It presents the lesson in the following outline:

1. Solving Exponential Equations and Inequalities
2. Domain and Range of Exponential Functions
3. Intercepts, Zeroes and Asymptotes of Exponential Functions

After going through this module, you are expected to:

1. solve exponential equations and inequalities (M11GM-Ie-f-1);
2. represent an exponential function through its: (a) table of values, (b) graph, (c) equation (M11GM-If-2);
3. find the domain and range of an exponential function (M11GM- If-3); and
4. determine the intercepts, zeroes, and asymptotes of an exponential functions (M11GM-If-3).
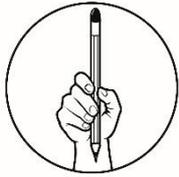
Find how much you already know about the topic in this module. Take note of the items that you were not able to answer correctly and find the right answer as you go through this module.

Write the letter of the correct answer on your answer sheet.

1. The _____ of an exponential function is the value of x that gives y = 0.

    A. Asymptotes   B. Zeroes   C. Intercepts   D. Domain

2. Solve for x in the equation $2^{x-1} = 2^{2x-4}$.

    A. -1   B. -3   C. 3   D. 6

3. Which of the following is an exponential function?

    A. $y = x^3 + 2$
    B. $y = 5^{-x}$
    C. $y = 3x^2 + x$
    D. $y = -3^x$

4. What is the range of the graph of an exponential functions of the form $f(x) = a^x$ where a > 1?

    A. set of all real numbers
    B. set of all positive real numbers
    C. set of all negative numbers
    D. set of all integers

5. If f(x) = bˣ, 0< b < 1, which property of exponential function is TRUE?

    A. The domain is the set of real numbers.
    B. The range is the set of positive real numbers.
    C. As x increases, bˣ decreases.
    D. All of these

6. The graph of an exponential functions of the form f(x) = aˣ where $a > 1$ has no x-intercept because it is asymptotic to

    A. x-axis
    B. x = 1
    C. y-axis
    D. y =

7. The graph $f(x) = 3^x$ and $g(x) = 6^x$ will intersect at __

    A. (3, 6)   B. (6, 3)   C. (1, 0)   D. (0, 1)

8. The following properties of $f(x) = b^x$, where $b > 0$ and $b \neq 1$, can be observed from the graph EXCEPT

    A. The domain is the set of all positive real numbers.
    B. The range is the set of all positive real numbers.
    C. The y-intercept is 1. There is no x-intercept.
    D. The horizontal asymptote is the line y = 0 (or the x-axis). There is no vertical asymptote.

9. Which of the following are the correct steps in graphing exponential functions?

I. Plot the points in the Cartesian Plane
II.   Complete the table of values
III.   Connect the points

A. III, I, II   B. II, I, III   C. II, I, III   D. I, III, II

10. Which of the following tables of values exhibit an exponential trend?

A.

X	-2	-1	0	1	2
Y	1/4	½	1	2	4

B.

X	-1	0	1	2	3
Y	-3	0	3	6	9

C.

X	-3	-2	-1	0	1
Y	0	1	2	3	4

D.

X	-3	-2	-1	0	1
Y	4	2	1	2	4

11. Find the value of x in the inequality $(\frac{1}{27})^{3x+13} \leq 9^{5x-\frac{1}{2}}$

A. x ≥ -2   B. x ≤ -2   C. x < 4   D. x > 4

12. Solve for x in the equation $256 = 4^{x-5}$
A. 9
B. 12
C. 27
D. 30

13. The _____ is a line or curve that approaches a given curve arbitrarily closely either in ordinate or abscissa but it never touches.
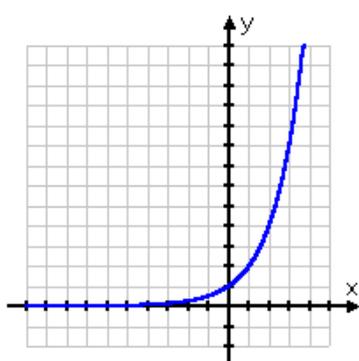
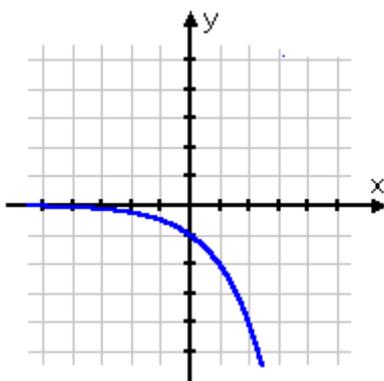A. Asymptotes   B. Zeroes   C. Intercepts   D. Domain
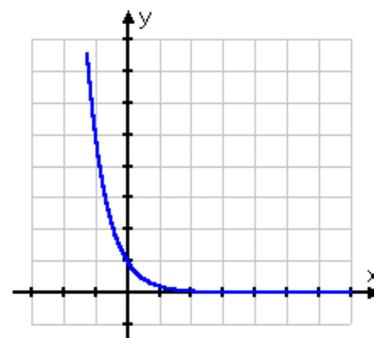
For questions 14-15, please refer to the following exponential graphs:

Graph 1   Graph 2   Graph 3

14. Graph of $y = 2^x$
A. Graph 1   B. Graph 2   C. Graph 3   D. none of these

15. Graph of $y = 2^{-x}$
A. Graph 1   B. Graph 2   C. Graph 3   D. none of these

| Lesson 1 | Exponential Equations and Inequalities; and Exponential Functions |

What's In

In the previous lessons, you were able to distinguish among exponential functions, exponential equations and exponential inequalities. As you go through with this module, you will need some important concepts which you may apply in solving exponential equations and inequalities as well as the different properties of exponential function.

Activity 1.1 How Will Do You Know Me?

Determine whether or not each expression is an exponential equation, exponential inequalities, or neither. Put a check (√) on the space that corresponds your answer.

Expression	Exponential Equation	Exponential Inequality	Neither
1. $49 = 7^{x+1}$			
2. $7 = 2x + 3$			
3. $3^x = 3^{2x-1}$			
4. $y = 5x^3$			
5. $5^{x-1} = 125$			
6. $8x = x^2 - 9$			
7. $f(x) = e^x$			
8. $x^2 = 3x^2 + 2x - 1$			
9. $2x + 3 < x - 1$			
10. $2^{x-2} \geq 8$			

 What's New

Recall the following definitions and theorems.

Definition.

Let a ≠ 0. We define the following:

- $a^0 = 1$
- $a^{-n} = \frac{1}{a^n}$

Theorem.

Let *r* and *s* be rational numbers. Then

- $a^r a^s = a^{r+s}$
- $\frac{a^r}{a^s} = a^{r-s}$
- $(a^r)^s = a^{rs}$
- $(ab)^r = a^r b^r$
- $\left(\frac{a}{b}\right)^r = \frac{a^r}{b^r}$

Activity 1.2 Solve and Conquer!

Solve each equation using the principle: if $b^x = b^y$, then x = y.

1. $7^x = 7^2$
2. $3^x = 9^4$
3. $2^{x+6} = 2^5$
4. $2^x = 128$
5. $3^{2x} = 243$

6. $2^{x-2} = 64$
7. $3^{2x+1} = 729$
8. $9^{x-1} = 27^{x+4}$
9. $4^{x-1} = 2^{x+5}$
10. $5^{2x-1} = 625$

 What is It

Some exponential equations can be solved by using the fact that exponential functions are one-to-one.

One-to-one Property of Exponential Functions

If $x_1 \neq x_2$, then $b^{x_1} \neq b^{x_2}$. Conversely, if $b^{x_1} = b^{x_2}$ then $x_1 = x_2$.

(One strategy to solve exponential equations is to write both sides of the equation as powers of the same base.)

EXAMPLE 1. Solve the equation $4^{x-1} = 16$.

Solution: Write both sides with 4 as the base.

$$4^{x-1} = 16$$
$$4^{x-1} = 4^2$$
$$x - 1 = 2$$
$$x = 2 + 1$$

8

$$x = 3$$

Alternate Solution. Write both sides with 2 as the base.

$$4^{x-1} = 16$$
$$(2^2)^{x-1} = 2^4$$
$$2^{2(x-1)} = 2^4$$
$$2(x - 1) = 4$$
$$2x - 2 = 4$$
$$2x = 6$$
$$x = 3$$

EXAMPLE 2. Solve the equation $125^{x-1} = 25^{x+3}$.

Solution: Both 125 and 25 can be written using 5 as the base.

$$125^{x-1} = 25^{x+3}$$
$$(5^3)^{x-1} = (5^2)^{x+3}$$
$$5^{3(x-1)} = 5^{2(x+3)}$$
$$3(x - 1) = 2(x + 3)$$
$$3x - 3 = 2x + 6$$
$$x = 9$$

EXAMPLE 3. Solve the equation $9^{x^2} = 3^{x+3}$

Solution: Both 9 and 3 can be written using 3 as the base.

$$(3^2)^{x^2} = 3^{x+3}$$
$$3^{2x^2} = 3^{x+3}$$
$$2x^2 = x + 3$$
$$2x^2 - x - 3 = 0$$
$$(2x - 3)(x + 1) = 0$$
$$2x - 3 = 0 \text{ or } x + 1 = 0$$
$$x = 3/2 \text{ or } x = -1$$

Exponential inequalities can be solved using the following property.

Property of Exponential Inequalities

If $b > 1$, then the exponential function $y = b^x$ is increasing for all x. This means that $b^x < b^y$ if and only if $x < y$.

If $0 < b < 1$, then the exponential function $y = b^x$ is decreasing for all x. This means that $b^x > b^y$ if and only if $x < y$.

(Be careful when solving exponential inequalities such as $b^m < b^n$. The resulting direction of the inequality ($m < n$ or $m > n$) is based on whether the base b is greater than 1 or less than 1.)

EXAMPLE 4. Solve the inequality $3^x < 9^{x-2}$.

Solution: Both 9 and 3 can be written using 3 as the base.

$$3^x < (3^2)^{x-2}$$
$$3^x < 3^{2(x-2)}$$
$$3^x < 3^{2x-4}$$

Since the base $3 < 1$, then this inequality is equivalent to

$$x < 2x - 4 \text{ (the direction of inequality is retained)}$$
$$4 < 2x - x$$
$$4 < x$$

Thus, the solution set is (4, + ∞]. (You can verify that x = 5 and 6 are solutions, but x = 4 and 3 are not.)

EXAMPLE 5. Solve the inequality $\left(\frac{1}{10}\right)^{x+5} \geq \left(\frac{1}{100}\right)^{3x}$.

Solution: Since $\frac{1}{10} = \left(\frac{1}{10}\right)^2$, then we write both sides of the inequality with $\frac{1}{10}$ as the base.

$$\left(\frac{1}{10}\right)^{x+5} \geq \left(\frac{1}{100}\right)^{3x}$$

$$\left(\frac{1}{10}\right)^{x+5} \geq \left(\frac{1}{10^2}\right)^{3x}$$

$$\left(\frac{1}{10}\right)^{x+5} \geq \left(\frac{1}{10}\right)^{6x}$$

Since the base $\frac{1}{10} < 1$, then this inequality is equivalent to

x + 5 ≤ 6x (the direction of the inequality is reversed)

5 ≤ 6x − x

5 ≤ 5x

1 ≤ x

Thus, the solution set is [1, +∞). (You can verify that x = 1 and 2 are solutions, but x = 0 and 1 are not.)

EXAMPLE 6. The half-life of Zn-71 is 2.45 minutes. Initially, there were y_0 grams of Zn-71, but only $\frac{1}{256}$ of this amount remains after some time. How much time has passed?

Solution: We can determine that after t minutes, the amount of Zn-71 in the substance is y = $y_0 \left(\frac{1}{2}\right)^{t/2.45}$. We solve the equation $y_0 \left(\frac{1}{2}\right)^{t/2.45} = \frac{1}{256} y_0$:

$$\left(\frac{1}{2}\right)^{t/2.45} = \frac{1}{256}$$

$$\left(\frac{1}{2}\right)^{t/2.45} = \left(\frac{1}{2}\right)^{8}$$

$$\frac{t}{2.45} = 8$$

$$t = 19.6$$

Thus, 19.6 minutes have passed since $t = 0$.

Equation of Exponential Functions

Exponential functions occur in various real world situations. It is used to model real-life situations such as population growth, radioactive decay, carbon dating, growth of an epidemic, loan interest rates, and investments.

Exponential function is a function of the form $f(x) = b^x$ where $b > 0$ and $b \neq 1$. An exponential function is not solved. Rather, it expresses a relationship between two variables (such as x and y).

Solved Examples

Determine whether the given is an exponential function or not.
1. $f(x) = 5x^2$ (Answer: Not)
2. $2 \geq \left(\frac{1}{2}\right)^x$ (Answer: Not)
3. $7^{4x} = y$ (Answer: Exponential function)
4. $4(10^{x-2}) = 500$ (Answer: Not)
5. $7 < 14^{x+3}$ (Answer: Not)
6. $y = 0.5^x$ (Answer: Exponential function)

Table of Values of Exponential Functions

A table values represent an exponential function if and only if ***first equal difference in x's yields first equal ratio in y's.***

Solved Examples

Determine whether the following table of values represent an exponential function or not.

1.

x	0	1	2	3
$f(x)$	- 6	-1	4	9

                 1   1   1

x	0	1	2	3
$f(x)$	- 6	-1	4	9

             $\frac{1}{6}$ -4 $\frac{9}{4}$

Equal first difference in x does not produce first equal ratio in y. Thus, the given table of values does not represent exponential function.

2.

x	0	1	2	3
$f(x)$	50	20	8	3.2

	1	1	1

x	0	1	2	3
$f(x)$	50	20	8	3.2

0.4   0.4   0.4

Equal first difference in x produces first equal ratio in y. Thus, the given table of values represent exponential function.

3.

x	0	1	2	3
$f(x)$	7	4	3	4

	1	1	1

x	0	1	2	3
$f(x)$	7	4	3	4

0.57   0.75   1.33

Equal first difference in x does not produce first equal ratio in y. Thus, the given table of values does not represent exponential function.

Graphs of Exponential Function

The following are the steps in graphing exponential functions.

1. Construct a table of values of ordered pairs for the given function.
2. Plot the points found in the table.
3. Connect the points using a smooth curve.

Example 1. Sketch the graph of $f(x) = 2^x$

Solution.

Step 1: Construct a table of values of ordered pairs for the given function. The table of values for $f(x) = 2^x$ is as follows:

x	−4	−3	−2	−1	0	1	2	3
$f(x)$								

$$f(-4) = 2^{-4} = \frac{1}{2^4} = \frac{1}{16}$$

$$f(-3) = 2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

$$f(-2) = 2^{-2} = \frac{1}{2^2} = \frac{1}{4}$$

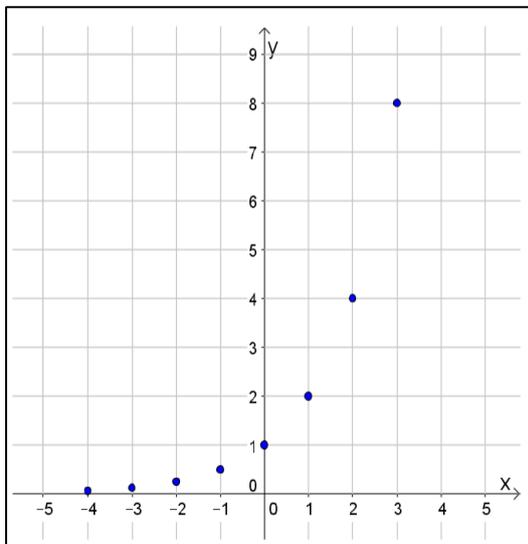$$f(-1) = 2^{-1} = \frac{1}{2^1} = \frac{1}{1}$$

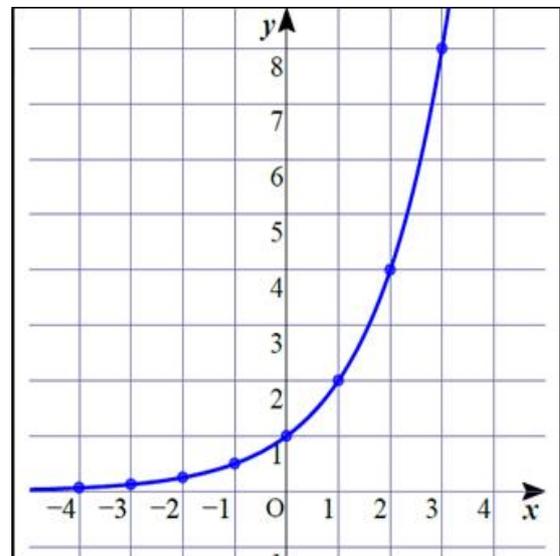$$f(0) = 2^0 = 1$$

$$f(1) = 2^1 = 2$$

$$f(2) = 2^2 = 4$$

$$f(3) = 2^3 = 8$$

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

Step 2. Plot the points found in the table.

Step 3. Connect the points using a smooth curve.

It can be observed that the function is defined for all values of x, is strictly increasing, and attains only positive y-values. As x decreases without bound, the function approaches 0. That is, the line $y = 0$ is a horizontal asymptote.

Example 2. Sketch the graph of $g(x) = \left(\frac{1}{2}\right)^x$

 Solution.

Step 1: Construct a table of values of ordered pairs for the given function. The table of values for $g(x) = \left(\frac{1}{2}\right)^x$ is as follows:

x	-3	-2	-1	0	1	2	3	4
$g(x)$								

$$g(-3) = \left(\frac{1}{2}\right)^{-3} = 2^3 = 8$$

$$g(-2) = \left(\frac{1}{2}\right)^{-2} = 2^2 = 4$$

$$g(-1) = \left(\frac{1}{2}\right)^{-1} = 2^1 = 2$$

$$g(0) = \left(\frac{1}{2}\right)^{0} = 1$$

$$g(1) = \left(\frac{1}{2}\right)^{1} = \frac{1^2}{2^2} = \frac{1}{2}$$

$$g(2) = \left(\frac{1}{2}\right)^{2} = \frac{1^2}{2^2} = \frac{1}{4}$$

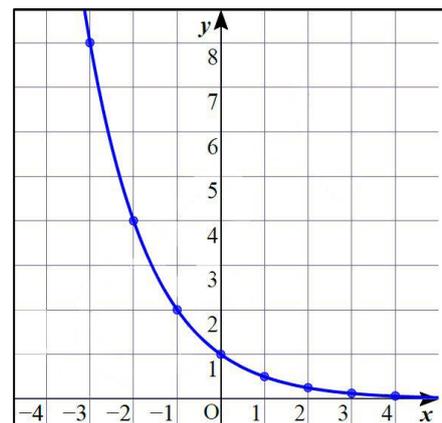$$g(3) = \left(\frac{1}{2}\right)^{3} = \frac{1^3}{2^3} = \frac{1}{8}$$

$$g(4) = \left(\frac{1}{2}\right)^{4} = \frac{1^4}{2^4} = \frac{1}{16}$$

x	-3	-2	-1	0	1	2	3	4
$g(x)$	8	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$

**Step 2.** Plot the points found in the table.

Step 3. Connect the points using a smooth curve.

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It can be observed that the function is defined for all values of x, is strictly decreasing, and attains only positive values. As x increases without bound, the function approaches 0. That is, the line $y = 0$ is a horizontal asymptote.

In general, depending on whether $b > 1$ or $0 < b < 1$, the graph of $f(x) = b^x$ has the following behavior:
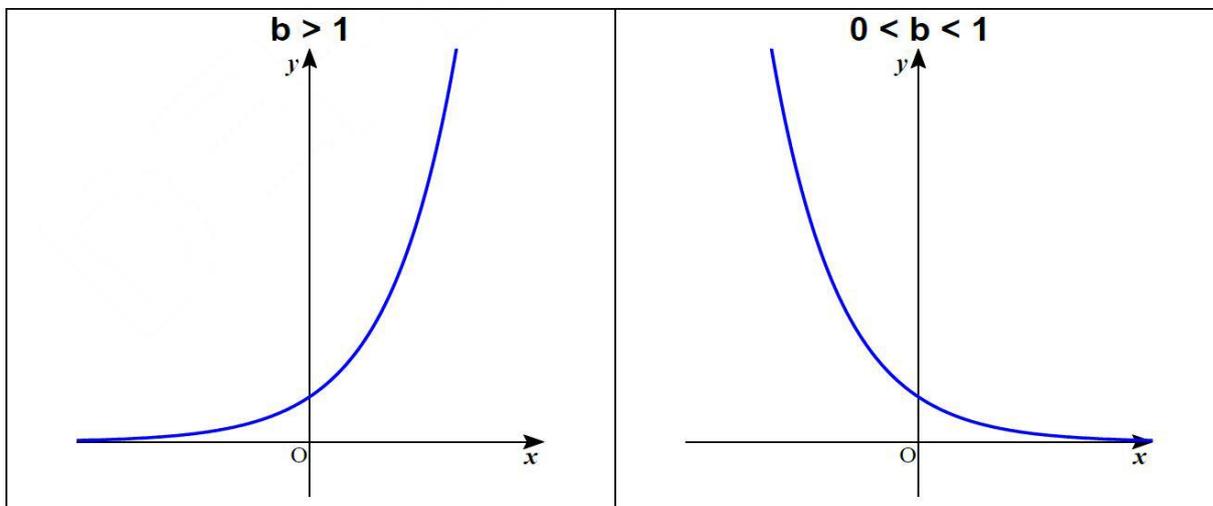
PROPERTIES OF EXPONENTIAL FUNCTIONS
1. The domain is the set of all real numbers.
2. The range is the set of all positive real numbers.
3. It is a one-to-one function. It satisfies the Horizontal Line Test.
4. The y-intercept is 1. There is no x-intercept.
5. The horizontal asymptote is the line y = 0 (or the x-axis). There is no vertical asymptote.
6. The function is increasing if b > 1, and is decreasing if 0 < b < 1.

Example 3. Graph the functions $f(x) = 3^x$ and $g(x) = 4^x$ in the same coordinate plane. Indicate the domain, range, y-intercept, and horizontal asymptote. Compare the two graphs.

x	-2	-1	0	1
$f(x)$	$\dfrac{1}{9}$	$\dfrac{1}{3}$	1	3
$g(x)$	$\dfrac{1}{16}$	$\dfrac{1}{4}$	1	4

Solution. For both these functions, the base is greater than 1. Thus, both functions are increasing.

For both functions:

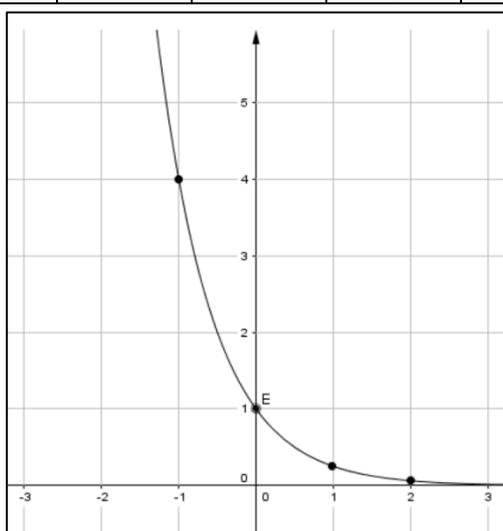|	
Domain	Set of all real numbers
Range	Set of all positive real numbers
y-intercept	1
x-intercept	There is no x – intercept
Horizontal asymptote	$y = 0$
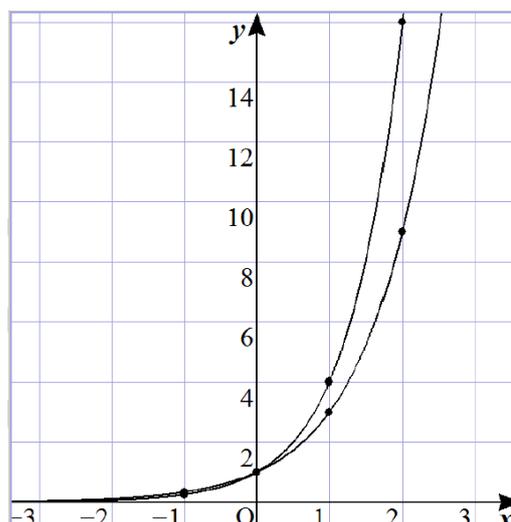
The two graphs have the same domain, range, y-intercept, and horizontal asymptote. However, the graph of $g(x) = 4^x$ rises faster than does $f(x) = 3^x$ as x increases, and is closer to the x-axis if $x < 0$.

Example 4. Graph the function $g(x) = 4^{-x}$.

Solution. The function $g(x) = 4^{-x}$ can be written as $g(x) = \left(\frac{1}{4}\right)^x$. This is an exponential function with base $b < 1$. Thus, the function is decreasing.
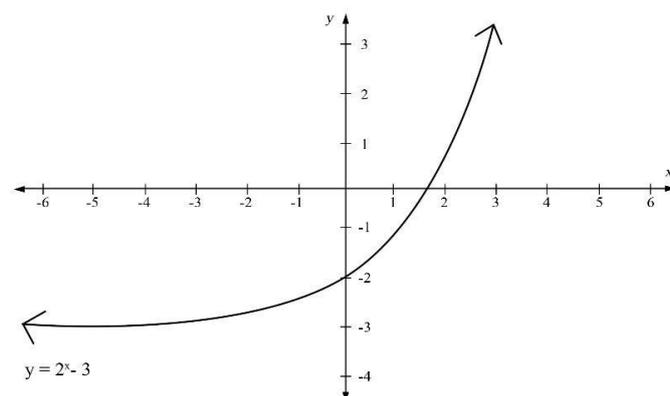
x	-1	0	1	2
$f(x)$	4	1	$\dfrac{1}{4}$	$\dfrac{1}{16}$

Domain	Set of all real numbers
Range	Set of all positive real numbers
y-intercept	1
x-intercept	There is no x – intercept
Horizontal asymptote	$y = 0$

The Zeros of Exponential Functions

Consider the function $y = 2^x - 3$. Its graph is shown below.

y = 2ˣ- 3

The zeros of an exponential function is the value of x that gives y=0. To find zeros, **set y=0 then solve for x.**

Find the zeros of the given exponential functions, if any. If there is none, explain why.

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

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

3. $y = 3^x + 1$

4. $y = 2(5^{x-2}) - 1$

5. $y = \frac{1}{3}\left(\frac{1}{7}\right)^x$

Solutions:

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

   Thus, the zero of the function is $-\frac{1}{2}$.

2. The function $y = \left(\frac{1}{4}\right)^{x+1}$ has no value of x for which y=0. The table below shows why.

| X	-3	-2	-1	0	1	2	3	4
Y	16	4	1	0.25	0.0625	0.015625	0.00390625	0.0009765625

In the table, as x increases, the value of y decreases and approaches zero, thus asymptotic, with the positive x-axis.

3. The function $y = 3^x + 1$ has no value of x for which y=0. The table below shows why.

x	-6	-5	-4	-3	-2	-1	0	1
y	1.001371	1.004115	1.012345	1.037037	1.111111	1.333333	2	4

In the table, as x decreases, the value of y decreases and approaches to one, thus asymptotic, with y=1.

Try Numbers 4 and 5.
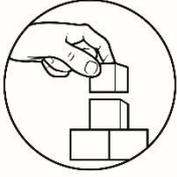
What's More

Activity 1.3 Hidden Message!

Direction: Answer this activity to solidify your understanding and skills in solving exponential equations and inequalities. Shade in the block that contains the answer to reveal the *hidden message*.

Solve for x.

1. $3^{2x-1} = 3^{x+2}$

2. $4^{x+1} = 8^{2x+3}$

3. $3^{x-4} < \frac{1}{27}$

4. $4^{2x-2} > 2^{x+1}$

5. $5^{2x} < 125^{x-5}$

6. $25^{2x+3} = 25^{5x-9}$

7. $(\frac{1}{9})^{2x+7} \le 27^{6x-12}$

8) $125^{3x-4} = 25^{4x+2}$

9) $9^{9x+1} < (\frac{1}{243})^{-3x+5}$

10) $(\frac{7}{343})^{x-3} \ge (\frac{1}{49})^{2x+1}$

11) $8^{x-2} = \frac{1}{16}$

12) $3^{2x-1} = \frac{1}{9}$

13) $9^{-x+5} = 27^{6x-10}$

14) $(\frac{1}{25})^{2x-1} \le 125^{3x+1}$

S x > 1	M $x > \frac{5}{3}$	G $x \ge \frac{-1}{13}$	C x = 16	I x > 15	F $x \ge 1$
D x = 4	T $X = \frac{1}{2}$	K X = 2	N $X = \frac{-7}{4}$	A x > 9	Y $X \ge \frac{2}{3}$
Z $X \ge -4$	R $X = \frac{2}{3}$	B X = 3	U X < -9	A $X \le 16$	T $X = \frac{1}{27}$
H X = 25	Q X < 1	O $X \ge -7$	M X = -4	S $X = \frac{-1}{2}$	E $X < \frac{1}{10}$

Hidden Message: _____

Activity 1.4 Is it a YES or NO?

Write YES if the given statement is true about the function $f(x) = 2^x$ and write NO if it is not.

1. It is an exponential function.
2. Its graph is decreasing.
3. Its graph has a horizontal asymptote at $y = 0$.
4. It intersects the y – axis at the point (0,1).
5. It intersects the x – axis.
6. Its domain is the set of positive real numbers.
7. Its range is the set of real numbers.
8. It is one – to – one.
9. The graph on the right is the graph of $f(x) = 2^x$.
10. The table of values on the right represents $f(x) =$
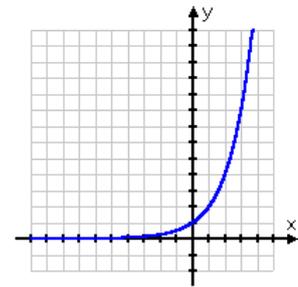
x	-2	-1	0	1	2
y	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4

Activity 1.5 Your Way to the Camp

Mario, the camper, is lost. He needs to find his way through the tent. Help Mario by graphing the exponential function $f(x) = 5^x$. Choose the right gate to reach the tent.

Gate 1

x	-2	-1	0	1	2
$f(x)$	$\frac{1}{25}$	$\frac{1}{5}$	1	5	25

Gate 2

x	-2	-1	0	1	2
$f(x)$	25	5	1	$\frac{1}{5}$	$\frac{1}{25}$

Start here: $f(x) = 5^x$.

You should choose Gate _____

Gate 3

Gate 4

You should choose Gate _____

Gate 5

Gate 6
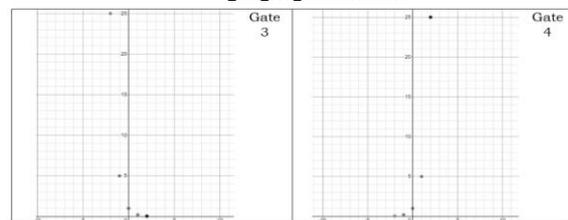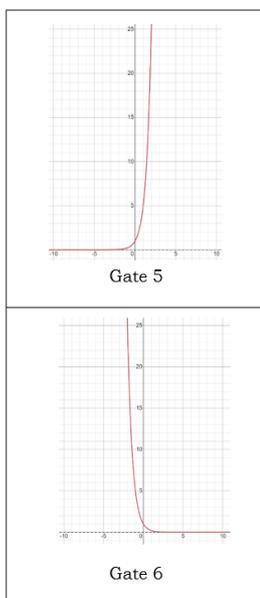
You should choose Gate _____

Tent

What I Have Learned

Activity 1.6 Do You Remember Me?

A. Fill in the blank(s) with the correct word or symbol.

1. In One-to-one Property of Exponential Functions, if $x_1 \neq x_2$, then $b^{x_1} \neq b^{x_2}$. Conversely, if $b^{x_1} = b^{x_2}$ then x_1 _____ x_2.

2. If $b > 1$, then the exponential function $y = b^x$ is _____ for all x. This means that $b^x < b^y$ if and only if x _____ y.

3. If $0 < b < 1$, then the exponential function $y = b^x$ is _____ for all x.

   This means that $b^x > b^y$ if and only if x _____ y.

B. In numbers 1-5, solve for x.
   1) $169^x = 13^x$
   2) $7^x = \frac{1}{49}$
   3) $\left(\frac{3}{5}\right)^{x+1} = \frac{25}{9}$
   4) $4^{3x+2} < 64$
   5) $\left(\frac{9}{27}\right)^{6x-1} \geq \left(\frac{27}{9}\right)^{-x+6}$

C. Do as indicated.

   A function of the form $y = f(x) = b^x; b > 0 \text{ and } b \neq 1$ is an exponential function with the following characteristics:

   a. The graph passes through the point _____.
   b. The domain is _____.
   c. The range is _____.
   d. The graph is _____.
   e. The graph is asymptotic to the x axis as x approaches _____ infinity.

   A function of the form $y = f(x) = b^{-x}; b > 0 \text{ and } b \neq 1$ is an exponential function with the following characteristics:

   f. The graph passes through the point _____.
   g. The domain is _____.
   h. The range is _____.
   i. The graph is _____.
   j. The graph is asymptotic to the x axis as x approaches _____ infinity.
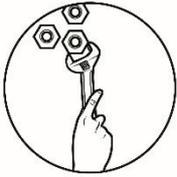
What I Can Do

Activity 1.7 Let's Do It!

A. Answer the following problems completely.

1. At time t = 0, 480 grams of an isotope with a half- life of 30 hours is present. How much time will have elapsed when only 15 grams remain?

2. Xian opened a savings account and put Php 6,250 in it. Each year, the account increases by 20%.

   a. How many years will it take the account to reach Php 12, 960?
   b. Write an equation that models the situation. Use t to represent the number of years since Xian opened the account.

B. Do as indicated.

a) Construct the following table of values $f(x) = 2^x$ and $g(x) = 3^x$

x	-4	-3	-2	-1	0	1	2	3
$f(x)$								
$g(x)$								

b) Construct a coordinate plane showing x from -4 to 4 and y from -1 to 30. Sketch the graphs of $f(x)$ and $g(x)$. Compare both graphs.

c) For each function, identify the domain, range, y-intercept, and horizontal asymptote.
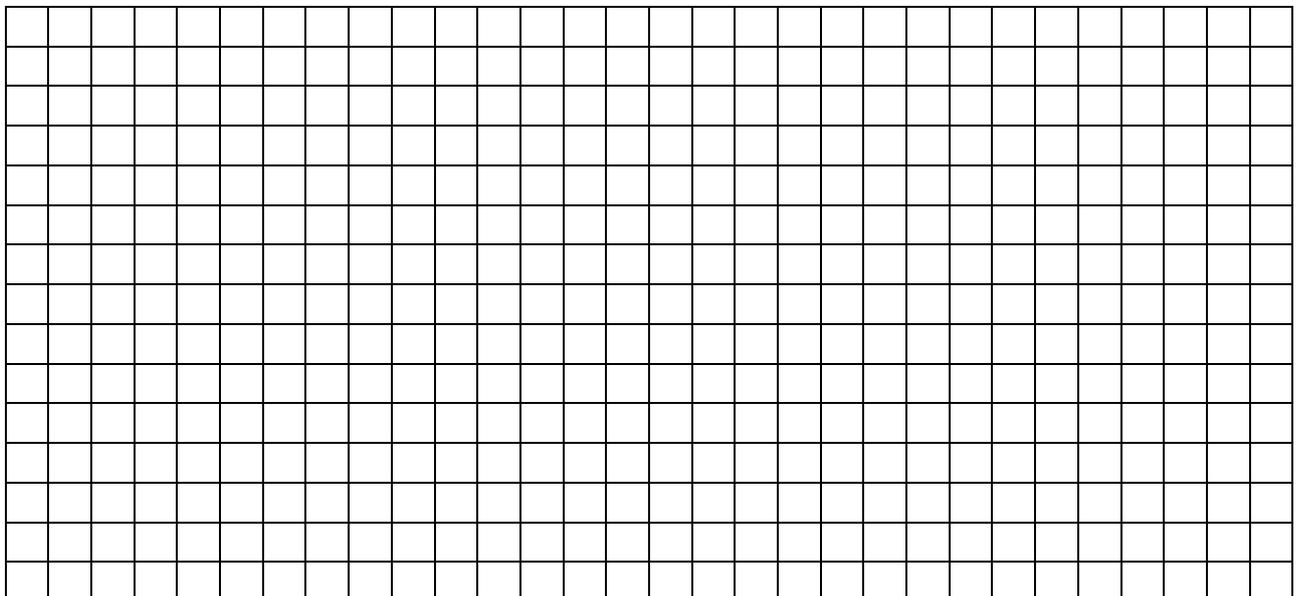
Assessment

A. Direction: Solve for x.

1) $16^{2x-3} = 4^{x+2}$

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

3) $4^{2x+7} \leq 32^{2x-3}$

4) $\left(\frac{2}{5}\right)^{5x-1} \geq \frac{25}{4}$

5) $\left(\frac{2}{3}\right)^{5x+2} = \left(\frac{3}{2}\right)^{2x}$

6) $4^{x+2} = 8^{2x}$

7) $10^{4x+1} > 100^{x-2}$

8) $36^{2x+4} = 216^{x+5}$

9) $\frac{1}{81} < 9^{2x-4}$

10) $32^{3x-4} > 128^{4x+3}$

B. Construct the following table of values $f(x) = \left(\frac{1}{2}\right)^x$ and $g(x) = \left(\frac{1}{3}\right)^x$

x	-4	-3	-2	-1	0	1	2	3
$f(x)$								
$g(x)$								

a) Construct a coordinate plane showing x from -4 to 4 and y from -1 to 30. Sketch the graphs of $f(x)$ and $g(x)$. Compare both graphs.
b) For each function, identify the domain, range, y-intercept, and horizontal asymptote.

Additional Activities

Activity 1.8 Investigate and Spot the Difference

Look at each pair of solutions below. Did anyone get the correct solution? If not, spot the error or errors.

	Peter's solution	Jane's solution

Problem # 1

$\left(\frac{1}{64}\right)^{x-2} = 16^{3x+1}$

Peter's solution

$\left(\frac{1}{64}\right)^{x-2} = 16^{3x+1}$

$4^{-3(x-2)} = 4^{2(3x+1)}$

-3x + 6 = 6x + 2

-9x = -4

$x = \frac{4}{9}$

Jane's solution

$\left(\frac{1}{64}\right)^{x-2} = 16^{3x+1}$

$4^{3(x-2)} = 4^{2(3x+1)}$

3x - 6 = 6x + 2

-3x = 8

$x = -\frac{8}{3}$

Problem # 2

$(0.6)^{x-3} > (0.36)^{-x-1}$

Peter's solution

$(0.6)^{x-3} > (0.36)^{-x-1}$

$(0.6)^{x-3} > (0.6^2)^{-x-1}$

$(0.6)^{x-3} > (0.6)^{2(-x-1)}$

$(0.6)^{x-3} > (0.6)^{-2x-2}$

$x - 3 > -2x - 2$

$3x > 1$

$x > \frac{1}{3}$

Jane's solution

$(0.6)^{x-3} > (0.36)^{-x-1}$

$(0.6)^{x-3} > (0.6^2)^{-x-1}$

$(0.6)^{x-3} > (0.6)^{2(-x-1)}$

$(0.6)^{x-3} > (0.6)^{-2x-2}$

$x - 3 < -2x - 2$

$3x < 1$

$x < \frac{1}{3}$
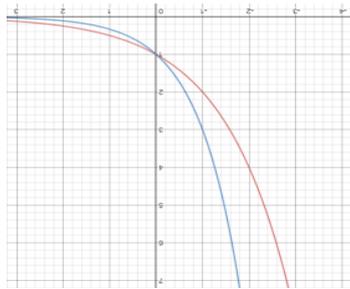
Activity 1.9 You Can Handle This

Graph the function $f(x) = 5^{-x}$. Identify the domain, range, y – intercept, and horizontal asymptote. *Hint:* $5^{-x} = \frac{1}{5^x} = \left(\frac{1}{5}\right)^x$.

Answer Key

What I Know

1. B
2. C
3. D
4. B
5. A
6. A
7. D
8. A
9. B
10. A
11. A
12. A
13. A
14. A
15. C

Activity 1.1 How Will Do You Know Me

1. Exponential Equation
2. Neither
3. Exponential Equation
4. Neither
5. Exponential Equation
6. Neither
7. Neither
8. Neither
9. Neither
10. Exponential Inequality

Activity 1.2 Solve and Conquer

1. $x = 2$
2. $x = 8$
3. $x = -1$
4. $x = 7$
5. $x = 5/2$
6. $x = 8$
7. $x = 5/2$
8. $x = -14$
9. $x = 7$
10. $x = 5/2$

Activity 1.3 Hidden Message

S T A Y   A T   H O M E

Activity 1.4 Is it a YES or NO?

1. Yes
2. No
3. Yes
4. Yes
5. Yes
6. No
7. No
8. Yes
9. Yes
10. Yes

Activity 1.5 Your Way to the Camp

Choose the Gate

Gate 1, Gate 4, Gate 5

EDITOR'S NOTE

This Self-learning Module (SLM) was developed by DepEd SOCCSKSARGEN with the primary objective of preparing for and addressing the new normal. Contents of this module were based on DepEd's Most Essential Learning Competencies (MELC). This is a supplementary material to be used by all learners of Region in all public schools beginning SY 2020-2021. The process of LR development was observed in the production of this module. This is Version 1.0. We highly encourage feedback, comment, and recommendations.

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