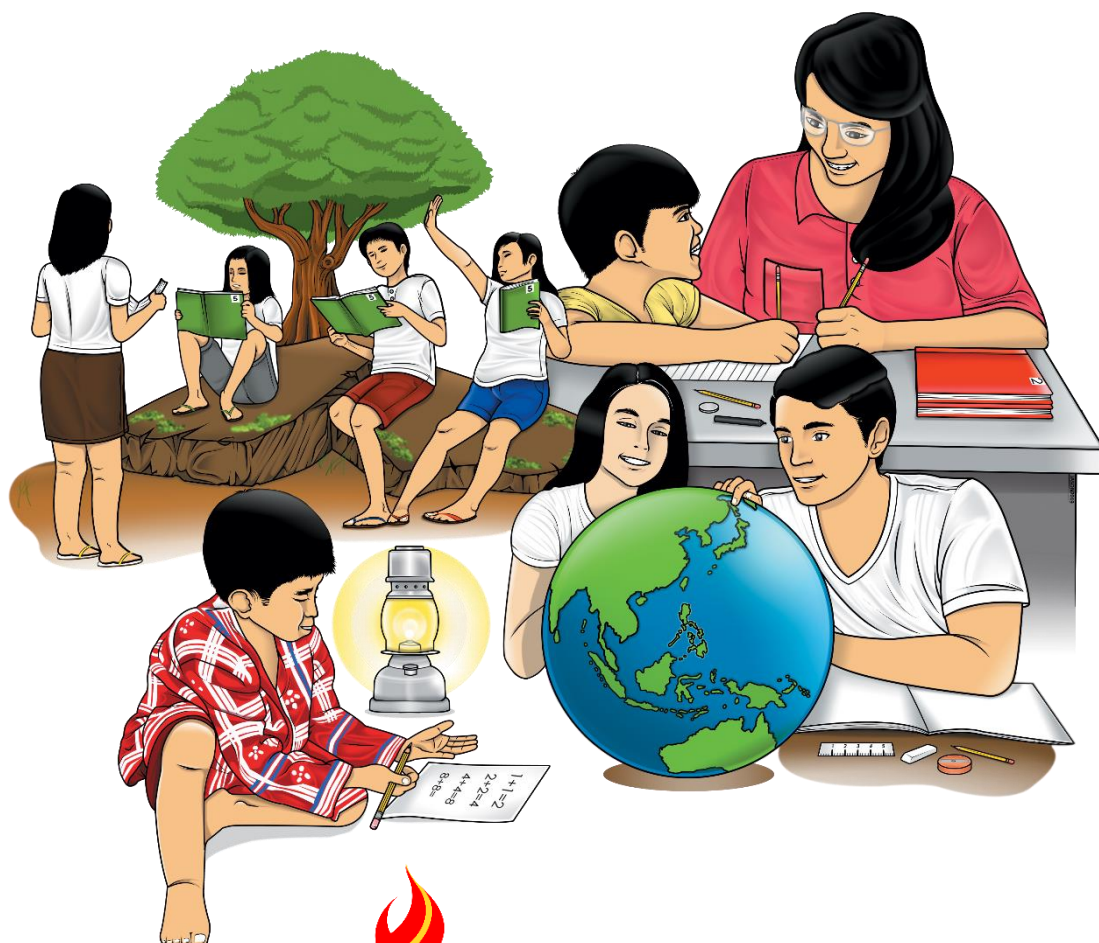


General Mathematics

Quarter 1 – Module 24:

Solving Logarithmic Equations and Inequalities



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General Mathematics

Quarter 1 – Module 24:

Solving Logarithmic Equations and Inequalities

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-tests 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 Teacher are also provided to our 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. And 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

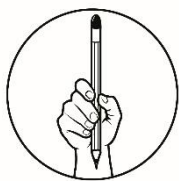
This module was designed and written with you in mind. It is here to help you distinguish logarithmic function, logarithmic equation, and logarithmic inequality. Furthermore, it is made for you to master solving logarithmic equations and logarithmic inequalities. The scope of this module permits it to 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 contains two lessons:

- Lesson 1 – Logarithmic Functions, Equations and Inequalities
- Lesson 2 – Solving Logarithmic Equations and Inequalities

After going through this module, you are expected to:

1. distinguishes logarithmic function, logarithmic equation, and logarithmic inequality;
2. apply basic properties of logarithms and laws of logarithms; and solves logarithmic equations and inequalities



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. It is an equation involving logarithms which can be solved for any values that satisfy the mathematical sentence.
 - a. logarithmic equation
 - b. logarithmic function
 - c. logarithmic inequality
 - d. none of these
2. It is a function of the form $f(x) = b^x$ where $b > 0$ and $b \neq 1$. It can be represented by a table of values, equations and graph.
 - a. logarithmic equation
 - b. logarithmic function
 - c. logarithmic inequality
 - d. logarithmic expression
3. The following symbols can be used in the logarithmic inequality EXCEPT:
 - a. $<$
 - b. $\geq$
 - c. $>$
 - d. $=$
4. Which of the following is an example of a logarithmic inequality?
 - a. $\log_2 128 = \log_2 x$
 - b. $y = \log_2 2x$
 - c. $\log_3 x < 4$
 - d. $\log_{(0.1)} 1000 = -4$
5. The following are examples of logarithmic equation EXCEPT:
 - a. $\log_2 4 = \log_2 x$
 - b. $\log_2 128$
 - c. $\log_3 x + 3 = 2$
 - d. $\log_5 x = \log_5 2(x - 4) + 2$
6. Which of the following is an example of a logarithmic function?
 - a. $\log_3 27 = \log_3 x$
 - b. $\log_2 x = \log_2 2$
 - c. $\log_3 x < 10$
 - d. $y = \log_2 2x - 1$
7. What is the value of $5^{\log_5 10}$?
 - a. 5
 - b. 10
 - c. 15
 - d. 50
8. Give the value of $\log_7 7 + \log_5 1$.
 - a. 0
 - b. 1
 - c. 9
 - d. 10
9. What is the expanded form of $\log_2 3xy^2$?
 - a. $\log_2 3 + \log_2 x + 2\log_2 y$
 - b. $\log_2 3x + 2\log_2 y$
 - c. $\log_2 3 + \log_2 x + \log_2 y^2$
 - d. $\log_2 3x + \log_2 y^2$

10. What is the expanded form of $\log_4 \frac{y}{z}$?
- $\log_4 y + \log_4 z$
 - $\log_4 y - \log_4 z$
 - $4\log_4 z + 4\log_4 y$
 - $\log_4 z - \log_4 y$
11. Express $3\log_5 x - \log_5 y$ as a single logarithm.
- $\log_5 \frac{y^3}{z}$
 - $\log_5 \frac{3x}{y}$
 - $\log_5 x^3 y$
 - $\log_5 \frac{x^3}{y}$
12. What is the value of n in the logarithmic equation $\log_2 n = \log_2 2n + 6$?
- 6
 - 6
 - 3
 - 3
13. Find x if $\log_8 x - 3 = \log_8 2$.
- 2
 - 3
 - 4
 - 5
14. Which of the following satisfies the inequality $\log_5 25 < n$?
- $n \geq 1$
 - $n \leq 3$
 - $n > 2$
 - $n < 2$
15. Solve for n : $\log_{n-3} 36 > 2$.
- $n > 9$
 - $n > 6$
 - $n > 3$
 - $n > -3$

Lesson**1****Logarithmic Functions,
Equations and Inequalities**

Functions, equations and inequalities are some of the most important terms in Algebra. These separate a single concept into three different ideas. We cannot say that equation is the same as a function or a function is equivalent to an inequality and so on. This module focuses on the three different ideas of the logarithm. And if you are interested about learning this concept, then this module is perfect for you!

***What's In***

Before we begin, let us recall the definition of a logarithm. The logarithm of a with base b is denoted by $\log_b a$, and is defined as $c = \log_b a$ if and only if $a = b^c$. Previously, you learned that exponential and logarithm are the inverses of each other. This means that you can transform exponential to logarithmic form.

Now, look at the following examples. How many can you identify as logarithmic functions? Name all the functions according to their types.

a. $f(x) = 3x - 5$

f. $k(x) = 4^x$

b. $g(x) = \log_3 \frac{3x}{4}$

g. $l(x) = \begin{cases} 2x + 1, & x > 1 \\ x, & -1 < x < 1 \\ x - 1, & x < -1 \end{cases}$

c. $h(x) = \log_3 2x - 4$

h. $m(x) = \log_x 3$

d. $i(x) = 2x^2 - 3x + 5$

i. $n(x) = \log_{1/2} 5 - 4x$

e. $j(x) = \frac{2x-1}{3x+1}$

j. $\log_x 3 + \log_x 5 = y$

From the examples above, did you spot some logarithmic functions? How many are they? If your answer is 5, you are correct! Letters b , c , h , i , and j are all examples of logarithmic functions. Letter a is an example of linear function while letter d is a quadratic one. Letters e and f are rational function and exponential function, respectively. Lastly, letter g is an example of a piecewise function.

Since you are already familiar with the logarithmic function, let us distinguish the difference among logarithmic functions, equations, and inequalities.



What's New

Classify Me!

Identify if the following are logarithmic (A) equation, (B) inequality or (C) function. Also, answer the questions below. Write your answers on a separate sheet of paper.

- | | |
|-------------------------------|-------|
| 1. $\log_4 3x = 5$ | _____ |
| 2. $f(x) = \log_2 4x + 1$ | _____ |
| 3. $8 \leq \log_2 3x - 3$ | _____ |
| 4. $y = \log_5 2x$ | _____ |
| 5. $\log_7 3x + \log_7 2 = 1$ | _____ |
| 6. $\log_6 3x > 2$ | _____ |

1. Based on your answers, how will you define logarithmic equation?

2. How can you distinguish a logarithmic equation from a logarithmic inequality?

3. When do you say that the given is a logarithmic function?

4. Can you identify the symbol/s that will help you determine the difference among logarithmic equation, inequality and function?



What is It

From the first activity, you classified the given expression as to logarithmic equation, function or inequality. The following will give you the definition and examples of the logarithmic function, equation and inequality.

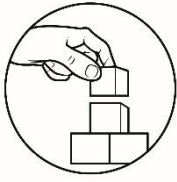
	Definition	Examples
Logarithmic Function	It is a function of the form $f(x) = \log_b x$, such that $b > 0$ and $b \neq 1$.	$f(x) = \log_3 x - 4$ $y = \log_2(2x + 3)$
Logarithmic Equation	It is an equation involving logarithms.	$\log_2 4 = \log_2 x$ $\log_3 x + 3 = 2$
Logarithmic Inequality	It is an inequality involving logarithms.	$\log_3 x < 4$ $\log_2 x - 5 \geq 4$

Identify whether the given is a logarithmic function, equation, inequality or neither of the three, then justify your answer. Write your answers on a separate sheet of paper.

- $\log_4 n + 3 = 2$
- $\log_4 x > 3/2$
- $f(x) = \log_2 2x - 5$
- $f(x) = 2^{3x-2}$

Solution:

- $\log_4 n + 3 = 2 \longrightarrow$ This is a logarithmic equation because it is an equation involving logarithms.
- $\log_4 x > 3/2 \longrightarrow$ This is a logarithmic inequality because it is an inequality involving logarithms.
- $f(x) = \log_2 2x - 5 \longrightarrow$ This is a logarithmic function because It is a function of the form $f(x) = \log_b x$, with $b = 2$.
- $f(x) = 2^{3x-2} \longrightarrow$ This is neither a logarithmic function, equation, nor inequality because it is an exponential function.



What's More

Activity 1.1

Determine whether the given is a logarithmic function, equation, inequality or neither of the three options. Write your answers on a separate sheet of paper.

- _____ 1. $f(x) = \log_5 2x$
- _____ 2. $2\log_3 x = \log_3 5x - 4$
- _____ 3. $y = \log_9 2(x - 5)$
- _____ 4. $x + y = 7$
- _____ 5. $\log_4 x \geq 0$
- _____ 6. $2\log_8 (x - 2) < 2$
- _____ 7. $\log_4 x = \log_4 4$
- _____ 8. $x^2 - 3x + 6 = 0$
- _____ 9. $g(x) = \log_8 4x - 1$
- _____ 10. $2x - y = 90$

Activity 1.2.

Justify or explain your answer in Activity 1.1. Write your answers on a separate sheet of paper.

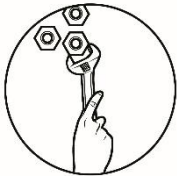
1. _____.
2. _____.
3. _____.
4. _____.
5. _____.
6. _____.
7. _____.
8. _____.
9. _____.
10. _____.



What I Have Learned

A. Complete the following statements by writing the correct word/s and formulas. Write your answers on a separate sheet of paper.

1. _____ is an equation involving logarithms.
2. _____ is an inequality involving logarithms.
3. Logarithmic function is a function of the form _____, such that $b > 0$ and $b \neq 1$.
4. The expression $\log_3(x - 1) > 2$ is an example of _____.
5. $\log_4(2x + 4) = 1$ is an example of _____.
6. The expression $\log_7 \frac{3x}{2} = y$ is a _____.



What I Can Do

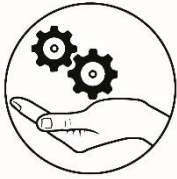
Journal Writing

Write a reflection of what you have learned about logarithmic functions, equations and inequalities in a math journal.

Many things in our life operate like an equation or an inequality where certain inputs produce outputs. By investing in friendships, we reap happiness. Through working hard, we achieve success. Can you cite examples in life that appear unequally related?

Rubrics for journal writing:

	4	3	2	1
Conventions of Journal Writing (includes the date, references to text or data, and personal thoughts and opinions)	The writer follows the conventions.	The writer follows most of the conventions.	The writer follows some of the conventions.	The writer does not follow any conventions.
Capitalization and Punctuation	The writer makes no mistakes.	The writer makes 1-2 mistakes.	The writer makes 3-4 mistakes.	The writer makes more than 4 mistakes.
Effective Written Communication	The writer communicates thoughts in a clear and organized manner.	The writer understandably communicates the thought, but the organization of ideas should be improved.	The writer communicates in a somewhat organized manner, but ideas were not very clear.	The writer's output shows no organization or consideration at all.
Reflection and Thoughts	The writer demonstrates a deep understanding of the topic.	The writer demonstrates some understanding of the topic.	The writer demonstrates minimal understanding of the topic.	The writer demonstrates no understanding of the topic.



Additional Activities

If you want to try more, these activities are for you.

An acrostic is a series of lines or verses in which the first, last, or other particular letters, when taken in order, spell out a word, phrase, etc. Try to create acrostics from the words equation, function, and inequality. Do this on a separate sheet of paper.

1. E -

Q -

U -

A -

L -

2. F -

U -

N -

C -

T -

I -

O -

N -

3. U -

N -

E -

Q -

U -

A -

L -

Lesson**2****Solving Logarithmic Equations and Inequalities**

Equations and inequalities may be true or false. Depending on the context, solving equations and inequalities may consist of finding either any solution, all solutions, or a solution that satisfies further properties. When the task is to find the solution, generally, it determines the possible value/s of the unknown variable. It can be a single value or a set of values. Have you experienced finding the value/s of the unknown from the previous lessons? How about trying to solve logarithmic equations and inequalities? If you are excited to learn about it, then this lesson is for you!

**What's In**

For you to begin, let us recall once again the previous lessons in this module. Logarithm comes in three forms: the logarithmic function, equation and inequality.

Example 1

Identify whether the given is logarithmic function, equation or inequality and explain why.

1. $\log_5 7 = 4x$
2. $f(x) = \log_p (5x + 7)$
3. $\log_8 (2m - 7) = 1$

Solution:

1. $\log_5 7 = 4$ $\longrightarrow$ This is a logarithmic inequality because it is an inequality involving logarithms.
2. $f(x) = \log_p (5x + 7)$ $\longrightarrow$ This is a logarithmic function because it is a function of the form $f(x) = \log_b x$ where $b > 0, b \neq 1$.
3. $\log_8 (2m - 7) = 1$ $\longrightarrow$ This is a logarithmic equation because it is an equation involving logarithms.

In lesson 2, you should be skilled in rewriting the logarithmic form to exponential form, applying the logarithmic properties and laws, and identifying the domain of the equations and inequalities. To check if you are ready, try to do the next activity.



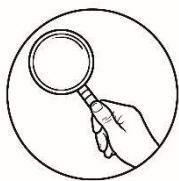
What's New

Investigate!

Study the table below and provide the information needed to complete the table. Use a calculator to check your answers and explain it. Do this on a separate sheet of paper.

Examples	Why?
$\log_3 3 = 1$ $\log_m m = ?$ $\log_{11} 11 = 1$	
$\log_3 1 = 0$ $\log_m 1 = ?$ $\log_9 1 = 0$	
$5^{\log_5 10} = 10$ $m^{\log_m x} = ?$ $2^{\log_2 5} = 5$	
$\log_3 12 = 2.26$ $\log_3 (4)(3) = \log_3 4 + \log_3 3 = 2.26$ $\log_m xy = ?$	
$\log_2 \frac{16}{2} = \log_2 16 - \log_2 2 = 3$ $\log_m \frac{x}{y} = ?$	
$\log_2 2^4 = 4 \log_2 2$ $\log_7 7^2 = 2 \log_7 7$ $\log_m m^x = ?$	

1. Based on your answers in the second column, what can you say about the activity?
2. Describe the property or rule applied in each item on the table.



What is It

From your What's New activity, you tried to apply the properties and laws of logarithms.

The next table shows the basic properties and laws of logarithms.

Basic Properties and Laws of Logarithm

Let b , x and y be real numbers such that $b > 0$ and $b \neq 1$. The basic properties and laws of logarithms are as follows:

PROPERTIES	EXAMPLES
I. $\log_b b = 1$	$\log_3 3 = 1$ $\log_{11} 11 = 1$
II. $\log_b 1 = 0$	$\log_3 1 = 0$ $\log_9 1 = 0$
III. $b^{\log_b x} = x$	$5^{\log_5 10} = 10$ $2^{\log_2 5} = 5$
IV. $\log_b b^x = x$	$\log_2 2^4 = 4$ $\log_7 7^2 = 2$
LAWS	EXAMPLES
Product Law I. $\log_b MN = \log_b M + \log_b N$	$\log_3 6m = \log_3 6 + \log_3 m$ $\log_6 mn = \log_6 m + \log_6 n$
Quotient Law II. $\log_b \frac{M}{N} = \log_b M - \log_b N$	$\log_3 \frac{m}{n} = \log_3 m - \log_3 n$ $\log_2 16 - \log_2 2 = 3$
Power Law III. $\log_b M^n = n \log_b M$	$\log_4 m^3 = 3 \log_4 m$ $\log_2 n^x = x \log_2 n$

Example 2

Now, let us use properties of the logarithms to evaluate the following:

- | | | | | | |
|-----------------|---|-------|--------------------|---|-------|
| 1. $\log_4 4$ | = | _____ | 4. $7^{\log_7 10}$ | = | _____ |
| 2. $\log_5 5^7$ | = | _____ | 5. $3 \log_9 9^3$ | = | _____ |
| 3. $\log_8 1$ | = | _____ | | | |

Solution:

1. $\log_4 4 = 1$ (Property I)
2. $\log_5 5^7 = 7$ (Property IV)
3. $\log_8 1 = 0$ (Property II)

4. $7^{\log_7 10} = 10$ (Property III)
5. $3\log_9 9^3 = 9$ (Property IV)

Example 3

This time, let us use the law of logarithms to expand the following expressions.

1. $\log_9 ab^2$
2. $\log_b \frac{x^3}{y^2}$

Solution:

1. $\log_9 ab^2 = \log_9 a + \log_9 b^2 = \log_9 a + 2\log_9 b$ (Product and Power Laws)
2. $\log_b \frac{x^3}{y^2} = \log_b x^3 - \log_b y^2 = 3\log_b x - 2\log_b y$ (Quotient and Power Laws)

Laws)

Now that you are familiar with the basic properties and laws of logarithms, read and analyze the following concepts and examples for you to learn how to solve logarithmic equations and inequalities.

Properties of Logarithmic Equations

If $b > 0$, then the logarithmic function $f(x) = \log_b x$ is increasing for all x .

If $0 < b < 1$, then the logarithmic function $f(x) = \log_b x$ is decreasing for all x .

This means that $\log_b u = \log_b v$ if and only if $u = v$.

Here are some techniques or strategies in solving the logarithmic equation.

1. Rewriting it to exponential form.
2. Use logarithmic properties.
3. Apply the one-to-one property of logarithmic functions.
4. Use the Zero Factor Property: If $ab = 0$, then $a = 0$ or $b = 0$.
5. Take into consideration the domain of logarithmic expression.

Example 4

Find the value of x in the following.

1. $\log_5 (x + 3) = \log_5 22$
2. $\log_3 (9x) = \log_3 (x - 8) = 4$

Solution:

1. $\log_5 (x + 3) = \log_5 22$ Given
 $x + 3 = 22$ One-to-one Property
 $x = 22 - 3$ Addition Property of Equality
 $x = 19$ Simplify

2. $\log_3 (9x) - \log_3 (x - 8) = 4$ Given
 $\log_3 \frac{9x}{x-8} = 4$ Quotient Law of Logarithm
 $\frac{9x}{x-8} = 3^4$ Change into exponential form
 $9x = 81(x - 8)$ Multiplication Property of Equality
 $9x = 81x - 648$ Distributive Property
 $-72x = -648$ Addition Property of Equality
 $\mathbf{x = 9}$ Multiplication Property of Equality

Solving Logarithmic Inequalities

Remember: If $b > 0$, then the logarithmic function $y = \log_b x$ is increasing for all x . If $0 < b < 1$, then the logarithmic function $y = \log_b x$ is decreasing for all x . This means that $\log_n a > \log_n b$ implies $a > b$. Moreover, bear in mind that the domain of the logarithmic function is the set of all positive real numbers. The techniques or strategies in solving logarithmic inequality are the same in solving logarithmic equations.

Example 5

Find all values of x that will satisfy the inequality.

1. $\log_2 (2x + 1) < 3$
2. $\log_4 9 > 2 \log_4 x$

Solution:

1. $\log_2(2x+1) < 3$

Given

$$2^3 < 2x+1$$

Changing into exponential form

$$8 < 2x+1$$

Simplify

$$7 < 2x$$

Addition Property of Equality

$$\mathbf{7/2 < x}$$

Multiplication Property of Equality

Since the domain of logarithmic function is the set of all positive real

numbers, the given $\log_2(2x+1)$ will be defined if $x > -1/2$ ($2x+1 > 0 \Rightarrow x > -1/2$).

Therefore, the solution set of the inequality is still $\mathbf{x > 7/2}$.

2. $\log_4 9 > 2\log_4 x$

Given

$$\log_4 9 > \log_4 x^2$$

Laws of Logarithm

$$9 > x^2$$

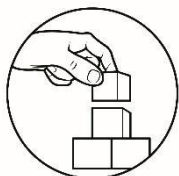
One-to-one Property

$$\mathbf{x < 3 \text{ or } x < -3}$$

Taking square root on both sides.

Since the domain of the logarithmic function is the set of all positive real

numbers, the given $2\log_4 x$ will be defined if $x > 0$. Therefore, the solution set of the inequality is $\mathbf{0 < x < 3}$.



What's More

Activity 2.1. Use the properties of logarithm to find the value of the following given. Write your answers on a separate sheet of paper.

1. $\log_2 2$ = _____

6. $\log_m 1$ = _____

2. $9^{\log_9 6}$ = _____

7. $\log_c c - 2^{\log_2 19}$ = _____

3. $\log_9 1$ = _____

8. $\log_{13} 1 + \log_5 5^2$ = _____

4. $4\log_8 8$ = _____

9. $7^{\log_7 10} + 10\log_5 5$ = _____

5. $7^{\log_7 10}$ = _____

10. $\log_5 5 - 2^{\log_2 9}$ = _____

Activity 2.2. Use the law of logarithm to expand the following given. Write your answers on a separate sheet of paper.

1. $\log_9 4np^3$

2. $\log_b \frac{4y^3}{x^4z}$

Activity 2.3. Find the value/s of x in the following equations/inequalities. Write your answers on a separate sheet of paper.

1. $\log_5 25 = 3x - 3$

2. $\log_4 (x+3) = 3/2$

3. $\log_{1/2} (3-x) = -3$

4. $\log_3 2x - \log_3 (x+5) = 0$

5. $\log_x (\log_2 256) = 3$

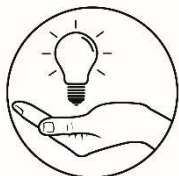
6. $\log_3 (3x-2) < 2$

7. $\log_3 (x-1)^2 > 2$

8. $\log_3 x + \log_3 6 \geq 2$

9. $\log_3 x - 3\log_3 2 \leq 1$

10. $\log_2 x + \log_2 (x+4) < 5$

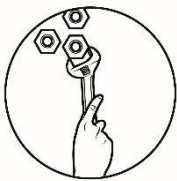


What I Have Learned

A. Complete the following statements by writing the correct word/s and formulas. Write your answers on another sheet of paper.

1. A logarithm of a number with the same number as its base is always equal to _____.
2. The logarithm of 1 at any base will always be equal to _____.
3. The logarithm of a number to a power x with the same number as its base is equal to _____.
4. The logarithm of the product of a positive real number is equal to the _____ of the logarithm of the factors to the given base.
5. The logarithm of the quotient of two positive real numbers is equal to the logarithm of the dividend _____ the logarithm of the divisor.

6. The logarithm of the power of positive real numbers is equal to the _____ times the logarithm of the number to the given base.
7. In logarithm, $y = \log_b x$ if and only if $x =$ _____
8. The one-to-one property of equality of logarithmic equation states that if $\log_a x = \log_b y$, then _____.
9. To solve for the unknown of the logarithmic equations and inequalities, you need to rewrite it into its equivalent _____.
10. The domain of logarithmic functions is _____.



What I Can Do

Enumerate the five (5) strategies or techniques that may help you to solve logarithmic equations and inequalities.

- 1.
- 2.
- 3.
- 4.
- 5.

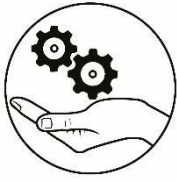


Assessment

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. This expresses a relationship between the input and the output and can be represented through a table of values, graph and equation.
 - a. logarithmic equation
 - b. logarithmic function
 - c. logarithmic inequality
 - d. none of these
2. Which of the following is an example of a logarithmic function?
 - a. $\log_3 27 = \log_3 x$
 - b. $y = \log_2 (2x - 1)$
 - c. $\log_2 x < 10$
 - d. $\log_2 x = \log_2 2$
3. It is an inequality involving logarithms.
 - a. logarithmic equation
 - b. logarithmic function
 - c. logarithmic inequality
 - d. logarithmic expression
4. The following are examples of a logarithmic equation EXCEPT:
 - a. $\log_2 4 = \log_2 x$
 - b. $\log_2 128$
 - c. $\log_3 (x + 3) = 2$
 - d. $\log_5 x = \log_5 2(x - 4) + 2$
5. What is the value of $8^{\log_8 9}$?
 - a. 0
 - b. 3
 - c. 6
 - d. 9
6. Give the value of $\log_9 9 + \log_5 1$.
 - a. 10
 - b. 9
 - c. 1
 - d. 0
7. Find the value of $4 \log_3 3^{11}$.
 - a. 44
 - b. 15
 - c. 7
 - d. 0
8. What is the expanded form of $\log_7 7mn^4$?
 - a. $\log_7 7 + \log_7 m + \log_7 n^4$
 - b. $\log_7 7m + 4\log_7 n$
 - c. $\log_7 7 + \log_7 m + 4\log_7 n$
 - d. $1 + \log_7 m + 4\log_7 n$
9. What is the expanded form of $\log \frac{x^2}{\sqrt{y}}$?
 - a. $\log x + \log y$
 - b. $2\log x - \frac{1}{2}\log y$
 - c. $2\log x + \log y^{\sqrt{2}}$
 - d. $\log x^2 - \log y^{1/2}$

10. Express $2\log_5 a + 4\log_5 b$ as a single logarithm.
- $\log_5 a^2 b^4$
 - $\log_5 2a^4 b$
 - $\log_5 a^2 + b^4$
 - $\log_5 8ab$
11. What is the value of x in the logarithmic equation $\log_7 x = \log_7 2x + 4$?
- 4
 - 2
 - 2
 - 4
12. Find b if $\log_3 (b + 2) = \log_3 8$.
- 0
 - 4
 - 6
 - 12
13. Which of the following satisfies the inequality $\log_3 27 < m$?
- $m \geq 3$
 - $m > 3$
 - $m \leq 3$
 - $m < 3$
14. Solve for x : $\log_{x-3} 36 > 2$.
- $x > 9$
 - $x > 6$
 - $x > 3$
 - $x > -3$
15. Solve for the unknown in the logarithmic equation: $\log_4 x + \log_4 (x - 3) = 1$.
- $x = 1$
 - $x = 4$ and $x = -1$
 - $x = 4$
 - $x = 1$ and $x = -4$



Additional Activities

If you want to try more, these activities are for you. It will help you practice your skill in solving logarithmic equations and inequalities. Study and analyze each situation to solve the problems.

1. If $\log_b 3 = 0.48$, $\log_b 4 = 0.60$, and $\log_b 5 = 0.70$, find the following logarithms. First item is done for you.

- a. $\log_b 15 = \log_b (3)(5) = \log_b 3 + \log_b 5 = 0.48 + 0.70 = \mathbf{1.18}$
- b. $\log_b 30$
- c. $\log_b 45$
- d. $\log_b 120$
- e. $\log_b 2.5$

2. Natural Logarithm

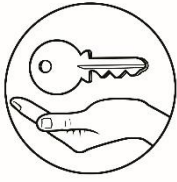
Base e logarithms are called natural logarithms. The irrational number e , which is approximately equal to 2.718281 is described in calculus. The following are the properties of natural logarithms.

a. $e^{\ln x} = x$

b. $\ln e^x = x$

Evaluate the following:

- a. $e^{\ln 5} + \ln e^7 =$
- b. $\ln e^{12} - e^{\ln 9} =$
- c. $5\ln e^2 + 2e^{\ln 5} =$
- d. $(e^{\ln 5})^2 =$
- e. $e^{\ln 81} - \ln 9 =$



Answer Key

Assessment 1. B 2. B 3. C 4. B 5. D 6. C 7. A 8. D 9. B 10. A 11. B 12. C 13. B 14. B 15. C	What's More LESSON 1 Activity 1.1 Log: Function Log: Equation Log: Function Neither Log: Inequality Log: Inequality Log: Equation Neither Log: Function Log: Function Neither Log: Function Neither Activity 1.2 1 6, 0 6 7, -18 0 8, 2 4 9, 20 10 10, -8 Activity 1.3 $\log_4 4 + \log_9 n + 3\log_9 p$ $\log_b 4 + 5\log_b y - 4\log_b x - \log_b z$ LESSON 2 Activity 2.1 $x = 5/3$ $x = 5$ $x = -5$ $x = 5$ $x = 2$ Activity 2.2 $2/3 < x \leq 11/3$ $-2 < x < 4$ $x \geq 3/2$ $0 < x \leq 6$ $0 < x \leq 4$	What I Know 1. A 2. B 3. D 4. C 5. B 6. D 7. B 8. B 9. A 10. A 11. D 12. B 13. D 14. C 15. A
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