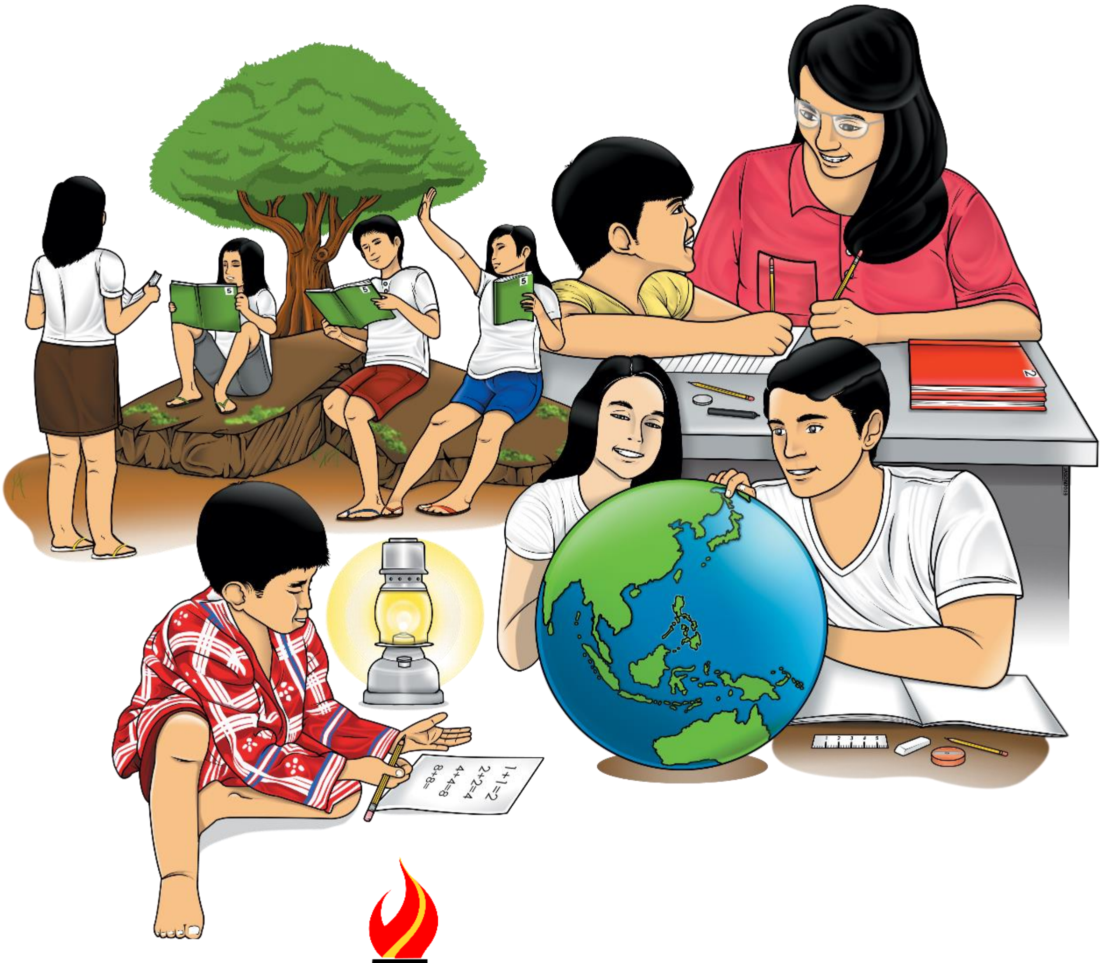
Senior High School

General Mathematics

Quarter 1 – Module 23:
Representing Real-Life Situations Using Logarithmic Functions



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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.

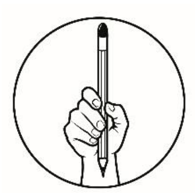
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you represent logarithmic functions using real-life situations. Likewise, this module will give you the idea of how the exponential function and logarithmic function are related to each other. 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.

After going through this module, you are expected to:

1. define logarithmic functions;
2. transform exponential function to logarithmic function or vice versa;
3. evaluate logarithmic expression; and
4. represent real-life situations using logarithmic function



What I Know

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

1. What do you call a function of the form $f(x) = log_b x$ where $b > 0$ and $b \neq 1$?
   a. inverse function
   b. rational function
   c. exponential function
   d. logarithmic function

2. In the expression $log_a x = y$, which is the base?
   a. log
   b. a
   c. x
   d. y

3. What is the logarithmic form of $5^3 = 125$?
    a. $\log_5 3 = 125$
    b. $\log_3 5 = 123$
    c. $\log_5 125 = 3$
    d. $\log_3 125 = 5$
4. Which of the following is the exponential form of $log_{0.1}\ 10000 = -4$?
    a. $(0.1)^{-4} = 10000$
    b. $(-4)^{0.1} = 10000$
    c. $(10000)^{-4} = 0.1$
    d. $(0.1)^{10000} = -4$

5. What is the value of $log_2\ 128$?
    a. 4
    b. 5
    c. 6
    d. 7

6. Which of the following is the logarithmic form of $a^b = c$?
    a. $\log_a b = c$
    b. $\log_b c = a$
    c. $\log_a c = b$
    d. $\log_c b = a$

7. Find the exponential form of $\log_m (x + y) = n$
    a. $m^n = x + y$
    b. $n^m = x + y$
    c. $(x + y)^m = n$
    d. $m^{(x+y)} = n$

8. Which of the following is equal to $\log_{100} 10$?
    a. 1/2
    b. 1/10
    c. 1
    d. 2

9. Find the value of $log_5 \left(\frac{1}{25}\right)$.
    a. -5
    b. -2
    c. 2
    d. 5

10. Evaluate: $log_2\ 16\ + log_7\ 49$.
    a. 2
    b. 4
    c. 6
    d. 8

11. Find the exact value of $log_4 64 + log_2 32 - log_3 27$.
    a. 3
    b. 4
    c. 5
    d. 6

12. What is the value of $2\, log_3 81$?
    a. 8
    b. 12
    c. 16
    d. 20

13. What is the magnitude in the Richter scale of an earthquake that released 10^{10} joules of energy?
    a. 2.4
    b. 3.7
    c. 4.5
    d. 5.3

14. A solution contains hydrogen ion concentration of $1x10^{-7}$ moles. Calculate its pH value.
    a. 10
    b. 9
    c. 8
    d. 7

15. The intensity of sound in a certain forest is 10^{-8} watts/m^2. What is the corresponding sound intensity in decibels?
    a. 4
    b. 5
    c. 6
    d. 7

Lesson 1 Representing Real-life Situations Using Logarithmic Functions

You have learned in previous modules that polynomial function, piecewise function, rational and exponential functions can be used to model real-life situations. The logarithmic function is just one of them. Since the logarithmic function is the inverse of the exponential function, most of the real-life problems involving exponential functions can also be solved by logarithmic functions.

This module will help you to represent logarithmic function to real-life situations like finding the magnitude of an earthquake in a Richter scale, the intensity of a sound in decibel, the acidity or the alkalinity of a solution, and a lot more.

What's In

For you to begin, let us recall some important concepts and skills from the previous lessons which are needed to understand the logarithmic function. In the previous module, you learned that exponential equations are equations involving exponential expressions like $4^{x-2} = 32$, $49^{x} = 7$, and $5^{2x} = \frac{1}{25}$. You also learned that exponential inequalities are inequalities involving exponential expressions like $3^{x} \leq 27, 10^{2x+1} = \frac{1}{1000}$, and $32^{x-1} = 128$. Moreover, you learned that exponential functions are functions of the form $f(x) = b^{x}$ where $b > 0$ and $b \neq 1$ and it can be used to model exponential growth and decay, the half-life of a substance, and the compound interests.

The example below shows how exponential function is used to represent a real-life situation.

Example

Laboratory findings show that the SARS causing corona virus, upon reaching maturity, divides itself into two after an hour. How many cells of the virus will be present after one day if it started with just one cell?

Solution:

Let t = number of hours elapsed
f(t) = number of corona virus present after t hour elapsed

t	0	1	2	3	4	5	6
f(t)	$1=2^0$	$2=2^1$	$4=2^2$	$8=2^3$	$16=2^4$	$32=2^5$	$64=2^6$

The table shows a pattern: as t increases by 1, f(t) increases rapidly by 2^t. In symbols, $f(t) = 2^t$.

Hence, if t = 24 hours (one day), $f(24) = 2^{24}$ = **16, 777, 216.**

In a matter of one day, a virus that started as a single cell can increase to millions of cells, each of which has the same ability to reproduce exponentially.

Notes to the Teacher

Advise the students that they may use calculator in solving for bigger numbers because it saves time. But at first, it is important to grasp the concepts and understand the computation on a manual basis. Use of calculator is just an aid to make their work easier.

Similarly, teach the students on how to read mathematical symbols in a proper way.

What's New

Investigate!

Investigate and discover the transformation of exponential equations to logarithmic equations.

Exponential Equation	Logarithmic Equation
$2^2 = 4$	$\log_2 4 = 2$
$3^4 = 81$	$\log_3 81 = 4$
$9^{\frac{1}{2}} = 3$	$\log_9 3 = \frac{1}{2}$
$n^3 = 64$	$\log_n 64 = 3$
$4^n = 2$	$log_4 2 = n$
$a^x = y$	$\log_a y = x$

1. What have you noticed in the transformation from exponential equation to logarithmic equation?

   ____
   ____
   ____

2. What happened to the exponent in the exponential form upon changing it to logarithmic form?

   ____
   ____
   ____

3. Give three examples of exponential equations and their equivalent logarithmic form.

   ____
   ____
   ____

What is It

There are exponential equations that are not easy to solve. For instance, the equation

$$2^x = 3$$

cannot be easily solved, but for sure, it has a solution. Since $2^1 < 3 < 2^2$, therefore, $1 < x < 2$. The solution to $2^x = 3$ can be written as $x = log_2 3$. This is read as "x is equal to the logarithm of 3 to the base 2." This suggests that $2^x = 3$ is equivalent to $x = log_2 3$.

From the activity earlier, you noticed the transformation of exponential equations to logarithmic equations. The said activity leads to the description of the logarithm as follows.

The Logarithm of a Number

Let a, b and c be positive real numbers such that $b > 0$ and b ≠ 1. 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 $a = b^c$.

Note:
1. Logarithmic functions are the inverses of exponential functions.
2. In logarithmic form $log_b a$, b cannot be negative.
3. The value of $log_b a$ can be negative.

Examples 1. Rewrite the following exponential equations in logarithmic form whenever possible.

a. $7^2 = 49$
b. $27^{\left(\frac{1}{3}\right)} = 3$
c. $(m-2)^3 = x$
d. $e^x = 3$
e. $\left(\frac{1}{2}\right)^{-2} = 4$
f. $\left(\sqrt{7}\right)^2 = 7$
g. $\left(\frac{5}{2}\right)^{-2} = \frac{4}{25}$
h. $81^{\frac{1}{2}} = 9$

Solutions:

a. $7^2 = 49 \Longrightarrow log_7 49 = 2$
b. $27^{\left(\frac{1}{3}\right)} = 3 \Longrightarrow log_{27} 3 = \frac{1}{3}$
c. $(m-2)^3 = x \Longrightarrow log_{(m-2)} x = 3$

d. $3^y = x \Rightarrow log_3 x = y$

e. $\left(\frac{1}{2}\right)^{-2} = 4 \Rightarrow log_{\frac{1}{2}} 4 = -2$

f. $\left(\sqrt{7}\right)^2 = 7 \Rightarrow log_{\sqrt{7}} 7 = 2$

g. $\left(\frac{5}{2}\right)^{-2} = \frac{4}{25} \Rightarrow log_{\frac{5}{2}} \frac{4}{25} = -2$

h. $81^{\frac{1}{2}} = 9 \Rightarrow log_{81} 9 = \frac{1}{2}$

Examples 2. Rewrite the following logarithmic equations in exponential forms whenever possible.

a. $log_3 81 = 4$
b. $log_x mn = p$
c. $log\, 5 = m$
d. $log_2 \frac{1}{16} = -4$
e. $log\, 0.00001 = -5$
f. $ln\, 7 = a$
g. $log_{169} 13 = \frac{1}{2}$
h. $log_3 3 = 1$

Solutions:

a. $log_3 81 = 4 \Rightarrow 3^4 = 81$
b. $log_x mn = p \Rightarrow x^p = mn$
c. $log\, 5 = m \Rightarrow 10^m = 5$
d. $log_2 \frac{1}{16} = -4 \Rightarrow 2^{-4} = \frac{1}{16}$
e. $log\, 0.00001 \Rightarrow 10^{-5} = 0.00001$
f. $ln\, 7 = a \Rightarrow e^a = 7$
g. $log_{169} 13 = \frac{1}{2} \Rightarrow 169^{\frac{1}{2}} = 13$
h. $log_3 3 = 1 \Rightarrow 3^1 = 3$

Note: If the base is not written, it is understood to be in the base 10. The next examples illustrate how to evaluate logarithms.

Examples 3. Find the value of each logarithm.

a. $log_2 64$
b. $log_4 256$
c. $log_{\frac{1}{2}} 32$
d. $log_{\frac{1}{9}} 3$
e. $log_3 81$
f. $log\, 1000$
g. $log \frac{1}{1000}$
h. $log_{0.5} 16$

Solution:

a. $log_2 64$ What should be the exponent of 2 to get 64? Since $2^6 = 64$, then, $log_2 64 = 6$.

b. $log_4 256$ What should be the exponent of 4 to get 256? Since $4^4 = 256$, then, $log_4 256 = 4$.

c. $log_{\frac{1}{2}} 32$ What should be the exponent of ½ to get 32? Since $\left(\frac{1}{2}\right)^{-5} = 32$ then, $log_{\frac{1}{2}} 32 = -5$.

d. $log_{\frac{1}{9}} 3$ What should be the exponent of $\frac{1}{9}$ to get 3" Since $\frac{1}{9}^{-\frac{1}{2}} = 3$, then, $log_{\frac{1}{9}} 3 = -\frac{1}{2}$.

e. $log_3 81$ What should be the exponent of 3 to get 81? Since $3^4 = 81$, then, $log_3 81 = 4$.

f. $log\ 1000$ What should be the exponent of 10 to get 1000? Since $10^3 = 1000$, then, $log\ 1000 = 3$.

g. $log \frac{1}{1000}$ What should be the exponent of 10 to get $\frac{1}{1000}$? Since $10^{-3} = \frac{1}{1000}$, then, $log \frac{1}{1000} = -3$.

h. $log_{0.5} 16$ What should be the exponent of 0.5 to get 16? Since $0.5^{-4} = 16$, then, $log_{0.5} 16 = -4$.

From the brief discussion of finding the value of each logarithm, you are now ready to represent logarithmic functions to real-life situations.

Here are some of the real-life applications of logarithms.

Richter Scale

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs.

The magnitude R of an earthquake is given by $R = \frac{2}{3} log \frac{E}{10^{4.40}}$ where E (in joules is the energy released by the earthquake (the quantity $10^{4.40}$ joules is the energy released by a very small reference earthquake).

The formula indicates that the magnitude of an earthquake is based on the logarithm of the ration between the energy it releases and the energy released by a reference earthquake.

Example 1

Suppose that an earthquake released approximately 10^8 joules of energy. (a) What is the magnitude on a Richter scale? (b) How much more energy does this earthquake release than the reference earthquake?

Solution:

(a) Since $E = 10^8, R = \frac{2}{3} log \frac{10^8}{10^{4.40}}$

$$R = \frac{2}{3} log\ 10^{3.6}$$

By, definition $log\ 10^{3.6}$ is the exponent by which 10 must be raised to obtain $10^{3.6}$, so $log\ 10^{3.6} = 3.6$.

Thus $R = \frac{2}{3} log\ 10^{3.6} \approx 2.4$

(b) This earthquake releases $\frac{10^8}{10^{4.40}} = 10^{3.6} \approx 3981$ times more energy than the reference earthquake.

Great! You can now identify how much energy the earthquake releases from than that of the reference earthquake. Now let us measure the intensity of the sound in decibel.

Sound Intensity in Decibel

The loudness of a sound is expressed as a ratio comparing the sound to the least audible sound. The range of energy from the lowest sound that can be heard to a sound so loud that it produces pain rather than the sensation of hearing is so large that an exponential scale is used. The lowest possible sound that can be heard is called the threshold of hearing.

In acoustics, the decibel (dB) level of a sound is

$$D = 10\ log\ log\ \frac{l}{10^{-12}}$$

where l is the sound intensity in watts$/m^2$ (the quantity m^{-12} watts$/m^2$ is the least audible sound a human can hear).

Example 2

The intensity of sound of a lawn mower is 10^{-3} watts$/m^2$. (a) What is the corresponding sound intensity in decibels? (b) How much more intense is this sound than the least audible sound a human can hear?

Solution:

(a) $Since\ l = 10^{-3}\ then\ D = 10\ log\ log\ \frac{10^{-3}}{10^{-12}}$

$D = 10\ log\ log\ 10^9$

By, definition $log\ 10^9$ is the exponent by which 10 must be raised to obtain 10^9, so $log\ 10^9$ =9

$D = 10(9)$

$D = 90\ decibels$

(b) This sound is $\frac{10^{-3}}{10^{-12}} = 10^9 = 1{,}000{,}000{,}000$ times more intense than the least audible sound a human can hear

pH Scale

Acidic and basic are two extremes that describe a chemical property. Mixing acids and bases can cancel out or neutralize their extreme effects. A substance that is neither acidic nor basic is neutral.

The pH scale measures how acidic or basic a substance is. The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic. A pH greater than 7 is basic. The pH level of a water-based solution is defined as

$$pH = -log[H^+]$$

where $[H^+]$ is the concentration of hydrogen ions in moles per liter.

Example 3

A 1-liter solution contains 0.01 moles of hydrogen ions. Determine and describe its pH level.

Solution:

Since there are 0.01 moles of hydrogen ions in 1 liter, then the concentration of hydrogen ions is 10^{-2} moles per liter. The pH level is $-\ log\ log\ 10^{-2}$. By, definition $log\ 10^{-2}$ is the exponent by which 10 must be raised to obtain 10^{-2}, so $log\ 10^{-2} = -2$,

So, $pH = -(-2) = 2$, therefore, the pH level is 2

Since the pH level is 2, then it is acidic.

The application of logarithmic function will be further discussed in the lesson solving real-life problems involving logarithmic functions, equations and inequalities.

What's More

Activity 1.1

Transform the following logarithmic expressions to exponential form or vice versa.

1. $9^2 = 81$ ______________
2. $125^{1/3} = 5$ ______________
3. $m^n = p$ ______________
4. $(x - 1)^2 = 12$ ______________
5. $m^{-3} = 1/27$ ______________
6. $\log_4 16 = 2$ ______________
7. $\log_m x = 10$ ______________
8. $\log_5 (a - b) = 0$ ______________
9. $\log x = 2$ ______________
10. $\log 1 = 0$ ______________

Activity 1.2.

Evaluate the following.

1. $\log_8 64$ ________________
2. $\log_5 625$ ________________
3. $\log_3 81$ ________________
4. $\log 0.0001$ ________________
5. $log_9 \frac{1}{729}$ ________________
6. $log_2 \frac{1}{32}$ ________________
7. $ln\, 5$ ________________
8. $log_3 1$ ________________
9. $log_5 \frac{1}{25}$ ________________
10. $log_3 \frac{27}{8}$ ________________

Activity 1.3.

Solve the following problems.

1. A 1-liter solution contains 0.0000001 moles of hydrogen ions. Find its pH level.
2. Suppose that an earthquake released approximately 10^6 joules of energy, what is the magnitude on a Richter scale? How much more energy does this earthquake release than the reference earthquake?

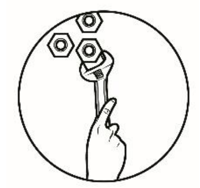
3. The intensity of sound of a background noise at a restaurant is 10^{-6} watts/m2. What is the corresponding sound intensity in decibels? (b) How much more intense is this sound than the least audible sound a human can hear?

4. The July 16, 1990 earthquake in Baguio City killed more than 2,000 people. What is the magnitude in the Richter Scale if it releases approximately 10^{16} joules of energy? How much more energy does this earthquake release than the reference earthquake?

What I Have Learned

Complete the following statements by writing the correct word or words and formulas.

1. Logarithm is the inverse of ____________________.
2. The logarithm of a with base b is denoted by ___________ , and is defined as $c = log_b\ a$ if and only if___________.
3. In logarithmic form $log_b\ a$,the value of b cannot be _____________.
4. The value of a can be ______________.
5. Let a, b, and c be ____________ real numbers such that b ≠ 1. The logarithm of a with base b is denoted by ___________, and is defined as _______ if and only if $a = b^c$
6. Logarithmic functions and exponential functions are _______________.
7. In logarithmic form $log_b\ a$, b cannot be ________________.
8. The base in the given logarithmic expression $log_{25} 5$ is ________.
9. If the base is not written in the logarithmic expression, then it is understood to be ________.
10. From the given $log_7 343$, it is the same as asking, “What will be the exponent of ______ to get _________? Since $7^3 = 343,$ therefore, $log_7 343$ = ________.



What I Can Do

What to do before, during and after the earthquake?

A brochure is an informative paper document (often used for advertising) that can be folded into pamphlet or leaflet. Brochures are promotional documents, primarily used to introduce a company, organization, products, or services and inform potential customers or members of the public of the benefits.

Task:

Make a brochure informing the public regarding different tips on what to do before, during and after the earthquake. You may use the following guidelines in creating your brochure.

1. Determine your purpose. Go straight to the point.
2. Know your brochure folds.
3. Be creative. Be unique.
4. Limit your font choices into just three. Avoid big words.
5. Use high-quality paper. Choose the right colors.
6. Add appropriate images.
7. Make the brochure worth keeping.
8. The content must focus on what to do before, during, and after an earthquake.

Please include the description of the effects of earthquake in different magnitude levels in the Richter scale.

Name of the Project:

Brief Description:

Rubrics for the task:

	4	3	2	1
Organization	The brochure has excellent formatting and very well-organized information.	The brochure has appropriate formatting and well-organized information.	The brochure has some organized information with random formatting.	The brochure's format and organization of material are confusing to the reader.
Ideas	The brochure communicates relevant information appropriately and effectively to the intended audience.	The brochure communicates relevant information appropriately to the intended audience.	The brochure communicates irrelevant information or communicates inappropriately to the intended audience.	The brochure communicates irrelevant information, and communicates inappropriately to the intended audience.
Conventions	All of the writing is done in a complete sentence. Capitalization and punctuation are correct throughout the brochure.	Most of the writing is done in a complete sentence. Most of the capitalization and punctuation are correct throughout the brochure.	Some of the writing is done in a complete sentence. Some of the capitalization and punctuation are correct throughout the brochure.	Most of the writing is not done in a complete sentence. Most of the capitalization and punctuation are not correct throughout the brochure.
Graphics	The graphics go well with the text and there is a good mix of text and graphics.	The graphics go well with the text, but there are so many that they distract from the text.	The graphs go well with the text, but there are too few	The graphics do not go with the accompanying text appears to be randomly chosen.

Assessment

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

1. It is a function defined as $y = a$ if and only if $b^y = a$ where a, b, and c are positive real numbers and b is not equal to 1.
   a. exponential function
   b. inverse function
   c. logarithmic function
   d. rational function

2. Which is the base of the given logarithm $log_p\, m = n$?
   a. log
   b. m
   c. n
   d. p

3. What is the logarithmic form of $10^3 = 1000$?
   a. $\log 3 = 1000$
   b. $\log 1000 = 3$
   c. $\log_3 1000 = 10$
   d. $\log_3 100 = 1000$

4. Which of the following is the exponential form of $log_{0.5}\, 4 = -2$?
   a. $(0.5)^{-2} = 4$
   b. $(-2)^{0.5} = 4$
   c. $(4)^{-2} = 0.5$
   d. $(0.5)^4 = -2$

5. Find the value of $log_4 \frac{1}{16}$.
   a. -2
   b. -1/2
   c. 1/2
   d. 2

6. Which of the following is the logarithmic form of $x^a = y$?
   a. $\log_x a = y$
   b. $\log_y x = a$
   c. $\log_x y = a$
   d. $\log_a x = y$

7. Find the exponential form of $log_a d = b + c$.
   a. $(b+c)^a = d$
   b. $a^{b+c} = d$
   c. $(b+c)^d = a$
   d. $d^a = b+c$

8. Which of the following is the correct value of $log_8 27$?
   a. 3/2
   b. 2/3
   c. -2/3
   d. -3/2

9. Find the value of $log_3 \frac{1}{243}$.
   a. 7
   b. 5
   c. -5
   d. -7

10. Evaluate: $log_3 27 + log_9 729$.
   a. 2
   b. 4
   c. 6
   d. 8

11. Find the exact value of $log_4 64 + log_3 9 - log_{25} 625$.
   a. 3
   b. 4
   c. 5
   d. 6

12. What is the value of $3\, log_8 512$?
   a. 7
   b. 8
   c. 9
   d. 10

13. What is the magnitude in the Richter scale of an earthquake that released 10^{14} joules of energy?
   a. 3.6
   b. 5.1
   c. 6.4
   d. 7.2

14. The decibel level of sound in a certain forest is 10^{-7} watts/m^2. What is the corresponding sound intensity in decibels?
    a. 4
    b. 5
    c. 6
    d. 7

15. A solution contains hydrogen ion concentration of 1×10^{-11} moles per liter. Calculate its pH value.
    a. 11
    b. 10
    c. 9
    d. 8

Additional Activities

If you want to try more, these activities are for you. It will help you to practice your skill in solving real-life problems involving logarithmic expression. Study and analyze each situation to solve the problem.

1. The magnitude M of an earthquake is a function of energy E measured in ergs. Richter and Gutenberg developed the so-called Richter scale and the formula for the magnitude is given earlier in this module. In 2013, a 7.2 magnitude earthquake hit Central Visayas and killed more than 150 people, destroyed century-old churches, and affected more than 3 million families. What is the amount of energy released by this earthquake?

2. To measure the brightness of a star from the earth, the brightness of the star Vega is used as a reference and is assigned a relative intensity $l_0 = 1$. The magnitude m of any given star is defined by $m = 2.5\ log\ log\ l$, where l is the relative intensity of that star. (a) What is the magnitude of Vega? (b) Suppose that light arriving from another star has a relative intensity of 2.4. What is the magnitude of this star?

Answer Key

What I Know

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

What's More

Activity 1.1

1. $\log_9 81 = 2$
2. $\log_{125} 5 = 1/3$
3. $\log_m p = n$
4. $\log_{x-1} 12 = 2$
5. $\log_m 1/27 = -3$
6. $4^2 = 16$
7. $m^{10} = x$
8. $5^0 = a - b$
9. $10^2 = x$
10. $10^0 = 1$

Activity 1.2

1. 2
2. 4
3. 4
4. -4
5. 3
6. -5
7. 1.609
8. 0
9. -2
10. 3/2

Activity 1.3

1. 7, neutral
2. 1.07 magnitude
3. 60 decibels
4. 7.7 magnitude

Assessment

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

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