Senior High School

General Mathematics

Module 5:
Exponential Functions, Equations and Inequalities

AIRs - LM

GENERAL MATHEMATICS
Module 5: Exponential Functions, Equations and Inequalities
Second Edition, 2021

Development Team of the Module

Authors: Lovely G. Tadije
Jhomar N. Balangue
Raymart Emerson A. Obungen
Editor: SDO La Union, Learning Resource Quality Assurance Team
Content Reviewers: Catherine F. Carbonell
Jiezyl Jamaica M. Aquino
Language Reviewer: Abelaine Joy B. Abaquita
Reviewers: Ryan V. Espiritu
Sherlyn A. De la Peña
Reynan O. Ibay
Illustrator: Ernesto F. Ramos, Jr.
Christian Bautista
Design and Layout: Angela Pauline C. Ganuelas

Management Team:

Atty. Donato D. Balderas Jr.
Schools Division Superintendent
Vivian Luz S. Pagatpatan, Ph.D
Assistant Schools Division Superintendent
German E. Flora, Ph.D, *CID Chief*
Virgilio C. Boado, Ph.D, *EPS in Charge of LRMS*
Erlinda M. Dela Peña, Ed.D, *EPS in Charge of Mathematics*
Michael Jason D. Morales, *PDO II*
Claire P. Toluyen, *Librarian II*

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Department of Education – SDO La Union
Office Address: Flores St. Catbangen, San Fernando City, La Union
Telefax: 072 – 205 – 0046
Email Address: launion@deped.gov.ph

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General Mathematics
Module 5:
Exponential Functions, 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 of lessons in each SLM. This will tell you if you need to proceed with completing this module or if you need to ask your facilitator or your teacher's assistance for a 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.

Target

In 1683, Jacob Bernoulli discovered the approximate value of the irrational number *e* through a study of compound interest and Johann Bernoulli began the study of the calculus of the exponential function in 1697. (Robertson, 2001)

An exponential function is defined as "a mathematical function in which an independent variable appears in one of the exponents." It is used to define the natural exponential function e^x, where *e* is Euler's number approximately equal to 2.718281828…

An exponential equation is an equation in which a variable occurs in the exponent and an exponential inequality is an inequality involving exponential expressions.

In the previous lessons about functions, you were able to learn about Rational Functions, Rational Equations, and Rational Inequalities as well as One-to-One Functions and their Inverse. In this learning material, you will be dealing with Exponential Functions, Exponential Equations, and Exponential Inequalities.

After going through this module, you are expected to:

1. represent real-life situations using exponential functions **(M11GM-1e-3)**,
2. distinguish among exponential function, exponential equation, and exponential inequality **(M11GM ie–4)**; and
3. solve exponential equations and inequalities **(M11GM-le-f-1)**.

Learning Objectives:

1. name and illustrate the most common applications of exponential functions in real life
2. identify exponential functions, exponential equations, and exponential inequalities
3. enumerate the steps in solving exponential equations and exponential inequalities
4. solve problems involving exponential equations and exponential inequalities

Before going on, check how much you know about this topic by answering the pretest on the next page on a separate sheet of paper.

Pretest

Directions: Read carefully each item. Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

For item numbers 1-3. Use the problem below:
Suppose that a colony of lice grows exponentially. There are 50 lice initially when its population doubles every 6 hours.

1. What is the correct exponential model of the situation?
   A. $y = 50(2)^{\frac{t}{6}}$ B. $y = 50(2)^{\frac{6}{t}}$
   C. $y = 6(2)^{\frac{t}{50}}$ D. $y = 6(2)^{\frac{50}{t}}$
2. How many lice are there after 18 hours?
   A. 100 B. 200
   C. 300 D. 400
3. How many lice are there after 2 days?
   A. 3,200 B. 6,400
   C. 9,600 D. 12,800

For item numbers 4-5. Use the problem below:
Suppose that the half-life of substance K is 50 days and there are initially 2000g.

4. What is the correct exponential model of the situation?
   A. $y = 2000\left(\frac{1}{2}\right)^{\frac{t}{50}}$ B. $y = 2000\left(\frac{1}{2}\right)^{\frac{50}{t}}$
   C. $y = 2050\left(\frac{1}{2}\right)^{\frac{t}{400}}$ D. $y = 2050\left(\frac{1}{2}\right)^{\frac{400}{t}}$
5. How many grams are left in substance K after 100 years?
   A. 125 B. 250
   C. 500 D. 1000

6. Which of the following terms is associated to $f(x) = b^x$?
   A. Exponential Equation B. Exponential Inequality
   C. Exponential Function D. Exponential Expression
7. What does an expression of the form $a \cdot b^{x-c} + d$ called?
   A. Exponential Equation B. Exponential Inequality
   C. Exponential Function D. Exponential Expression
8. What symbol represents the equality of two terms, values, or expressions?
   A. = B. <
   C. > D. ≠
9. Which of the following is an example of exponential inequality?
   A. $3^{2x+1} = 729$ B. $5^{3x} = 25^{2x-1}$
   C. $\left(\frac{1}{4}\right)^{3X} \leq 16^{X-1}$ D. $\left(\frac{1}{9}\right)^{x} = 81$
10. For the function $f(x) = b^x$, what does **b** stands for?
    A. Base B. Exponent
    C. Input D. Output
11. What is the first step in solving exponential equations?
    A. Solve the equation B. Make the base the same
    C. Equate the exponents D. Use trial and error method

12. What is the value of x in the expression $3^{x+2} = \frac{1}{27}$?

A. $x = -5$ B. $x = \frac{2}{3}$

C. $x = \frac{3}{2}$ D. $x = 3$

13. Which of the following is the solution set of $25^{x+6} > 125$?

A. $x > -3$ B. $x > -\frac{9}{2}$

C. $x > \frac{2}{9}$ D. $x > 2$

14. When a diesel-electric generator is switched off, the electricity dies away according to the formula $I(t) = 24(0.25)^t$ amperes, where t is the time in seconds. To have a 0.375 ampere of electricity, how long should be the time elapsed?

A. 1 second B. 2 seconds

C. 3 seconds D. 4 seconds

15. The weight of a radioactive substance t years after being set aside is given by $W(t) = 250(0.04)^t$ grams. How many years will you set aside a substance to make its weight be 2 grams?

A. $\frac{2}{3}$ B. $\frac{3}{2}$

C. 3 D. 4

Jumpstart

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

This activity will help you to learn the concept of exponential functions.

Activity 1: Fold Me, Count Me!

Directions: Get a whole sheet of paper and follow the steps carefully. Write your answer on the table below for every step you have done.

No. of Folds	0	1	2	3	4	5	6
No. of Sections							

Step 1 Count the number of sections created by folds in your paper. (The number of folds is zero)

Step 2 Fold your paper in half. Make sure to make a crease.

Step 3 Unfold the paper.

Step 4 Count the number of sections created by folds in your paper. (The number of folds is 1)

Step 5 Fold the paper back in half. Then fold it in half again.

Step 6 Unfold the paper.

Step 7 Count the number of sections created by folds in your paper. (The number of folds is 2)

Step 8 Repeat the process until you have 6 folds.

Step 9 After you fill-up the table, answer the following questions below.

Questions:

a. What did you observe in the number of sections as the number of folds in the paper increases?

_____

_____

b. Based on the knowledge that you had learned when you were in junior high, what formula can you define to the number of sections as the number of folds increases?

_____

_____

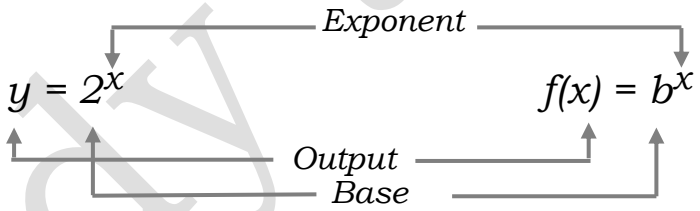
Discover

The table below shows the number of sections created. After folding the paper six times, you will be having a total of 64 sections.

No. of Folds	0	1	2	3	4	5	6
No. of Sections	1	2	4	8	16	32	64

The pattern of change in folding the paper in **Activity 1** can be modeled using rules involving exponents. The number of sections created is: 1, 2, 4, 8, 16, 32, 64 … can be expressed exponentially as: 2^0, 2^1, 2^2, 2^3, 2^4, 2^5, 2^6 …, respectively.

The number of sections is described by the exponential function $f(x) = 2^x$ or $y = 2^x$ where **y** represents the number of sections created and **x** represents the number of folds. It can be used to calculate the number of sections created without starting from the first stage.



An **exponential function** can be written as

$f(x) = b^x$

where b > 0, b ≠ 1, and x is any real number.

In the equation $f(x) = b^x$, b is a constant called the **base** and x is an independent variable called the **exponent**.

Here are some examples of exponential functions.

1. $f(x) = 5^x$ 2. $g(x) = 12^x$ 3. $h(x) = 3^{x+1}$

The following are **not** exponential functions.

1. $F(x) = x^2$ — Variable is the base and not the exponent.
2. $G(x) = 1^x$ — The base is a positive constant equal to 1.
3. $H(x) = x^x$ — Both the base and exponent are variables.

Exponential Functions can be found in many real-life situations such as growth in population like bacteria and ants, radioactive decay of certain chemical substances, compound interest of loans, and investments.

Exponential Growth

Scientist often studies bacteria, animals, viruses, observe their behaviors and watch them how their population grows. For example, there's a bacterium in a plate and its population grows every 2 hours, this kind of behavior can be represented using an exponential function.

Example 1: Let $t =$ *time* in days. At $t = 0$, there were 10 initial bacteria in a specific mug. Suppose that the bacteria double every 20 hours. Give an exponential model for the bacteria as a function of t.

Given:

Initially, at $t = 0$, the number of bacteria is 10.

Solution:

t= 0 Number of bacteria =10

t=20 Number of bacteria $=10(2)^1 = 20$ — *where the power of 1 came from (t = 20)/(one cycle=20)*

t=40 Number of bacteria $= 10(2)^2 = 40$ — *where the power of 2 came from (t = 40)/(one cucle=20)*

t=60 Number of bacteria $= 10(2)^3 = 80$ — *where the power of 3 came from (t = 60)/(one cycle=20)*

An exponential model for this situation is $\boldsymbol{y = 10(2)^{t/20}}$.

Exponential Models for Population Growth

$$y = a_1(2)^{t/T}$$

Where:

y is the quantity that doubles every period of time

a_1 is the initial amount when time is at rest

t is the units of time is given

T is every unit of time that had been passed when the quantity has doubled.

Exponential Decay (Half-Life)

The **half-life** of a substance is the time it takes for half of the substance to decay.

Example 2: Suppose that the half-life of substance A is 50 days and there are initially 100g, determine the amount of substance A remains after 100 days.

Solution:

Initially, at $t = 0$ amount of substance $A = 100g$

$t = 0$ Amount of substance $A = 100$

$t = 50$ Amount of substance $A = 100\left(\frac{1}{2}\right)^1 = 50$ *where the power of 1 came from ($t = 50$)/(one cycle = 50)*

$t = 100$ Amount of substance $A = 100\left(\frac{1}{2}\right)^2 = 50$ *where the power of 2 came from ($t = 100$)/(one cycle = 50)*

An exponential model for this situation is $y = 100\left(\frac{1}{2}\right)^{t/50}$.

Exponential Models for Population Decay

$$y = a_1\left(\frac{1}{2}\right)^{t/T}$$

Where:

y is the substance remaining after t units of time

a_1 is the initial amount when time is at rest

t is the units of time is given

T is every unit of time that had been passed when the quantity has doubled.

Compound Interest

A starting amount of money (called the **principal**) can be invested at a certain interest rate that is earned at the end of a given period (such as one year). If the interest rate is **compounded**, the interest earned at the end of the period is added to the principal, and this amount will earn interest in the next period. The same process is repeated for each succeeding period: interest previously earned will also earn interest in the next period.

Example 3: Mr. Halog saves his money amounting to Php 50,000 in Landbank that offers 6% interest compounded annually. How much savings does he have after 3 years?

Given:

Initial savings is P50,000

Interest rate = 6% = 0.06

Solution:

at $t = 1$ savings $= 50{,}000(1.06)^1 = Php\ 53{,}000$

at $t = 2$ savings $= Php\ 50{,}000(1.06)^2 = Php\ 56{,}180$

at $t = 3$ savings $= P50{,}000(1.06)^3 \approx Php\ 59{,}550.80$

where the 1.06 came from $1 + r$ where r = 6% = 0.06

The exponential model for this situation is $\boldsymbol{y = 50000(1.06)^t}$.

Compound Interest

$$y = P(1 + r)^t$$

Where:

y is the amount after t years
P is the starting amount of money
r is the amount of interest
t is the units of time is given

Going back to **Activity 1**, we have the following table which shows the number of sections created after folding a paper six times.

No. of Folds	0	1	2	3	4	5	6
No. of Sections	1	2	4	8	16	32	64

An equation can be formed and can be used to calculate the number of sections created without starting from the first stage. If we let **y** represent the number of sections created and **x** the number of folds, our equation will be $y = 2^x$, which is an ***exponential function***, where **x** is the independent variable and **y** is the dependent variable.

Note that in the equation formed, the variable **x** appears as an exponent. We can equate the data from the second row of our table as $1 = 2^x$, $2 = 2^x$, $4 = 2^x$, $8 = 2^x$, ..., $64 = 2^x$. We call each of the listed equations an ***exponential equation***.

With the exponential function and exponential equation in mind, we can already define an ***exponential inequality*** as a form having any among the inequality symbols $<, >, \leq, \geq$ and $\neq$, in which **x** appears in the exponent.

An **exponential equation** is an equation in which the independent variable occurs in the exponent.

The following equations are examples of exponential equations.

1. $5^x = 125$
2. $12^x = 144$
3. $3^{x+1} = 81$
4. $4^{2x} = 256$
5. $3^{2x-1} = 243$
6. $2^{x-1} = 32$

Let us know more about the different steps in evaluating exponential equations.

Example 1: Find the value of x in the equation $4^{x+1} = 64$.

Solution:

Step 1: Make the bases the same.

$4^{x+1} = 4^3$

Step 2: Copy the exponents and equate them.

$x + 1 = 3$

Step 3: Solve the resulting equation.

$x + 1 = 3$

$x = 3 - 1$

$x = 2$

Step 4: Check if the obtained value satisfies the given equation.

$4^{2+1} = 64$

$64 = 64$

Therefore, $x = 2$.

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 $x_1 = x_2$.

Example 2: Solve the equation $81^{x-1} = 27^{x+3}$

Solution:

Both 81 and 27 can be written using 3 as the base.

$$(3^4)^{x-1} = (3^3)^{x+3}$$
$$3^{4(x-1)} = 3^{3(x+3)}$$
$$4(x-1) = 3(x+3)$$
$$4x - 4 = 3x + 9$$
$$4x - 3x = 9 + 4$$
$$\boldsymbol{x = 13}$$

Example 3: Solve the equation $4^{x^2} = 2^{x+3}$

Solution:

Both 4 and 2 can be written using 2 as the base.

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

An **exponential inequality** is an inequality involving exponential forms where x is in the exponent.

The following are examples of exponential inequalities.

1. $36^x \geq 6^{x+1}$
2. $10^{5x-3} > 10000$
3. $\left(\frac{1}{4}\right)^{3x+5} \leq \left(\frac{1}{32}\right)^{x-6}$
4. $\left(\frac{5}{3}\right)^n > \frac{9}{25}$
5. $8^{x-2} < 16$
6. $49^x \geq 343$

Let us know more about the different steps in evaluating exponential inequality.

Example1: Find the possible values of x in $3^{3x+1} > 243$.

Solution:

Step 1: Make the bases the same.

$3^{3x+1} > 243$

$3^{3x+1} > 3^5$

Step 2: Copy the exponents and the relational symbol.

$3x + 1 > 5$

Step 3: Solve the resulting inequality.

$3x > 5 - 1$

$3x > 4$

$\frac{3x}{3} > \frac{4}{3}$

$x > \frac{4}{3}$

Step 4: Test a value to check if it satisfies the given inequality.

$x > \frac{4}{3}$

Let $x = \frac{5}{3}$ (since this value is greater than $\frac{4}{3}$)

$3^{3\left(\frac{5}{3}\right)+1} > 243$

$3^{5+1} > 243$

$729 > 243$

Thus, the solution set is $x > \frac{4}{3}$.

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 $x < y$.

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

Example 2: Solve the inequality $3^x < 9^{x-2}$.

Solution:

Both 3 and 9 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

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

$$4 < 2x - x$$

$$4 < x$$

Thus, the solution set is $(\mathbf{4}, +\infty]$.

(*You can verify that* $x = 5$ *and 6 are solutions, but* $x = 4$ *and 3 are not*)

$x = 5$	$x = 6$	$x = 4$	$x = 3$
$3^x < 9^{x-2}$	$3^x < 9^{x-2}$	$3^x < 9^{x-2}$	$3^x < 9^{x-2}$
$3^5 < 9^{5-2}$	$3^6 < 9^{6-2}$	$3^4 < 9^{4-2}$	$3^3 < 9^{3-2}$
$3^5 < 9^3$	$3^6 < 9^4$	$3^4 < 9^2$	$3^3 < 9^1$
$243 < 729$ ✓	$729 < 6561$ ✓	$81 < 81$ ✗	$27 < 9$ ✗

Example 3: Solve the inequality $\left(\frac{1}{5}\right)^{x+5} \geq \left(\frac{1}{25}\right)^{3x}$.

Solution:

Since $\frac{1}{25} = \left(\frac{1}{5}\right)^2$, then we write both sides of the inequality with $\frac{1}{5}$ as the base.

$$\left(\frac{1}{5}\right)^{x+5} \geq \left(\frac{1}{25}\right)^{3x}$$

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

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

Since the base $\frac{1}{5} < 1$, then this inequality is equivalent to

$x + 5 \leq 6x$ (the direction of the inequality is reversed)

$5 \leq 6x - x$

$5 \leq 5x$

$1 \leq x$

Thus, the solution set is $[\mathbf{1}, +\infty)$.

(You can verify that $x = 1$ and 2 are solutions, but $x = 0$ and -1 are not.)

$x = 1$

$\left(\frac{1}{5}\right)^{x+5} \geq \left(\frac{1}{25}\right)^{3x}$

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

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

$\left(\frac{1}{5}\right)^{6} \geq \left(\frac{1}{5}\right)^{6}$ ✓

$x = 2$

$\left(\frac{1}{5}\right)^{x+5} \geq \left(\frac{1}{25}\right)^{3x}$

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

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

$\left(\frac{1}{5}\right)^{7} \geq \left(\frac{1}{5}\right)^{12}$

or

$5^{-7} \geq 5^{-12}$ ✓

$x = 0$

$\left(\frac{1}{5}\right)^{x+5} \geq \left(\frac{1}{25}\right)^{3x}$

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

$\left(\frac{1}{5}\right)^{0+5} \geq \left(\frac{1}{5}\right)^{2[3(0)]}$

$0.00032 \geq 1$ ✗

$x = -1$

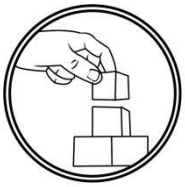
$\left(\frac{1}{5}\right)^{x+5} \geq \left(\frac{1}{25}\right)^{3x}$

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

$\left(\frac{1}{5}\right)^{-1+5} \geq \left(\frac{1}{5}\right)^{2[3(-1)]}$

$\left(\frac{1}{5}\right)^{4} \geq \left(\frac{1}{5}\right)^{2[3(-1)]}$

$\frac{1}{625} \geq 15{,}625$ ✗



Explore

Here are some enrichment activities for you to work on to master and strengthen the basic concepts you had learned from this lesson.

Activity 1: Find My Value.

Directions: Construct the exponential model of every problem. You may use a separate half sheet of paper for your answer.

1. At $t = 0$, there were 30 initial bacteria in dirty clothes. Suppose that the bacteria double every 4 hours. Give an exponential model for the bacteria as a function of t.
2. Suppose that the half-life of substance Q is 24 days and there are initially 400g, determine the amount of substance A remains after 96 days.
3. Mr. Delos Santos invested his money amounting to Php 80,000 in Robinsons that offers 8% interest compounded annually. How much savings does he have after 6 years?
4. Ms. Nica loans Php 200,000 from the Philippine National Bank with an interest of 6.5% compounded annually. How much total money does Philippine National Bank receive after 2 years?
5. Philip, a senior high student wants to save his money in Banco de Oro with an interest rate of 9% compounded annually. How much savings does he have after 4 years if he deposits Php 5,000?

Activity 2: Distinguish the Given

Directions: Determine whether each of the given is an exponential equation, an exponential inequality, or an exponential function by placing each of them in their respective column in the table that follows.

A. $3^{x+1} < 81$

B. $5^{2x-1} = 125$

C. $f(x) = 7^x$

D. $g(x) = 81^{x-2}$

E. $4^{2x} = \frac{1}{256}$

F. $h(x) = \left(\frac{1}{9}\right)^{-3x}$

G. $2^{3x} + 2^{x+1} \geq 0$

H. $6^{2x} - 216^{x-1} = 0$

I. $\left(\frac{1}{9}\right)^{3x-1} \leq \left(\frac{1}{81}\right)^{x+5}$

Exponential Equation	Exponential Inequality	Exponential Function

Activity 3: Evaluate the Expression

Directions: Evaluate the following exponential equations and inequalities.

A. $4^{x+2} = 8^{2x}$

B. $81^{2x-3} = 9^{x+2}$

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

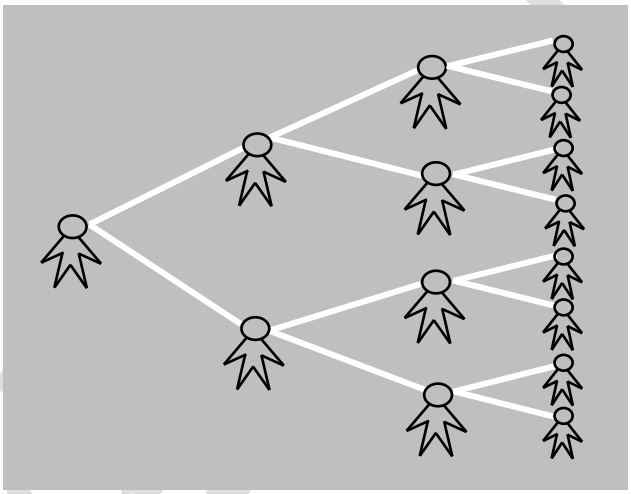
D. $2^{3-x} < 4^{2-x}$

E. $\left(\frac{1}{125}\right)^{-3x-1} \geq 25^{-x-1}$

Deepen

In these challenging and difficult times, we all know that God is always there. He is always ready to guide us, to take care of us, and to provide us all the things we need as long as we will ask it to Him diligently and faithfully in our prayers, as the Bible says in Matthew 21:22, "And all things, whatsoever ye shall ask in prayer, believing, ye shall receive."

If the diagram below shows the pattern on how you are going to inform others about this Bible verse, we know that just after the 10th stage of the information pattern there will be a total of 2,047 people who will learn and apply it in their daily lives. It just needs a single person, to begin with, and that is nobody but "YOU". (How awesome is that? ☺)



At this point, make your artistic tree diagram having the same pattern as the one presented above. Aside from the Bible verse, think of another information that you would like the people in your community to know following the same pattern of sharing presented. Explain also why you want that information to be known by others in the community where you belong by composing a short but substantial essay.

What you need

1. Pen
2. Two Sheets of Papers
3. Pencil
4. Ruler
5. Coloring Materials

What you have to do

1. Create your artistic tree diagram on a sheet of paper.
2. Write your short but meaningful essay on the other sheet of paper.

Rubrics for Scoring the Output

Drawing Rubrics

Components	Mastery 4	Accomplished 3	Unacceptable 2
Reflection and Knowledge	The drawing represents a clear understanding of the information presented.	The drawing represents a somewhat clear understanding of the material.	The student clearly did not understand the information. The drawing is not representative of the knowledge gained.
Basic Skills	Drawing exhibits attention to detail and a variety of drawing techniques	The drawing contains many strong elements but needs further refinement and fine-tuning. Only a few drawing techniques were used.	The drawing lacks detail. Little effort in work and appears improvised and looks incomplete. No variety in drawing techniques.
Originality/ Creativity	The student explored several choices, generating many ideas, unusual combinations, or changes on several ideas.	Tried a few ideas but based his/her work on someone else's idea.	Fulfilled the assignment, but gave no evidence of trying anything unusual. Shows no evidence of original thought.
Effort	The project is complete and shows effort far beyond that which was required.	Worked hard and completed the project but could have improved with more effort.	Chose only easy projects and did the work indifferently. Completed with minimum effort or not finished.
Performance	Worked independently. Followed directions. Used art materials wisely.	Worked independently most of the time. Needed a few reminders on proper care of materials.	Made little progress toward goals. Very little was accomplished. Materials and tools used inappropriately.

Rubrics Uploaded by Joric Magusara on Sep 02, 2013
https://www.scribd.com/document/164851874/Drawing-Rubrics-General
Rubric for Drawing Activity

Rubrics for Essay

Criteria	5	4	3	2
Focus/ Main Point	The essay is focused, purposeful, and reflects clear insight and ideas.	The essay is focused on the topic and includes relevant ideas	The essay is focused on the topic and includes few loosely related ideas	The essay poorly addresses the topic and includes irrelevant ideas
Support	Persuasively supports the main point with well-developed reasons and/or examples	Supports the main point with developed reasons and/or examples	Supports the main point with some underdeveloped reasons	Provides little or no support for the main point
Organization & Format	Effectively organizes ideas to build a logical, coherent argument	Organizes ideas to build an argument	Some organization of ideas to build an argument	Little or no organization of ideas to build an argument
Originality/ Creativity	Distinctive experimentation with language and usage to enhance concepts Applies higher-order thinking and creative skills to relay complex ideas	Sufficient experimentation with language and usage to enhance concepts Applies basic creative skills to relay ideas	Very little experimentation to enhance concepts Does not exhibit creativity	No experimentation nor enhancement of concepts No adherence to the theme

Rubrics downloaded from https://www.kpu.ca > NEVRPDF
Web results
High School Rubrics

$$\textbf{Grand Total} = \frac{(\textbf{Total Score in Drawing} + \textbf{Total Score in Essay})}{\textbf{2}}$$

Gauge

Directions: Read carefully and analyze each item. Use a separate sheet of paper where you will write the letter of the correct answer beside the item number. (Use "CAPITAL" letters)

For numbers 1-3. Use the problem below:

Mrs. Santiago invests her money in Jollibee amounting to Php250,000 that offers 7% interest compounded annually.

1. What is the correct exponential model of the situation?
   A. $y = 250{,}000(1.7t)$ B. $y = 250{,}000(1.7)^t$
   C. $y = 250{,}000(1.07t)$ D. $y = 250{,}000(1.07)^t$
2. How much money does she have after 5 years?
   A. Php350,637.93 B. Php350,673.93
   C. Php350,736.93 D. Php350,763.93
3. How much money does she have after 10 years?
   A. Php491,778.84 B. Php491,787.84
   C. Php491,788.84 D. Php491,887.84

4. There's a colony of termites inside your house. Their initial population is 360. If their population doubles every 2 hours, how many termites are there after 10 hours?
   A. 570 B. 5760
   C. 11502 D. 11520
5. Suppose that the half-life of substance K is 50 days and there are initially 2000g. How many grams are left in substance K after 200 days?
   A. 125 B. 250
   C. 500 D. 1000
6. Each of the following is an example of exponential equations EXCEPT one. Which one is the EXCEPTION?
   A. $3^{2x+1} = 729$ B. $\left(\frac{1}{4}\right)^{3x} \leq 16^{x-1}$
   C. $5^{3x} = 25^{2x-1}$ D. $\left(\frac{1}{9}\right)^{x} = 81$
7. Which of the following is an example of exponential inequality?
   A. $8^x = 64$ B. f(x) = 9^{x-1}
   C. $7^{x+1} = 343$ D. $3^{x+5} > 9^{x+2}$

8. Which among the choices does NOT belong to the group of exponential functions?
   A. $g(x) = 4^x$ B. $h(x) = 3^{x+1}$
   C. $j(x) = 2^{x-2}$ D. $k(x) = x^{2x-3}$
9. An exponential expression is an expression of the form $a \cdot b^{x-c} + d$. Which of the variables used should be any real number greater than 0 except 1?
   A. a B. b
   C. c D. d
10. To know if a given function is NOT an exponential function, it may be described by one or more of the following EXCEPT one. Which one is the EXCEPTION?
   A. Variable is the base and not the exponent.
   B. Both the base and exponent are variables.
   C. The variable must be seen as part of the exponent and not the base.
   D. The base of an exponential function is a positive constant equal to 1.
11. What value of x will satisfy the exponential equation $4^{2x+1} = 8^{1-x}$?
   A. $x = -5$ B. $x = \frac{1}{7}$
   C. $x = \frac{3}{2}$ D. $x = 3$
12. What value of x will satisfy the exponential equation $4^x + 2^x - 20 = 0$?
   A. -3 B. -2
   C. 2 D. 5
13. What solution set will satisfy the exponential inequality $3^{2-x} < \frac{1}{27}$?
   A. $x > \frac{2}{3}$ B. $x < \frac{3}{2}$
   C. $x > 5$ D. $x < 5$
14. A certain money was invested with a given formula for interest $I(t) = 64(1.25)^t$, where t is the time in years. What time will it require when the interest is at most ₱125?
   A. $t \leq 1$ B. $t \leq 2$
   C. $t \leq 3$ D. $t \leq 4$
15. A certain population of bacterium is tripled every minute. After how many minutes will the number of bacteria be at least 2187?
   A. $x \geq 5$ B. $x \geq 6$
   C. $x \geq 7$ D. $x \geq 8$

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For inquiries or feedback, please write or call:

Department of Education – SDO La Union
Curriculum Implementation Division
Learning Resource Management Section
Flores St. Catbangen, San Fernando City La Union 2500
Telephone: (072) 607 - 8127
Telefax: (072) 205 - 0046
Email Address:
launion@deped.gov.ph
lrm.launion@deped.gov.ph