Senior High School

DepED
DEPARTMENT OF EDUCATION

General Mathematics

Quarter 1 – Module 17: Exponential Functions, Equations and Inequalities

ALTERNATIVE DELIVERY MODE
ADM

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Quarter 1 – Module 17: Exponential Functions, Equations, and Inequalities
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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.

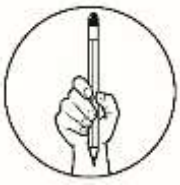
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you master Exponential Function, Exponential Equation and Exponential Inequality. 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. distinguish exponential function, exponential equation, and exponential inequality; and
2. formulate own examples of exponential functions, equations, and inequalities.



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 an expression that is of the form $a \cdot b^{x-c}d$, where *a, b, c,* and d are real numbers and x is a variable?
    a. Exponential Expression
    b. Logarithmic Expression
    c. Mathematical Expression
    d. Rational Algebraic Expression

2. Which of the following expresses the relationship between two variables?
    a. Exponential Equation
    b. Exponential Expression
    c. Exponential Function
    d. Exponential Inequality

3. Which of the following is most commonly expressed as an independent variable?
    a. y
    b. x
    c. $f(x)$
    d. $g(x)$

4. In which of the following is $16 = 4^{x-2}$ classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

5. In which of the following is 2^{3x-4} classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

6. In which of the following is $f(x) = 7x^3$ classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

7. In which of the following is $\left(\frac{1}{2}\right)^{3x} \leq 16$ classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

8. What is true about the exponential function $y = 10^{x-2}$?
    a. This shows the relationship between two variables.
    b. The possible values for y can be assigned beforehand.
    c. This can also be considered as an exponential equation.
    d. The possible values for x can be solved based on y-values.

9. Which of the following is an exponential function?
    a. $y = 9x^2$
    b. $h(x) = 4^x$
    c. $2^{x+1} = 4$
    d. $3x^2 = 81$

10. Which of the following is an exponential inequality?
    a. $9^x < 27^{2x}$
    b. $3^{4x} = y$
    c. $2x = 64x^2$
    d. $f(x) = 6^x$

11. Which of the following is an exponential equation?
    a. $10^{x-2} \geq 100^{x}$
    b. $g(x) = 8^{3x}$
    c. $12 = 144^{x}$
    d. $(0.25)^{x+4} > (0.5)^{5x}$

12. In which of the following is $2^{2}(400^{x+1}) = 80$ classified?
    a. Exponential Equation
    b. Exponential Function
    c. Exponential Inequality
    d. Exponential Model

13. In which of the following is $64 \geq 4^{x+1}$ classified?
    a. Exponential Equation
    b. Exponential Function
    c. Exponential Inequality
    d. Exponential Model

14. Which of the following is an exponential equation?
    a. $36 = x^{2}$
    b. $3^{4x} > 27$
    c. $f(x) = 10^{2x}$
    d. $81 = 9^{x}$

15. Which of the following is an exponential inequality?
    a. $(0.64) \leq (0.8)^{x}$
    b. $3 > 27x^{3}$
    c. $10^{2} \geq 1000x$
    d. $49 < 7^{3}$

Lesson 1 Exponential Functions, Equations and Inequalities

What is the pride of your city or province? Are you aware of the natural sources of income your city or province have? Have you ever thought of the pattern in the production of some natural sources of income in your hometown? Are they increasing or declining quickly? As a Senior High School learner and a concerned citizen, that is one good thing you need to be aware of.

What's In

Anything that increases or decreases rapidly is said to be exponential. You have learned in the previous module that there are a lot of real-life situations involving such conditions. For instance, population growth, exponential decay, and compound interest are some of the situations that depict the so-called exponential functions.
Recall that an exponential function with base b is of the form $f(x) = b^x$ or $y = b^x$, where $b > 0$, but $b \neq 1$. Have you noticed anything with the exponent? How does it differ from the exponents of some other functions? Good! The exponential function has exponents that are variables. In the past lesson, you have learned that this exponent determines how fast a function increases or decreases.

Notes to the Teacher

Lead learners to the concept that f(x) and y are the same in dealing with functions, as they both refer to dependent variable. Guide learners as well in understanding that the symbols "$b > 0,\ b \neq 1$" mean all positive numbers, but one.

What's New

Spot the Similarity and Difference!

Below are statements with exponential expressions. Observe them and spot their similarities and differences.

(a) $3^{x-2} = 81$ (b) $y = 4^x$ (c) $2^x \geq 32$

Questions:

1. What is the similarity of (a), (b), and (c)?
2. What is the similarity of (a) and (c)?
3. How do (a) and (c) differ from (b)?
4. How are (a) and (b) similar to each other?
5. How do (a) and (b) differ from (c)?
6. Can you recall which among them is an exponential function?
7. Which among the three involve/s exponential expression/s?

As you have noticed, all the three givens involve variable as the exponent. The statements in (a) and (c) have only one variable, while (b) has the relationship between two variables. It is also shown that (a) and (b) both use an equal sign, whereas (c) contains an inequality symbol.

Recall that (b) is an exponential function since it shows the relation between dependent variable y and independent variable x. Nevertheless, all three involve exponential expressions. It is so since all include expressions with a variable used as an exponent.

What is It

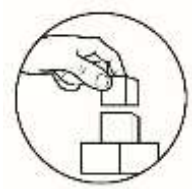
From the previous activity, you have learned that there are other statements with exponential expressions aside from exponential function. Based on what you have observed, they do not involve a dependent variable y or *f(x).* But taking a deeper look, you will then notice that these expressions can be further classified into two – exponential equation and inequality. Let us now differentiate the three.

An **exponential function** is a function involving exponential expression showing a relationship between the independent variable x and dependent variable y or *f(x).* Examples of which are $f(x) = 2^{x+3}$ and $y = 10^{2x}$.

On the other hand, an **exponential equation** is an equation involving exponential expression that can be solved for all x values satisfying the equation. For instance, $121 = 11^x$ and $3^x = 9^{x-2}$.

Lastly, an **exponential inequality** is an inequality involving exponential expression that can be solved for all x values satisfying the inequality. For example, $64^{1/3} > 2^x$ and $(0.9)^x \leq 0.81$.

After learning the differences among the three exponential expressions, can you give your own examples for each? What are they?



What's More

Activity 1.1

Where Do They Belong?

Below is a list of statements with exponential expressions. Classify each as to whether it is an exponential function, equation, inequality, or does not belong to any of these three.

$32^{x-4} \leq 16^{x+2}$	$36^x = 6$	$6 > \left(\frac{1}{36}\right)^x$	$x^7 + 1 < 10x^8$	$y = x^5$	$64 = 2^{x+2}$
$100 > 10^{2x}$	$f(x) = x^3$	$g(x) = 4^{5x}$	$y = 5^{x-1}$	$\left(\frac{1}{2}\right)^{x+2} = \left(\frac{1}{8}\right)^x$	$f(x) = 2^x$
$7 = 49^x$	$27 < 3^x$	$f(x) = 5^{x+2}$			

Exponential Function	Exponential Equation	Exponential Inequality	None of these

Activity 1.2

Classify and Justify!

On the blank provided before each number, classify each given as an exponential function, equation, inequality, or none of these three. Justify your decision in one sentence for every item. Write the justification on the blanks provided below each given expression.

_____ 1. $3^{2x} = 81$

_____

_____

_____ 2. $x^5 < 15x^3$

_____

_____

_____ 3. $5 > \left(\frac{1}{25}\right)^x$

_____

_____

_____ 4. $h(x) = 6^{3x}$

_____

_____

_____ 5. $3^2 = 2^{x+1}$

_____

_____

What I Have Learned

Complete the following statements by filling in the blanks with the correct words or phrases.

1. An expression involving a rapid increase or decrease is said to be _____ _____.
2. The exponent of an exponential expression is a _____ _____ showing how fast the function increase or decrease.
3. When a statement with exponential expression depicts a relationship between two variables, it involves _____.
4. An _____ can be solved for all x values of those involving equations.
5. An exponential inequality is a/an _____ that can also be solved for all values of x.

What I Can Do

Coordinate with authorities regarding the production rate of the natural sources of income in your area such as rice, coconut, or fish production.

Construct an exponential function corresponding to the production rate that you will be given.

Based on the exponential expression you formulated, what can you contribute to the situation as a responsible youth citizen.

Try scoring your essay using the rubric below.

Criteria	4	3	2	1
Proficiency (score x 2)	Formulated an exponential function corresponding to the given situation	Formulated an exponential function but do not correspond to the given situation	Formulated an exponential function but there is no given situation	Formulated an equation but not an exponential fucntion
Idea (score x 2)	Very relative to the topic and well-organized ideas	Quite relative to the topic and the organization of ideas is somehow inadequate	Less relative to the topic with poorly organized ideas	Not relative to the topic with very poorly organized
Spelling, Grammar, and Punctuations (score x 1)	No spelling, punctuation or grammatical errors	Very few spelling, punctuation, and grammatical errors	Several spelling, punctuation, and grammatical errors	Many spelling, punctuation, and grammatical errors

Assessment

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

1. What is true about exponential expression?
    a. It has an exponent.
    b. Its exponent is a variable.
    c. Its exponent is constant.
    d. Its exponent is an expression.
2. Which of the following is an exponential function?
    a. $f(x) = (4 + x)^2$
    b. $f(x) = 4x^2$
    c. $f(x) = 4x$
    d. $f(x) = 4^x$
3. In which of the following is $36^x = 6^{x+4}$ classified?
    a. Exponential Model
    b. Exponential Function
    c. Exponential Inequality
    d. Exponential Equation

4. Which of the following is commonly used as a dependent variable in an exponential function?
    a. $f(x)$
    b. x
    c. $2x$
    d. 2^x

5. In which of the following is $169 \geq 13^{2x}$ classified?
    a. Exponential Inequality
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Model

6. In which of the following is $3^{5x-1} = 27$ classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

7. Which of the following is an exponential function?
    a. $5^{x+3} < 25^{x}$
    b. $12 = 144^{x}$
    c. $y = 12^{x-1}$
    d. $(0.64)^{x} > (0.8)^{x+4}$

8. Which of the following is an exponential inequality?
    a. $(0.04) \leq 0.2x$
    b. $3 > 27^{x}$
    c. $30^{2} \geq 900x$
    d. $64x < 2^{6}$

9. Which of the following is an exponential function?
    a. $y = 11x^{2}$
    b. $f(x) = 11x$
    c. $j(x) = 11^{x}$
    d. $11x^{2} = x^{11}$

10. Which of the following is an exponential inequality?
    a. $4^{x-1} > 16^{2x}$
    b. $4x - 1 < 16x^{2}$
    c. $y = 16x^{2}$
    d. $f(x) = (16 + x)^{2}$

11. Which of the following is an exponential equation?
    a. $x^{2} = 144$
    b. $15^{x+2} = 225$
    c. $2x + 3 = 29$
    d. $f(x) = 8^{x}$

12. In which of the following is $y = 2^{3x+1}$ classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

13. What is true about an exponential function?
    a. It contains the inequality symbol.
    b. It has a numerical exponent only.
    c. It is written in the form $f(x) = b^{x}$ where $b > 0, b \neq 1$.
    d. It involves radical expression.

14. In which of the following is $g(x) = 4^{x-1}$ classified?
    a. Exponential Expression
    b. Exponential Equation
    c. Exponential Function
    d. Exponential Inequality

15. What is true about $1000 = 100^x$?
    a. It can be considered as an exponential function.
    b. It is an exponential equation whose x-value can be solved.
    c. It can be expressed as an exponential inequality with one variable.
    d. It shows the relationship between the independent and dependent variables.

Additional Activities

Formulate your own 5 examples for each of the following:

- Exponential function
- Exponential equation
- Exponential inequality

Answer Key

What I Know

1. a
2. c
3. b
4. b
5. a
6. c
7. d
8. a
9. b
10. a
11. c
12. a
13. c
14. d
15. a

What's More

Activity 1.1

Exponential Function

$g(x) = 4^{5x}$

$y = 5^{x-1}$

$f(x) = 2^x$

$f(x) = 5^{x+2}$

Exponential Equation

$36^x = 6$

$64 = 2^{x+2}$

$\left(\frac{1}{2}\right)^{x+2} = \left(\frac{1}{8}\right)^x$

$7 = 49^x$

Exponential Inequality

$32^{x-4} \leq 16^{x+2}$

$6 > \left(\frac{1}{36}\right)^x$

$100 > 10^{2x}$

$27 < 3^x$

None of these

$x^7 + 1 < 10x^8$

$y = x^5$

$f(x) = x^3$

Activity 1.2

1.Exponential Equation
It is an exponential expression involving equation with only 1 variable.

2.None of these
It is not an exponential expression.

3.Exponential Inequality
It is an exponential expression involving equation with only 1 variable.

4.Exponential Function
It is an exponential expression involving relationship between 2 variables.

5. Exponential Equation
It is an exponential expression involving equation with only 1 variable.

Assessment

1. b
2. d
3. d
4. a
5. a
6. b
7. c
8. b
9. c
10. a
11. b
12. c
13. c
14. c
15. b

References

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