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Mathematics
Quarter 2- Module 3:
Zero, Negative, and Rational Exponents

AIRs - LM

MATHEMATICS 9
Quarter 2 - Module 3: Zero, Negative and Rational Exponents
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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.

Target

Good day, this module requires your knowledge on laws of exponent which will help you understand zero, negative integral and rational exponent. As you go through to this module you will know on how to apply the laws involving positive integral to zero and negative integral exponent. In order for you to succeed in this module, you must recall on the laws of exponent which you have learned from previous lessons.

Recall on this so that you will guided on the next activities:

If a and b are real numbers and m and n are positive integers, then

$$a^m * a^n = a^{m+n} \qquad (a^m)^n = a^{mn} \qquad (ab)^n = a^n b^n$$

$$(a/b)^m = (a^m/b^m) \qquad (a^m/a^n) = a^{m-n} \qquad (a^m/a^n) = 1/a^{n-m}$$
if b ≠ 0   *if m>n and a ≠ 0*   *if n>m and a ≠ 0*

Before we start, let us consider the most essential learning competency.

1. applies the laws involving positive integral to zero and negative integral exponent **(M9AL-IId-1)**

   After going through this module, you are expected to:
   1. recall the laws of exponent;
   2. state negative exponent into positive exponents;
   3. applies the laws involving positive integral to zero and negative integral exponent

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

Pre-Assessment:

Direction: Choose the letter of the correct answer. Write your answer on a separate sheet of paper

1. Which of the following is **TRUE**?
   A. $-7^0 = -1$
   B. $(-7)^0 = 1$
   C. $-7^0 = -7$
   D. $-7^0 = 7$

2. What is the result when we simplify $4x^2 y^0$?
   A. $4x$
   B. $4x^2$
   C. x^2
   D. $4x^2 y$

3. What is the value if we simplify the expression $b^3 (b^{-1})$?
   A. b
   B. b^2
   C. b^3
   D. b^4

4. What is the value if we simplify the expression $\frac{pr}{3pr^{-2}}$?

   A. $\frac{1}{3pr}$

   B. $\frac{r^3}{3p}$

   C. $\frac{r^3}{3}$

   D. $\frac{p}{3r^2}$

5. Simplify the expression $3c^{-4}$.

   A. $\frac{1}{3c^4}$

   B. $\frac{3}{13c^4}$

   C. $\frac{3}{c^4}$

   D. $\frac{1}{3c^4}$

6. Which of the following will complete the equation $\frac{c^3}{c^4} = \frac{1}{c^{4-3}} = $ _____ ?

   A. $\frac{1}{c^{-1}}$

   B. $\frac{1}{c^7}$

   C. $\frac{1}{c^4}$

   D. $\frac{1}{c}$

7. Which of the following will complete the equation $\frac{c^{-8}}{c^{-7}} = $ _____?

   A. $\frac{1}{c^{15}}$

   B. $\frac{1}{c^{56}}$

   C. $\frac{1}{c^5}$

   D. $\frac{1}{c}$

8. Which of the following expression will **NOT** give a result of 1?
   A. $\dfrac{1}{c^0}$
   B. $\dfrac{c^{56}}{c^{56}}$
   C. $\dfrac{5}{c^5}$
   D. c^0

9. Simplify the expression $(5^0 \, a^2 \, b^{-3})^0$.
   A. 1
   B. -1
   C. 5
   D. -5

10. Simplify the expression $(25a^2 \, b^4)^{1/2}$.
   A. $5a^2b$
   B. $5ab^2$
   C. $5ab$
   D. $5a^2 \, b^4$

11. What is the simplified form of the expression $(a^{-2} \, b^{-4})^{-2}$?
   A. $a^4 \, b^8$
   B. $1/a^4 \, b^8$
   C. $1/a^{-4} \, b^{-8}$
   D. $a^4 \, b^6$

12. What is the simplified form of the expression $(-4)^{1/2}$?
   A. -2
   B. 2
   C. 4
   D. undefined

13. What is the simplified form of the expression $(4^{1/2})(4^{1/2})$?
   A. 4
   B. 8
   C. 16
   D. undefined

14. What is the simplified form of the expression $(81)^{-1/2}$?
   A. 1/81
   B. 1/9
   C. 1/3
   D. undefined

15. If the exponent of the numerator is negative, what will you do?
   A. change the negative exponent to positive
   B. change the negative exponent to positive then place it to the denominator
   C. change the negative exponent to positive then simplify the expression
   D. change the negative exponent to positive then interchange the denominator and numerator

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Jumpstart

> *For you to understand the lesson well, do the following activities.*
> *Have fun and good luck!*

Activity 1: Remember Me and My Exponents!

Directions: Simplify the following expression using the laws of exponent. Write your answers on the space provided.

$c^3(c^2)$	-9^0	5^{-1}	$a^{-1/2}$	$a^2 b^{-3} c^0$

Questions:
  a. How did you solve the given problem?
  b. What concept have you applied?
  c. How did you apply your knowledge of the laws of integral exponent in answering the questions?

Activity 2: Fill My Emptiness!

Directions: Fill in the missing parts of the solution in simplifying the given expression. Assume that c, a, l, and r ≠ 0. Answer the question that follows.

1. $\frac{c^2}{c^4} = \frac{1}{c^{4-2}} = $ _____

2. $\frac{a^9}{a} = $ _____ $= a^{10}$

3. $\frac{l^{-2}}{l^{-4}} = \frac{l^4}{l^2} = $ _____ $= $ _____

4. _____ $= \frac{1}{c^2}$

5. _____ $= (\frac{1}{c^2})^{1/2} = $ _____

Questions:
  a. What did you observe about the exponent?
  b. How were the problems solved?
  c. What can you conclude from the process of solving the activity?

> *Were you able to simplify the given expressions? In the next activity, you will encounter and get familiarized with another kind of exponents.*

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Activity 3: My Super Power!

Directions: Fill in the table below. One is already done as an example.

Set A	Set B	Set C
$p^{1/n}$	$(p^{1/n})^n$	Values of $p^{1/n}$ that satisfy the equation in Set B
1. $36^{1/2}$	$(36^{1/2})^2$	6 and -6
2. $121^{1/2}$		
3. $4^{1/2}$		
4. $16^{1/4}$		
5. $36^{1/5}$		

Questions:
   a. What did you multiply to the exponent?
   b. How did you arrive Set C?
   c. What can you conclude from the process of solving the activity?

Were you able to fill in the table. If YES then a new set of activity awaits you for the mastery of the subject matter in this module.

Activity 4: Understand Me More and More!

Directions: In this activity, you will learn the definition of $p^{m/n}$. If we assume that the rules for integral exponents can be applied to rational exponent, how will the following expression be simplified? One example is done as your basis.

1. $(2^{1/2}) (2^{1/2})$ $= 2^{1/2 + 1/2} = 2^1 = 2$
2. $(4^{1/2}) (4^{1/2}) (4^{1/2}) (4^{1/2})$ _____
3. $(6^{1/3}) (6^{1/3}) (6^{1/3}) (6^{1/3}) (6^{1/3}) (6^{1/3})$ _____
4. $(w^{2/3}) (w^{2/3}) (w^{2/3})$ _____
5. $(S^{2/5}) (S^{2/5}) (S^{2/5}) (S^{2/5}) (S^{2/5})$ _____

Questions:
   a. What operation did you apply to simplify the following expressions?
   b. What did you make to simplify the exponents?
   c. What can you conclude from the process of solving the activity?

Discover

ZERO, NEGATIVE, AND RATIONAL EXPONENTS

In simplifying zero, negative, and rational exponents we will start recalling the laws of exponents which will be your guide in simplifying expressions.

Recall on this so that you will guided on the next activities:

If a and b are real numbers and m and n are positive integers, then

$a^m * a^n = a^{m+n}$ $(a^m)^n = a^{mn}$ $(ab)^n = a^n b^n$

$(a/b)^m = (a^m/b^m)$ $(a^m /a^n) = a^{m-n}$ $(a^m /a^n) = 1/a^{n-m}$
if b ≠ 0   *if m>n and a ≠ 0*   *if n>m and a ≠ 0*

So, Let us try the following examples.

1. Simplify $(\frac{1}{m})^0$

Note: If a is a real number, then $a^0 = 1$

$(\frac{11}{m})^0 = \frac{11^0}{m^0} = \frac{1}{1} = 1$

2. Simplify $2x^{-2}y^4x^0$

Note: If n is a positive integer, then $a^{-n} = \frac{1}{a^n}$

$2x^{-2}y^4x^0 = \frac{2y^4(1)}{x^2} = \frac{2y^4}{x^2}$

3. Simplify $\frac{(-2)(3^{-2})}{4^{-2}}$

$= \frac{(-2)(4^2)}{3^2}$

$= \frac{(-2)(16)}{9}$

$= \frac{-32}{9}$

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4. Simplify $\dfrac{(-d)(3c^{-2})}{33r^{-2}}$

$= \dfrac{(-d)(3r^2)}{33c^2}$

$= \dfrac{-3dr^2}{33c^2}$

$= \dfrac{-dr^2}{11c^2}$

> *Now that you have learned on the application of the laws involving positive integral to zero and negative integral exponent, so you can proceed to the next activities.*

Explore

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

Activity 5: Me and My Power!

Directions: Complete the table below and observe the pattern given. Answer the questions that follow.

A	B	C	D	E	F	G	H
4^0	1	4^{-1}	1/4	4^{-2}	1/16	4^{-3}	1/64
5^0							
6^0							
7^0							
8^0							

Questions:
1. What can you say if the expression is raised to positive integral exponent?
2. What did you observe if the expression is raised to negative integral exponent?
3. What can you conclude if the expression is raised to Zero exponent?

> *Did you determine the pattern in the activity? I know you did it! So, let us proceed to the next activity.*

Activity 6: Let Us Play With Negative!

Directions: Study the situation below and answer the questions that follow.

A grain of rice has a volume of 20^{-9} m^3. A box full of rice has a volume of 20^{-3} m^3. How many grains of rice are there in the box?

Questions:
1. What did you noticed from the values given in the problem?
2. What have you done to simplify these values?
3. How did you solve the problem?

Rubric

POINTS	CRITERIA
5	correct representation of equation, correct solution, & correct answer
4	correct representation of equation, correct solution, & incorrect answer
3	correct representation of equation, incorrect solution, & incorrect answer
2	incorrect representation of equation, incorrect solution, & incorrect answer
1	unfinished solution

Great job! You have understood the lesson. Are you now ready to summarize?

.

Reflect on the activities you have done in this lesson by completing the following sentences. Write your answers on your journal notebook

I learned that I _____

I was surprised that I _____

I noticed that I _____

I discovered that I _____

I was pleased that I _____
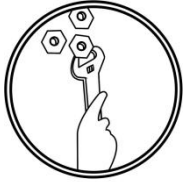
Deepen

Activity 7: Did I Simplify You Correctly?

Directions: Simplify the following expressions correctly.

1. $(\frac{1}{2m})^{-1}$

2. $(21x^{-6}y^6x^0)^{-2}$

3. $(\frac{(-2)(3^{-2})}{4^{-2}})^{-1}$

4. $\frac{(-d)(3c^{-2})}{(33r^{-2})}$

5. $6x^0 + (7x) + 12/x^{-1}$

6. $2^2 - x + 2^{-5}$

7. $-2^{-3} - 4^{-2} + 4x^{-2}$

8. $(xyz)^{-1} / (x^2 y^{-1} z)^{-3}$

Questions:
a. How did you apply your understanding of simplifying expression with zero and negative integral exponent to solve the given expression?
b. What are the concepts / processes to be remembered in simplifying expressions with zero and negative integral exponents?

Gauge

Post-Assessment

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

1. Which of the following is **NOT TRUE**?
   A. $-2^0 = 1$
   B. $(-7)^0 = 1$
   C. $-7^{-1} = -1/7$
   D. $-(7)^2 = -49$

2. What is the result when we simplify $40x^{-2} y^0$?
   A. $40x$
   B. $40/x^2$
   C. $40x^2$
   D. $40x^2 y$

3. What is the value if we simplify the expression $b^5 (b^{-2})$?
   A. b^2
   B. b^3
   C. b^4
   D. b^5

4. What is the value if we simplify the expression $\frac{6pr}{13pr^{-3}}$?

   A. $\frac{6}{13pr}$
   B. $\frac{6r^3}{13p}$
   C. $\frac{6r^3}{13}$
   D. $\frac{6p}{13r^2}$

5. Simplify the expression $23c^{-4}$.
   A. $\frac{23c}{3}$
   B. $\frac{23}{3c^4}$
   C. $\frac{23}{c^4}$
   D. $\frac{1}{3c^4}$

6. Which of the following will complete the equation $\frac{c^8}{c^9} = \frac{1}{c^{9-8}} = $ _____ ?
   A. $\frac{1}{c^{-1}}$
   B. $\frac{1}{c^8}$
   C. $\frac{1}{c^{17}}$
   D. $\frac{1}{c}$

7. Which of the following will complete the equation $\frac{c^{-10}}{c^{-5}} =$ _____?

    A. $\frac{1}{c^{15}}$

    B. $\frac{1}{c^{50}}$

    C. $\frac{1}{c^{5}}$

    D. $\frac{1}{c}$

8. Which of the following expression will give a result of 2 if it is simplified?

    A. $\frac{1}{c^{0}}$

    B. $\frac{c^{56}}{c^{28}}$

    C. $\frac{10c^{5}}{5c^{5}}$

    D. c^{0}

9. Simplify the expression $(15^{0}\ a^{2}\ b^{-3}cd)^{0}$.

    A. 1

    B. -1

    C. 5

    D. -5

10. Simplify the expression $(125a^{3}\ b^{6})^{1/3}$.

    A. $5a^{2}\ b$

    B. $5a\ b^{2}$

    C. $5a\ b$

    D. $5a^{2}\ b^{4}$

11. What is the simplified form of the expression $(a^{-2}\ b^{-4})^{--3}$?

    A. $a^{6}\ b^{12}$

    B. $1/a^{6}\ b^{12}$

    C. $1/a^{-6}\ b^{-12}$

    D. $a^{6}\ b^{12}$

12. What is the simplified form of the expression $(-81)^{1/2}$?

    A. -9

    B. 9

    C. 81

    D. undefined

13. What is the simplified form of the expression $(5^{1/2})(5^{1/2})$?

    A. 5

    B. 10

    C. 25

    D. undefined

14. What is the simplified form of the expression $(9)^{-1/2}$?

    A. 1/9

    B. 1/3

    C. $1/3^{-1}$

    D. undefined

15. If the exponent of the denominator is negative, what will you do?

    A. change the negative exponent to positive

    B. change the negative exponent to positive then place it to the numerator

    C. change the negative exponent to positive then place on the numerator and simplify the expression

    D. change the negative exponent to positive then interchange the denominator and numerator

References

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