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MATHEMATICS

Quarter 2 - Module 5:
Laws of Exponent
Multiplication and Division of Polynomials

AIRs - LM

MATHEMATICS 7
Quarter 2 - Module 5: Laws of Exponent Multiplication and Division of Polynomials
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MATHEMATICS

Quarter 2 - Module 5:
Laws of Exponent
Multiplication and Division of Polynomials

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

In the previous lesson, you learned how to add and subtract polynomials by combining like terms. The next operations to learn are multiplication and division. However, multiplication and division of polynomials requires an understanding of the laws of exponents. These laws shall be discussed in this module. This module will help you understand laws of exponents and how to use this laws in multiplying and dividing polynomials.

Learning Competencies:

After going through this module, you are expected to:

- derive the laws of exponent **(M7AL-IId-e-1)**;
- multiply and divide polynomials **(M7AL-IIe-2)**.

Learning Objectives:

1. define and interpret the meaning of a^n where n is a positive integer;
2. derive inductively the laws of exponents (restricted to positive integers)
3. illustrate the Laws of Exponents.
4. multiply polynomials such as;
    a. monomial by monomial,
    b. monomial by polynomial with more than one term,
    c. binomial by binomial,
    d. polynomial with more than one term by polynomial with three or more terms.
5. divide polynomials such as:
    a. polynomial by a monomial and
    b. polynomial by a polynomial with more than one term.

Before we start the lesson, find out how much you already know about these topics.

Pre – Assessment

Directions: Read carefully each statement below. Select the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What law of exponent should be applied to simplify $a \cdot a^2 \cdot a^3$?
   A. Power
   B. Power of a Product
   C. Product
   D. Quotient
2. What law of exponent should be applied to simplify $(x^2)^7$?
   A. Negative Exponent
   B. Power
   C. Power of a Product
   D. Quotient
3. What law of exponent should be applied to simplify $\frac{x^3}{x}$?
   A. Power
   B. Product
   C. Quotient
   D. Zero Exponent
4. What is the simplified form of $(2x4)^5$?
   A. $10x^9$ B. $10x^{20}$ C. $32x^9$ D. $32x^{20}$
5. What is the simplified form of $(x^{30})^0$?
   A. 0 B. 1 C. x0 D. x30
6. What is the product of $(5m^2n^2)$ and $(8mn^2)$?
   A. 13m2n2 B. 13m3n4 C. 40m3n4 D. 40mn6
7. What is the product of $(9x^3y^4)$ and $(6x^3y^2 – 8xy^3+9y^3)$?
   A. $54x^6y^6 – 72x^4y^7 + 81x^3y^7$
   B. $54x^6y^6 + 72x^4y^7 + 81x^3y^7$
   C. $54x^9y^8 – 72x^3y^{12} + 81x^3y^{12}$
   D. $54x^9y^8 + 72x^3y^{12} + 81x^3y^{12}$
8. What is the product of (x + 3) and (x + 5)?
   A. $x^2 + 8$ B. $x^2 + 15$ C. $x^2 + 8x + 8$ D. $x^2 + 8x + 15$
9. What is the product of (2x – 4) and (3y + 6)?
   A. 5xy + 15xy – 10
   B. 6xy + 24xy – 24
   C. 5xy + 7x – 8y – 10
   D. 6xy +12x – 12y – 24
10. What is the product of $(3x^2 + 4x +7)$ and $(x^2 +2x + 8)$
    A. $3x^4 – 8x^2 + 56$
    B. $3x^4 + 8x^2 + 56$
    C. $3x^4 – 10x^3 + 39x^2 – 46x + 56$
    D. $3x^4 + 10x^3 +39x^2 + 46x + 56$
11. What is the simplified form of $\frac{144x^4 - 72x^2}{12x}$?
    A. 12x – 6 B. 12x + 6 C. $12x^3 – 6x$ D. $12x^3 + 6x$
12. What is the simplified form of $\frac{20x^4 - 25x^3 + 5x^2}{5x^2}$?
    A. $4x^2 – 5x$ B. $4x^2 + 5x$ C. $4x^2 – 5x + 1$ D. $4x^2 + 5x + 1$
13. What should be multiplied to -2x2 to get the product $12x^4 + 4x^3 + 6x^2$?
    A. $– 6x^2 – 2x – 3$
    B. $6x^2 + 2x + 3$
    C. $– 24x^6 – 8x^5 – 12x^4$
    D. $24x^6 + 8x^5 + 12x^4$
14. What should be multiplied to 4x – 1 to get the product $4x^2 + 23x – 6$?
    A. x – 6
    B. x + 6
    C. $16x^3 + 88x^2 – 47x + 6$
    D. $16x^3 + 88x^2 + 47x + 6$
15. What should be multiplied to x – 5 to get the product $x^2 + 2x – 35$?
    A. x + 7
    B. x – 7
    C. $x^3 – 3x^2 – 45x + 175$
    D. $x^3 + 3x^2 + 45x + 175$

Lesson 1: Laws of Exponent

Jumpstart

The laws of exponents help us to simplify terms containing exponents.

Putting all the rules together, we can simplify more complex expression containing exponents.

A little reminder before we derive these laws of exponents:

Recall that $2 \times 2 \times 2 = 2^3$

This activity will enable you to assess your prior knowledge in laws of exponent.

Activity 1

Give the product of each of the following as fast as you can.

1. 2 x 2 = _____
2. 3 x 3 x 3 = _____
3. 5 x 5 x 5 = _____
4. 4 x 4 x 4 = _____
5. 2 x 2 x 2 x 2 = _____
6. 2 x 2 x 2 x 2 x 2 = _____

Activity 2

Evaluate the following. Investigate the result. The first two are done for you

1. $(32)^3 = 32 \bullet 32 \bullet 32 = (3 \bullet 3) \bullet (3 \bullet 3) \bullet (3 \bullet 3) = 9 \bullet 9 \bullet 9 = 729$
2. $(x4)^3 = x^4 \bullet x^4 \bullet x^4 = (x \bullet x \bullet x \bullet x) \bullet (x \bullet x \bullet x \bullet x) \bullet (x \bullet x \bullet x \bullet x) = x^{12}$
3. $(23)^2$ =_____
4. $(42)^2$ =_____
5. $(a2)^5$=_____

Did you notice something?

Activity 3

Evaluate the following. Notice that the bases are the same. The first two are done for you.

1. $(2^3)(2^2) = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 2^5 = 32$
2. $(x^5)(x^4) = (x \cdot x \cdot x \cdot x \cdot x) \cdot (x \cdot x \cdot x \cdot x) = x^9$
3. $(3^4)(3^2) =$ _____
4. $(2^2)(2^4) =$ _____
5. $(y^3)(y^7) =$ _____

Did you notice something?

Activity 4

Evaluate the following. Notice that the bases are the same. The first two are done for you.

1. $((2^3)(3^2))^2 = [(2^3)(3^2)] \cdot [(2^3)(3^2)]$ ➡ Observe the numbers of 2 and 3
   $= (2 \cdot 2 \cdot 2 \cdot 3 \cdot 3) \cdot (2 \cdot 2 \cdot 2 \cdot 3 \cdot 3)$
   $= 2^6 \cdot 3^4 = 5184$
2. $(x^3y^2)^3 = (x^3y^2) \cdot (x^3y^2) \cdot (x^3y^2)$
   $= (x \cdot x \cdot x \cdot y \cdot y) \cdot (x \cdot x \cdot x \cdot y \cdot y) \cdot (x \cdot x \cdot x \cdot y \cdot y)$ ➡ Observe the numbers of x and y
   $= x^9 y^6$
3. $((2^2)(x^3))^2 =$ _____
4. $(m^2y^2)^2 =$ _____
5. $(4y^7)^2 =$ _____

Did you notice something?

Activity 5

Evaluate each of the following. Notice that the bases are the same. The first two are done for you.

1. $\frac{2^5}{2^2} = \frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2} = \frac{32}{4} = 8$ ➡ remember that 8 is the same as $\mathbf{2^3}$. So, $\frac{2^5}{2^2} = \mathbf{2^3}$
2. $\frac{3^7}{3^3} = \frac{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3}{3 \cdot 3 \cdot 3} = \frac{2187}{27} = 81$ ➡ 81 is the same as $\mathbf{3^4}$, then $\frac{3^7}{3^3} = \mathbf{3^4}$
3. $\frac{4^4}{4^2} =$ _____
4. $\frac{5^3}{5^2} =$ _____
5. $\frac{10^8}{10^3} =$ _____

Did you notice something?

Discover

Discovering the Laws of Exponents

In a^n, a is called the base and n is called the exponent

$a^n = a \cdot a \cdot a \cdot a$ ..... (n times)

Examples

a) $2^4 = 2 \cdot 2 \cdot 2 \cdot 2 = 16$

b) $3^2 = 3 \cdot 3 = 9$

c) $(2^2)^3 = 2^2 \cdot 2^2 \cdot 2^2$
$= (2 \cdot 2) \cdot (2 \cdot 2) \cdot (2 \cdot 2)$
$= 4 \cdot 4 \cdot 4$
$= 64$

d) $x^5 = x \cdot x \cdot x \cdot x \cdot x$

e) $y^2z^3 = y \cdot y \cdot z \cdot z \cdot z$

f) $(m^3)^2 = m^3 \cdot m^3$
$= (m \cdot m \cdot m) \cdot (m \cdot m \cdot m)$
$= m \cdot m \cdot m \cdot m \cdot m \cdot m$
$= m^6$

Summary of Laws of Exponent

a) Product Law: The product of two powers with the same base will be the common base raised to the sum of the two powers.

$$a^m \cdot a^n = a^{m+n}$$

Examples: $x^3 \cdot x^4 = x^{3+4} = x^7$ $y^2 \cdot y^3 \cdot y^8 = y^{2+3+8} = y^{13}$

b) Power Law: If a power is raised to another power, the result is the based raised to the products of the inner and outer powers.

$$(a^m)^n = a^{mn}$$

Examples: $(x^4)^2 = x^{4 \cdot 2} = x^8$ $(m^5)^6 = m^{5 \cdot 6} = m^{30}$

c) Power of a Product Law: If an expression with more than one base is raised to a certain power, then the power can be distributed separately to the bases.

$$(ab)^n = a^n \cdot b^n \text{ or } (a^n b^m)^k = a^{nk} \cdot b^{mk}$$

Examples: $(xy)^2 = x^2y^2$ $(k^5m^6)^3 = k^{5 \cdot 3}m^{6 \cdot 3} = k^{15}\, m^{18}$

d) Quotient Law: The quotient of two powers with the same base will be the common base raised to the difference of the two powers.

$$\frac{a^m}{a^n} = a^{m-n}$$

Examples: $\left(\frac{h^3}{p}\right)^2 = \frac{h^{3 \cdot 2}}{p^{1 \cdot 2}} = \frac{h^6}{p^2}$ $\left(\frac{y^6}{3}\right)^4 = \frac{y^{6 \cdot 4}}{3^4} = \frac{y^{24}}{81}$

e) Power of a Quotient Law: If a power is raised to another power, the result is the based raised to the quotients of the inner and outer powers.

$$\left(\frac{a^m}{b^n}\right)^k = \frac{a^{mk}}{b^{nk}}$$

Examples:

$\left(\frac{a^3}{b^4}\right)^2 = \frac{a^{3\cdot 2}}{b^{4\cdot 2}} = \frac{a^6}{b^8}$ $\left(\frac{4}{k^4}\right)^3 = \frac{4^3}{k^{4\cdot 3}} = \frac{64}{k^{12}}$

f) Zero Exponent Law: Any number raised to zero is 1, except 0.

(Note: 0^0 is undefined.) $\boldsymbol{a^0 = 1,\ a \neq 0}$

Remember in quotient law that: $\frac{a^3}{a^3} = a^{3-3} = a^0$, if a= 2, then $\frac{2^3}{2^3} = 2^0$. It is true also that when we evaluate $\frac{2^3}{2^3} = \frac{8}{8} = 1$. Therefore $2^0 = 1$.

Examples: $5^0 = 1$ $(x^{100})^0 = x^0 = 1$

In addition, an expression with **no exponent is automatically raised to 1**.

Examples: $x = x^1$ $(x^3)(x) = x^{3+1} = x^4$ ➡ Using product law

g) Negative Exponent Law: If $a \neq 0$, and n is an integer, then $\boldsymbol{a^{-n} = \frac{1}{a^n}}$

Using the quotient law, $\frac{a^5}{a^8} = \boldsymbol{a^{-3}}$**.** But what does $\boldsymbol{a^{-3}}$ *mean?*

Let's evaluate by expanding the expression.

$$\frac{a^5}{a^8} = \frac{a \cdot a \cdot a \cdot a \cdot a}{a \cdot a \cdot a \cdot a \cdot a \cdot a \cdot a \cdot a} = \frac{1}{a \cdot a \cdot a} = \frac{1}{a^3}$$

Examples: $5^{-2} = \frac{1}{25}$ $2x^{-3} = \frac{2}{X^3}$ $mx^{-6} = \frac{m}{X^6}$

Explore

Activity 6: *Process Me!*

Directions: Determine the law of exponent that should be used to simplify each expression then simplify. Write all the law of exponent that can be applied to simplify the expression. Copy the table in your paper then answer.

Expression	Law/s of Exponent	Simplified Form
1. $(g^2)(g^5)(g^7)$		
2. $((my^7)^9)^0$		
3. $(p^6)^{-4}$		
4. $\frac{d^{50}k^{20}}{d^{30}k^{25}}$		
5. $(\frac{9}{m^5})^2$		

Deepen

Activity 6: *Simplify Me!*

Simplify the following expressions by using the different laws of exponents.

1. $(y^{10})^5$=_____

2. $(x^{100})^3$=_____

3. $(x^{12})\ (x^{20})$ = _____

4. $(m^{100})\ (m^{41})$ =_____

5. $(c^{12}d^3)^4$ = _____

6. $(5a^{12}b^3c^6)^2$=_____

7. $\frac{y^{10}}{y^2}$ = _____

8. $\frac{m^{80}}{m^{35}}$ = _____

9. $(\frac{a^3}{b^5})^7$ = _____

10. $(\frac{5}{12x^3})^0$ = _____

Lesson 2: Multiplication of Polynomials

Jumpstart

In this lesson we are going to apply what we have learned about the laws of exponent. Before we proceed to the lesson proper, let's try how well you mastered the laws of exponents.

Activity1: Simplify the following expressions.

1. $(r^3)(r^4)(r^5)$= _____
2. $(9)^2$ = _____
3. $(m^3)(m^{10})$ = _____
4. $(b^3g^3)(b^6g^7)$ = _____
5. $(x^3y^4)^2$ = _____

Did you get a perfect score? If not, review lesson 1 about the applied laws in each item. This law will help you understand and master the multiplication of polynomials that we are going to discuss in this lesson.

Discover

A. Multiplication of Monomial by Monomial

To multiply a monomial by another monomial, simply multiply the numerical coefficients then multiply the literal coefficients by applying the basic laws of exponent.

Examples:

1. $(5x^5)\ (3x^2) = (5)(3)\ (x^5)\ (x^2) = 15x^7$
2. $(-\ 3x^2y^4)\ (4x^5y^8) = (-\ 3)\ (4)\ (x^2)\ (x^5)\ (y^4)\ (y^8) = -\ 12x^7y^{12}$
3. $(-\ 8a^3b^2)\ (-9a^5bc^3) = (-\ 8)\ (-9)\ (a^3)\ (a^5)\ (b^2)\ (b)(c^3) = 72a^8b^3c^3$

B. Multiplication of Monomial by Polynomial

To multiply monomial by a polynomial, simply apply the distributive property and follow the rule in multiplying monomial by a monomial.

Examples:

1. $(5x^5)\ (3x^2 + 8) = [(5x^5)\ (3x^2)] + [(5x^5)\ (8)] = \mathbf{15x^7 + 40x^5}$ — Distributive property

2. $(-\ 3x^2y^4)\ (x - 9y + 4x^5y^8) = [(-\ 3x^2y^4)\ (x)] - [(-\ 3x^2y^4)\ (9y)] + [(-\ 3x^2y^4)\ (4x^5y^8)]$

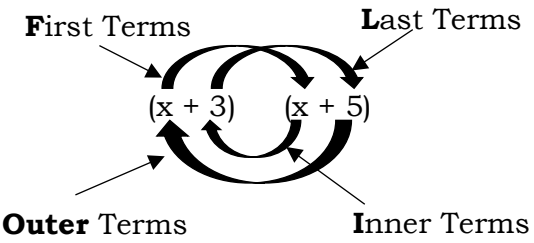
$= \mathbf{-\ 3x^3y^4 + 27x^2y^5 - 12x^7y^{12}}$

C. Multiplication of Binomial by Binomial

To multiply binomial by another binomial, simply distribute the first term of the first binomial to each term of the other binomial then distribute the second term to each term of the other binomial and simplify the results by combining similar terms. This procedure is also known as the F-O-I-L method or Smile method. Another way is the vertical way of multiplying which is the conventional one.

Examples:

1. $(x + 3)(x + 5) = \mathbf{x^2 + 8x + 15}$



F: $(x)(x) = x^2$
O: $(x)(5) = 5x$
I: $(3)(x) = 3x$ } 8x
L: $(3)(5) = 15$
Since 5x and 3x are similar terms we can combine them. 5x + 3x = 8x. The final answer is ***$x^2 + 8x + 15$***

2. $(x + 4)(x – 4) = \mathbf{x^2 – 16}$

F: $(x)(x) = x^2$
O: $(x)(– 4) = – 4x$
I: $(4)(x) = 4x$ } 0
L: $(4)(– 4) = -16$
Since $– 4x$ and $4x$ are similar terms we can combine them. $– 4x + 4x = 0$. The final answer is ***$x^2 – 16$***

3. $(2a^2 – 3b^4)(4a + 5) = \mathbf{8a^3 + 10a^2 – 12ab^4 – 15b^4}$

F: $(2a^2)(4a) = 8a^3$
O: $(2a^2)(5) = 10a^2$
I: $(–3b^4)(4a) = – 12ab^4$
L: $(–3b^4)(5) = – 15b^4$
There are no similar terms so the final answer is
$8a^3 + 10a^2 – 12ab^4 – 15b^4$

The other way to multiply binomial by binomial is using the vertical way.

Examples:

1. $(x + 1)(x – 7)$

$$\begin{array}{r} x + 1 \\ x + 7 \\ \hline 7x + 7 \\ x^2 + x \\ \hline \mathbf{x^2 + 8x + 7} \end{array}$$

2. $(3x – 2)(y + 9)$

$$\begin{array}{r} 3x – 2 \\ y + 9 \\ \hline 27x – 18 \\ 3xy – 2y \\ \hline \mathbf{3xy – 2y + 27x – 18} \end{array}$$

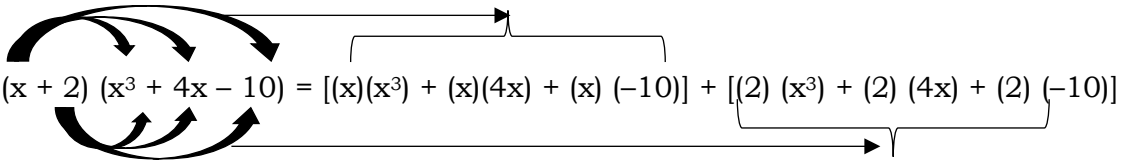
This process is the same when you multiply more than 1-digit whole numbers. But you have to align similar terms so you could combine them after multiplying the expressions.

D. Multiplication of Polynomial by Polynomial

To multiply a polynomial with more than one term by a polynomial with three or more terms, simply distribute the first term of the first polynomial to each term of the other polynomial. Repeat the procedure up to the last term and simplify the results by combining similar terms.

Examples:

1. Using Distributive Property:



$(x + 2)(x^3 + 4x - 10) = [(x)(x^3) + (x)(4x) + (x)(-10)] + [(2)(x^3) + (2)(4x) + (2)(-10)]$

$= (x^4 + 4x^2 - 10x) + (2x^3 + 8x - 20)$

$= x^4 + 2x^3 + 4x^2 - 10x + 8x - 20 =$ **$x^4 + 2x^3 + 4x^2 - 2x - 20$**

2. Using Vertical Way

$(y + 4)(4y^2 - 2y + 3)$

$$\begin{array}{r} 4y^2 - 2y + 3 \\ y + 4 \\ \hline 16y^2 - 8y + 12 \\ 4y^3 - 2y^2 + 3y \\ \hline \mathbf{4y^3 + 14y^2 - 5y + 12} \end{array}$$

Always see to it that similar terms were aligned**.**

3. Using Panel Square

$(3x^2 + 4x - 7)(x^2 - 9x + 8) =$ **$3x^4 - 23x^3 - 19x^2 + 95x - 56$**

	$3x^2$			**$4x$**			**-7**		
x^2	$(3x^2)$	(x^2)	**$=3x^4$**	$(4x)$	(x^2)	**$=4x^3$**	(-7)	(x^2)	**$=-7x^2$**
$-9x$	$(3x^2)$	$(-9x)$	**$=-27x^3$**	$(4x)$	$(-9x)$	**$=-36x^2$**	(-7)	$(-9x)$	**$=63x$**
8	$(3x^2)$	(8)	**$=24x^2$**	$(4x)$	(8)	**$=32x$**	(-7)	(8)	**$=-56$**

The answers are: **$3x^4 - 27x^3 + 4x^3 + 24x^2 - 36x^2 - 7x^2 + 32x + 63x - 56$**

Combining similar terms, the **final answer** will be: **$3x^4 - 23x^3 - 19x^2 + 95x - 56$**

Explore

Activity 2. *Let's Solve!*

Multiply the following expressions.

1. $(5k^3)(8k^4)(3k^5)$ = _____
2. $(4x^2)\ (-10x^2 + 5x)$ = _____
3. $(4m^3 + 3)\ (4m^3 + 3)$ =_____
4. $(3x + 4\ )\ (2x - 5\ )$ = _____
5. $(y - 9\ )\ (y^2 + 2y + 1)$ =_____

Deepen

Activity 3: ***Let's Travel!***

Multiply the following expressions then match your answer on the box to know the 5 top tourist attractions in the Philippines. Copy this in your paper then answer.

$30m^3n^2 + 21m^3n$	$m^4 - 81$	$-216m^9n^8$	$m^3 - 125$	$4mn+4m-2n-2$
Chocolate Hills, Bohol	Puerto Princesa Underground River, Palawan	White Beach, Boracay	Cebu's Beaches and Diving Spots	Cloud 9, Siargao

Expressions	**Product**	**Tourist attractions in the Philippines**
1. $(8mn^3)(-9m^2n^4)(3m^6n)$		
2. $(3m^3)(10n^2 + 7n)$		
3. $(m^2 - 9)(m^2 + 9)$		
4. $(2m - 1)(2n + 2)$		
5. $(m - 5)(m^2 + 5m + 25)$		

Source: https://guidetothephilippines.ph/articles/things-to-do/top-tourist-spots-philippines.
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Lesson 3: Division of Polynomials

Jumpstart

In this lesson we are going to apply what we have learned about the laws of exponent. Before we proceed to the lesson proper, let's try how well you mastered the laws of exponents.

Activity 1. Simplify Me!

Simplify the following expressions.

1. $\frac{a^5}{a^3}$ = _____
2. $\frac{15n^{12}}{5n^2}$ = _____
3. $\frac{w^{10}}{w^{12}}$= _____
4. $\frac{z^3}{z^3}$ = _____
5. $\frac{-24x^9y^{12}z^3}{-8x^2yz^8}$ = _____

Did you get a perfect score? If not, review lesson 1 about the applied laws in each item. This law will help you understand and master the division of polynomials that we are going to discuss in this lesson.

Discover

A. Division of Polynomial by Monomial

To divide polynomial by a monomial, simply divide each term of the polynomial by the given divisor, aligned**.**

Example:

Divide $6x^4 - 2x^2 + 1$ by $6x$ using the long division.

Solution:

$(6x^4 - 2x^2 + 1)$ is called the dividend and $(6x)$ is called the divisor.

Step 1: Divide the first term of the dividend with the first term of the divisor and write the result as the first term of the quotient.

$$\begin{array}{r} \mathbf{6x^4} \\ 6x\,\overline{)\,36x^5 - 12x^3 + 6x} \end{array}$$

Step 2: Multiply that term with the divisor.

$$\begin{array}{r} \mathbf{6x^4 - 2x^2} \\ 6x\,\overline{)\,36x^5 - 12x^3 + 6x} \\ 36x^5 \end{array}$$

Step 3: Subtract and write the result to be used as the new dividend.

$$\begin{array}{r} \mathbf{6x^4 - 2x^2} \\ 6x\,\overline{)\,36x^5 - 12x^3 + 6x} \\ \underline{36x^5} \\ -12x^3 \end{array}$$

Step 4: Divide the first term of this new dividend by the first term of the divisor and write the result as the second term of the quotient.

$$\begin{array}{r} \mathbf{6x^4 - 2x^2} \\ 6x\,\overline{)\,36x^5 - 12x^3 + 6x} \\ \underline{36x^5} \\ -12x^3 \\ -12x^3 \end{array}$$

Step 5: Multiply that term and the divisor and write the result under the new dividends.

$$
\begin{array}{r}
\mathbf{6x^4 - 2x^2 + 1} \\
6x\,\overline{)\,36x^5 - 12x^3 + 6x} \\
\underline{36x^5} \\
-12x^3 \\
\underline{-12x^3} \\
6x \\
\underline{6x} \\
0
\end{array}
$$

Note that it also possible that the remainder of a polynomial division may not be zero.

B. Division of Polynomial by Polynomial

To divide polynomial by a polynomial with more than one term (by long division), simply follow the procedure in dividing numbers by long division.
These are some suggested steps to follow:

1) Check the dividend and the divisor if it is in standard form.
2) Set-up the long division by writing the division symbol where the divisor is outside the division symbol and the dividend inside it.
3) You may now start the Division, Multiplication, Subtraction and Bring Down cycle.
4) You can stop the cycle when:
   a) the quotient (answer) has reached the constant term.
   b) the exponent of the divisor is greater than the exponent of the dividend

Examples:

1. Divide $x^2 - 3x - 10$ by $x + 2$

$$
\begin{array}{r}
\mathbf{x - 5} \\
x + 2\,\overline{)\,x^2 - 3x - 10} \\
\underline{x^2 + 2x} \\
-5x - 10 \\
\underline{-5x - 10} \\
0
\end{array}
$$

1) ***divide*** x^2 by x and put the result on top
   $\frac{x^2}{x}$ = x (the divisor is x because it is the first term in the given)
2) ***multiply*** that result to x + 2
   $(x)(x+2) = x^2 + 2x$
3) ***subtract*** the product to the dividend
   $x^2 - 3x \rightarrow \quad x^2 - 3x$
   $-(x^2 + 2x) \rightarrow \; +\,-x^2 - 2x$
   $-5x$
4) ***bring down*** the next term.
   In this example. We bring down – 10
5) repeat the procedure from 1.

2. Divide $x^3 - 6x^2 + 11x - 6$ by $x - 3$

$$
\begin{array}{r}
\mathbf{x^2 - 3x^2 + 2} \\
x - 3\overline{)\ x^3 - 6x^2 + 11x - 6} \\
x^3 - 3x^2 \\
\hline
-3x^2 + 11x \\
-3x^2 + 9x \\
\hline
2x - 6 \\
2x - 6 \\
\hline
0
\end{array}
$$

3. Divide $4x^2 + 6x - 7$

$$
\begin{array}{r}
\mathbf{4x - 10} \\
x - 1\overline{)\ 4x^2 + 6x - 7} \\
4x^2 - 4x \\
\hline
10x - 7 \\
10x + 10 \\
\hline
-17
\end{array}
$$

$\longrightarrow$ $\mathbf{4x - 10 + \frac{-17}{x - 1}}$

Since there is a remainder, it will be added to the quotient as a rational expression with the divisor as the denominator

Explore

Activity 2. *Process Me!*

Divide the following expressions.

1) $\frac{35h^9k^{12}m^9}{-7h^2km^8} =$ _____

2) $\frac{28\,w^8z^8 - 72w^5z^6 + 4\,w^2z}{4\,w^2z} =$ _____

3) $\frac{x^2 - 7x + 12}{x-4} =$ _____

4) $\frac{5x^2 - 2x - 3}{5x + 3} =$ _____

5) $\frac{2x^3 - 3x^2 - 10x - 6}{2x + 1} =$ _____

Deepen

Activity 3: ***Did You Know?***

Divide the following expressions then match your answer on the box to know the top 5 provinces in the Philippines with largest land area. Copy this in your paper then answer.

$x + 2$	$\frac{2}{x^3}$	$x - 7$	$3x^2 + x + 1 + \frac{1}{3x+1}$	$x^6 - 3x^3 + 2$
Bukidnon	Palawan	Isabela	Agusan del Sur	Lanao del Sur

Expressions	Quotient	Provinces in the Philippines with Largest Land Area
1. $\frac{-14x^9}{-7x^{12}}$		
2. $\frac{7x^8 - 21x^5 + 14x^2}{7x^2}$		
3. $\frac{x^2 - 49}{x + 7}$		
4. $\frac{x^2 + 9x + 14}{x+7}$		
5. $\frac{9x^3 + 6x^2 + 4x + 2}{3x + 1}$		

Source: Philippine Center for Investigation Journalism: Stats on state of regions: Land, population, population density; Posted: July 11, 2018

Gauge

Directions: Read each statement below carefully. Select the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What law of exponent should be applied to simplify $\frac{b}{b^6}^{20}$?

   A. Power
   B. Power of a Product
   C. Product
   D. Quotient

2. What law of exponent should be applied to simplify $5x^{-7?}$

   A. Negative Exponent
   B. Power
   C. Power of a Product
   D. Quotient

3. What law of exponent should be applied to simplify $(100y^4z^4)^2$?

   A. Power
   B. Power of a Product
   C. Product
   D. Zero Exponent

4. What is the meaning of 3^4?

   A. 3 + 4
   B. 3 • 4
   C. 3 + 3 + 3 + 3
   D. 3 • 3 • 3 • 3

5. What is the simplified form of $(\frac{3ab^2}{2d^2})^3)^0$?

   A. 0
   B. 1
   C. $\frac{3a^4b^5}{2d^5}$
   D. $\frac{27a^4b^5}{8d^5}$

6. What is the product of $(-5p^2)$ and $(4n^2p)$?

   A. $-20n^2p^3$
   B. $-n^2p^3$
   C. n^2p^3
   D. $20n^2p^3$

7. What is the product of $(3x^4)$ and $(x^4 - 4x^3 + 2x)$?

   A. $3x - 12x + 6x^4$
   B. $3x^8 - 12x^7 + 6x$
   C. $3x^8 - 12x^7 + 6x^5$
   D. $3x^{16} - 12x^{28} + 6x^4$

8. What is the product of $(x - 3)$ and $(2x - 5)$?

   A. $2x^2 - 15$
   B. $2x^2 + 15$
   C. $2x^2 - 11x - 15$
   D. $2x^2 - 11x + 15$

9. What is the simplified form of $\frac{121y^4 - 77y^2}{11y}$?

   A. $11y^3 - 7$
   B. $11y^3 + 7$
   C. $11y^3 - 7y$
   D. $11y^3 + 7y$

10. What is the simplified form of $\frac{100x^4 - 200x^3 + 300x^2}{100x^2}$?

    A. $x^2 - 2x + 3$
    B. $x^3 - 2x^2 + 3x$
    C. $100x^2 - 200x + 300$
    D. $100x^3 - 200x^2 + 300x$

11. What is the quotient when you divide $12x^4 + 3x^3 + 6x^2$ by 3x?

A. $-24x^5 - 9x^4 - 18x^3$ B. $-4x^3 - x^2 - 2x$

C. $4x^3 + x^2 + 2x$ D. $24x^5 + 9x^4 + 18x^3$

12. What should be multiplied to x – 6 to get the product $x^2 - 11x + 30$?

A. x – 5 B. x + 5

C. $16x^3 + 88x^2 - 47x + 6$ D. $16x^3 + 88x^2 + 47x + 6$

13. What should be multiplied to 2x – 7 to get the product $6x^2 - 17x - 14$?

A. 3x – 2 B. 3x + 2

C. $12x^3 - 76x^2 + 105x + 98$ D. $12x^3 - 76x^2 - 105x + 98$

14. When $2x^2 + x - 12$ is divided by x + 5, what is the remainder?

A. 2 B. 0 C. – 2 D. – 4

15. What will you do to the remainder in dividing polynomial by another polynomial?

The remainder will be _____.

A. disregarded as part of the quotient

B. added to the constant term of the quotient

C. added to the quotient as rational expression with the divisor as the denominator

D. added to the quotient as rational expression with the dividend as the denominator

References

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- Mathematics – Grade 7 Learner's Material. DepEd IMCS. First Edition, 2013 .ISBN: 978-971-9990-60-4

B. Online Resources

- http://bento.cdn.pbs.org/hostedbento-prod/filer_public/ems/teacher%20video%20streaming/Download_lessons/12_4dividingpolynomials1.ppt
- https://www.mcckc.edu/tutoring/docs/bt/exp_rad_log/Exponent_Rules_&_Practice.pdf
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- https://www.algebra.com/algebra/homework/Polynomials-and-rational-expressions/Polynomials-and-rational-expressions.faq.question.7179.html
- https://www.superprof.co.uk/resources/academic/maths/algebra/polynomials/polynomial-word-problems.html#chapter_exercise-1

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