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MATHEMATICS

Quarter 2 - Module 6:
Special Products and Solving Problems on Algebraic Expressions

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MATHEMATICS 7
Quarter 2 - Module 6: Special Products and Solving Problems on Algebraic Expressions
Second Edition, 2021

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Region I

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MATHEMATICS

Quarter 2 - Module 6:
Laws of Exponent
Special Products and Solving Problems on Algebraic Expressions

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

You already learned how to multiply polynomials using the FOIL METHOD. In this topic, you will discover other approaches/patterns in deriving the product of polynomials.

After going through this module, you are expected to:

Learning Competencies:

- Use models and algebraic methods to find the (a) product of two binomials, (b) product of the sum and difference of two terms, (c) square of a binomial, (d) cube of a binomial, (e) product of a binomial and a trinomial. **(M7AL-IIe-g-1)**
- Solve problems involving algebraic expressions **(M7AL-IIg-2)**

Learning Objectives:

1. Illustrate products of polynomials.
2. Use models in solving problems involving algebraic expressions.
3. Identify the steps in solving problems involving algebraic expressions.
4. Solve problems involving algebraic expressions.

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 is the product of $(x+3)$ and $(x-1)$?

   A. x^2+3 B. x^2-3 C. x^2+2x-3 D. x^2-2x-3

2. If you multiply $(2x+3)$ and $(x+5)$, the product is $2x^2+$ _____ $+15$. What is the middle term?

   A. $-13x$ B. $3x$ C. $10x$ D. $13x$

3. What is the result when $(x+2)$ and $(x-2)$ are multiplied?

   A. x^2+4 B. x^2-4 C. x^2+4x-4 D. x^2+4x+4

4. What is the product of the sum and difference of two terms?

   A. binomial B. monomial C. multinomial D. trinomial

5. How will you arrive at the middle term of a square of a binomial?

   A. multiply the first and the last

   B. square the first term

   C. square the last term

   D. twice the product of the first and last term

6. What is the square of $(x+1)$?

   A. x^2+1 B. x^2-1 C. x^2+x+1 D. x^2+2x+1

7. How many terms are there in each of the cubes of a binomial?

   A. 1 B. 2 C. 3 D. 4

8. What is the simplified form of $(x-1)^3$?

   A. x^3+3x^2-3x-1 B. x^3-3x^2+3x-1

   C. x^3+x^2-x+1 D. x^3-x^2-x+1

9. The result of the cubes of binomials is in standard form. When do we say that the expression is in standard form? Exponents of the variables are in _____ order.

   A. ascending B. descending C. increasing D. the same

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

    A. x^3+8 B. x^3-8

    C. x^3+4x^2+4x+8 D. x^3-4x^2-4x+8

11. Which mathematical statement is correct?

    A. $(2x-1)(3x-4)=6x^2-5x+4$ B. $(4x-5)(4x-5)=16x^2-40x+25$

    C. $(3x-4)(2x+7)=6x^2-3x-8$ D. $(2x-5)^2=4x^2-20x+25$

12. The area of a square is $4x^2 + 12x + 9$ square units. Which expression represents the length of the side?

A. $(3x + 2)$ units B. $(2x + 3)$ units

C. $(4x + 9)$ units D. $(4x + 3)$ units

13. Your classmate was asked to square $(2x - 3)$, the answered $4x^2 + 9$. Is his answer, correct?

A. No, because the answer must be $4x^2 + 9$.

B. Yes, because the product rule is correctly applied.

C. No, because squaring a binomial always produces a trinomial product.

D. Yes, because squaring a binomial always produces a binomial product.

14. Let A:$4x^2 - 81$, and let B: $(2x - 9)\ (2x + 9)$. If $x = 2$, which statement is true about A and B?

A. $A > B$ B. $A < B$ C. $A = B$ D. A

15. The length of a box is five meters less than twice the width. The height is 4 meters more than three times the width. The box has a volume of 520 cubic meters. Which of the following equations can be used to find the height of the box?

A. $W\ (2L - 5)\ (3H + 4) = 520$ B. $W\ (2L + 5)\ (3H - 4) = 520$

C. $W\ (2W - 5)\ (3W - 4) = 520$ D. $W\ (2W - 5)\ (3W + 4) = 520$

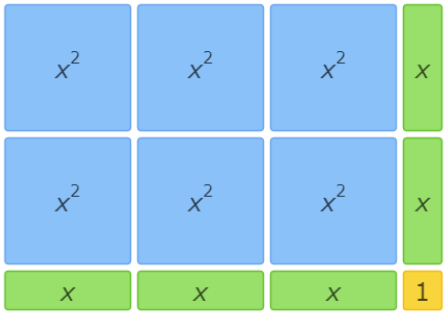
Lesson 1: Laws of Exponent

Jumpstart

Product means the result we get after multiplying.

Activity 1: Count My Area!

A.



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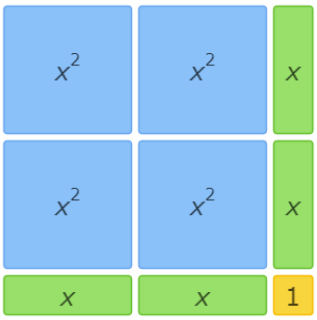

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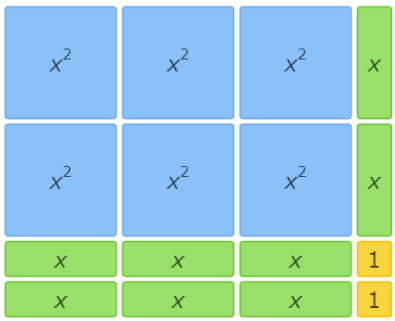

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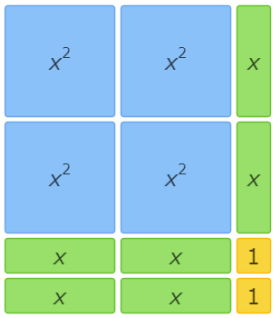


Discover

Products of Polynomials Using Models

Algebra tiles can be used to model operations involving integers.
Let:

- represent + 1
- represent – 1 (flip side of yellow)

Yellow and red small squares are additive inverse of each other.

- represent + 1x or x
- represent – 1x or x

The green and red rectangles are additive inverse of each other.

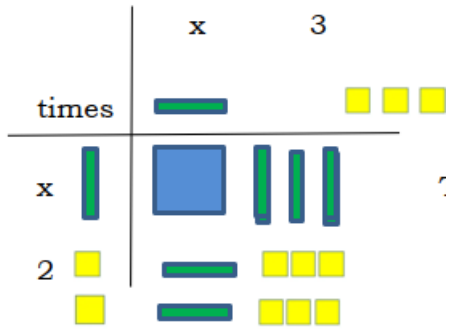
- represent x^2
- represent $-x^2$ (the flip side of blue)

As with integers, the red shapes and their corresponding flip sides to form zero pair.

 - these are called zero pairs because they are additive inverse of each other. When they put together, they model zero.

Adding can be viewed as "combining". Combining involves the forming and removing all zero pairs.

Multiply (x + 2) (x + 3) using algebra title



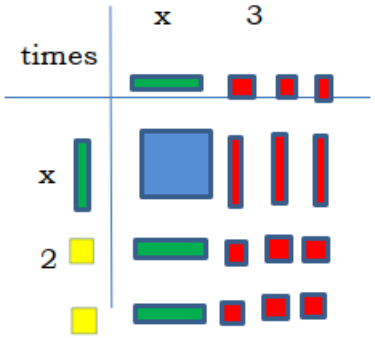
This row shows x (x + 3) = $x^2 + 3$

This row shows 2 (x – 3) = 2x - 6

So that (x + 2) (x- 3)

$= x(x + 3) + 2(x + 3)$
$= x^2 + 3x + 2x + 6$
$= x^2 + 5x + 6$

Find the product of (x + 2) (x – 3) using algebra tiles.



This row shows x (x – 3) = $x^2 - 3x$

This row shows 2 (x – 3) = 2x - 6

So that $(x + 2)(x - 3)$

$= x(x - 3) + 2(x - 3)$

$= x^2 - 3x + 2x - 6$

$= x^2 - x - 6$

Finding the Products of Polynomials Algebraically

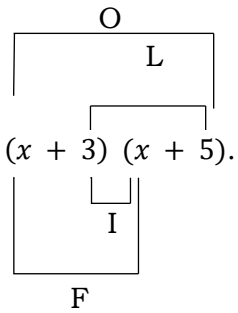
A. Product of Two Binomials

Remember that when you multiply a binomial you get four terms. Sometimes you can combine like terms to get a trinomial, but sometimes there are no like terms to combine.

We might say we use the FOIL method to multiply two binomials. FOIL literally stands for F- First terms, O- Outer terms, I- Inner terms, and L- Last terms.

Examples:

1. Find the product of $(x + 3)(x + 5)$.



First: $x(x) = x^2$

Outer: $x(5) = 5x$

Inner: $3(x) = 3x$

Last: $(3)(5) = 15$

$(x + 3)(x + 5) = x^2 + 5x + 3x + 15$

combine similar terms

$= x^2 + 8x + 15$

2. $(3x-2)(4x+1) = 12x^2 + 3x - 8x - 2$

combine similar terms

$= 12x^2 - 5x - 2$

First: $(3x)(4x) = 12x^2$
Outer: $(3x)(1) = 3x$
Inner: $(-2x)(4) = -8x$
Last: $(-2)(1) = -2$

B. Product of the Sum and Difference of the Two Terms

1. $(x + 1)(x - 1) = x^2 + x - x - 1 = x^2 - 1$

combine similar terms

F: $(x)(x) = 12x^2$
O: $(x)(-1) = -x$
I: $(1)(x) = x$
L: $(1)(-1) = -1$

2. $(2x - 3)(2x + 3) = 4x^2 + 6x - 6x - 9 = x^2 - 9$

combine similar terms

F: $(2x)(2x) = 4x^2$
O: $(2x)(3) = 6x$
I: $(-3)(2x) = 6x$
L: $(-3)(3) = -9$

C. Square of a Binomial

1. $(x + 3)^2 = (x + 3)(x + 3) = x^2 + 3x + 3x + 9 = x^2 + 6x + 9$

combine similar terms

F: $(x)(x) = x^2$
O: $(x)(3) = 3x$
I: $(3)(x) = 3x$
L: $(3)(3) = 9$

2. $(3x-2)^2 = (3x-2)(3x-2) = 9x^2 - 6x - 6x + 4 = 9x^2 - 12x + 4$

combine similar terms

F: $(3x)(3x) = 9x^2$
O: $(3x)(-2) = -6x$
I: $(-2)(3x) = -6x$
L: $(-2)(-2) = 4$

In the succeeding lesson, (D) Cube of a Binomial and (E) Product of a Binomial and a Trinomial, FOIL Method is not applicable.

D. Cube of a Binomial

1. Expand $(x+1)^3$

   The cube of the binomial $(x + 1)$ can be expressed as $(x+1)^3$. This is equivalent to: $(x + 1)\ (x + 1)\ (x + 1)$.

   By using special products for the square of a binomial, we can show that

   $$(x+1)(x+1) = (x+1)^2 = x^2 + 2x + 1$$
   $$(x+1)^3 = (x+1)^2(x+1) = (x^2 + 2x + 1)(x+1)$$

   Applying the distributive property:

   $(x^2 + 2x + 1)(x + 1) = x^3 + x^2 + 2x^2 + 2x + x + 1$

   Combining similar terms

   $(x^2 + 2x + 1)(x + 1) = x^3 + x^2 + 2x^2 + 2x + x + 1$

   Thus, $(x+1)^3 = x^3 + 3x^2 + 3x + 1$

   Notice that the product is in standard form (exponents of the variables in descending order) and has four terms.

2. $(2x-5)^3 = (2x-5)(2x-5)(2x-5)$

   $$(2x-5)(2x-5) = (2x-5)^2 = 4x^2 - 20x + 25$$
   $$(2x-5)^3 = (4x^2 - 20x + 25)(2x-5)$$
   $$(4x^2 - 20x + 25)(2x-5) = 8x^3 - 20x^2 - 40x^2 + 100x + 50x - 125$$
   $$(4x^2 - 20x + 25)(2x-5) = 8x^3 - \underline{20x^2 - 40x^2} + \underline{\underline{100x + 50x}} - 125$$
   $$(2x-5)^3 = 8x^3 - 60x^2 + 150x - 125$$

E. Product of a Binomial and Trinomial

1. Find the product of $x^2 - 2x + 1$ and $x+1$

   Following the steps used in the previous lesson, cube of a binomial:

   $(x^2 - 2x + 1)\ (x + 1) = x^3 + x^2 - x^2 - x + x + 1$ Apply distribute property

   $= x^3 + \underline{x^2 - x^2} - \underline{\underline{x + x}} + 1$ Combine like terms

   $= x^3 + 1$ Remaining result

2. $(x^2 + 3x + 9)(x-3) = x^3 - 3x^2 + 3x^2 - 9x + 9x - 27$

   $$= x^3 - \underline{3x^2 + 3x^2} - \underline{9x + 9x} - 27$$

To generalize special products, here are the list of the general formula with examples.

	Examples	General Formula
A. Product of Two Binomials	1. $(x+2)(x+7)$ $= x^2+9x+14$ 2. $(x-2)(x-4)$ $= x^2-6x+8$ 3. $(3x-2)(4x+1)$ $= 12x^2-5x-2$	$(a+b)(c+d)$ $= ac+ad+bc+bd$
B. Product of the Sum and Difference of Two Terms	1. $(x-5)(x+5)$ $= x^2-25$ 2. $(3x-1)(3x+1)$ $= 9x^2-1$ 3. $(x^2-10)(x^2+10)$ $= x^4-100$	$(a+b)(a-b)$ $= a^2-b^2$
C. Square of a Binomial	1. $(x+5)^2$ $= x^2+10x+25$ 2. $(x-4)^2$ $= x^2-8x+16$ 3. $(3x-2)^2$ $= 9x^2-12x+4$	$(a+b)^2$ $= a^2+2ab+b^2$ $(a-b)^2$ $= a^2-2ab+b^2$
D. Cube of a Binomial	1. $(x+5)^3$ $= x^3+15x^2+75x+125$ 2. $(x-6)^3$ $= x^3-18x^2+108x-216$ 3. $(3x-2)^3$ $= 27x^3-54x^2+36x-8$	$(a+b)^3$ $= a^3+3a^2b+3ab^2+b^3$ $(a-b)^3$ $= a^3-3a^2b+3ab^2-b^3$
E. Product of a Binomial and a Trinomial	1. $(x^2+4x+16)(x-4)$ $= x^3-64$ 2. $(x^2-6x+36)(x+6)$ $= x^3+216$ 3. $(4x^2+10x+25)(2x-5)$ $= 8x^3-125$	$(a^2-ab+b^2)(a+b)$ $= a^3+b^3$ $(a^2+ab+b^2)(a-b)$ $= a^3-b^3$

Solving Problems Involving Algebraic Expressions

The main key when solving word problems with algebraic sentences is to accurately translate the algebraic expressions then set up and write each algebraic equation correctly. In doing so, we can ensure that we are solving the right equation and as a result, will get the correct answer for each word problem.

Look at the following examples.

Problem 1. The length of a side of a square lot is $4x-3$ cm. What is the area of the square lot?

Solution:

Step 1: Determine what is given and what is being asked.

Given: The length of a side of a square lot is $4x - 3$ cm

Asked: Find the area of the square lot

Step 2: Represent unknowns by variables.

Let A be the area of the square lot

Let s be the side of the square lot

Step 3: Formulate equation based on the conditions.

$A = s^2$	Formula of the area of a square
$A = (4x - 3)^2$	Substituting the value of the side

Step 4: Solve the equation.

$A = (4x - 3)^2$	Equation obtained in Step 3
$A = (4x)^2 + 2(4x)(-3) + (-3)^2$	Squaring a Binomial (General Formula)
$A = 16x^2 - 24x + 9$	Simplifying the equation

Step 5: Answer the question being asked.

Therefore, the area of the square lot is $16x^2 - 24x + 9\ cm^2$.

Problem 2: Alex made a rectangular planter box. Now, he wants to determine its volume. If the height of the box is $2x - 6$ inches and its base has a length of $x + 8$ inches and a width of $x + 5$ inches. What is the volume of the box?

Solution:

Step 1: Determine what is given and what is being asked.

Given: The height of the box is $2x - 6$ inches

The length of the box is $x + 8$ inches

The width of the box is $x + 5$ inches

Asked: Find the volume of the box.

Step 2: Represent unknowns by variables.

Let h be the height of the box

Let l be the length of the box

Let w be the width of the box

Let V volume of the box

Step 3: Formulate the equation based on the conditions.

$V = Bh$	General formula of the volume
$V = lwh$	Substituting B as the area of a rectangle then multiplied to the height
$V = (x + 8)(x + 5)(2x - 6)$	Substituting the value of the length, width and height

Step 4: Solve the equation.

$V = (x + 8)(x + 5)(2x - 6)$	Equation obtained in Step 3
$V = (x^2 + 5x + 8x + 40)(2x - 6)$	Product of Two Binomials
$V = (x^2 + 13x + 40)(2x - 6)$	Simplifying the equation
$V = (2x^3 - 6x^2 + 26x^2 - 78x + 80x - 240)$	Product of a Binomial and a Trinomial
$V = 2x^3 + 20x^2 + 2x - 240$	Simplifying the equation

Step 5: Answer the question being asked.
Therefore, the volume of the box is$2x^3 + 20x^2 + 2x - 240in^3$

In solving problems involving algebraic expressions, follow the given steps.

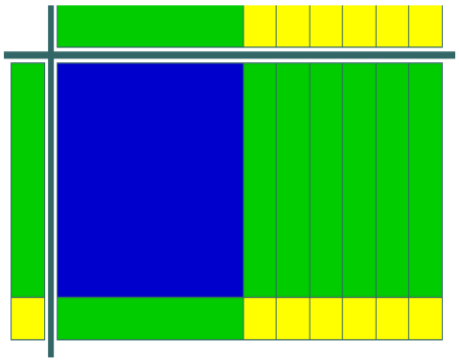
1. Determine what is given and what is being asked.
2. Represent unknowns by variables.
3. Formulate the equation based on the conditions.
4. Solve the equation.
5. Answer the question being asked.

Explore

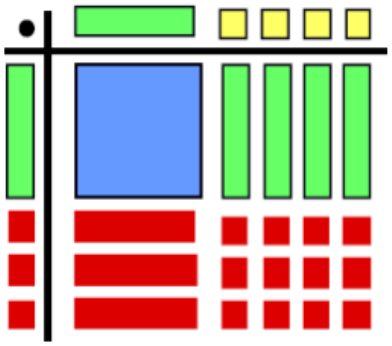
Here are algebraic expressions for you to work on to master and strengthen the basic concepts you have learned from this lesson.

Activity 2: Find My Sides!
Directions: Find the sides and get the product

1.



2.



Activity 3: Is the formula effective?

Fill in the blanks to find the product of the following.

1. $(x+4)(x+8) = x^2$_____ $+ 32$
2. $(5x-2)(5x+2) =$ _____ $- 4$
3. $(2x-4)^2 = 4x^2$_____ $+$ _____
4. $(x+7)^3 = x^3$_____ $+ 147x$_____
5. $(4x+1)(16x^2-4x+1) =$ _____ $+ 1$

Deepen

Activity 4: Draw Me!

Use algebra tiles to model each multiplication problem and find the product. Draw your model in the frame. Write your simplified answer in the space provided. Use separate sheet of paper.

1. $(2x + 1)(x - 4)$

Answer: _____

2. $(-2x - 2)(x - 4)$

Answer: _____

Activity 5: Practice What You've Learned!

Multiply using grid. The first is done for you.

1. $(x - 4)(2x^2 + 3x + 6)$

	$2x^2$	$3x$	6
x	$2x^3$	$3x^2$	6x
-4	$-8x^2$	$-12x$	-24
	$2x^3 + 3x + 6 - 8x^2 - 12x - 24$		
	$2x^3 - 5x^2 - 6x - 24$		

2. $(x^2 + 5)(x^2 - 11x + 6)$
3. $(x + 7)(x^2 + 2x + 1)$
4. $(y - 2)^3$
5. $(z + 3)^3$

Activity 6: Get the order!
Directions: In the problem below, solutions are already presented. Identify the steps used to solve the problem. Write your answers on a separate sheet of paper.

Problem: If $(3x + 2)cm$ represents a side of a square, what expression represents its perimeter? What represents its area?

Solution	Steps
1. $(3x + 2)cm$	
2. Expression representing the perimeter and area	
3. Let P be the perimeter and A be the area	
4. $P = 4(3x + 2)$ $A = (3x + 2)^2$	
5. $P = 12x + 8$ $A = 9x^2 + 12x + 4$	
6. The expressions representing the perimeter and area are $12x + 8$ and $9x^2 + 12x + 4$, respectively.	

Activity 7: Solve Me!
Solve the problem below. Show your solutions.

1. Mel bought 2 pairs of hair clip at $P(2x - y)^2$ per clip and a dozen of handkerchief at $P(3x + y)^2$ per piece. How much did she spend for the clips and handkerchiefs?

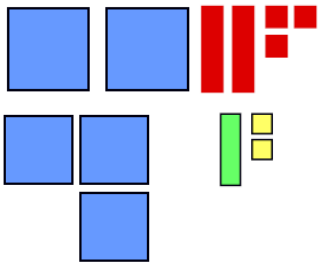
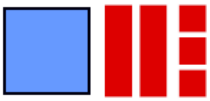
2. The area of a rectangle is 24 cm^2. The width is two less than the length. What is the length and width of the rectangle?

Rubric for Problem Solving

4	3	2	1
Used an appropriate strategy to come up with a correct solution and arrived at a correct answer	Used an appropriate strategy to come up with a solution, but a part of the solution led to an incorrect answer	Used an appropriate strategy but came up with an entirely wrong solution that led to an incorrect answer	Attempted to solve the problem but used an inappropriate strategy that led to a wrong solution

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 do you notice about all the negative tiles; -1, -x and $-x^2$?
   A. They are all yellow. B. They are all green.
   C. They are all red. D. They are all blue.
2. What is the middle term when you multiply $(x + 8)$and $(2x - 3)$?
   A. -19x B. -13x C. 13x D. 19x
3. What is the product of $(2x - 7)$ and $(3x + 5)$?
   A. $6x^2 - 11x - 35$ B. $6x^2 + 11x - 35$
   C. $6x^2 + 11x + 35$ D. $6x^2 - 11x + 35$
4. Which is the model for this expression $2x^2 - 2x - 3$?
   A.  B. 
   C. D. 
5. What is the product of $(2x + 5)$ and $(2x - 5)$?
   A. $4x^2 + 25$ B. $4x^2 - 25$
   C. $4x^2 + 10x - 25$ D. $4x^2 - 10x + 25$
6. What should be multiplied to $5x - 6$, so that the result is $25x^2 - 36$?
   A. $5x - 6$ B. $5x + 6$ C. $6x - 5$ D. $6x + 5$
7. Which of the following shows the general formula of a square of a binomial?
   A. $(a + b)^2 = a^2 + ab + b^2$ B. $(a + b)^2 = a^2 + 2ab + b^2$
   C. $(a - b)^2 = a^2 - ab + b^2$ D. $(a - b)^2 = a^2 + ab + b^2$
8. What is the square of $x - 5$?
   A. $x^2 - 5x + 25$ B. $x^2 + 5x + 25$ C. $x^2 - 10x + 25$ D. $x^2 + 10x + 25$
9. What is the middle term of the square of $(7x + 3)$?
   A. $-42x$ B. $-21x$ C. $21x$ D. $42x$
10. What is the missing term in $(x + 3)^3 = x^3 + 9x^2 + \_\_\_\_ + 27$?
    A. $-27x$ B. $-9x$ C. $9x$ D. $27x$
11. If the dimension of a rectangular solid are $(4x + 3)$ cm, $(3x - 5)$ cm, and $(2x - 1)$ cm, find its volume?
    A. $24x^3 + 34x^2 + 19x - 64$ B. $24x^3 - 34x^2 - 19x + 15$
    C. $24x^3 - 34x^2 + 19x - 64$ D. $24x^3 - 34x^2 - 19x - 15$
12. The area of a square is $16x^2 - 40x + 25$ square units, which expression represents the length of the sides?
    A. $(4x + 5)$ units B. $(4x - 5)$ units C. $(5x + 4)$ units D. $(5x - 4)$ units
13. Which value of x will make the largest area of a square with a side of $(8x + 1)$?
    A. 0.75 B. 0.5 C. 0.35 D. 0.12

14. The volume of a cube is $8x^3 - 60x^2 + 150x - 125$ units, what is the side of the cube?
A. $(2x + 5)$ units B. $(2x - 5)$ units C. $(5x + 2)$ units D. $(5x - 2)$ units

15. $(3x - 5)$ boys and $(x + 8)$ girls are required to bring $(x^2 + 4x - 5)$ colored chips for the DAMATH BOARD. How many will there be if all the boys and girl will comply with the requirement?
A. $4x^3 + 19x^2 + 8x - 15$ B. $4x^3 + 19x^2 + 8x - 15$
C. $4x^3 + 19x^2 + 8x - 15$ D. $4x^3 + 19x^2 + 8x + 15$

Great job! You are done with this module.

References

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