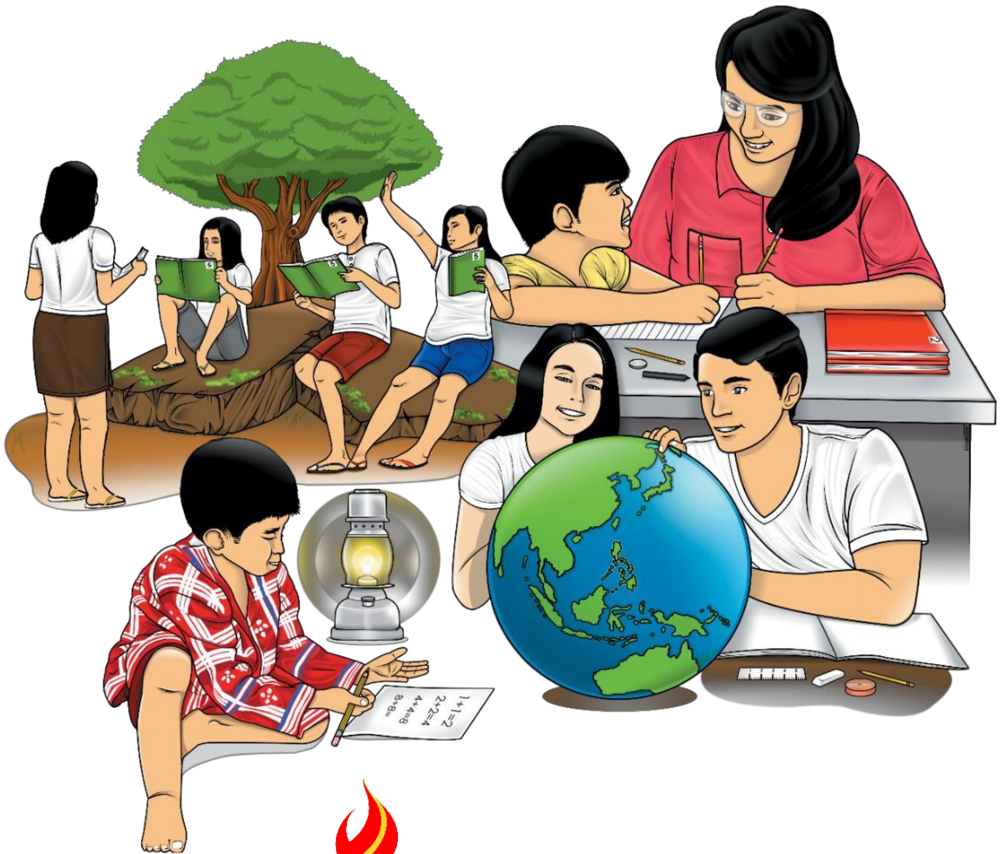
8

Mathematics

Quarter 1– Module 1B

Factoring Perfect Square Trinomials and General Trinomials



ALTERNATIVE DELIVERY MODE

Mathematics – Grade 8
Alternative Delivery Mode
Quarter 1 – Module 1B Factoring Perfect Square Trinomials and General Trinomials
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Factoring Perfect Square Trinomials and General Trinomials

Introductory Message

For the facilitator:

Welcome to the Mathematics 8 Alternative Delivery Mode (ADM) Module on Factoring Perfect Square Trinomials and General Trinomials!

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

As a facilitator, you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the Mathematics 8 Alternative Delivery Mode (ADM) Module on Factoring Perfect Square Trinomials and General Trinomials!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:

	What I Need to Know	This will give you an idea of the skills or competencies you are expected to learn in the module.
	What I Know	This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.
	What's In	This is a brief drill or review to help you link the current lesson with the previous one.
	What's New	In this portion, the new lesson will be introduced to you in various ways; a story, a song, a poem, a problem opener, an activity or a situation.
	What is It	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
	What's More	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
	What I Have Learned	This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.
	What I Can Do	This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.
	Assessment	This is a task which aims to evaluate your level of mastery in achieving the learning competency.
	Additional Activities	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned.
	Answer Key	This contains answers to all activities in the module.

At the end of this module you will also find:

References	This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

What I Need to Know

This module is designed and written to help you factor polynomials completely using different techniques. In all lessons, you are given the opportunity to use your prior knowledge and skills in multiplying and dividing polynomials. Activities are also given to process your knowledge and skills acquired, deepen and transfer your understanding of the different lessons. The scope of this module enables you to use it in many different learning situations. 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.

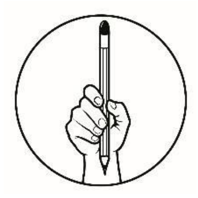
This module contains the following lessons:

Lesson 1: Factoring Perfect Square Trinomials

Lesson 2: Factoring General Trinomials

After going through this module, you are expected to:

1. determine patterns in factoring polynomials; and
2. factor perfect square trinomials and general trinomials completely.



What I Know

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

1. What is the result when you square a binomial?
   A. binomial
   B. sum of two squares
   C. difference of two squares
   D. perfect square trinomial

For items 2 – 4. Expand $(2\text{x}-4)^2$and answer what is asked.

2. What is the last term?
   A. $4x^2$
   B. -16
   C. 16
   D. $-4x^2$

3. What is the middle term?
   A. 8x
   B. -8x
   C. 16x
   D. -16x

4. What is the first term?
   A. 4x^2
   B. -4x^2
   C. 2x^2
   D. -2x^2

5. Which of the following is the expanded form of $(x-5)^2$?
   A. x^2-25
   B. $\text{x}^2-5\text{x}-25$
   C. $\text{x}^2-10\text{x}+25$
   D. $\text{x}^2-10\text{x}+25$

6. Which of the following is a perfect square trinomial?
   A. x^2-2x+4
   B. $4x^2+12x+9$
   C. $x^2-4y+2y^2$
   D. $9x^2-6xy-y^2$

7. All of the following are perfect square trinomials EXCEPT one. Which is it?
   A. $4x^2+12xy+\ 9y^2$
   B. $9a^2-36a+36$
   C. $x^2y^2-4x^2y^2+4x^2y^2$
   D. $a^2b^2+4a^3b+4a^2$

8. What is the complete factored form of $4x^2+16xy+16y^2$?
   A. $(2x+4y)^2$
   B. $(2x+4y)(2x-4y)$
   C. $(2x-4y)^2$
   D. $(2x-4y)(2x-4y)$

9. What are the two numbers whose sum is 1 and whose product is -12?
   A. 3 and -4
   B. -3 and 4
   C. -3 and -4
   D. 3 and 4

10. What are the two expressions whose sum is 7x and whose product is $10x^2$?
    A. 2x and 5x
    B. -2x and 5x
    C. 2x and -5x
    D. -2x and – 5x

11. If one factor of $x^2 - 5x - 24$ is $x + 3$, what is the other factor?

A. x – 3 | C. x + 8
B. x – 8 | D. 2x – 8

12. What is complete factored form of $x^2 + 7x + 10$?

A. $(x + 2)(x + 5)$
B. $(x - 2)(x + 5)$
C. $(x + 1)(x + 10)$
D. $(x - 1)(x + 10)$

13. If one factor of $3x^2 + 17x + 10$ is $3x + 2$, what is the other factor?

A. $x - 5$
B. $x + 5$
C. $3x - 2$
D. $2x + 5$

14. What is the complete factored form of $2x^2 + 5x - 3$?

A. $(2x - 1)(x - 3)$
B. $(2x + 1)(x + 3)$
C. $(2x - 1)(x + 3)$
D. $(2x + 1)(x - 3)$

15. The rectangle has an area of $2x^2 + 8x + 8$. If the length is represented by $2x + 4$ find a binomial that represents the width of the rectangle.

A. $x + 2$
B. $x - 2$
C. $-x - 2$
D. $-x + 2$

Lesson 1 Factoring Perfect Square Trinomials

Another factoring technique that you are going to explore is factoring perfect square trinomials. Before you will start learning this topic, recall the pattern to square a binomial as this is very important in understanding this factoring technique. Do the following activity to refresh your learning in squaring a binomial.

What's In

Patterns in squaring binomial

1. $(a + b)^2 = a^2 + 2ab + b^2$
2. $(a - b)^2 = a^2 - 2ab + b^2$

Activity: Remember Me!

Following the pattern in squaring a binomial, fill-in the missing term. Write your answer on your answer sheet.

1. $(x + 2)^2 =$ ___ $+ 4x + 4$
2. $(2x - 3)^2 = 4x^2 -$ ____ $+ 9$
3. $(3x + 4)^2 = 9x^2 + 24x +$ ____
4. $(x - y)^2 =$ ___ $- 2xy + y^2$
5. $(2x + 3y)^2 = 4x^2 +$ ____ $+ 9y^2$

Questions:

1. What did you do to find the first term of the product? the second term? the last term?
2. How will you determine the sign of the middle term?
3. What do you call the product of squaring a binomial?

What's New

Recall that squaring a binomial is a perfect square trinomial. Say, $(2\mathrm{x}+1)^2 = 4\mathrm{x}^2 + 4\mathrm{x} + 1$ thus, $4x^2 + 4x + 1$ is a perfect square trinomial. The following activity will test your ability in determining perfect square trinomial.

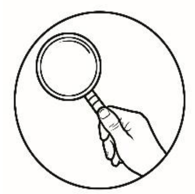
Activity: Am I Perfect?

Determine whether the given expressions are perfect square trinomials. Write P if it is a perfect square trinomial and N if not. Write your answer on your answer sheet.

1. $\mathrm{a}^2 - 22\mathrm{a} + 121$
2. $\mathrm{b}^2 - 8\mathrm{b} + 16$
3. $4\mathrm{d}^2 + 20\mathrm{d} - 25$
4. $100 + 50\mathrm{e} + \mathrm{e}^2$
5. $36\mathrm{r}^2 - 60\mathrm{rt} + 25\mathrm{t}^2$

Questions:

1. How did you determine whether the given expression is a perfect square trinomial?
2. Did you encounter difficulties in determining it?
3. Do you see pattern in determining perfect square trinomials?
4. What are your observations on the terms of a perfect square trinomial?



What is It

Perfect Square Trinomial is the result of squaring a binomial. A perfect square trinomial has first and last terms which are perfect squares and the middle term is twice the product of the first and last terms.

That is,

$(\mathrm{a}+\mathrm{b})^2 = \mathrm{a}^2 + 2\mathrm{ab} + \mathrm{b}^2$ or

$(\mathrm{a}-\mathrm{b})^2 = \mathrm{a}^2 - 2\mathrm{ab} + \mathrm{b}^2$

To factor the given trinomial,

1. Examine whether the first term and last term are perfect squares.
2. Look at the middle term. Check whether it is twice the product of the square root of the first term and last term.
3. If conditions 1 and 2 were satisfied then, the expression is a perfect square trinomial.
4. Factor completely the given trinomial following the pattern $\mathrm{a}^2 + 2\mathrm{ab} + \mathrm{b}^2 = (\mathrm{a}+\mathrm{b})^2 \mathrm{or} (\mathrm{a}+\mathrm{b})(\mathrm{a}+\mathrm{b})$. Similarly, $\mathrm{a}^2 - 2\mathrm{ab} + \mathrm{b}^2 = (\mathrm{a}-\mathrm{b})^2 \mathrm{or} (\mathrm{a}-\mathrm{b})(\mathrm{a}-\mathrm{b})$.

The steps given above are applicable for perfect square trinomial. If what is to be factored is not a perfect square trinomial then other possible techniques may be applied.

To fully understand the process, consider the following examples.

Example 1: Factor $\mathrm{n}^2 + 16\mathrm{n} + 64$

Solution:

Step 1: Determine whether the first term and the last term are perfect squares.

$$\left.\begin{array}{l} \text{First Term: } n^2 = n \cdot n = (n)^2 \\ \\ \text{Last Term: } 64 = 8 \cdot 8 = (8)^2 \end{array}\right\} \quad \textit{Both are perfect squares}$$

Step 2: Determine whether the middle term is twice the product of the square root of the first term and the last term.

$$16\mathrm{n} = 2(\mathrm{n})(8)$$

Step 3: Since the conditions are satisfied then $\mathrm{n}^2 + 16\mathrm{n} + 64$ is a perfect square trinomial.

Step 4: Factor completely $\mathrm{n}^2 + 16\mathrm{n} + 64$

$$\mathrm{n}^2 + 16\mathrm{n} + 64 = (n+8)^2 or\ (n+8)(n+8)$$

To factor perfect square trinomial, use the following relationships:

$$\begin{array}{ccccc} (a)^2 & 2ab & (b)^2 & = & (a \quad + \quad b)^2 \\ \downarrow & \downarrow & \downarrow & & \downarrow \\ (\text{First term})^2 & + 2(\text{First term})(\text{Last term}) + & (\text{Last term})^2 & = & (\text{First term} + \text{Last term})^2 \end{array}$$

$$\begin{array}{ccccc} (a)^2 & 2ab & (b)^2 & = & (a \quad - \quad b)^2 \\ \downarrow & \downarrow & \downarrow & & \downarrow \\ (\text{First term})^2 & - 2(\text{First term})(\text{Last term}) + & (\text{Last term})^2 & = & (\text{First term} - \text{Last term})^2 \end{array}$$

Example 2: Factor $4\mathrm{x}^2 + 4\mathrm{x} + 1$.

Solution:

Step 1: Determine whether the first term and the last term are perfect squares.

$$\left.\begin{array}{l}\text{First Term: } 4x^2 = 2x \cdot 2x = 4x^2 \\[1em] \text{Last Term: } 1 = 1 \cdot 1 = 1^2\end{array}\right\} \quad \textit{Both are perfect squares}$$

Step 2: Determine whether the middle term is twice the product of the square root of the first term and the last term.

$$4x = 2(2x)(1)$$

Step 3: Since the conditions are satisfied then $4x^2 + 4x + 1$ is a perfect square trinomial.

Step 4: Factor completely $4x^2 + 4x + 1$ you have,

$$4x^2 + 4x + 1 = (2x + 1)^2 \text{or } (2x + 1)(2x + 1)$$

Example 3: Factor $x^2 + 14xy + 49y^2$

Solution:

Step 1: Determine whether the first term and the last term are perfect squares.

$$\left.\begin{array}{l}\text{First Term: } x^2 = x \cdot x = (x)^2 \\[1em] \text{Last Term: } 49y^2 = 7y \cdot 7y = (7y)^2\end{array}\right\} \quad \textit{Both are perfect squares}$$

Step 2: Determine whether the middle term is twice the product of the square root of the first term and the last term.

$$14xy = 2(x)(7y)$$

Step 3: Since the conditions are satisfied then $x^2 + 14xy + 49y^2$ is a perfect square trinomial.

Step 4: Factor completely $x^2 + 14xy + 49y^2$ you have,

$$x^2 + 14xy + 49y^2 = (x + 7y)^2 \text{or } (x + 7y)(x + 7y)$$

There are some cases in which you need to factor out first the **greatest common monomial factor** before factoring the perfect square trinomial. To fully understand this, take the following examples.

Example 4: Factor $3x^2 - 18xy + 27y^2$

Solution:

At first glance, we can't find the perfect square trinomial in it. But if we factor out its greatest common monomial factor, like the following:

Step 1: Factor $3x^2 - 18xy + 27y^2$ by GCF.

$$3x^2 - 18xy + 27y^2 = 3(x^2 - 6xy + 9y^2)$$

Step 2: Determine whether the trinomial is a perfect square. The first term and the last term should be perfect squares.

$$\left.\begin{array}{l}\text{First Term: } x^2 = x \cdot x = (x)^2 \\ \\ \text{Last Term: } 9y^2 = 3y \cdot 3y = (3y)^2\end{array}\right\} \quad \textit{Both are perfect squares}$$

Step 3: Determine whether the middle term is twice the product of the square root of the first term and the last term.

$$-6xy = -2(x)(3y)$$

Step 4: Since the conditions are satisfied then $x^2 - 6xy + 9y^2$ is a perfect square trinomial.

Step 5: Factor completely $3x^2 - 18xy + 27y^2$ you have,

$$3x^2 - 18xy + 27y^2 = 3(x - 3y)^2 \text{or } 3(x - 3y)(x - 3y)$$

Example 5: Factor $75t^3 + 30t + 3t$

Solution:

Step 1: Factor $75t^3 + 30t + 3t$ by GCF.

$$75t^3 + 30t + 3t = 3t(25t^2 + 10t + 1)$$

Step 2: Determine whether the trinomial is a perfect square. The first term and the last term should be perfect squares.

$$\left.\begin{array}{l}\text{First Term: } 25t^2 = 5t \cdot 5t = (5t)^2 \\ \\ \text{Last Term: } 1 = 1 \cdot 1 = (1)^2\end{array}\right\} \quad \textit{Both are perfect squares}$$

Step 3: Determine whether the middle term is twice the product of the square root of the first term and the last term.

$$10t = 2(5t)(1)$$

Step 34: Since the conditions are satisfied then $25t^2 + 10t + 1$ is a perfect square trinomial.

Step 5: Factor completely $75t^3 + 30t + 3t$ you have,

$$75t^3 + 30t + 3t = 3t(5t + 1)(5t + 1)$$

Example 6: Factor $9x^2 + 12xy + 16y^2$.

Step 1: Determine whether the trinomial is a perfect square. The first term and the last term should be perfect squares.

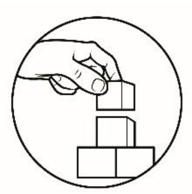
First Term: $9x^2 = 3x \cdot 3x = (3x)^2$
Last Term: $16y^2 = 4y \cdot 4y = (4y)^2$

$\left.\begin{array}{l} \text{First Term: } 9x^2 = 3x \cdot 3x = (3x)^2 \\ \text{Last Term: } 16y^2 = 4y \cdot 4y = (4y)^2 \end{array}\right\}$ *Both are perfect squares*

Step 2: Determine whether the middle term is twice the product of the square root of the first term and the last term.

$$12xy \neq 2(3x)(4y)\text{, as } 2(3x)(4y) = 24xy$$

This means that the trinomial is not a perfect square. Thus, you don't have to proceed to factoring.



What's More

Activity 1: You're the One.

Supply the missing term of the factor of the given perfect trinomials below. Write your answer on a separate sheet of paper.

1. $x^2 - 6x + 9 = (x - \_\_)^2$
2. $4x^2 - 4x + 1 = (\_\_\_ - 1)^2$
3. $9x^2 + 12x + 4 = (3x + \_\_\_)^2$
4. $4x^2 + 16xy + 16y^2 = (2x + \_\_\_)^2$
5. $16a^2 - 24ab + 9b^2 = (\_\_\_ - 3b)^2$

Activity 2: Break it Perfectly

Factor the following completely by writing each of the perfect square trinomial as the square of a binomial. Write your answers on a separate sheet of paper.

1. $y^2 + 20y + 100$
2. $k^2 - 8k + 16$
3. $16m^2 + 48m + 36$
4. $49b^2 - 14b + 1$
5. $3x^2y - 24xy + 48y$

What I Have Learned

Complete the paragraph below by filling in the blanks with correct word/s or figure/s which you can choose from the box below. Each word or figure may be used repeatedly. Write your answers on your answer sheet.

first term	$\mathrm{a}^2 + 2\mathrm{ab} + \mathrm{b}^2 = (\mathrm{a} - \mathrm{b})^2$	*third term*	*squaring a binomial*
multiplied	*two*	*factoring*	*perfect square*
polynomials	*second term*	*square*	$\mathrm{a}^2 - 2\mathrm{ab} + \mathrm{b}^2 = (\mathrm{a} - \mathrm{b})^2$
$\mathrm{a}^2 + 2\mathrm{ab} + \mathrm{b}^2 = (\mathrm{a} + \mathrm{b})^2$	*Simplifying*	$\mathrm{a}^2 - 2\mathrm{ab} - \mathrm{b}^2 = (\mathrm{a} - \mathrm{b})^2$	*technique*

Factoring is an important process that helps us understand more about mathematical expressions or equations. Through ______**(1)**______, you can rewrite your _____**(2)**______ in a simpler form, and when you apply the factoring _______**(3)**_______ to mathematical expressions or equations, it can yield a lot of useful information. You have learned in this lesson about factoring perfect square trinomial. This trinomial is a result of ______**(4)**______. The first term of the trinomial is the square of the _____**(5)**________ of the binomial. The second term is the product of the _____**(6)**________ and _____**(7)**______ of the binomial which will always be _____**(8)**_______ by ______**(9)**_____. The third term of the trinomial is the _____**(10)**__________ of the ______**(11)**________ of the binomial. If the trinomial follows the pattern in squaring a binomial, then it is a ________**(12)**_______. To factor this, you should recognize first, whether the ________**(13)**______ and _______**(14)**______ are ________**(15)**_______. After recognizing whether the given trinomial is a perfect square, then you can proceed to factoring following the pattern ________**(16)**_________ or ________**(17)**________.

What I Can Do

Suppose you have a square room with an area of $4x^2 + 16x + 16$.

1. Find the binomial that represents each side of your room.
2. Supposed the measure of the side of your room is 300 inches, what is the value of x?
3. What is the area of the square?
4. Supposed you want to tile the floor of your room; how many 30 x 30 inches tiles will be used?

Lesson 2 Factoring General Trinomials

In this lesson you will learn how to factor general trinomials. There will be two types of trinomials that you are going to deal with. First is the trinomial in the form $\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c}$, where a = 1, and $ax^2 + bx + c$, where a ≠ 1. Before you will start exploring this lesson, let us first reactivate your basic mathematical skills.

What's In

Activity: The Two of Us

Think of two numbers whose sum and product are given in the table below. Write your answers on your answer sheet. Item 1 is done for you.

Item	Sum	Product	The Two Numbers
1	6	8	2 and 4
2	6	-16	
3	-2	-15	
4	4	-12	
5	6	9	
6	-5	-14	

Notice that in item 1, the numbers 2 and 4 in Column 4 when added will give a sum of 6 and when multiplied will give a product of 8.

Questions:

1. How did you find the two numbers in column 4 to satisfy the conditions in columns 2 (sum) and 3(product)?
2. Was it easy to find the two numbers?
3. What does it mean when the product of the numbers is negative? positive?
4. Did you recognize a pattern or technique on how to find the two numbers given its sum and product? What is it?

What's New

Recall that FOIL method is a method in multiplying binomial to the other binomial. FOIL stands for:

F - first terms
O – Outer terms
I – Inner terms
L – last terms

Activity: Grilling with F O I L

Given below are expressions in factored form in which both factors are binomials. Follow the process in multiplying the binomials using FOIL method and answer the questions that follow. Write your answer on your answer sheet.

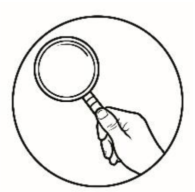
		F		O		I		L
1. (x + 1)(x + 2)	=	x^2	$+$	$2x$	$+$	x	$+$	2
	=	$x^2 + 3x + 2$						

		F		O		I		L
2. (x – 2)(x -3)	=	x^2	$-$	$3x$	$-$	$2x$	$+$	6
	=	$x^2 - 5x + 6$						

		F		O		I		L
3. (x + 3)(x – 4)	=	x^2	$-$	$4x$	$+$	$3x$	$-$	12
	=	$x^2 - x - 12$						

Questions:

1. What did you observe with the numerical coefficients of the x^2 term?
2. What did you notice about the last terms of the trinomial? How are the last terms of each trinomial related to the last terms of the given binomials?
3. What did you notice with the numerical coefficients of the middle terms? How are the coefficients of the middle term related to the last terms of the given binomials?
4. Suppose a trinomial is given, how are you going to find its two binomials factors?



What is It

General trinomials can be classified into two (2) ways:

1. Trinomial in the form $\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c}$, where a = 1; and
2. Trinomial in the form of $\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c}$, where a ≠ 1.

In this lesson you will first learn factoring general trinomial where a = 1. The following are some examples of trinomials of the form $\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c}$, where a = 1.

$$\mathrm{x}^2 + 5\mathrm{x} + 6 \qquad \mathrm{x}^2 - 7\mathrm{x} + 12 \qquad \mathrm{x}^2 + 2\mathrm{x} - 15$$

Trinomials of this form are the product of two binomials having leading coefficients of 1. Consider the illustration below where the **FOIL** method is being applied in multiplying two binomials having leading coefficients of 1.

$$(x + 1)(x + 2) = \overset{\text{F}}{x^2} + \overset{\text{O}}{2x} + \overset{\text{I}}{x} + \overset{\text{L}}{2}$$

$$= \mathrm{x}^2 + 3\mathrm{x} + 2$$

Sum of 2 and 1

Product of 2 and 1

Notice that the coefficient of the middle term is the sum of the last terms of the two binomials and the third term is the product of the last terms of the two binomials. If you are going to factor trinomials of the form $\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c}$, where a = 1, you will reverse the FOIL method. These are the steps in factoring this trinomial.

1. Find two factors with a product equal to the last term (c) of the trinomial and a sum equal to the middle term (b) of the trinomial.

2. Write the factored form of the trinomial following the pattern:
   $(x \pm \ first\ factor)\ (x \pm \ second\ factor)$

The sign in the last term of the binomial factors can be minus signs, depending on the signs of **b** and **c.**

Let us take the following examples.

Example 1: Factor $x^2 + 7x + 10$.

Solution:

Step 1. Find two factors with a product equal to the last term (c) of the trinomial and a sum equal to the middle term (b) of the trinomial.

Here, you are going to find two factors whose product is 10 (last term) and whose sum is 7 (middle term).

Refer to the illustration below.

Product	Sum
$(1)(10) = 10$	$1 + 10 = 11$
$(\mathbf{2})(\mathbf{5}) = \mathbf{10}$	$\mathbf{2 + 5 = 7}$

This is the correct combination. So, 2 and 5 are the factors.

Step 2: Write the factored form of the trinomial following the pattern (x+ first factor) (x+ second factor).

$$x^2 + 7x + 10 = (\mathbf{x} + \mathbf{2})(\mathbf{x} + \mathbf{5})$$

Example 2: Factor $x^2 + 2x - 15$.

Solution:

Step 1: Find two factors with a product equal to the last term (c) of the trinomial and a sum equal to the middle term (b) of the trinomial.

Here, you are going to find two factors whose product is -15 (last term) and whose sum is 2 (middle term). Since the product is negative, the two numbers must have different signs. And since the sum is positive, the bigger number (the number with greater absolute value) must be positive.

Refer to the table below.

Product	Sum
$(-1)(15) = -15$	$-1 + 15 = 14$
$(\mathbf{-3})(\mathbf{5}) = \mathbf{-15}$	$\mathbf{-3 + 5 = 2}$

This is the correct combination. So -3 and 5 are the factors.

Step 2: Write the factored form of the trinomial following the pattern (x+ first factor) (x+ second factor).

$$x^2 + 2x - 15 = (\mathbf{x} - \mathbf{3})(\mathbf{x} + \mathbf{5})$$

Example 3: Factor $x^2 - 5x - 24$.

Solution:

Step 1. Find two factors with a product equal to the last term (c) of the trinomial and a sum equal to the middle term (b) of the trinomial.

Here, you are going to find two factors whose product is -24 (last term) and whose sum is -5 (middle term). Since the product is negative, the two numbers must have different signs. And since the sum is also negative, the bigger number (number with the greater absolute value) must be negative.

Refer to the table below.

Product	Sum
$(1)(-24) = -24$	$1 + (-24) = -23$
$(2)(-12) = -24$	$2 + (-12) = -10$
$\mathbf{(3)(-8) = -24}$	$\mathbf{3 + (-8) = -5}$

This is the correct combination. So, 3 and -8 are the two factors.

Step 2. Write the factored of the trinomial following the pattern
(x+ first factor)(x+ second factor).

$$x^2 - 5x - 24 = \mathbf{(x + 3)(x - 8)}$$

Example 4: Factor $x^2 + 6x + 14$.

Solution

Step 1. Find two factors with a product equal to the last term (c) of the trinomial and a sum equal to the middle term (b) of the trinomial.

Here, you are going to find two factors whose product is 14 (last term) and whose sum is 6 (middle term). Since the product is positive and the sum is also positive so both numbers must also be positive.

Refer to the table below.

Product	Sum
$(1)(14) = 14$	$1 + 14 = 15$
$(2)(7) = 14$	$2 + 7 = 9$

Based on the table, all the possible factors of 14 were already listed. However, there are NO two numbers having a product of 14 and the sum of 6. Thus, the given polynomial, $x^2 + 6x + 14$, is a ***PRIME***. However, it can be factored using different method to be discussed in other lesson.

Let us discuss the second classification of general trinomial $ax^2 + bx + c$, where a ≠ 1.

Consider now factoring trinomials in which the coefficient of the squared term is other than one such as the following:

$$6x^2 - 5x - 6 \qquad\qquad 3x^2 + 17x + 10$$

Trinomials of these forms also have two binomial factors in which you need to consider the ax^2 term (first term of the trinomial), the *bx* term (second term of the trinomial) and the *c* term (third term of the trinomial) in getting the two binomial factors.

There are many ways of factoring this type of trinomials. One of those is through trial and error. Here is an example.

Example 1: Factor $6x^2 - 5x - 6$ through trial and error.

Solution:

Give all the factors of $6x^2$ and -6.

Factors of $6x^2$	Factors of -6
$(3x)(2x)$	$(3)(-2)$
$(6x)(x)$	$(-3)(2)$
	$(1)(-6)$
	$(-1)(6)$

Write all the possible factors using the values above and determine the middle term which is $-5x$ by getting the sum of the product of the outer terms and the product of the inner terms in FOIL method.

Possible Factors	Product of the Outer Terms	Product of the Inner terms	Sum of the product of the outer terms and the product of the inner terms
$(3x-2)(2x+3)$	$(3x)(3) = 9x$	$(-2)(2x) = -4x$	$9x + (-4x) = 5x$
$(3x+3)(2x-2)$	$(3x)(-2) - 6x$	$(3)(2x) = 6x$	$-6x + 6x = 0$
$(3x-3)(2x+2)$	$(3x)(2) = 6x$	$(-3)(2x) = -6x$	$6x + (-6x) = 0$
$\mathbf{(3x+2)(2x-3)}$	$\mathbf{(3x)(-3) = -9x}$	$\mathbf{(2)(2x) = 4x}$	$\mathbf{-9x + 4x = -5x}$
$(3x+1)(2x-6)$	$(3x)(-6) = -18x$	$(1)(2x) = 2x$	$-18x + (2x) = -16x$
$(3x-6)(2x+1)$	$(3x)(1) = 3x$	$(-6)(2x) = -12x$	$3x + (-12x) = -9x$
$(6x+3)(x-2)$	$(6x)(-2) = -12x$	$(3)(x) = 3$	$-12x + 3x = -9x$
$(6x-2)(x+3)$	$(6x)(3) = 18x$	$(-2)(x) = -2x$	$18x + (-2x) = 16x$
$(6x-3)(x+2)$	$(6x)(2) = 12x$	$(-3)(x) = -3x$	$12x + (-3x) = 9x$
$(6x+2)(x-3)$	$(6x)(-3) = -18x$	$(2)(x) = 2x$	$-18x + 2x = -16x$
$(6x+1)(x-6)$	$(6x)(-6) = -36x$	$(1)(x) = x$	$9x + (-4x) = 5x$
$(6x-6)(x+1)$	$(6x)(1) = 6x$	$(-6)(x) = -6x$	$6x + (-6x) = 0$

With the factors above, $(3x+2)(2x-3)$ has the sum of the product of the outer terms and the product of the inner terms of $-5x$, thus making it as the factors of the trinomial $6x^2 - 5x - 6$.

Factoring using trial and error is a long process. Knowing another way of factoring trinomials of $ax^2 + bx + c$ where $a \neq 1$ is very important and it is up to you which method you are going to use.

Another way of factoring this kind of trinomial is by grouping.

The following are the steps in factoring trinomials of the form $ax^2 + bx + c$ where a ≠ 1.

1. Multiply the first term and the last term of the trinomial.

$(ax^2)(c) = (ac)x^2$ (ac) = constant

2. Get the possible factors of the product of the first term and the last term of the trinomial in such a way that their sum is equal to the second term of the trinomial.

$$\begin{array}{c|c} \multicolumn{2}{c}{(ac)x^2} \\ nx & mx \end{array}$$

Where *nx* and *mx* are the factors of *acx²*. And,

$\mathrm{nx} + \mathrm{mx} = \mathrm{bx}$ (second term of the trinomial)

3. Replace the middle term (*bx)* by the two factors.

$$\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c} = \mathrm{ax}^2 + \mathrm{nx} + \mathrm{mx} + \mathrm{c}$$

4. Group $\mathrm{ax}^2 + \mathrm{nx} + \mathrm{mx} + \mathrm{c}$ as follows,

$$(ax^2 + nx) + (mx + c)$$

5. Factor out the greatest common monomial factor of each group such that you can obtain the same binomial factor.

6. Combine the greatest common monomial factor of each group and multiply it to same binomial factor obtained in step 5. The result serves as the factors of the trinomial.

Example 1: Factor $6x^2 - 5x - 6$

Solution:

Step 1: Multiply the first term and the last term.

$$(6x^2)(-6) = -36x^2$$

Step 2: Get the possible factors of the product of the first term and the last term of the trinomial in such a way that the sum will be equal to the second term of the trinomial.

Here, the product is $-36\mathrm{x}^2$ and the sum is $-5\mathrm{x}$ which is the middle term. Since the product is negative, the two numbers must have different signs. And since the sum is also negative, the bigger number (number with the greater absolute value) must be negative.

Refer to the table below.

Product	Sum
$(x)(-36x) = -36x^2$	$x + (-36x) = -35x$
$(2x)(-18x) = -36x^2$	$2x + (-18x) = -16x$
$(3x)(-12x) = -36x^2$	$3x + (-12x) = -9x$
$\mathbf{(4x)(-9x) = -36x^2}$	$\mathbf{4x + (-9x) = -5x}$
$(6x)(-6x) = -36x^2$	$6x + (-6x) = 0$

This is the correct combination, so 4x and -9x are the two factors.

Step 3: Replace the middle term in such a way that $\mathrm{ax}^2 + \mathrm{bx} + \mathrm{c} = \mathrm{ax}^2 + \mathrm{nx} + \mathrm{mx} + \mathrm{c}$, where nx and mx are the factors. Here, the factors are 4x and -9x

$$6x^2 - 5x - 6 = 6x^2 + 4x - 9x - 6$$

Step 4: Group $ax^2 + nx + mx + c$ in this pattern $(ax^2 + nx) + (mx + c)$.
$(6x^2 + 4x) - (9x + 6)$

Note: Notice that the operation used in the second group was changed. This will happen if the operation between the two groups is minus (-). Always do this if you encounter this case. In this case -9x - 6 becomes 9x + 6.

Step 5: Factor out the greatest common monomial factor of each group such that you can obtain the same binomial factor**.**

$$(6x^2 + 4x) = 2x(3x + 2)$$

$$-(9x + 6) = -3(3x + 2)$$

$2x$ and -3 are the GCF and $3x + 2$ and $3x + 2$ are the two same binomial factors.

Step 6: Combine the greatest common monomial factor of each group and multiply it to same binomial factor obtained in step 5. The result serves as the factors of the trinomial.

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

So, $6x^2 - 5x - 6 = \mathbf{(2x - 3)(3x + 2)}$

Example : Factor $3x^2 + 17x + 10$.

Solution:

Step 1: Multiply the first term and the last term.

$$(3x^2)(10) = 30x^2$$

Step 2: Get the possible factors of the product of the first term and the last term of the trinomial in such a way that the sum will be equal to the second term of the trinomial.

Here, the product is $30x^2$ and the sum is $17x$ which is the middle term.

Since the product and the sum are positive, the two factors should also be both positive.

Refer to the table below.

Product	Sum
$(x)(30x) = 30x^2$	$x + 30x = 31x$
$(2x)(15x) = 30x^2$	**$2x + 15x = 17x$**
$(3x)(10x) = 30x^2$	$3x + 10x = 13x$
$(5x)(6x) = 30x^2$	$5x + 6x = 11x$

This is the correct combination, so 2x and 15x are the two factors.

Step 3: Replace the middle term in such a way that $ax^2 + bx + c = ax^2 + nx + mx + c$, where nx and mx are the factors. Here, the factors are 2x and 15x

$$3x^2 + 17x + 10 = 3x^2 + \mathbf{2x} + \mathbf{15x} + 10$$

Step 4: Group $ax^2 + nx + mx + c$ in this pattern $(ax^2 + nx) + (mx + c)$.
$(3x^2 + 2x) + (15x + 10)$

Step 5: Factor out the greatest common monomial factor of each group such that you can obtain the same binomial factor**.**

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

$$(15x + 10) = 5(3x + 2)$$

x and *5* are the GCF and *(3x + 2)* and *(3x + 2)* are the two same binomial factors.

Step 6: Combine the greatest common monomial factor of each group and multiply it to same binomial factor obtained in step 5. The result serves as the factors of the trinomial.

$$(x + 5)(3x + 2)$$

So, $3x^2 + 17x + 10 = (\mathbf{x + 5})(\mathbf{3x + 2})$

Example 3: Factor $2x^2 + 5x - 3$.

Solution:

Step 1: Multiply the first term and the last term.

$$(\boldsymbol{2x^2})(\boldsymbol{-3}) = \boldsymbol{-6x^2}$$

Step 2: Get the possible factors of the product of the first term and the last term of the trinomial in such a way that their sum is equal to the second term of the trinomial.

Here, the product is $-6x^2$ and the sum is 5x which is the middle term.

Since the product is negative, the two factors must have different signs. And since the sum is positive, the factor with bigger coefficient (the number with greater absolute value) must be positive.

Refer to the table below.

Product	Sum
(-x)(6x) = - 6x^2	**(-x) + 6x = 5x**
(-2x)(3x) = - 6x^2	(-2x) + 3x = x

This is the correct combination, so -x and 6x are the two factors.

Step 3: Replace the middle term in such a way that $ax^2 + bx + c = ax^2 + nx + mx + c$, where nx and mx are the factors. Here, the factors are $-x$ and $6x$.

$$\mathbf{2x^2 + 5x - 3 = 2x^2 + 6x + (-x) - 3}$$

Step 4: Group $ax^2 + nx + mx + c$ in this pattern $(ax^2 + nx) + (mx + c)$.

$$(\mathbf{2x^2 + 6x}) + [(-x) - 3]$$

Step 5: Factor out the greatest common monomial factor of each group such that you can obtain the same binomial factor.

$$2x^2 + 6x = 2x(x + 3)$$
$$(-x) - 3 = -1(x + 3)$$

2*x* and *-1* are the GCF and *(x + 3)* and *(x + 3)* are the two the same binomial factors.

Step 6: Combine the greatest common monomial factor of each group and multiply it to same binomial factor obtained in step 5. The result serves as the factors of the trinomial.

$$(2x - 1)(x + 3)$$

So, $2x^2 + 5x - 3 = (\mathbf{2x - 1})(\mathbf{x + 3})$

Example 4: Factor $3x^2 - 17x + 10$.

Solution:

Step 1: Multiply the first term and the last term.

$$(3x^2)(10) = 30x^2$$

Step 2: Get the possible factors of the product of the first term and the last term of the trinomial in such a way that their sum is equal to the second term of the trinomial.

Here, the product is $30x^2$ and the sum is 17x which is the middle term.

Since the product is positive and the sum is negative, the two factors must have both negative signs.

Refer to the table below.

Product	Sum
$(-x)(-30x) = 30x^2$	$(-x) + (-30x) = -31x$
$(-2x)(-15x) = 30x^2$	**$(-2x) + (-15x) = -17x$**
$(-3x)(-10x) = 30x^2$	$(-3x) + (-10x) = -13x$
$(-5x)(-6x) = 30x^2$	$(-5x) + (-6x) = -11x$

This is the correct combination, so -2x and -15x are the two factors.

Step 3: Replace the middle term in such a way that $ax^2 + bx + c = ax^2 + nx + mx + c$, where nx and mx are the factors. Here, the factors are $-2x$ and $-15x$.

$$3x^2 - 17x + 10 = 3x^2 + (-2x) + (-15x) + 10 \text{ or}$$
$$= 3x^2 - 2x - 15x + 10$$

Step 4: Group $ax^2 + nx + mx + c$ in this pattern $(ax^2 + nx) + (mx + c)$.

$$3x^2 - 2x - 15x + 10 = (3x^2 - 2x) - (15x - 10)$$

Note: Notice that the operation used in the second group was changed. This will happen if the operation between the two groups is minus (–). Always do this if you encounter this case. In this case 15x + 10 becomes 15x – 10.

Step 5: Factor out the greatest common monomial factor of each group such that you can obtain the same binomial factor.

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

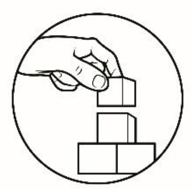
$$-(15x - 10) = -5(3x - 2)$$

x and *-5* are the GCF and *(3x - 2)* and *(3x - 2)* are the two the same binomial factors.

Step 6: Combine the greatest common monomial factor of each group and multiply it to same binomial factor obtained in step 5. The result serves as the factors of the trinomial.

$$(x - 5)(3x - 2)$$

So, $3x^2 - 17x + 10 = (x - 5)(3x - 2)$



What's More

Activity 1: Missing You!

Fill in the blank of the given equation. Write your answers on your answer sheet.

1. $a^2 + 12a + 11 = (a + \_\_\_)(a + 11)$
2. $b^2 + 6b + 8 = (b + 2)(b + \_\_\_\_)$
3. $c^2 - 7c + 6 = (c - \_\_\_)(c - 1)$
4. $2x^2 - 3x - 9 = (\_\_\_x + 3)(x - 3)$
5. $3x^2 + 5x - 2 = (\_\_\_x - 1)(x + 2)$

Activity 2: Break It to Me Gently

Factor each trinomial completely, if possible. If the polynomial is not factorable, Write PRIME. Write your answer on your answer sheet.

1. $c^2 - 6c - 40$
2. $e^2 + 10e + 16$
3. $h^2 - 5h - 24$
4. $3x^2 - 5x - 12$
5. $4x^2 + 4x - 15$

What I Have Learned

This lesson discusses factoring general type of trinomials, which are divided into two forms. These are trinomials in the form of $ax^2 + bx + c$ where a=1, and $ax^2 + bx + c$ where $a \neq 1$. Write what you have learned about each one, including the step-by-step process on how factoring is done. Write your answers on a separate sheet.

For $ax^2 + bx + c$ where $a = 1$	$ax^2 + bx + c$ where $a \neq 1$.
Concepts Learned:	Concepts Learned:
Give a trinomial of the form $ax^2 + bx + c$ where a = 1 and factor it completely.	Give a trinomial of the form $ax^2 + bx + c$ where $a \neq 1$ and factor it completely.

What I Can Do

Suppose you have a rectangular garden that has an area represented by $15x^2 + 4x - 4$ square meters and its length is represented by $5x + 2$ meters.

1. Find the binomial that represents the width of your garden.
2. Suppose the measure of the length is 12m, what is the measure of the width of the rectangle?
3. What is the area of the rectangular garden?
4. If you are going to plant your garden with okra which is 25cm apart, how many okra can you plant?

Assessment

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

1. Which of the following is a perfect square number?
   A. 8 B. 24 C. 125 D. 121

2. All of the following expressions are perfect squares, **EXCEPT** one. What is it?
   A. $12a^2b^2$ B. x^2y^6 C. $16a^2b^6$ D. $25x^6y^8$

3. Which of the following is equal to $(2x - 1)^2$?
   A. $4x^2 + 4x + 1$ C. $4x^2 - 4x + 1$
   B. $2x^2 + 2x + 1$ D. $4x^2 - 4x - 1$

4. Which of the following is a perfect square trinomial?
   A. $x^2 + 6x + 9$ C. $4x^2 + 20xy + 9y^2$
   B. $4x^2 - 20x - 25$ D. $9a^2 - 6a^2bc + a^2b^2c^2$

5. All of the following are perfect square trinomials, except one. Which is it?
   A. $x^2 - 4xy + 4y^2$ C. $4x^2 - 12xy + 9y^2$
   B. $9a^2 + 24a - 16$ D. $x^2y^2 - 6x^3y^2 + 9x^4y^2$

6. If one factor of a perfect square trinomial is $2xy - 3x$, what is the other factor?
   A. $2y - 3x$ B. $2y + 3x$ C. $2xy - 3x$ D. $2xy + 3x$

7. Which of the following is equal to $x^2 - 6xy + 9y^2$?
   A. $(x - 3y)^2$ B. $(x + 3y)^2$ C. $(2x - 3y)^2$ D. $(2x + 3y)^2$

8. What is the complete factored form of $4a^2 - 4a^2b + a^2b^2$?
   A. $(2a + ab)^2$ C. $(2a - ab)^2$
   B. $(a - 2ab)^2$ D. $(ab - 2a)^2$

9. What is the complete factored form of $8x^2 - 24xy + 18y^2$
   A. $2(2x - 3y)(2x - 3y)$ C. $2(3x + 2y)^2$
   B. $2(2x - 3y)(2x + 3y)$ D. $2(3x - 2y)^2$

10. Which of the following trinomials is factorable?
    A. $x^2 - 6x + 7$ C. $x^2 + 3x + 2$
    B. $2x^2 + 5x + 10$ D. $3x^2 - 6x + 12$

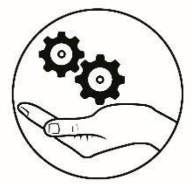
11. All of the following trinomials are factorable, except one. What is it?
    A. $x^2 - 2x - 3$ C. $2x^2 + 3x - 2$
    B. $x^2 + 5x + 6$ D. $2x^2 + 2x + 4$

12. What is the complete factored form of $x^2 - 4x - 96$?
    A. $(x + 8)(x - 12)$ C. $(x - 8)(x - 8)$
    B. $(x - 8)(x + 12)$ D. $(x + 8)(x + 12)$

13. What is the complete factored form of $2x^2 - 6x - 8$?
    A. $(x + 4)(2x - 2)$ C. $(4x + 2)(x - 2)$
    B. (x-4)(2x+2) D. $(4x - 2)(x + 2)$

14. Which of the following trinomials has factors $(3a - 2b)$and$(2a - b)$?
    A. $6a^2 - 7ab + 2b^2$ C. $6a^2 - 7ab - 2b^2$
    B. $6a^2 + 7ab - 2b^2$ D. $6a^2 + 7ab + 2b^2$

15. A rectangular garden has an area by $6x^2 + x - 2$ square meter. If the length is represented by $3x + 2$, find a binomial that represents the width.
    A. $2x + 1$ B. $x - 2$ C. $2x - 1$ D. $x - 2$



Additional Activities

Activity: Do More!

Solve each of the following. Write you answer on your answer sheet.

1. What does it mean when we say to completely factor a polynomial?
2. Discuss how you will factor $11x^2 + 19x - 6$.
3. Explain why $16 - 8x + x^2$can be factored as either $(4 - x)^2 or\ (x - 4)^2$.
4. Student A gives $(4x - 1)(x - 3)$ as the answer to a factoring problem. Student B gets $(3 - x)(1 - 4x)$. Who has the correct answer?
5. Is $-6x^2 - x + 2$ factorable? If yes, how will you do it?

Answer Key

What I Know
1. D
2. C
3. D
4. A
5. C
6. B
7. D
8. A
9. B
10. A
11. B
12. A
13. B
14. C
15. A

Lesson 1: Factoring Perfect Square Trinomial

What's In
1. x^2
2. 12x
3. 16
4. x^2
5. 12xy

What's New
1. P
2. P
3. N
4. N
5. P

What's More

Activity 1
1. 3
2. $2x$
3. 2
4. $4y$
5. $4a$

Activity 2
1. $(y + 10)^2$
2. $(k - 4)^2$
3. $(4m + 6)^2$
4. $(7b - 1)^2$
5. $3y(x - 4)^2$

What I have Learned
1. Factoring
2. Polynomial
3. Technique
4. Squaring a binomial
5. First term
6. First term
7. Second term
8. Multiplied
9. Two
10. Square
11. Second term
12. Perfect square
13. First term
14. Second term
15. Perfect square
16. $a^2 + 2ab + b^2 = (a + b)^2$
17. $a^2 - 2ab + b^2 = (a - b)^2$

Note: Answers to Items 16 & 17 may be interchanged

What I Can Do
1. 2x + 4
2. 148
3. 90 000 in^2
4. 100 pieces

Lesson 2: Factoring General Trinomial

What's In
1. 2 and 4
2. -2 and 8
3. 3 and -5
4. -2 and 6
5. 3 and 3
6. 2 and -7

What's In

Answers may vary

What's More

Activity 1
1. 1
2. 4
3. 6
4. 2
5. 3

What's More

Activity 2
1. (c + 4)(c – 10)
2. (e+2)(e+8)
3. (h+3)(h-8)
4. (x-3)(3x+4)
5. (2x + 5)(2x – 3)

What I Have Learned

Answers may vary

What Can I Do
1. 3x – 2
2. 4m
3. $48m^2$
4. 768 okras

Assessment
1. D
2. A
3. C
4. A
5. B
6. C
7. A
8. C
9. A
10. C
11. D
12. A
13. B
14. A
15. C

Additional Activities
1. A polynomial is completely factored if its factors are considered to be prime.
2. Discussion may vary but leads to (11x-3)(x+2)
3. They will just give the same product when expanded.
4. Both have the correct answers.
5. Yes, (-3x+2)(x+1) or (2-3x)(1+x).

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