

ALGEBRA

Lesson 4 Simplification of Algebraic Expressions

1. WHAT IS AN ALGEBRAIC EXPRESSION?

An algebraic expression is an expression made from numbers, such as 6, 15, or 158; variables, such as x , y , or a ; and the four operations, $+$ $-$ \times or \div . The variable in an expression stands for a number whose value is unknown.

Think of $5 + x$ as 5 plus some number.

Think of $12x$ as 12 times some number.

Algebraic expressions usually use x for the variable, but any letter can be used. If the variable is used several times in an expression, it will have the same value each time. For example, in the expression $4x + 12x^2 - 3x$, the variable x will have the same value in all three places it appears.

Here are some examples of algebraic expressions:

$$5x + 17 + 4x^2 + 16x$$

$$3x^3 + 4x - 17x + 6$$

$$x^2 + 4x - 6x^2 + 7 + 4x - 6$$

Expressing Multiplication in Algebra

You are used to seeing multiplication represented by the \times sign, like 5×6 , or 12×4 . In algebra, multiplication is usually shown differently. A number next to a variable means multiplication.

$4x$ means 4 times x .

$7y$ means 7 times y .

If there is no number next to the variable, it is understood to be 1 times that variable, but the 1 is not written.

x means 1 times x .

x^2 means 1 times x^2 .

Multiplication can also be shown by using parentheses.

$5(7)$ means 5 times 7.

$(4)(x)$ means 4 times x .

$(6)(3)$ means 6 times 3.

Terms

A term in an algebraic expression can be a number, a variable, or a number times a variable.

Terms are separated with + signs or – signs. $5x$ x $3x^2$ 16 $8x^4$ 12 are all terms.

$7x^2 + 5$ An expression of two terms is called a **binomial**.

$4x^3 + x^2 - 3x + 7$ An expression of more than two terms is called a **polynomial**.

$3x^2 - 6x + 7$ An expression of three terms can be called a **trinomial** or a **polynomial**.

Like Terms

Like terms are terms that have the same variable with the same exponent. Like terms can be combined with addition and subtraction.

$4x$ $5x$ $-2x$ are all like terms because they have the same variable x with no exponent.

$6x^2$ $2x^2$ $-5x^2$ are all like terms because they have the same variable x with the same exponent 2 .

$4x^4$ $7x^4$ $-9x^4$ are all like terms because they have the same variable x with the same exponent 4 .

7 12 -6 are all like terms because they are regular numbers with no variable.

2. SIMPLIFICATION MEANS COMBINING LIKE TERMS

To simplify an algebraic expression, combine like terms using addition and subtraction.

Combine all the x^3 terms into one term.

Combine all the x^2 terms into one term.

Combine all the x terms into one term.

Combine all the numbers that don't have a variable into one term.

$4x^3 + 9x^3$ combines to $13x^3$

$2x^2 - 5x^2$ combines to $-3x^2$

$7x + 6x + 3x$ combines to $16x$

$7 + 5$ combines to 12

$5x + 7x^2$ can't be simplified.

The x term can't be combined with the x^2 term.

An x term can only be combined with another x term.

An x^2 term can only be combined with another x^2 term.

$13x^3 + 8$ can't be simplified.

The x^3 term can't be combined with the number.

An x^3 term can only be combined with another x^3 term.

A number can only be combined with another number.

Examples

1. $3 + 4x + 7 + 2x = 6x + 10$ Combine $4x$ and $2x$ to get $6x$.
Combine 3 and 7 to get 10 .

2. $4 + 6x + 2x^2 + 3x + 9x^2 = 11x^2 + 9x + 4$ Combine $2x^2$ and $9x^2$ to get $11x^2$.
Combine $6x$ and $3x$ to get $9x$.
There is nothing to combine with 4 .

3. $x^2 + 5x + 7 - 4x + 3 + 4x^3 + 6x^2 = 4x^3 + 7x^2 + x + 10$
There is nothing to combine with $4x^3$.
Combine x^2 and $6x^2$ to get $7x^2$.
Combine $5x$ and $-4x$ to get x .
Combine 7 and 3 to get 10 .

4. $2x + 3x^2 - 8x + 3x - 7x^2 = -4x^2 - 3x$
Combine $3x^2$ and $-7x^2$ to get $-4x^2$. Think $3 - 7$ to combine them. If you are not sure what $3 - 7$ equals, don't guess. Use your calculator.
 $3 - 7 = -4$ so you have $-4x^2$.
Combine $2x$, $-8x$, and $3x$ to get $-3x$. Think $2 - 8 + 3 = -3$ so you have $-3x$.

TIP – Circle the terms as you combine them so you don't skip any. Start with the highest exponent, combine terms and write the result as the first term of your answer. Go to the next highest exponent, combine, and write the result as the next term of your answer. Continue until all terms have been circled.

The term with the highest exponent should be written first in the answer, then the term with the next highest exponent, etc. The number with no variable comes last.

TIP – In the expression $4x^2 - 9x + 7$, think of the minus sign as belonging to the number that follows it, so $4x^2 + (-9x) + 7$ is another way to write this expression. Both are correct. The first way is standard form. When circling terms, circle the minus sign with the number to make sure you combine it as a negative number.

TIP – You may find it useful to rewrite a problem without the addition signs. It can make it easier to see all the separate terms and to combine them correctly.

$$x^2 + 5x + 7 - 4x + 3 + 4x^3 + 6x^2 \quad \text{becomes} \quad x^2 \quad 5x \quad 7 \quad -4x \quad 3 \quad 4x^3 \quad 6x^2$$

As you rewrite the problem, you can also group like terms in columns.

$$x^2 + 5x + 7 - 4x + 3 + 4x^3 + 6x^2 \quad \text{becomes} \quad \begin{array}{cccc} x^2 & 5x & 7 & 4x^3 \\ 6x^2 & -4x & 3 & \end{array}$$

If you choose to rewrite the problem, be very careful to leave ample space between the terms, and to copy them correctly. Don't forget any exponents or minus signs.

Practice One Answers – p. 17

1. $4x + 8 + 2x =$ 6. $3x^2 + 12 + 4x^5 + 2x^2 + 4x + x^5 =$
2. $2x + 2x^2 + 19 + 6x^2 =$ 7. $12x + 2x^2 + 4 - 8x =$
3. $5x^2 + 9 + 6x + x^2 + 3 =$ 8. $x^2 + 2x - 3x^2 + 7 + x =$
4. $x^2 + 3x + 2x^2 + 4x^3 + 15 =$ 9. $-4x + 7 + 2x^2 + 6x - 10 =$
5. $6x + 10 + 15x + 14 + 2x + x^2 =$ 10. $8x^3 + 16 + 2x + 5x + 2x^2 =$
11. Which expression has the same value as $8x + 9 + 2x - 5$? (*Has the same value as means to combine like terms.*)
A. $10x + 14$ B. $19x - 5$ C. $10x + 4$
D. $17x + 7x$ E. $10x - 5$
12. What is the sum of these two polynomials? (*Sum means to add; then combine like terms.*)
$$\begin{array}{r} 4x^2 + 5x + 9 \\ + 3x^2 + 4x - 2 \\ \hline \end{array}$$

A. $7x^2 + 9x + 11$ B. $9x^2 + 7x + 11$ C. $7x^4 + 9x^2 + 7$
D. $7x^2 + 9x + 7$ E. $7x^2 + 9x - 7$

NOTE – The “answer” to a simplification problem is an algebraic expression that can’t be simplified any further. You are given an expression that is not in simplest form, and you then combine all like terms until the expression is in simplest form.

You will not have a numerical answer like you are used to getting when you do math problems. For all the problems in Lesson 4, your “answer” will be an expression, not a number.

REMEMBER – Simplified algebraic expressions are usually written with the terms in descending order of exponent. The term with the highest exponent comes first, then the term with the next highest exponent, down to the term with no exponent. The number without a variable comes last.

So, you would write $4x^3 + 5x^2 - 6x + 7$.

You would not write $5x^2 - 6x + 7 + 4x^3$.

Both expressions have the same terms and the same value. The second expression is not wrong, but it is not how it is usually written.

On the HiSET Math Test, multiple choice answers will be written like the first expression, with terms in descending order of exponent. If your answer is not written that way, it may be hard to see which of the multiple choice answers is the same as your answer.

3. ALGEBRAIC EXPRESSIONS WITH MORE THAN ONE VARIABLE

An algebraic expression can have more than one variable. Terms with one variable can't be combined with terms that have a different variable. For example, in the expression $2y^2 + 3x^2 + 6x + 5y + 7$ there are no terms that can be combined.

You can only combine terms that have the same variable exponent combination.

y^2 terms only combine with other y^2 terms.

y terms only combine with other y terms.

x^2 terms only combine with other x^2 terms.

x terms only combine with other x terms.

Examples

1. $3x + 5y + 2x^2 + 4y + 2y^2 = 2y^2 + 2x^2 + 9y + 3x$ Combine 4y and 5y to get 9y.
Nothing else can combine.

2. $6y + 5x + x^2 + 17 + y + 2x^2 - 2y = 3x^2 + 5x + 5y + 17$
Combine $x^2 + 2x^2$ to get $3x^2$.
Combine 6y, y, and $-2y$ to get 5y.
Think: $6 + 1 - 2 = 5$
Nothing else can combine.

3. $5y^2 - 6x + 2x^2 + y^2 + 8x = 2x^2 + 6y^2 + 2x$
Combine $5y^2$ and y^2 to get $6y^2$.
Combine $-6x$ and $8x$ to get $2x$.
Think: $-6 + 8 = 2$
Nothing combine with $2x^2$.

4. $4x^2 + 4y^2 + 3 - 8y - 2y^2 + 4 + 5x^2 = 9x^2 + 2y^2 - 8y + 7$
Combine $4x^2 + 5x^2$ to get $9x^2$.
Combine $4y^2$ and $-2y^2$ to get $2y^2$.
Combine 3 and 4 to get 7.
Nothing combines with $-8y$.

Practice Two

Answers – p. 17

1. $3x^2 + 6y + x^2 + 2y^2 + y =$

4. $4x + 4y + 4 + 2y^2 + 6 + 7x =$

2. $6y - 2x + x^2 + 12x - 3y =$

5. $15 + 6x + 2y^2 + x^2 + 12 + 4x =$

3. $15y + 6y^2 + 4x + 4y + 18 =$

6. $2x^2 + 7y + 14 - 3y + 2y^2 =$

7. The sum of $6x$, x , $3y$, and $5y$ is equivalent to which of the following expressions?

A. $6x + 8y$

B. $7x + 8y$

C. $7x^2 + 8y^2$

(Sum means to add all of the terms.)

D. $5x + 2y$

E. $7x + 7y$

8. Which polynomial below is equal to the sum of $3y^2$, $4x^2$, $2y$, 18 , $-5y$, and x^2 ?

A. $3y^2 + 5x^2 - 3y + 18$

B. $8x^2y^2 - 3y + 18$

C. $3y^2 + 5x^2 - 7y + 18$

D. $3y^2 + 5x^2 + 7y + 18$

E. $3y^2 + 4x^2 - 3y + 18$

4. SIMPLIFYING PARENTHESES IN ALGEBRAIC EXPRESSIONS

To simplify an algebraic expression with parentheses, first use multiplication to remove the parentheses, and then combine like terms if there are any.

Expressions with a Number Multiplied times Parentheses

A number in front of an expression that is inside parentheses means to multiply each term inside the parentheses times that number.

Note that $6(x + 4)$ and $(6)(x + 4)$ have the same meaning. It can be written either way. You will usually see it as $6(x + 4)$.

Examples

- $6(x + 4) = 6(x) + 6(4)$
 $= 6x + 24$
Multiply 6 times x and then 6 times 4.
Rewrite $6(x)$ as $6x$. Multiply $6(4)$.
- $4(x^2 + 2x + 9) = 4(x^2) + 4(2x) + 4(9)$
 $= 4x^2 + 8x + 36$
Multiply 4 times all terms inside parentheses.
Rewrite $4(x^2)$ as $4x^2$. Multiply $4(2x)$ and $4(9)$.
- $(5)(x - 5) = (5)(x) + (5)(-5)$
 $= 5x + (-25)$
 $= 5x - 25$
Multiply (5) times x and then (5) times -5 .
Rewrite $(5)(x)$ as $5x$. Multiply $(5)(-5)$.
Rewrite in standard form.

Sometimes an expression will have parentheses that need to be simplified and then combined with other terms in the expression.

Examples

- $3x^2 + 4x + 6(3x + 2) = 3x^2 + 4x + 6(3x) + 6(2)$
 $= 3x^2 + 4x + 18x + 12$
 $= 3x^2 + 22x + 12$
Rewrite single terms. Simplify parentheses.
Carry down single terms. Multiply $6(3x)$ and $6(2)$.
Combine like terms.
- $5(x - 2) + 2x + 1 = 5(x) + 5(-2) + 2x + 1$
 $= 5x + (-10) + 2x + 1$
 $= 7x + (-9)$
 $= 7x - 9$
Simplify parentheses. Rewrite single terms.
Multiply $5(-2)$. Carry down the other terms.
Combine like terms.
Rewrite in standard form.

Notice that in the above examples you are working down the right side of the equal sign, one step at a time. With each step you do only one thing, such as remove parentheses, multiply, combine like terms, or rewrite in standard form. Continue until there is nothing else you can combine or simplify.

Practice Three Answers – p. 18

1. $3(x^2 + 5x) =$
 2. $3(x^2 - 5x) =$
 3. $(6)(x^5 + 9) =$
 4. $4(2x - 3 + 2x^2) =$
 5. $5(2x + 3) + 4x^2 + 5x =$
 6. $7(x^2 + 2x + 3) - 10 - 3x =$
 7. $8(3x^3 + 2x^2 - 4) + x^3 - 2x =$
 8. $(-2)(9x^2 + 3x - 6) =$
 9. $4x^2 + 16 + 5(x^2 + 2) =$
 10. $-3x + 9x^2 + 4(x + 8) =$
11. Simplify the expression $5(x + 4) + 3x + 14$. (Simplify means to combine like terms.)
A. $8x + 18$ B. $8x + 23$ C. $8x + 34$
D. $8x + 14$ E. $8x + 20$
12. Which expression has the same value as $4(x^3 + 2x^2 - 3)$?
A. $4x^3 + 8x^2 + 12$ B. $4x^3 + 2x^2 - 3$ C. $4x^3 + 8x^2 - 3$
D. $4x^3 + 8x^2 + 3$ E. $4x^3 + 8x^2 - 12$

Expressions with a Variable Multiplied times a Variable

To simplify some expressions with parentheses, you will have to multiply a variable times a variable, for example, $(x)(x)$.

$(x)(x)$ means x times x .

$$(x)(x) = x^2$$

Any number times itself is that number squared, so just like $(3)(3) = 3^2$, $(x)(x) = x^2$.

$(4x)(7x)$ means $4x$ times $7x$.

$$(4x)(7x) = 28x^2$$

Think of this as $(4)(x)(7)(x)$.

Rearrange as $(4)(7)(x)(x)$. Multiply the numbers, then multiply the variables to get $28x^2$.

$(2x)(4x + 3)$ means $2x$ times $(4x + 3)$.

Multiply $(2x)$ times each term inside the parentheses.

$$\begin{aligned}(2x)(4x + 3) &= (2x)(4x) + (2x)(3) \\ &= 8x^2 + 6x.\end{aligned}$$

Examples

1. $(2x)(6x) = 12x^2$
2. $(-5x)(4x) = -20x^2$
3. $3x(6x + 7) = 3x(6x) + 3x(7)$
 $= 18x^2 + 21x$
4. $x(3x) = 3x^2$
5. $2x(3x) = 6x^2$
6. $5x(x - 9) = 5x(x) + 5x(-9)$
 $= 5x^2 + (-45x)$
 $= 5x^2 - 45x$

Practice Four Answers – p. 19

1. $3x(5x) =$
 2. $-6x(2x) =$
 3. $(x)(8x) =$
 4. $7x(9x) =$
 5. $2x(4x + 7) =$
 6. $(3x)(-8x + 1) =$
 7. $x(x - 6) =$
 8. $4x(7x + 7) =$
 9. $2x(7x + 5) + x^2 + 3x =$
 10. $9x^2 + 6 + 3x(2x + 4) =$
11. Which of the following is the product of $5x$ and $-4x$? (Product means to multiply.)
A. x B. $-20x^2$ C. $-20x$ D. $-9x^2$ E. $20x^2$
12. $x(2x + 5)$ is equivalent to which of the following?
A. $7x$ B. $2x^2 + 5x$ C. $2x^2 + 5$ D. $3x + 5$ E. $7x^2$

NOTE – When a question asks for the product of two terms, it means to multiply the two terms. In question 11 above, when it says “the product of $5x$ and $-4x$,” the word “and” does not mean to add. It is only used to refer to the two terms that are multiplied.

Expressions with Parentheses Times Parentheses

$(x + 4)(x + 5)$ means $(x + 4)$ times $(x + 5)$.

To simplify an algebraic expression like $(x + 4)(x + 5)$, multiply to remove the parentheses by following the steps below. Then combine like terms.

To simplify $(x + 4)(x + 5)$

Step 1: Multiply the first term of the first expression times both terms in the second expression, $(x)(x)$ then $(x)(5)$.

Step 2: Multiply the second term of the first expression times both terms in the second expression, $(4)(x)$ then $(4)(5)$.

Step 3: Combine like terms.

$$\begin{aligned}(x + 4)(x + 5) &= (x)(x) + (x)(5) + (4)(x) + (4)(5) && \text{Step 1 \& 2: Remove parentheses.} \\ &= x^2 + 5x + 4x + 20 && \text{Multiply individual terms.} \\ &= x^2 + 9x + 20 && \text{Step 3: Combine like terms.}\end{aligned}$$

NOTE – $(x)(5)$ becomes $5x$, not $x5$. In this type of term the number always comes before the variable.

Examples

1. $(3x + 2)(5x + 4) = (3x)(5x) + (3x)(4) + (2)(5x) + (2)(4)$ Multiply to remove parentheses.
 $= 15x^2 + 12x + 10x + 8$ Multiply individual terms.
 $= 15x^2 + 22x + 8$ Combine like terms.

$$\begin{aligned}
 2. \quad (x - 6)(2x + 4) &= (x)(2x) + (x)(4) + (-6)(2x) + (-6)(4) && \text{Multiply to remove} \\
 & && \text{parentheses.} \\
 &= 2x^2 + 4x + (-12x) + (-24) && \text{Multiply individual terms.} \\
 &= 2x^2 + (-8x) + (-24) && \text{Combine like terms.} \\
 &= 2x^2 - 8x - 24 && \text{Rewrite in standard format.}
 \end{aligned}$$

$$\begin{aligned}
 3. \quad (2x + 7)^2 &= (2x + 7)(2x + 7) && \text{Rewrite expression.} \\
 &= (2x)(2x) + (2x)(7) + (7)(2x) + (7)(7) && \text{Multiply to remove parentheses.} \\
 &= 4x^2 + 14x + 14x + 49 && \text{Multiply individual terms.} \\
 &= 4x^2 + 28x + 49 && \text{Combine like terms.}
 \end{aligned}$$

NOTE – In Example 3 above, the exponent is outside the parentheses, so it applies to the whole expression inside the parentheses. You multiply the entire expression times itself, as shown. $(2x + 7)^2 = (2x + 7)(2x + 7)$

You **do not** square each term inside the parentheses.

$(2x + 7)^2$ **does not equal** $(2x)^2 + 7^2 \rightarrow 4x^2 + 49$, though this is a common mistake.

Practice Five Answers – p. 20

1. $(x + 2)(x + 7) =$
2. $(x - 6)(x + 6) =$
3. $(2x + 1)(x + 9) =$
4. $(3x + 2)^2 =$
5. $(4x + 4)(2x - 5) =$
6. $(8x + 6)(2x + 4) =$
7. $(x + 5)(2x + 4) + 4x^2 + 2x =$
8. $3x + 2 + (2x + 4)(3x + 1) =$
9. Which expression is equivalent to $(x + 5)(x - 5)$?
 A. $x^2 - 25$ B. $2x - 10$ C. $x^2 + 25$ D. $2x$ E. $2x^2 - 10$
10. Which of the following is the product of $(2x + 6)$ and $(4x + 1)$? (*Product means to multiply*)
 A. $6x + 7$ B. $8x^2 + 8x + 6$ C. $8x^2 + 26x + 6$ D. $8x^2 + 7$ E. $8x + 6$
 ($(2x + 6)(4x + 1)$)
11. Which expression has the same value as $(2x + 5)^2$?
 A. $x^2 + 25$ B. $8x^2 + 8x + 6$ C. $4x^2 + 10x + 25$
 D. $4x^2 + 10$ E. $4x^2 + 20x + 25$

5. EXTRA SIMPLIFICATION PRACTICE

Do as much of the extra practice below as you need to feel comfortable simplifying expressions. You decide how much you need to do. Then, move ahead to the next section which will test your simplification skills with HiSET style problems.

Practice Six Answers – p. 21

Simplify each algebraic expression by combining like terms.

- $3x + 7 + 2x$
- $4x + 5 + 7x + 3$
- $3x^2 + 4 + 2x^2 + 8$
- $x^2 + 6x^2 + 6 + 3x - 7$
- $4x^2 + 10 - 2x^2 - 5$
- $5x^2 + 6x + x^4 + 2x^2 + 3x + 7 + 3x^4$
- $3x^2 + 3y + 2x - 5y + 5x$
- $5x^2 + 4y^2 + 7 + 2y^2 + 8$
- $x + y + 3x^2 + 4y + 2x$
- $2x^2 - 3y^2 + 4 + 4x + 4y^2$
- $6(5 + x)$
- $6(5 - x)$
- $3x(5x)$
- $(-5x)(2x)$
- $6(x^3 + 2) + x^2 - 2x^3 + 4x + 1$
- $(5)(3 - x^2 + 5x)$
- $(x + 2)(x + 6)$
- $(4x + 3)(5x - 4)$
- $(2x + 3)(4x + 2)$
- $(x + 5)(x + 5) + 3$

6. ALGEBRAIC SIMPLIFICATION: HiSET STYLE QUESTIONS

Practice Seven Answers – p. 22

- Which expression has the same value as $3x + 7 + 2x - 3$?
 - $5x + 10$
 - $5x + 4$
 - $10x + 3$
 - $5x + 21$
 - $5x - 4$

(This means to combine like terms.)
- Which expression is equivalent to $5x^2 + 7x + 4x + 2 + 2x^2$?
 - $5x^2 + 11x + 2$
 - $7x^2 + 10x + 2$
 - $5x^2 + 11x$
 - $7x^2 + 11x + 2$
 - $7x^2 + 13x + 2$

(Equivalent to means has the same value as.)

3. What is the sum of these two polynomials?

$$\begin{array}{r} 3x^2 + 6x + 8 \\ + 2x^2 + 2x - 5 \\ \hline \end{array}$$

(Sum means to add; then combine like terms.)

- a) $5x^2 + 8x + 13$
- b) $5x^2 + 8x + 3$
- c) $5x^4 + 8x^2 - 3$
- d) $5x^4 + 8x^2 + 3$
- e) $5x^4 + 8x + 3$

4. Simplify the expression $4(x + 8) + 3x + 10$.

(Simplify means to combine like terms.)

- a) $7x + 42$
- b) $7x + 80$
- c) $7x + 18$
- d) $7x - 2$
- e) $7x + 2$

5. Which expression is equivalent to $(x + 3)(x - 3)$?

- a) $x^2 + 9$
- b) $2x - 9$
- c) $x^2 - 9$
- d) $2x + 6$
- e) $2x^2 - 6$

6. Which expression has the same value as the sum of these two polynomials?

$$\begin{array}{r} 12x^2 + 4x + 9 \\ + 2x^2 + 3x + 5 \\ \hline \end{array}$$

- a) $14x^2 + 7x + 4$
- b) $14x^2 - x - 4$
- c) $14x^2 + 7x + 14$
- d) $14x^4 + x^2 + 14$
- e) $14x^4 + 7x - 4$

7. The sum of $4x$, x , $2y$, and $6y$ is equivalent to which of the following expressions?

- a) $4x^2 + 8y$
- b) $5x^2 + 8y$
- c) $4x + 8y$
- d) $5x + 8y$
- e) $7x + 6y$

(Sum means to add all of the terms.)

8. Which of the following is the product of $(x + 6)$ and $(x + 1)$?
- a) $2x + 7$
b) $x^2 + 7x + 6$
c) $2x + 6$
d) $x^2 + 6$
e) $x^2 + 6x + 6$
- (Product means to multiply)
 $(x + 6)(x + 1)$
9. Simplify the expression $8x^2 - 9x + 4x$.
- a) $8x^2 + 5x$
b) $8x^2 - 5x$
c) $8x^2 + 13x$
d) $8x^2 - 13x$
e) $-21x^2$
10. Which expression is the sum of $(4x^2 + 5x + 6)$ and $(6x^2 - 7x + 4)$?
- a) $10x^2 + 12x + 10$
b) $10x^2 + 2x + 10$
c) $10x^2 - 2x + 10$
d) $10x^4 - 12x^2 + 10$
e) $10x^4 + 2x^2 + 10$
11. Which expression below is equal to $(2x + 8)(3x + 4)$?
- a) $6x^2 + 32$
b) $5x^2 + 12$
c) $6x^2 + 24x + 32$
d) $6x + 32$
e) $6x^2 + 32x + 32$
12. Which polynomial below is equal to the sum of $4y^2$, $6y$, 18 , $-8y$, and $2y^2$?
- a) $6y^2 + 2y + 18$
b) $6y^2 - 14y + 18$
c) $10y^2 - 10y + 18$
d) $6y^2 - 2y + 18$
e) $8y^2 - 2y + 18$
13. Which expression has the same value as $3(x + 4) + 6x$?
- a) $9x + 12$
b) $9x + 4$
c) $3x + 10$
d) $18x + 12$
e) $3x + 12$

14. What is the sum of $4x^2$, $4y^2$, 13 , $6x^2$, and $-7y^2$?
- $10x^2 - 11y^2 + 13$
 - $10x^2 + 11y^2 + 13$
 - $10x^2 - 3y^2 + 13$
 - $10x^2 + 3y^2 + 13$
 - $7x^2y^2 + 13$
15. Which of the following is the product of $3x$ and $-2x$?
- x
 - $6x^2$
 - $-6x$
 - $-6x^2$
 - $-5x$

7. ADVANCED SIMPLIFICATION: MULTIPLYING VARIABLES WITH EXPONENTS

Multiplying Variables with Exponents

Two terms with the same variable can be multiplied by adding the exponents.

For example, $(x^2)(x^4) = x^{2+4} = x^6$.

Why does it work like that? Why don't you multiply the exponents?

x^2 means multiply x times itself two times, or $(x)(x)$.

x^4 means multiply x times itself four times, or $(x)(x)(x)(x)$.

So, $(x^2)(x^4) = (x)(x)(x)(x)(x)(x)$. x is multiplied times itself six times, which means x^6 .

Examples

- $(x^2)(x^3) = x^{2+3} = x^5$
- $(x^2)(x^5) = x^{2+5} = x^7$
- $(x)(x^4) = x^{1+4} = x^5$ **NOTE:** x is the same as x^1 .

Practice Eight

Answers – p. 23

- | | | |
|-------------------|-----------------|-----------------|
| 1. $(x)(x^3) =$ | 4. $x(x^2) =$ | 7. $x^5(x^2) =$ |
| 2. $x^3(x^3) =$ | 5. $(x)(x^4) =$ | 8. $(x^5)(x) =$ |
| 3. $(x^2)(x^7) =$ | 6. $x^2(x^3) =$ | 9. $x^2(x^2) =$ |

Multiplying Numbers times Variables with Exponents

If the variables with exponents are also multiplied by numbers, add the exponents of the variable, and multiply the numbers.

For example, $(3x^2)(4x^3) = 12x^5$.

Why does it work like that?

$(3x^2)(4x^3)$ is the same as $(3)(x^2)(4)(x^3)$.

Rearrange as $(3)(4)(x^2)(x^3)$, which equals $12x^{2+3} = 12x^5$.

Examples

1. $(4x)(5x^2) = (4)(5)(x^{1+2})$
 $= 20x^3$

4. $(-2x^2)(10x^4) = (-2)(10)(x^{2+4})$
 $= -20x^6$

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

5. $-7x^3(-5x^2) = -7(-5)(x^{3+2})$
 $= 35x^5$

3. $6x^3(8x) = 6(8)(x^{3+1})$
 $= 48x^4$

6. $9x(2x^2) = 9(2)(x^{1+2})$
 $= 18x^3$

Practice Nine *Answers – p. 24*

1. $(6x)(2x^2) =$

6. $-4x(8x^2) =$

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

7. $(6x^2)(x) =$

3. $4x(x^2) =$

8. $-2x^3(-3x^5) =$

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

9. $x^2(x^3) =$

5. $7x(9x^3) =$

10. $(9x^5)(3x^2) =$

Multiplying Variables with Exponents inside Parentheses

When simplifying problems with parentheses, multiply to get your terms, then combine like terms if there are any.

Examples

1. $4x^3(2x^2 + 5x) = (4x^3)(2x^2) + (4x^3)(5x)$
 $= 8x^5 + 20x^4$

No like terms to combine.

2. $(2x + 6)(3x^2 + 3x) = (2x)(3x^2) + (2x)(3x) + (6)(3x^2) + (6)(3x)$
 $= 6x^3 + 6x^2 + 18x^2 + 18x$
 $= 6x^3 + 24x^2 + 18x$

Combine the two x^2 terms.

3. $(5x^2 + 4)(6x + 7) = (5x^2)(6x) + (5x^2)(7) + (4)(6x) + (4)(7)$
 $= 30x^3 + 35x^2 + 24x + 28$

No like terms to combine.

4. $(2x^2 + 5)(6x^3 + 4x) = (2x^2)(6x^3) + (2x^2)(4x) + (5)(6x^3) + (5)(4x)$ Combine the two
 $= 12x^5 + 8x^3 + 30x^3 + 20x$ x^3 terms.
 $= 12x^5 + 38x^3 + 20x$
5. $(5x^2 + 6)(2x^2 - 2) = (5x^2)(2x^2) + (5x^2)(-2) + (6)(2x^2) + (6)(-2)$ Combine the
 $= 10x^4 + (-10x^2) + 12x^2 + (-12)$ two x^2 terms.
 $= 10x^4 + 2x^2 + (-12)$
 $= 10x^4 + 2x^2 - 12$

Practice Ten Answers – p. 24

1. $(4x)(2x^2 + 7x) =$ 5. $(7x + 4)(3x^3 + 5) =$
2. $(2x^3 + 5)(4x^2 + 7) =$ 6. $2x^2(x + 4) =$
3. $(4x^4 + 6)(3x^2 - 2x) =$ 7. $(8x + 4)(2x^2 + x) =$
4. $(6x^2 - 2)(2x^2 + 3) =$ 8. $(9x + 3)(x^2 - 2) =$

8. ADVANCED SIMPLIFICATION: HiSET STYLE QUESTIONS

Practice Eleven Answers – p. 25

1. Which expression below is equivalent to $(4x + 5)(2x^2 + 3x)$?
A. $8x^3 + 15x$ B. $8x^3 + 22x^2 + 15x$ C. $8x^3 + 12x^2 + 10x$
D. $8x^2 + 15x$ E. $7x + 10x^2$
2. What is the product of $(3x^2 + 7)$ and $(4x^4 + 3x)$?
A. $12x^8 + 28x^4 + 9x^2 + 21x$ B. $12x^6 + 9x^3 + 21x$
C. $12x^6 + 28x^4 + 9x^3 + 21x$ D. $12x^6 + 21x$ E. $12x^8 + 21x$
3. Which of the following has the same value as $(4x^3)(-3x^3)$?
A. $-7x^3$ B. $-12x^9$ C. $12x^6$ D. x^3 E. $-12x^6$
4. Which of the following polynomials is equivalent to $(6x + 4)(3x^2 + 2)$?
A. $18x^3 + 12x^2 + 12x + 8$ B. $18x^3 + 12x^2 + 24x + 8$ C. $18x^2 + 8$
D. $9x^2 + 8$ E. $18x^3 + 8$

5. What is the product of $5x^2$ and $(3x - 4)$?
A. $15x^3 - 4$ B. $15x^2 - 4$ C. $8x^2 - 4$
D. $15x^3 - 20x^2$ E. $5x^2 + 3x - 4$
6. The product of $6x^2$ and $3x^4$ is equal to which of the following?
A. $18x^6$ B. $18x^8$ C. $9x^6$ D. $9x^8$ E. $9x^4$
7. Which polynomial has the same value as $8x^2 + (2x + 5)(3x^2 + 3x)$?
A. $11x^2 + 5x + 5$ B. $11x^2 + 6x + 5$ C. $6x^3 + 29x^2 + 15x$
D. $6x^3 + 14x^2 + 20x$ E. $32x^2 + 6x + 5$
8. Which polynomial is equivalent to $(4x^3 + 6x)(3x^2 - 5)$?
A. $12x^5 - 38x^3 - 30$ B. $12x^5 - 2x^3 - 30x$ C. $12x^6 - 2x^3 - 30x$
D. $12x^5 - 2x^3 + 30$ E. $12x^5 - 38x^3 + 30$

ANSWER KEY Lesson 4 Simplification of Algebraic Expressions

Practice One

- $4x + 8 + 2x = \mathbf{6x + 8}$
- $2x + 2x^2 + 19 + 6x^2 = \mathbf{8x^2 + 2x + 19}$
- $5x^2 + 9 + 6x + x^2 + 3 = \mathbf{6x^2 + 6x + 12}$
- $x^2 + 3x + 2x^2 + 4x^3 + 15 = \mathbf{4x^3 + 3x^2 + 3x + 15}$
- $6x + 10 + 15x + 14 + 2x + x^2 = \mathbf{x^2 + 23x + 24}$
- $3x^2 + 12 + 4x^5 + 2x^2 + 4x + x^5 = \mathbf{5x^5 + 5x^2 + 4x + 12}$
- $12x + 2x^2 + 4 - 8x = \mathbf{2x^2 + 4x + 4}$
- $x^2 + 2x - 3x^2 + 7 + x = \mathbf{-2x^2 + 3x + 7}$
- $-4x + 7 + 2x^2 + 6x - 10 = \mathbf{2x^2 + 2x - 3}$ $2x^2 + 2x + (-3)$ is also correct, but is not standard form.
- $8x^3 + 16 + 2x + 5x + 2x^2 = \mathbf{8x^3 + 2x^2 + 7x + 16}$
- Which expression has the same value as $8x + 9 + 2x - 5$? **C. $10x + 4$**
Combine $8x + 2x = 10x$.
Combine $9 + (-5) = 4$.
- What is the sum of these two polynomials? **D. $7x^2 + 9x + 7$**
$$\begin{array}{r} 4x^2 + 5x + 9 \\ + 3x^2 + 4x - 2 \\ \hline 7x^2 + 9x + 7 \end{array}$$

Combine $4x^2 + 3x^2 = 7x^2$.
Combine $5x + 4x = 9x$.
Combine $9 + (-2) = 7$.

Practice Two

- $3x^2 + 6y + x^2 + 2y^2 + y = \mathbf{4x^2 + 2y^2 + 7y}$
- $6y - 2x + x^2 + 12x - 3y = \mathbf{x^2 + 10x + 3y}$
- $15y + 6y^2 + 4x + 4y + 18 = \mathbf{6y^2 + 19y + 4x + 18}$
- $4x + 4y + 4 + 2y^2 + 6 + 7x = \mathbf{2y^2 + 4y + 11x + 10}$
- $15 + 6x + 2y^2 + x^2 + 12 + 4x = \mathbf{2y^2 + x^2 + 10x + 27}$
- $2x^2 + 7y + 14 - 3y + 2y^2 = \mathbf{2y^2 + 2x^2 + 4y + 14}$

7. The sum of $6x$, x , $3y$, and $5y$ is equivalent to which of the following expressions?

Combine $6x + x = 7x$.

B. $7x + 8y$

Combine $3y + 5y = 8y$.

8. Which polynomial below is equal to the sum of $3y^2$, $4x^2$, $2y$, 18 , $-5y$, and x^2 ?

Combine $4x^2 + x^2 = 5x^2$.

A. $3y^2 + 5x^2 - 3y + 18$

Combine $2y + (-5y) = -3y$.

$3y^2$ and 18 don't combine.

Practice Three

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

2. $3(x^2 - 5x) = 3(x^2) + 3(-5x)$
 $= 3x^2 + (-15x)$
 $= \mathbf{3x^2 - 15x}$ $3x^2 + (-15x)$ is also correct, but is not standard form.

3. $(6)(x^5 + 9) = (6)(x^5) + (6)(9)$
 $= \mathbf{6x^5 + 54}$

4. $4(2x - 3 + 2x^2) = 4(2x) + 4(-3) + 4(2x^2)$
 $= 8x + (-12) + 8x^2$
 $= \mathbf{8x^2 + 8x - 12}$

5. $5(2x + 3) + 4x^2 + 5x = 5(2x) + 5(3) + 4x^2 + 5x$
 $= 10x + 15 + 4x^2 + 5x$
 $= \mathbf{4x^2 + 15x + 15}$

6. $7(x^2 + 2x + 3) - 10 - 3x = 7(x^2) + 7(2x) + 7(3) - 10 - 3x$
 $= 7x^2 + 14x + 21 - 10 - 3x$
 $= \mathbf{7x^2 + 11x + 11}$

7. $8(3x^3 + 2x^2 - 4) + x^3 - 2x = 8(3x^3) + 8(2x^2) + 8(-4) + x^3 - 2x$
 $= 24x^3 + 16x^2 + (-32) + x^3 - 2x$
 $= \mathbf{25x^3 + 16x^2 - 2x - 32}$

8. $(-2)(9x^2 + 3x - 6) = (-2)(9x^2) + (-2)(3x) + (-2)(-6)$
 $= -18x^2 + (-6x) + 12$
 $= \mathbf{-18x^2 - 6x + 12}$

9. $4x^2 + 16 + 5(x^2 + 2) = 4x^2 + 16 + 5(x^2) + 5(2)$
 $= 4x^2 + 16 + 5x^2 + 10$
 $= \mathbf{9x^2 + 26}$

$$\begin{aligned}
 10. \quad -3x + 9x^2 + 4(x + 8) &= -3x + 9x^2 + 4(x) + 4(8) \\
 &= -3x + 9x^2 + 4x + 32 \\
 &= \mathbf{9x^2 + x + 32}
 \end{aligned}$$

11. Simplify the expression $5(x + 4) + 3x + 14$. **C. $8x + 34$**

$$\begin{aligned}
 5(x + 4) + 3x + 14 &= 5(x) + 5(4) + 3x + 14 \\
 &= 5x + 20 + 3x + 14 \\
 &= \mathbf{8x + 34}
 \end{aligned}$$

12. Which expression has the same value as $4(x^3 + 2x^2 - 3)$? **E. $4x^3 + 8x^2 - 12$**

$$\begin{aligned}
 4(x^3 + 2x^2 - 3) &= 4(x^3) + 4(2x^2) + 4(-3) \\
 &= 4x^3 + 8x^2 + (-12) \\
 &= \mathbf{4x^3 + 8x^2 - 12}
 \end{aligned}$$

Practice Four

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

2. $-6x(2x) = \mathbf{-12x^2}$

3. $(x)(8x) = \mathbf{8x^2}$

4. $7x(9x) = \mathbf{63x^2}$

5. $2x(4x + 7) = 2x(4x) + 2x(7)$
 $\quad\quad\quad = \mathbf{8x^2 + 14x}$

6. $(3x)(-8x + 1) = (3x)(-8x) + (3x)(1)$
 $\quad\quad\quad = \mathbf{-24x^2 + 3x}$

7. $x(x - 6) = x(x) + x(-6)$
 $\quad\quad\quad = x^2 + (-6x)$
 $\quad\quad\quad = \mathbf{x^2 - 6x}$

8. $4x(7x + 7) = 4x(7x) + 4x(7)$
 $\quad\quad\quad = \mathbf{28x^2 + 28x}$

9. $2x(7x + 5) + x^2 + 3x = 2x(7x) + 2x(5) + x^2 + 3x$
 $\quad\quad\quad = 14x^2 + 10x + x^2 + 3x$
 $\quad\quad\quad = \mathbf{15x^2 + 13x}$

10. $9x^2 + 6 + 3x(2x + 4) = 9x^2 + 6 + 3x(2x) + 3x(4)$
 $\quad\quad\quad = 9x^2 + 6 + 6x^2 + 12x$
 $\quad\quad\quad = \mathbf{15x^2 + 12x + 6}$

11. Which of the following is the product of $5x$ and $-4x$? **B. $-20x^2$**

$$(5x)(-4x) = -20x^2$$

12. $x(2x + 5)$ is equivalent to which of the following? **B. $2x^2 + 5x$**
- $$\begin{aligned} x(2x + 5) &= x(2x) + x(5) \\ &= 2x^2 + 5x \end{aligned}$$

Practice Five

1. $(x + 2)(x + 7) = (x)(x) + (x)(7) + (2)(x) + (2)(7)$
 $= x^2 + 7x + 2x + 14$
 $= \mathbf{x^2 + 9x + 14}$

2. $(x - 6)(x + 6) = (x)(x) + (x)(6) + (-6)(x) + (-6)(6)$
 $= x^2 + 6x + (-6x) + (-36)$
 $= \mathbf{x^2 - 36}$

*Note: $6x + (-6x) = 0x$
 $0x$ is the same as 0
so it does not get written.*

3. $(2x + 1)(x + 9) = (2x)(x) + (2x)(9) + (1)(x) + (1)(9)$
 $= 2x^2 + 18x + x + 9$
 $= \mathbf{2x^2 + 19x + 9}$

4. $(3x + 2)^2 = (3x + 2)(3x + 2)$
 $= (3x)(3x) + (3x)(2) + (2)(3x) + (2)(2)$
 $= 9x^2 + 6x + 6x + 4$
 $= \mathbf{9x^2 + 12x + 4}$

5. $(4x + 4)(2x - 5) = (4x)(2x) + (4x)(-5) + (4)(2x) + (4)(-5)$
 $= 8x^2 + (-20x) + 8x + (-20)$
 $= 8x^2 + (-12x) + (-20)$
 $= \mathbf{8x^2 - 12x - 20}$

6. $(8x + 6)(2x + 4) = (8x)(2x) + (8x)(4) + (6)(2x) + (6)(4)$
 $= 16x^2 + 32x + 12x + 24$
 $= \mathbf{16x^2 + 44x + 24}$

7. $(x + 5)(2x + 4) + 4x^2 + 2x = (x)(2x) + (x)(4) + (5)(2x) + (5)(4) + 4x^2 + 2x$
 $= 2x^2 + 4x + 10x + 20 + 4x^2 + 2x$
 $= \mathbf{6x^2 + 16x + 20}$

8. $3x + 2 + (2x + 4)(3x + 1) = 3x + 2 + (2x)(3x) + (2x)(1) + (4)(3x) + (4)(1)$
 $= 3x + 2 + 6x^2 + 2x + 12x + 4$
 $= \mathbf{6x^2 + 17x + 6}$

9. Which expression is equivalent to $(x + 5)(x - 5)$? **A. $x^2 - 25$**

$$\begin{aligned} (x + 5)(x - 5) &= (x)(x) + (x)(-5) + (5)(x) + (5)(-5) \\ &= x^2 + (-5x) + 5x + (-25) \\ &= x^2 + (-25) \\ &= \mathbf{x^2 - 25} \end{aligned}$$

*Note: $-5x + (5x) = 0x$
 $0x$ is the same as 0
so it does not get written.*

10. Which of the following is the product of $(2x + 6)$ and $(4x + 1)$? **C. $8x^2 + 26x + 6$**

$$\begin{aligned}(2x + 6)(4x + 1) &= (2x)(4x) + (2x)(1) + (6)(4x) + (6)(1) \\ &= 8x^2 + 2x + 24x + 6 \\ &= \mathbf{8x^2 + 26x + 6}\end{aligned}$$

11. Which expression has the same value as $(2x + 5)^2$? **E. $4x^2 + 20x + 25$**

$$\begin{aligned}(2x + 5)^2 &= (2x + 5)(2x + 5) \\ &= (2x)(2x) + (2x)(5) + (5)(2x) + (5)(5) \\ &= 4x^2 + 10x + 10x + 25 \\ &= \mathbf{4x^2 + 20x + 25}\end{aligned}$$

Practice Six

1. $3x + 7 + 2x = \mathbf{5x + 7}$
2. $4x + 5 + 7x + 3 = \mathbf{11x + 8}$
3. $3x^2 + 4 + 2x^2 + 8 = \mathbf{5x^2 + 12}$
4. $x^2 + 6x^2 + 6 + 3x - 7 = \mathbf{7x^2 + 3x - 1}$
5. $4x^2 + 10 - 2x^2 - 5 = \mathbf{2x^2 + 5}$
6. $5x^2 + 6x + x^4 + 2x^2 + 3x + 7 + 3x^4 = \mathbf{4x^4 + 7x^2 + 9x + 7}$
7. $3x^2 + 3y + 2x - 5y + 5x = 3x^2 + (-2y) + 7x$
 $\quad\quad\quad = \mathbf{3x^2 - 2y + 7x}$
8. $5x^2 + 4y^2 + 7 + 2y^2 + 8 = \mathbf{5x^2 + 6y^2 + 15}$
9. $x + y + 3x^2 + 4y + 2x = \mathbf{3x^2 + 3x + 5y}$
10. $2x^2 - 3y^2 + 4 + 4x + 4y^2 = \mathbf{2x^2 + y^2 + 4x + 4}$
11. $6(5 + x) = 6(5) + 6(x)$
 $\quad\quad\quad = 30 + 6x$
 $\quad\quad\quad = \mathbf{6x + 30}$
12. $6(5 - x) = 6(5) + 6(-x)$
 $\quad\quad\quad = 30 + (-6x)$
 $\quad\quad\quad = \mathbf{-6x + 30}$
13. $3x(5x) = \mathbf{15x^2}$
14. $(-5x)(2x) = \mathbf{-10x^2}$
15. $6(x^3 + 2) + x^2 - 2x^3 + 4x + 1 = 6(x^3) + 6(2) + x^2 - 2x^3 + 4x + 1$
 $\quad\quad\quad = 6x^3 + 12 + x^2 - 2x^3 + 4x + 1$
 $\quad\quad\quad = \mathbf{4x^3 + x^2 + 4x + 13}$

16. $(5)(3 - x^2 + 5x) = (5)(3) + (5)(-x^2) + (5)(5x)$
 $= 15 + (-5x^2) + 25x$
 $= -5x^2 + 25x + 15$
17. $(x + 2)(x + 6) = (x)(x) + (x)(6) + (2)(x) + (2)(6)$
 $= x^2 + 6x + 2x + 12$
 $= x^2 + 8x + 12$
18. $(4x + 3)(5x - 4) = (4x)(5x) + (4x)(-4) + (3)(5x) + (3)(-4)$
 $= 20x^2 + (-16x) + 15x + (-12)$
 $= 20x^2 + (-x) + (-12)$
 $= 20x^2 - x - 12$
19. $(2x + 3)(4x + 2) = (2x)(4x) + (2x)(2) + (3)(4x) + (3)(2)$
 $= 8x^2 + 4x + 12x + 6$
 $= 8x^2 + 16x + 6$
20. $(x + 5)(x + 5) + 3 = (x)(x) + (x)(5) + (5)(x) + (5)(5) + 3$
 $= x^2 + 5x + 5x + 25 + 3$
 $= x^2 + 10x + 28$

Practice Seven

1. Which expression has the same value as $3x + 7 + 2x - 3$? **b) $5x + 4$**
 Combine like terms to get $5x + 4$.
2. Which expression is equivalent to $5x^2 + 7x + 4x + 2 + 2x^2$? **d) $7x^2 + 11x + 2$**
 Combine like terms to get $7x^2 + 11x + 2$.
3. What is the sum of these two polynomials? **b) $5x^2 + 8x + 3$**

$$\begin{array}{r} 3x^2 + 6x + 8 \\ + 2x^2 + 2x - 5 \\ \hline \end{array}$$
 Combine like terms to get $5x^2 + 8x + 3$.
4. Simplify the expression $4(x + 8) + 3x + 10$. **a) $7x + 42$**
 $4(x + 8) + 3x + 10 = (4)(x) + (4)(8) + 3x + 10$
 $= 4x + 32 + 3x + 10$
 $= 7x + 42$
5. Which expression is equivalent to $(x + 3)(x - 3)$? **c) $x^2 - 9$**
 $(x + 3)(x - 3) = (x)(x) + (x)(-3) + (3)(x) + (3)(-3)$
 $= x^2 + (-3x) + 3x + (-9)$
 $= x^2 - 9$
6. Which expression has the same value as the sum of these two polynomials? **c) $14x^2 + 7x + 14$**

$$\begin{array}{r} 12x^2 + 4x + 9 \\ + 2x^2 + 3x + 5 \\ \hline \end{array}$$
 Combine like terms to get $14x^2 + 7x + 14$.

7. The sum of $4x$, x , $2y$, and $6y$ is equivalent to which of the following expressions?
 Add terms to get $4x + x + 2y + 6y$. **d) $5x + 8y$**
 Combine like terms to get $5x + 8y$.
8. Which of the following is the product of $(x + 6)$ and $(x + 1)$? **b) $x^2 + 7x + 6$**
 $(x + 6)(x + 1) = (x)(x) + (x)(1) + (6)(x) + (6)(1)$
 $= x^2 + x + 6x + 6$
 $= x^2 + 7x + 6$
9. Simplify the expression $8x^2 - 9x + 4x$. **b) $8x^2 - 5x$**
 Combine like terms to get $8x^2 - 5x$.
10. Which expression is the sum of $(4x^2 + 5x + 6)$ and $(6x^2 - 7x + 4)$?
 Add terms to get $4x^2 + 5x + 6 + 6x^2 + (-7x) + 4$. **c) $10x^2 - 2x + 10$**
 Combine like terms to get $10x^2 - 2x + 10$.
11. Which expression below is equal to $(2x + 8)(3x + 4)$? **e) $6x^2 + 32x + 32$**
 $(2x + 8)(3x + 4) = (2x)(3x) + (2x)(4) + (8)(3x) + (8)(4)$
 $= 6x^2 + 8x + 24x + 32$
 $= 6x^2 + 32x + 32$
12. Which polynomial below is equal to the sum of $4y^2$, $6y$, 18 , $-8y$, and $2y^2$?
 Add terms to get $4y^2 + 6y + 18 + (-8y) + 2y^2$. **d) $6y^2 - 2y + 18$**
 Combine like terms to get $6y^2 - 2y + 18$.
13. Which expression has the same value as $3(x + 4) + 6x$? **a) $9x + 12$**
 $3(x + 4) + 6x = (3)(x) + (3)(4) + 6x$
 $= 3x + 12 + 6x$
 $= 9x + 12$
14. What is the sum of $4x^2$, $4y^2$, 13 , $6x^2$, and $-7y^2$? **c) $10x^2 - 3y^2 + 13$**
 Add the terms to get $4x^2 + 4y^2 + 13 + 6x^2 + (-7y^2)$.
 Combine like terms to get $10x^2 - 3y^2 + 13$.
15. Which of the following is the product of $3x$ and $-2x$? **d) $-6x^2$**
 Multiply $(3x)(-2x)$ to get $-6x^2$.

Practice Eight

- | | | |
|---------------------------------|-------------------------------|-------------------------------|
| 1. $(x)(x^3) = x^{1+3} = x^4$ | 4. $x(x^2) = x^{1+2} = x^3$ | 7. $x^5(x^2) = x^{5+2} = x^7$ |
| 2. $x^3(x^3) = x^{3+3} = x^6$ | 5. $(x)(x^4) = x^{1+4} = x^5$ | 8. $(x^5)(x) = x^{5+1} = x^6$ |
| 3. $(x^2)(x^7) = x^{2+7} = x^9$ | 6. $x^2(x^3) = x^{2+3} = x^5$ | 9. $x^2(x^2) = x^{2+2} = x^4$ |

Practice Nine

- $(6x)(2x^2) = (6)(2)(x^{1+2}) = \mathbf{12x^3}$
- $5x^5(2x^2) = 5(2)(x^{5+2}) = \mathbf{10x^7}$
- $4x(x^2) = 4(x^{1+2}) = \mathbf{4x^3}$
- $(3x^4)(6x^2) = (3)(6)(x^{4+2}) = \mathbf{18x^6}$
- $7x(9x^3) = 7(9)(x^{1+3}) = \mathbf{63x^4}$
- $-4x(8x^2) = -4(8)(x^{1+2}) = \mathbf{-32x^3}$
- $(6x^2)(x) = (6)(x^{2+1}) = \mathbf{6x^3}$
- $-2x^3(-3x^5) = -2(-3)(x^{3+5}) = \mathbf{6x^8}$
- $x^2(x^3) = (x^{2+3}) = \mathbf{x^5}$
- $(9x^5)(3x^2) = (9)(3)(x^{5+2}) = \mathbf{27x^7}$

Practice Ten

- $(4x)(2x^2 + 7x) = (4x)(2x^2) + (4x)(7x)$
 $= \mathbf{8x^3 + 28x^2}$
- $(2x^3 + 5)(4x^2 + 7) = (2x^3)(4x^2) + (2x^3)(7) + (5)(4x^2) + (5)(7)$
 $= \mathbf{8x^5 + 14x^3 + 20x^2 + 35}$
- $(4x^4 + 6)(3x^2 - 2x) = (4x^4)(3x^2) + (4x^4)(-2x) + (6)(3x^2) + (6)(-2x)$
 $= 12x^6 + (-8x^5) + 18x^2 + (-12x)$
 $= \mathbf{12x^6 - 8x^5 + 18x^2 - 12x}$
- $(6x^2 - 2)(2x^2 + 3) = (6x^2)(2x^2) + (6x^2)(3) + (-2)(2x^2) + (-2)(3)$
 $= 12x^4 + 18x^2 + (-4x^2) + (-6)$
 $= 12x^4 + 14x^2 + (-6)$
 $= \mathbf{12x^4 + 14x^2 - 6}$
- $(7x + 4)(3x^3 + 5) = (7x)(3x^3) + (7x)(5) + (4)(3x^3) + (4)(5)$
 $= 21x^4 + 35x + 12x^3 + 20$
 $= \mathbf{21x^4 + 12x^3 + 35x + 20}$
- $2x^2(x + 4) = (2x^2)(x) + (2x^2)(4)$
 $= \mathbf{2x^3 + 8x^2}$
- $(8x + 4)(2x^2 + x) = (8x)(2x^2) + (8x)(x) + (4)(2x^2) + (4)(x)$
 $= 16x^3 + 8x^2 + 8x^2 + 4x$
 $= \mathbf{16x^3 + 16x^2 + 4x}$
- $(9x + 3)(x^2 - 2) = (9x)(x^2) + (9x)(-2) + (3)(x^2) + (3)(-2)$
 $= 9x^3 + (-18x) + 3x^2 + (-6)$
 $= \mathbf{9x^3 + 3x^2 - 18x - 6}$

Practice Eleven

1. Which expression below is equivalent to $(4x + 5)(2x^2 + 3x)$?

B. $8x^3 + 22x^2 + 15x$

$$\begin{aligned}(4x + 5)(2x^2 + 3x) &= (4x)(2x^2) + (4x)(3x) + (5)(2x^2) + (5)(3x) \\ &= 8x^3 + 12x^2 + 10x^2 + 15x \\ &= 8x^3 + 22x^2 + 15x\end{aligned}$$

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

C. $12x^6 + 28x^4 + 9x^3 + 21x$

$$\begin{aligned}(3x^2 + 7)(4x^4 + 3x) &= (3x^2)(4x^4) + (3x^2)(3x) + (7)(4x^4) + (7)(3x) \\ &= 12x^6 + 9x^3 + 28x^4 + 21x \\ &= 12x^6 + 28x^4 + 9x^3 + 21x\end{aligned}$$

3. Which of the following has the same value as $(4x^3)(-3x^3)$?

E. $-12x^6$

$$\begin{aligned}(4x^3)(-3x^3) &= (4)(-3)(x^3)(x^3) \\ &= (-12)(x^{3+3}) \\ &= -12x^6\end{aligned}$$

4. Which of the following polynomials is equivalent to $(6x + 4)(3x^2 + 2)$?

A. $18x^3 + 12x^2 + 12x + 8$

$$\begin{aligned}(6x + 4)(3x^2 + 2) &= (6x)(3x^2) + (6x)(2) + (4)(3x^2) + (4)(2) \\ &= 18x^3 + 12x + 12x^2 + 8 \\ &= 18x^3 + 12x^2 + 12x + 8\end{aligned}$$

5. What is the product of $5x^2$ and $(3x - 4)$?

D. $15x^3 - 20x^2$

$$\begin{aligned}5x^2(3x - 4) &= (5x^2)(3x) + (5x^2)(-4) \\ &= 15x^3 + (-20x^2) \\ &= 15x^3 - 20x^2\end{aligned}$$

6. The product of $6x^2$ and $3x^4$ is equal to which of the following?

A. $18x^6$

$$\begin{aligned}(6x^2)(3x^4) &= (6)(3)(x^2)(x^4) \\ &= 18(x^{2+4}) \\ &= 18x^6\end{aligned}$$

7. Which polynomial has the same value as $8x^2 + (2x + 5)(3x^2 + 3x)$?

C. $6x^3 + 29x^2 + 15x$

$$\begin{aligned}8x^2 + (2x + 5)(3x^2 + 3x) &= 8x^2 + (2x)(3x^2) + (2x)(3x) + (5)(3x^2) + (5)(3x) \\ &= 8x^2 + 6x^3 + 6x^2 + 15x^2 + 15x \\ &= 6x^3 + 29x^2 + 15x\end{aligned}$$

8. Which polynomial is equivalent to $(4x^3 + 6x)(3x^2 - 5)$?

B. $12x^5 - 2x^3 - 30x$

$$\begin{aligned}(4x^3 + 6x)(3x^2 - 5) &= (4x^3)(3x^2) + (4x^3)(-5) + (6x)(3x^2) + (6x)(-5) \\ &= 12x^5 + (-20x^3) + 18x^3 + (-30x) \\ &= 12x^5 - 2x^3 - 30x\end{aligned}$$