

Simplify the following expression:

$$9z^2 + 19z^2 + 13z + 11z + 18 - 2 + 3$$

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Simplifying Algebraic Expressions

To simplify algebraic expressions, you must combine all like terms.

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Since adding or subtracting unlike terms is like mixing apples and oranges - only like terms can be added or subtracted.



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In algebraic expressions, like terms are terms that have the same variable raised to the same power. Only the coefficients of like terms are different.

Examples:
 $2x$ and $3x$
 $7x$ and $10x$
 $4y^2$ and $2y^2$
 $4ab$ and $6ab$

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Look at these terms. Let's find all the terms that can be combined.

3	9v	2x
6x	4xy	22
2xy	8	16v

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3	9v	2x
6x	4xy	22
2xy	8	16v

THE LIKE TERMS ARE:
 $3 + 8 = 11$
 $9v + 16v = 25v$
 $2x + 6x = 8x$
 $2xy + 4xy = 6xy$

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Usually when we combine like terms we put the terms in alphabetical order. When powers are used, such as $x^2 + 3x + 5$, usually the highest powers of the variable are placed first and the number term given last. This is called **descending powers** of the variable.

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Properties

Commutative Property of Addition and Multiplication
Addition: The property that states that two or more numbers can be added to any **order** without changing the sum.
 $8 + 7 = 7 + 8$
 $a + b = b + a$
Multiplication: The property that states that two or more numbers can be multiplied in any **order** without changing the sum.
 $6 \times 9 = 9 \times 6$
 $a \times b = b \times a$

Associative Property of Addition and Multiplication
Addition: The property that states that for all real numbers a , b , and c , the sum is always the same regardless of their **grouping**.
 $a + b + c = (a + b) + c = a + (b + c)$
Multiplication: The property that states that for all real numbers a , b , and c , the product is always the same regardless of their **grouping**.
 $a \times b \times c = (a \times b) \times c = a \times (b \times c)$

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Identity Property of One: The property that states that the product to 1 and any number is that number.
 $5 \times 1 = 5$
 $a \times 1 = a$

Identity Property of Zero: The property that states the sum of zero and any number is that number.
 $5 + 0 = 5$
 $a + 0 = a$

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To combine like terms in an algebraic expression use the properties of real numbers:

$5x + 2y + 3x + 7y$
 $5x + 3x + 2y + 7y$ Commutative Property of Addition
 $(5x + 3x) + (2y + 7y)$ Associative Property of Addition
 $8x + 9y$ is in simplest form

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Let's try it out

1. $4x + 6 - 2x + 9$
2. $16y + 9 - 7y + 8x$
3. $17 + 5x + 10x - 2x$
4. $4x - 2x + 6 + 5x + 3x$

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Check Your Answers

1. $2x + 15$
2. $8x + 9y + 9$
3. $13x + 17$
4. $10x + 6$

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Let's try some more difficult problems!

1. $4p + p$
2. $k + 2k + 23$
3. $6m + 4m + 3$
4. $y + 9 + 14 + 2y$
5. $9(r + 7) + 12r$
6. $14(b + 3) + 8b$
7. $18y + 5(7 + 3y)$
8. $3(8 + a) + 7(6 + 4a)$

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Let's check our answers

1. $5p$
2. $3k + 23$
3. $10m + 3$
4. $3y + 23$
5. $21r + 63$
6. $22b + 42$
7. $33y + 35$
8. $31a + 66$

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Distributive Property

For any numbers a, b, and c,
 $a(b + c) = ab + ac$
 and
 $(b + c)a = ba + ca$

If you multiply a sum by a number, you will get the same result if you multiply each addend by that number and then add the products.

$5(20 + 1) = (5 \times 20) + (5 \times 1)$

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Simplify each of the following expressions and write the property that allows you to complete each step:

- a. $r + 3(z + 8r)$
 - b. $2(n + 3) + 4(3n + 2)$
 - c. $6(x + y) + 4x - 6y$
 - d. $2(x + 12) + 3(x - 9)$
- Handwritten work for problem d:
 $2(x+12) + 3(x-9)$
 $(2x+24) + (3x-27)$
 $5x + (-3)$
 $5x - 3$

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a. $r + 3(z + 8r)$
 $r + 3z + 24r$ distributive property
 $r + 24r + 3z$ ☆ ☆
 $(r + 24r) + 3z$ ☆ ☆
 $25r + 3z$

b. $2(n + 3) + 4(3n + 2)$
 $2n + 6 + 12n + 8$ ☆
 $2n + 12n + 6 + 8$ ☆
 $(2n + 12n) + (6 + 8)$ ☆
 $14n + 14$

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c. $6(x + y) + 4x - 6y$
 $6x + 6y + 4x - 6y$ *
 $6x + 4x + 6y - 6y$ *
 $(6x + 4x) + (6y - 6y)$ *
 $10x$

d. $2(x + 12) + 3(x - 9)$
 $2x + 24 + 3x - 27$ *
 $2x + 3x + 24 - 27$ *
 $(2x + 3x) + (24 - 27)$ *
 $5x - 3$ *

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Simplify each of the following:

a. $80x + 2y - 15x + 3y$
 b. $80y \div 2 \times 6 + 4y$
 c. $6x \times 3 \div 9 - 1$
 d. $3x + 10(2x - 4) + 32x \div 2^4$
 e. $3x + 10 \times 2x - 4 + 32x \div 2^4$

Answers

a. $65x + 5y$
 b. $244y$
 c. $2x - 1$
 d. $25x - 40$
 e. $25x - 4$

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In the blank write the property that allows you to go from one step to the next in the example below:

$3(w + 5) + 5w + 2$
 $3w + 15 + 5w + 2$ _____
 $3w + 5w + 15 + 2$ _____
 $(3w + 5w) + (15 + 2)$ _____
 $8w + 17$

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- | | |
|------------------------------------|---------------------|
| 1. $8x - 3x$ | a. $5x^2y + 2xy^2$ |
| 2. $3c + 9y - 5c$ | b. $5x$ |
| 3. $-4m + 5m - 7mn$ | c. $3c + 9y$ |
| 4. $6ab + 4bc - 3ab + bc$ | d. $3ab + 5bc$ |
| 5. $7x^2y - 2x^2y + 5xy^2 - 3xy^2$ | e. $-2c + 9y$ |
| 6. $-4m - 7mn + 8n$ | f. $-4m + 7mn + 8n$ |
| 7. $8c + 9y - 5c$ | g. $m - 7mn$ |

**Combining Like Terms
(Collecting)**

1. Clear the parentheses using the distributive property.
2. Combine like terms by adding coefficients.
3. Combine the constants.

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1. $3(2x + 5) + 6(x + 2)$
 = _____ distributive property
 = _____ combine like terms
2. $3(2x + 5) + 6(x + 2)$
 = _____ distributive property
 = _____ combine like terms
3. $7(3x + 9) + 6(2x + 5)$
 = _____ distributive property
 = _____ combine like terms



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