

Simplifying and Combining Like Terms

$$\begin{array}{ccc} & \text{Exponent (2)} & \\ & 4x^2 & \\ \text{Coefficient (4)} & & \text{Variable (or Base) (x)} \end{array}$$

* Write the coefficients, variables, and exponents of:

a) $8c^2$

b) $9x$

c) y^8

d) $12a^2b^3$

Like Terms: Terms that have identical variable parts {same variable(s) and same exponent(s)}

When simplifying using addition and subtraction, combine "like terms" by keeping the "like term" and adding or subtracting the numerical coefficients.

Examples:

$$3x + 4x = 7x$$

$$13xy - 9xy = 4xy$$

$$12x^3y^2 - 5x^3y^2 = 7x^3y^2$$

Why can't you simplify?

$$4x^3 + 4y^3$$

$$11x^2 - 7x$$

$$6x^3y + 5xy^3$$

Simplify:

1) $7x + 5 - 3x$

2) $6w^2 + 11w + 8w^2 - 15w$

3) $(6x + 4) + (15 - 7x)$

4) $(12x - 5) - (7x - 11)$

5) $(2x^2 - 3x + 7) - (-3x^2 + 4x - 7)$

6) $11a^2b - 12ab^2$

WORKING WITH THE DISTRIBUTIVE PROPERTY

Example:

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

Since in the order of operations, multiplication comes before addition and subtraction, we must get rid of the multiplication before you can combine like terms. We do this by using the distributive property:

$$\begin{aligned} 3(2x - 5) + 5(3x + 6) &= \\ 3(2x) - 3(5) + 5(3x) + 5(6) &= \\ 6x - 15 + 15x + 30 &= \end{aligned}$$

Now you can combine the like terms:

$$\begin{aligned} 6x + 15x &= 21x \\ -15 + 30 &= 15 \end{aligned}$$

Final answer: $21x + 15$

Normally we don't write out the work with all those steps. Your actual work will look like this:

$$\begin{aligned} 3(2x - 5) + 5(3x + 6) &= \\ 6x - 15 + 15x + 30 &= \\ 21x + 15 & \end{aligned}$$

Practice Problems:

Simplify:

1) $(5x - 4) + (3 - 4x)$

2) $(7x^4 - 6x^3 + 4x^2 - 11x + 5) - (9x^4 + x^3 + 8x^2 - 13x - 4)$

3) $3(5x - 3) + 6(2x + 4)$

4) $7(2x^2 - 6x + 2) + 3(-5x^2 + 14x - 4)$

5) $9(7x^2 - 5x + 9) - 7(8x^2 - 3x + 12)$

6) $6(3x^3 - 4x^2 + 11x - 5) - 10(-2x^3 - 6x^2 + 6x + 7)$

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

8) $12(3x^2 - 6x + 9) - 9(4x^2 - 8x - 12)$

9) $5(6x^3 - 4x^2 + 11) - 6(5x^2 + 9)$

10) $10(3x^4 - 5x^3 + 7x^2 - 10x + 6) - 5(6x^4 - 10x^3 - 14x^2 - 20x + 12)$

Q1 Quiz 6 Review Sheet

1) $(8x + 9) + (7x - 11)$

2) $(6x - 3) + (9 - 7x)$

3) $(13x - 7) - (21x - 9)$

4) $(16x + 5) - (11x - 7)$

5) $7(3x + 4) + 5(4x - 7)$

6) $6(15 - 6x) + 11(4x - 8)$

7) $3(12x - 4) - 5(8x + 7)$

8) $4(8x + 5) - 10(5x + 2)$

9) $6(4x^2 - x + 7) + 8(3x^2 - 2x - 6)$

10) $10(3x^2 - 5x + 3) + 6(5x^2 - 4)$

11) $4(5c^2 - 9c - 6) - 6(3c^2 - 6c + 4)$

12) $12(3x^2 - 6x + 9) - 9(4x^2 - 8x + 12)$

13) $9(5x^2 - 3x + 2) + 4(4x^2 - 7x + 1)$

14) $10(4x^2 - 3x + 8) - 8(5x^2 - 4x + 9)$

Answer Key (1-14):

- | | | | | |
|-----------------------|-----------------|--------------|------------------------|--------------|
| 1) $15x - 2$ | 2) $-x + 6$ | 3) $-8x + 2$ | 4) $5x + 12$ | 5) $41x - 7$ |
| 6) $8x + 2$ | 7) $-4x - 47$ | 8) $-18x$ | 9) $48x^2 - 22x - 6$ | |
| 10) $60x^2 - 50x + 6$ | 11) $2c^2 - 48$ | 12) 0 | 13) $61x^2 - 55x + 22$ | 14) $2x + 8$ |

Multiplying and Dividing Monomials

Multiplication:

$$3^2 = 3 \cdot 3 = 9 \quad 4 \cdot 4 = 4^2 = 16 \quad 4^3 = (4)(4)(4) = 64 \quad (5)(5)(5)(5)(5)(5) = 5^6 = 15,625$$

The same goes for variables:

$$x \cdot x = x^2$$

$$x^2 \cdot x^3 = (x)(x) \cdot (x)(x)(x) = x^5$$

(The only difference is you can't simplify x^2 like you did $3^2 = 9$. You must leave it as x^2 .)

When multiplying monomials you must deal with the coefficients.

Coefficients: **Multiply the coefficients.**

Variables: When multiplying the **variables** of monomials you **keep the base and add the exponents**. (Remember if there is no exponent written, the exponent is 1.)

Look at the previous example: $x^1 \cdot x^1 = x^{(1+1)} = x^2$

Simplify: $(3xy^5)(4x^2y^3)$

$$(3xy^5)(4x^2y^3) = (3)(4)(x)(x^2)(y^5)(y^3) = 12 [x^{(1+2)}] [y^{(5+3)}] = \mathbf{12x^3y^8}$$

Do now:

1) $(-6x^2y^7)(-9x^5y)$

2) $(-4x^3y^5)^2$

3) $(-2xy^8)^3$

Division:

$$6^4/6^2 = \frac{(6)(6)(6)(6)}{(6)(6)} \rightarrow \text{cancel} \rightarrow \frac{\cancel{(6)}\cancel{(6)}(6)(6)}{\cancel{(6)}\cancel{(6)}} = (6)(6) = 6^2 = 36$$

$$x^3/x = \frac{(x)(x)(x)}{(x)} \rightarrow \text{cancel} \rightarrow \frac{(x)(x)\cancel{(x)}}{\cancel{(x)}} = (x)(x) = x^2$$

Just like multiplying, when dividing monomials you must deal with the coefficients.

Coefficients : **Divide the coefficients.**

Variables: When dividing the **variables** of monomials you **keep the base and subtract the exponents.**

Look at the previous example: $x^3/x = x^{3-1} = x^2$

Simplify: $(12xy^5)/(4xy^3) =$

$$12/4 = 3 \quad x^{1-1} = x^0 \quad y^{5-3} = y^2$$

What is x^0 equal to? : _____ Any number or variable with an exponent of 0 = ? _____

Final answer = _____

Do Now:

4) $\frac{48x^5y^{12}z^5}{64x^3y^5z^5}$

5) $\frac{35x^2y^5z}{20x^4y^3z^5}$

6) $\frac{(3x^4y^5z)^3}{18x^3y^{14}z^7}$

7) $(2x^5yz^6)^5(-3x^2y^{-3}z^{-15})^2$

Show all steps!

1) Multiply:

a) $(5x^3y^2z^{11})(12xy^7z^{-4})$

b) $(9x^5y^2z^4)^3$

c) $(4x^3y^7z^6)^4(3x^8y^{-5}z^{-12})^2$

2) Multiply:

a) $(6x^3y^2z^{-12})(11x^5y^{-3}z^7)$

b) $(8x^5y^{-2}z^4)^4$

c) $(3x^6y^5z^8)^3(5x^{-9}y^5z^{-15})^2$

3) Divide:

a) $\frac{27x^3y^2z^5}{9x^3y^5z^4}$

b) $\frac{(4x^4y^5z)^3}{16x^4y^{13}z^4}$

c) $\frac{(2x^5yz^6)^5}{(4x^{11}y^5z^{14})^2}$

4) Divide:

$$a) \frac{45x^3y^9z^5}{18x^6y^5z}$$

$$b) \frac{24x^8y^{12}z^9}{72x^{10}y^{12}z^8}$$

$$c) \frac{32x^5y^{12}z^{28}}{8x^7y^{-12}z^{14}}$$

$$5) \frac{(3x^5y^8z^5)^5}{(9x^{14}y^{20}z^{12})^2}$$

$$6) \frac{(6x^5y^4z^6)^3}{(12x^7y^8z^9)^2}$$

$$7) 5a(8a^2 - 6a + 3) - 3a(11a^2 - 10a - 5)$$

$$8) 8b(7b^2 - 4b + 2) - 5(6b^2 + 3b - 1)$$

9) $7x(4x^2 - 11x + 3) - 4x(8x^2 - 18x + 5)$

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

11) $6y^2(5y^3 - 4y^2 + 8y - 7) - 8y(3y^3 + 6y^2 - 5y - 9)$

Answer Key:

1) a) $60x^4y^9z^{11}$ b) $729x^{15}y^6z^{12}$ c) $2,304x^{28}y^{18}$

2) a) $\frac{66x^8}{yz^8}$ b) $\frac{4,096x^{20}z^{16}}{y^8}$ c) $\frac{675y^{25}}{z^6}$

3) a) $\frac{3z}{y^3}$ b) $\frac{4x^8y^2}{z}$ c) $\frac{2x^3z^2}{y^5}$

4) a) $\frac{5y^4z^4}{2x^3}$ b) $\frac{z}{3x^2}$ c) $\frac{4y^{24}z^{14}}{x^2}$

5) $\frac{3z}{x^3}$ 6) $\frac{3xz^{36}}{2y^4}$

7) $7a^3 + 30a$ 8) $56b^3 - 32b^2 + b + 5$ 9) $-4x^3 - 5x^2 + x$

10) $5x^3 - 9x^2 + 23x$

11) $30y^5 - 48y^4 - 2y^2 + 72y$

When MULTIPLYING monomials you _____ the coefficients and _____ the exponents.

When DIVIDING monomials you _____ the coefficients and _____ the exponents.

1) $(3x^9y)(6x^{11}y^4)$

2) $\frac{36x^9y^6z^5}{12x^{-9}y^6z^4}$

3) $(7x^2yz^3)^3$

4) $\frac{45x^4y^3z^7}{18x^6y^{-3}z^5}$

5) $\frac{(4x^5yz^3)^3}{(2x^3y^6z^{-2})^5}$

6) $(5x^2y^2z^{-4})(2x^{-5}y^3z)^3$

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$$7) (6x^7y^4z^3)^2(2x^{-5}y^3z)^3$$

$$8) \frac{(9x^2y^5z^{-11})^2}{(3x^{-2}y^2z^4)^5}$$

$$9) \frac{(6x^2y^5z^3)^2}{(2x^{-3}y^2z^2)^5}$$

$$10) 4x(9x^2 - 15x - 12) - 12x(3x^2 + 5x - 4) \quad 11) 3y^2(5y^3 - 4y^2 + 8y - 7) - 7y(3y^3 + 6y^2 - 5y - 9)$$

Answer Key:

$$1) 18x^{20}y^5 \quad 2) 3x^{18}z \quad 3) 343x^6y^3z^9 \quad 4) \frac{5y^6z}{2x^2} \quad 5) \frac{2z^{19}}{y^{27}} \quad 6) \frac{40y^5}{x^{13}z} \quad 7) \frac{288y^{17}z^9}{x}$$

$$8) \frac{x^{14}}{3z^{42}} \quad 9) \frac{9x^{19}}{8z^4} \quad 10) -120x^2 \quad 11) 15y^5 - 33y^4 - 18y^3 + 14y^2 + 63y$$

Q1 Quiz 7 Review:

Multiplication

1) $(10x^3y^{11}z^8)(-11xy^7z^3)$

2) $(7x^3yz^6)^3$

3) $(2x^3y^5z^6)^4(5x^6y^9z^{-12})^2$

4) $(-6x^4y^2z^{-5})^3(-8x^5y^{-3}z^8)^2$

5) $(4xy^4z^8)^3(9x^9y^5z^{-10})^2$

Division:

6) $\frac{42x^5y^4z^5}{63x^{-5}y^4z^9}$

7) $\frac{(4x^2yz^5)^3}{16x^7y^{-3}z^{10}}$

8) $\frac{(2x^4y^2z^6)^5}{(4x^7y^3z^{10})^3}$

$$9) \frac{(9x^3y^5z^8)^2}{(3xy^2z^{-3})^5}$$

$$10) \frac{(8x^{-6}y^4z^5)^3}{(10x^9y^{-6}z^2)^2}$$

$$11) 10x(3x^2 - 5x + 6) - 6x(5x^2 + 8x + 10) \quad 12) 3x(7x^2 + 6x - 4) - 8(10x^2 - 7x - 1)$$

Answer Key:

$$1) -110x^4y^{18}z^{11} \quad 2) 343x^9y^3z^{18} \quad 3) 400x^{24}y^{38} \quad 4) -13,284x^{22}z \quad 5) 5,184x^{21}y^{22}z^4$$

$$6) \frac{2x^{10}}{3z^4} \quad 7) \frac{4y^6z^5}{x} \quad 8) \frac{y}{2x} \quad 9) \frac{xz^{31}}{3} \quad 10) \frac{128y^{24}z^{11}}{25x^{36}} \quad 11) -98x^2 \quad 12) 21x^3 - 62x^2 + 44x + 8$$

4) $(2x + 9)^2$
Double Distribute

FOIL

Boxes

5) $(7x - 11)(4x - 3)$
Double Distribute

FOIL

Boxes

6) $(6x - 7)(7x + 8)$
Double Distribute

FOIL

Boxes

Multiplying Binomials: Do each problem only once using whichever method you choose:

1) $(x - 5)(x + 4)$

2) $(x - 6)(x - 3)$

3) $(x + 4)(x + 7)$

4) $(x + 3)(x - 7)$

5) $(3x - 5)(2x + 8)$

6) $(11x - 7)(5x + 3)$

7) $(4x - 9)(9x + 4)$

8) $(x - 2)(x + 2)$

9) $(x - 2)(x - 2)$

10) $(x - 2)^2$

11) $(5x - 4)^2$

12) $(3x + 2)^2$

Multiplying a *TRINOMIAL* by a binomial:

$$13) (4x^2 - 3x + 6)(2x - 7)$$

Method 1: Split, distribute, and combine like terms:

$$2x(4x^2 - 3x + 6) - 7(4x^2 - 3x + 6)$$

Method 2: Box Method:

$$\begin{array}{r} 4x^2 - 3x + 6 \\ \hline 2x - 7 \end{array}$$

Do now:

14) $(5x^2 + 6x - 8)(9x + 4)$

15) $(7x^2 - 3x - 4)(6x^2 + 2x - 5)$

16) $(4x - 3)^3$

Multiplying Polynomials

1) $(5x + 8)(9x - 7)$

2) $(6x - 5)(4x - 3)$

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

4) $(5x - 2)^3$

5) $(7x + 3)^3$

6) $(2x^2 + 5x + 4)(8x + 3)$

7) $(6x^2 - 4x - 3)(2x^2 - 3x - 1)$

8) $(5x^2 - 6x + 1)(4x^2 - 9)$

9) $(7x^2 - 6x + 4)(8x^2 + 5x - 2)$

Q1 Quiz 8 Review:

1) $6x(9x^2 - 4x + 8) + 4x(6x^2 + 12x - 9)$

2) $8x^2(7x^2 - 3x - 12) - 6x(4x^2 - 16x - 3)$

3) $(x + 8)(x - 7)$

4) $(x - 9)(x - 12)$

5) $(x - 4)(x + 7)$

6) $(x - 11)^2$

7) $(5x - 4)^2$

8) $(3x + 4)^3$

9) $(3x^2 - 5x + 3)(5x - 4)$

10) $(4x^2 - 7x + 2)(10x^2 - 3x - 5)$

11) $(3x + 2)^3$