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Add polynomials (group like terms)

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Slope Formula

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System of Linear Equations (graphing)

System of Linear Equations (number of solutions)

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Relations and Functions

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- Discontinuity (Asymptotes)
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- Linear Function - Transformational Graphing (Dilation/Reflection m<0)
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- Quadratic Function - Transformational Graphing (Dilation a>0)
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- Transformations or Parent Functions (Dilation)
- Transformations or Parent Functions (Reflection)
- Transformations or Parent Functions (Translation)

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Combination (formula)

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Curve of Best Fit (linear)

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Fundamental Counting Principle

Inverse Variation

Joint Variation

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No Correlation

Outlier Data (graphic)

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Permutation (formula)

Positive Linear Relationship (Correlation)

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Standard Deviation (graphic)

Statistics Notation

Summation

Variance

z-Score (definition)

z-Score (graphic)

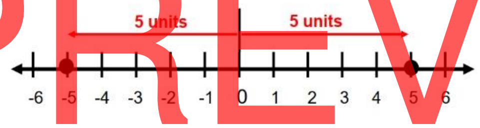
Expressions and Operations

Expressions and Operations

Absolute Value

The distance between a number and zero

|5| = 5 |-5| = 5



Add and Subtract Radical Expressions

Add or subtract the numerical factors of the like radicals.

Examples:

$$2\sqrt{a} + 5\sqrt{a} = (2+5)\sqrt{a} = 7\sqrt{a}$$

$$6\sqrt[3]{xy} - 4\sqrt[3]{xy} - \sqrt[3]{xy} = (6-4-1)\sqrt[3]{xy} = \sqrt[3]{xy}$$

$$2\sqrt[4]{c} + 7\sqrt{2} - 2\sqrt[4]{c} = (2-2)\sqrt[4]{c} + 7\sqrt{2} = 7\sqrt{2}$$

Add Polynomials (Align like Terms – Vertical Method)

Example:

$h(g) = 2g^3 + 6g^2 - 4;\ k(g) = g^3 - g - 3$

$h(g) + k(g) = (2g^3 + 6g^2 - 4) + (g^3 - g - 3)$

(Align like terms and add)

$$\begin{array}{r} 2g^3 + 6g^2 \qquad - 4 \\ + \quad g^3 \qquad - g - 3 \\ \hline \end{array}$$

$h(g) + k(g) = 3g^3 + 6g^2 - g - 7$

Add Polynomials (Group like Terms – Horizontal Method)

Example:

$$h(g) = 2g^2 + 6g - 4;\ k(g) = g^2 - g$$

$$h(g) + k(g) = (2g^2 + 6g - 4) + (g^2 - g)$$

$$= 2g^2 + 6g - 4 + g^2 - g$$

(Group like terms and add)

$$= (2g^2 + g^2) + (6g - g) - 4$$

$$h(g) + k(g) = 3g^2 + 5g - 4$$

Coefficient

A numerical or constant quantity placed before and multiplying the variable in an algebraic expression (e.g. 4 in 4x y).

$$(-4) + 2\log x$$

$$-7y^{\frac{1}{3}}$$

$$\frac{2}{3}ab - \frac{1}{2}$$

$$\pi r^2$$

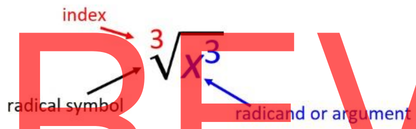
Complex Numbers

The set of all real and imaginary numbers. A complex number is a number that can be expressed in the form a + bi, where a and b are real numbers, and i represents the imaginary unit, satisfying the equation i2 = −1. Because no real number satisfies this equation, i is called an imaginary number. Either part, both real (a) and imaginary (bi) can be 0.

Case	Examples
$a = 0$	$-i$, $0.01i$, $\frac{2i}{5}$
$b = 0$	$\sqrt{5}$, 4, -12.8
$a \neq 0$, $b \neq 0$	$39 - 6i$, $-2 + \pi i$

Cube Root

The cube root of a number is a special value that when cubed gives the original number. The cube root of 27 is 3, because when 3 is cubed you get 27. Cubing a number and taking a cube root are inverse operations.



Degree of Polynomial

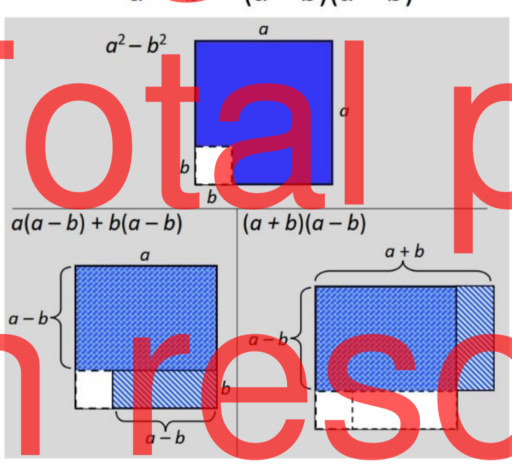
The largest exponent of the largest sum of exponents of a term within a polynomial.

Polynomial	Degree of Each Term	Degree of Polynomial
$-7m^3n^5$	$-7m^3n^5 \rightarrow$ degree 8	8
$2x + 3$	$2x \rightarrow$ degree 1 $3 \rightarrow$ degree 0	1
$6a^3 + 3a^2b^3 - 21$	$6a^3 \rightarrow$ degree 3 $3a^2b^3 \rightarrow$ degree 5 $-21 \rightarrow$ degree 0	5

Difference of Squares

The difference of two squares is a squared (multiplied by itself) number subtracted from another squared number.

$$a^2 - b^2 = (a + b)(a - b)$$



Divide Polynomials (Binomial Divisor)

Factor and simplify

Example:

$$f(w)=7w^2+3w-4;\ g(w)=w+1$$

$$\frac{f(w)}{g(w)}=(7w^2+3w-4)\div(w+1)$$

$$=\frac{7w^2+3w-4}{w+1}$$

$$=\frac{(7w-4)(w+1)}{w+1}$$

$$\frac{f(w)}{g(w)}=7w-4$$

Divide Polynomials (Monomial Divisor)

Divide each term of the dividend by the monomial divisor

Example:

$$f(x)=12x^3-36x^2+16x;\ g(x)=4x$$

$$\frac{f(x)}{g(x)}=(12x^3-36x^2+16x)\div 4x$$

$$=\frac{12x^3-36x^2+16x}{4x}$$

$$=\frac{12x^3}{4x}-\frac{36x^2}{4x}+\frac{16x}{4x}$$

$$\frac{f(x)}{g(x)}=3x^2-9x+4$$

Exponential Form

exponent

$$a^n=\underbrace{a\cdot a\cdot a\cdot a\ldots}_{n\text{ factors}},\ {\scriptstyle a\neq 0}$$

base

Expression

A representation of a quantity that may contain numbers, variable or operation symbols.

x

$-\sqrt[4]{54}$

$3^{\frac{1}{2}} + 2m$

$3(y + 3.9)^4 - \frac{8}{9}$

Factor by Grouping

For trinomials of the form
$ax^2 + bx + c$

Example: $3x^2 + 8x + 4$

$ac = 3 \bullet 4 = 12$
Find factors of ac that add to equal b
$12 = 2 \bullet 6 \rightarrow 2 + 6 = 8$

$3x^2 + 2x + 6x + 4$	Rewrite $8x$ as $2x + 6x$
$(3x^2 + 2x) + (6x + 4)$	Group factors
$x(3x + 2) + 2(3x + 2)$	Factor out a common binomial
$(3x + 2)(x + 2)$	

Factoring (Difference of Squares)

$a^2 - b^2 = (a + b)(a - b)$

Examples:

$x^2 - 49 = x^2 - 7^2 = (x + 7)(x - 7)$
$4 - n^2 = 2^2 - n^2 = (2 - n)(2 + n)$
$9x^2 - 25y^2 = (3x)^2 - (5y)^2$ $= (3x + 5y)(3x - 5y)$

Factoring (Greatest Common Factor)

Find the greatest common factor (GCF) of all terms of the polynomial and then apply the distributive property.

Example: $20a^4 + 8a$

$$2 \cdot 2 \cdot 5 \cdot a \cdot a \cdot a \cdot a + 2 \cdot 2 \cdot 2 \cdot a$$

$$\text{GCF} = \overbrace{2 \cdot 2 \cdot a}^{\text{common factors}} = 4a$$

$$20a^4 + 8a = 4a(5a^3 + 2)$$

Factoring (Perfect Squares Trinomials)

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

Examples:

$$x^2 + 6x + 9 = x^2 + 2 \cdot 3 \cdot x + 3^2 = (x + 3)^2$$

$$4x^2 - 20x + 25 = (2x)^2 - 2 \cdot 2x \cdot 5 + 5^2 = (2x - 5)^2$$

Factoring (Sum and Difference of Cubes)

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$
$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

Examples:

$$27y^3 + 1 = (3y)^3 + (1)^3 = (3y + 1)(9y^2 - 3y + 1)$$

$$x^3 - 64 = x^3 - 4^3 = (x - 4)(x^2 + 4x + 16)$$

Factors of a Monomial

The number(s) and/or variable(s) that are multiplied together to form a monomial.

Examples:	Factors	Expanded Form
$5b^2$	$5 \cdot b^2$	$5 \cdot b \cdot b$
$6x^2y$	$6 \cdot x^2 \cdot y$	$2 \cdot 3 \cdot x \cdot x \cdot y$
$\frac{-5p^2q^3}{2}$	$\frac{-5}{2} \cdot p^2 \cdot q^3$	$\frac{1}{2} \cdot (-5) \cdot p \cdot p \cdot q \cdot q \cdot q$

Leading Coefficient

The coefficient of the first term of a polynomial written in descending order of exponents.

Examples:

$7a^3 - 2a^2 + 8a - 1$
$-3n^3 + 7n^2 - 4n + 10$
$16t - 1$

Multiply Binomials

Apply the distributive property.

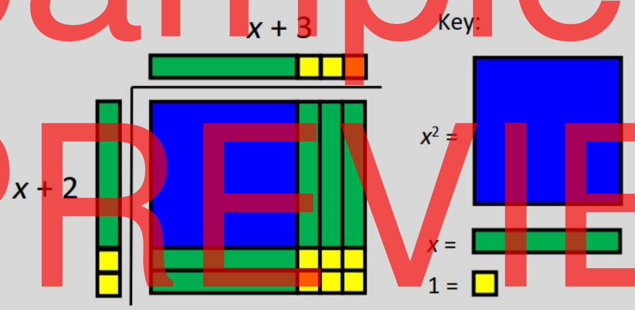
$(a + b)(c + d) =$
$a(c + d) + b(c + d) =$
$ac + ad + bc + bd$

Example: $(x + 3)(x + 2)$

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

Multiply Binomials (Model)

Example: $(x + 3)(x + 2)$



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

Multiply Binomials (Squaring a Binomial)

$(a + b)^2 = a^2 + 2ab + b^2$

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

Examples:

$(3m + n)^2 = 9m^2 + 2(3m)(n) + n^2$
$= 9m^2 + 6mn + n^2$

$(y - 5)^2 = y^2 - 2(5)(y) + 25$
$= y^2 - 10y + 25$

Multiply Binomials (Sum and Difference)

$(a + b)(a - b) = a^2 - b^2$

Examples:

$(2b + 5)(2b - 5) = 4b^2 - 25$

$(7 - w)(7 + w) = 49 - w^2$

Multiply Polynomials

Apply the distributive property.

$$(a + b)(d + e + f)$$

$$(a + b)(d + e + f)$$

$$= a(d + e + f) + b(d + e + f)$$

$$= ad + ae + af + bd + be + bf$$

Negative Exponent

Since the exponent of a number says how many times to use the number in a multiplication, a negative exponent means how many times to divide by the number.

$$a^{-n} = \frac{1}{a^n}, \; a \neq 0$$

Examples:

$4^{-2} = \frac{1}{4^2} = \frac{1}{16}$
$\frac{x^4}{y^{-2}} = \frac{x^4}{\frac{1}{y^2}} = \frac{x^4}{1} \cdot \frac{y^2}{1} = x^4y^2$
$(2-a)^{-2} = \frac{1}{(2-a)^2}, \; a \neq 2$

N^{th} Root

index

$$\sqrt[n]{x^m} = x^{\frac{m}{n}}$$

radical symbol

radicand or argument

Examples:

$\sqrt[5]{64} = \sqrt[5]{4^3} = 4^{\frac{3}{5}}$
$\sqrt[6]{729x^9y^6} = 3x^{\frac{3}{2}}y$

Order of Operations

Grouping Symbols	( ) √ { } | | [ ] —
Exponents	a^n
Multiplication Division	Left to Right
Addition Subtraction	Left to Right

Polynomial

An expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s).

Example	Name	Terms
7 $6x$	monomial	1 term
$3t - 1$ $12xy^3 + 5x^4y$	binomial	2 terms
$2x^2 + 3x - 7$	trinomial	3 terms

Power of a Power Property

Power of a power property says that to find a power of a power you just have to multiply the exponents.

$$(a^m)^n = a^{m \cdot n}$$

Examples:

$$\left(y^{\frac{1}{4}}\right)^8 = y^{\frac{1}{4}\cdot\frac{8}{1}} = y^2$$

$$(g^2)^{-3} = g^{2\cdot(-3)} = g^{-6} = \frac{1}{g^6}$$

Power of a Product Property

Power of a Product says that a term raised to a power is equal to the product of its factors raised to the same power.

$$(ab)^m = a^m \cdot b^m$$

Examples:

$$(9a^4b^6)^{\frac{1}{2}} = (9)^{\frac{1}{2}} \cdot (a^4)^{\frac{1}{2}}(b^6)^{\frac{1}{2}} = 3a^2b^3$$

$$\frac{-1}{(2x)^3} = \frac{-1}{2^3x^3} = \frac{-1}{8x^3}$$

Power of a Quotient Property

The Power of a Quotient Rule says that the power of a quotient is equal to the quotient obtained when the numerator and denominator are each raised to the indicated power separately before the division is performed.

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m},\ b \neq 0$$

Examples:

$$\left(\frac{y}{3}\right)^4 = \frac{y^4}{3^4} = \frac{y^4}{81}$$

$$\left(\frac{5}{t}\right)^{-3} = \frac{5^{-3}}{t^{-3}} = \frac{\frac{1}{5^3}}{\frac{1}{t^3}} = \frac{1}{5^3} \cdot \frac{t^3}{1} = \frac{t^3}{5^3} = \frac{t^3}{125}$$

Prime Polynomial

Cannot be factored into a product of lesser degree polynomial factors.

Example
r
$3t + 9$
$x^2 + 1$
$5y^2 - 4y + 3$

Nonexample	**Factors**
$x^2 - 4$	$(x + 2)(x - 2)$
$3x^2 - 3x - 6$	$3(x + 1)(x - 2)$
x^3	$x \cdot x^2$

Product of Powers Property

The product of powers property says that when you multiply powers with the same base you just must add the exponents.

$$a^m \cdot a^n = a^{m+n}$$

Examples:

$x^4 \cdot x^2 = x^{4+2} = x^6$
$a^3 \cdot a = a^{3+1} = a^4$
$w^{\frac{1}{3}} \cdot w^{\frac{1}{4}} = w^{\frac{1}{3}+\frac{1}{4}} = w^{\frac{7}{12}}$

Product Property of Radicals

The n^th root of a product equals the product of the n^th roots.

$$\sqrt[n]{ab} = \sqrt[n]{a} \cdot \sqrt[n]{b}$$

$a \geq 0$ and $b \geq 0$

Examples:

$\sqrt{4x} = \sqrt{4} \cdot \sqrt{x} = 2\sqrt{x}$
$\sqrt{5a^3} = \sqrt{5} \cdot \sqrt{a^3} = a\sqrt{5a}$
$\sqrt[3]{16} = \sqrt[3]{8 \cdot 2} = \sqrt[3]{8} \cdot \sqrt[3]{2} = 2\sqrt[3]{2}$

Quotient of Powers Property

The quotient of powers property says that dividing two powers with the same base is the same as subtracting the exponent of the denominator from the exponent of the numerator and raising the base to that power.

$$\frac{a^m}{a^n} = a^{m-n}, \quad a \neq 0$$

Examples:

$\frac{x^{\frac{3}{5}}}{x^{\frac{1}{5}}} = x^{\frac{3}{5}-\frac{1}{5}} = x^{\frac{2}{5}}$
$\frac{y^{-3}}{y^{-5}} = y^{-3-(-5)} = y^2$
$\frac{a^4}{a^4} = a^{4-4} = a^0 = 1$

Quotient Property of Radicals

The n^{th} root of a quotient equals the quotient of the n^{th} roots of the numerator and denominator.

$$\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$$

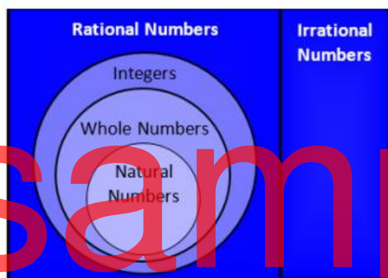
$a \geq 0$ and $b > 0$

Examples:

$\sqrt{\frac{5}{y^2}} = \frac{\sqrt{5}}{\sqrt{y^2}} = \frac{\sqrt{5}}{y}, y \neq 0$
$\frac{\sqrt{25}}{\sqrt{3}} = \frac{5}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{5\sqrt{3}}{3}$

Real Numbers

The set of all rational and irrational numbers.



Natural Numbers	{1, 2, 3, 4 …}
Whole Numbers	{0, 1, 2, 3, 4 …}
Integers	{… -3, -2, -1, 0, 1, 2, 3 …}
Rational Numbers	the set of all numbers that can be written as the ratio of two integers with a non-zero denominator (e.g., $2\frac{3}{5}$, -5, 0.3, $\sqrt{16}$, $\frac{13}{7}$)
Irrational Numbers	the set of all nonrepeating, nonterminating decimals (e.g, $\sqrt{7}$, π, -.23223222322223…)

Scientific Notation

Scientific notation is a way of writing very large or very small numbers. A number is written in scientific notation when a number between 1 and 10 is multiplied by a power of 10.

$$a \times 10^{n}$$

$1 \leq |a| < 10$ and n is an integer

Examples:

Standard Notation	Scientific Notation
17,500,000	1.75×10^{7}
-84,623	-8.4623×10^{4}
0.0000026	2.6×10^{-6}
-0.080029	-8.0029×10^{-2}
$(4.3 \times 10^{5})(2 \times 10^{-2})$	$(4.3 \times 2)(10^{5} \times 10^{-2}) =$ $8.6 \times 10^{5+(-2)} = 8.6 \times 10^{3}$
$\dfrac{6.6 \times 10^{6}}{2 \times 10^{3}}$	$\frac{6.6}{2} \times \frac{10^{6}}{10^{3}} = 3.3 \times 10^{6-3} =$ 3.3×10^{3}

Simplify Radical Expressions

Simplify radicals and combine like terms where possible.

Examples:

$$\frac{1}{2} + \sqrt[3]{-32} - \frac{11}{2} - \sqrt{8}$$
$$= -\frac{10}{2} - 2\sqrt[3]{4} - 2\sqrt{2}$$
$$= -5 - 2\sqrt[3]{4} - 2\sqrt{2}$$

$$\sqrt{18} - 2\sqrt[3]{27} = 2\sqrt{3} - 2(3)$$
$$= 2\sqrt{3} - 6$$

Square Root

A square root of a number x is a number y such that $y^2 = x$.

$\sqrt{x^2}$

radical symbol

radicand or argument

Examples:

$$\sqrt{9x^2} = \sqrt{3^2 \cdot x^2} = \sqrt{(3x)^2} = 3x$$

$$-\sqrt{(x-3)^2} = -(x-3) = -x+3$$

Subtract Polynomials (Align Like Terms – Vertical Method)

Example:

$$f(x) = 4x^2 + 5;\ g(x) = -2x^2 + 4x - 7$$

$$f(x) - g(x) = (4x^2 + 5) - (-2x^2 + 4x - 7)$$

(Align like terms then add the inverse and add the like terms.)

$$\begin{array}{lcl} 4x^2 \qquad + 5 & \rightarrow & 4x^2 \qquad + 5 \\ -(-2x^2 + 4x - 7) & \rightarrow & +2x^2 - 4x + 7 \\ \hline \end{array}$$

$$f(x) - g(x) = 6x^2 - 4x + 12$$

Subtract Polynomials (Group Like Terms – Horizontal Method)

Example:

$$f(x) = 4x^2 + 5;\ g(x) = -2x^2 + 4x - 7$$

$$f(x) - g(x) = (4x^2 + 5) - (-2x^2 + 4x - 7)$$

(Add the inverse)

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

$$= 4x^2 + 5 + 2x^2 - 4x + 7$$

(Group like terms and add.)

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

$$f(x) - g(x) = 6x^2 - 4x + 12$$

Term

In Algebra a term is either a single number or variable, or numbers and variables being added, subtracted, multiplied or divided.

$$\underbrace{3\,log\,x} + \underbrace{2y} - \underbrace{8}$$

3 terms

$$\underbrace{-5x^2} - \underbrace{x}$$

2 terms

$$\underbrace{\left(\frac{2}{3}\right)^a}$$

1 term

Variable

A variable is a quantity that may change within the context of a mathematical problem or experiment. The letters x, y, and z are common generic symbols used for variables.

$$2^y + 3$$

$$9 + log\,x = 2.08$$

$$d = 7c - 5$$

$$A = \pi r^2$$

Zero Exponent

The zero exponent rule basically says that any base with an exponent of zero is equal to one.

$$a^0 = 1, \ a \neq 0$$