

# COLLEGE ALGEBRA BASICS TUTORIAL

THIS IS A COMPREHENSIVE GUIDE TO UNDERSTANDING THE FUNDAMENTAL CONCEPTS OF COLLEGE ALGEBRA. THIS COLLEGE ALGEBRA BASICS TUTORIAL WILL EQUIP YOU WITH THE KNOWLEDGE NEEDED TO NAVIGATE COMMON ALGEBRAIC TOPICS, FROM SOLVING EQUATIONS TO UNDERSTANDING FUNCTIONS AND THEIR GRAPHS. WE WILL DELVE INTO ESSENTIAL BUILDING BLOCKS LIKE VARIABLES, EXPRESSIONS, AND EQUATIONS, AND EXPLORE HOW TO MANIPULATE THEM EFFECTIVELY. FURTHERMORE, THIS TUTORIAL WILL PROVIDE A CLEAR ROADMAP FOR MASTERING CRUCIAL AREAS SUCH AS POLYNOMIAL OPERATIONS, RATIONAL EXPRESSIONS, AND THE INTRICATE WORLD OF INEQUALITIES. BY THE END OF THIS DETAILED RESOURCE, YOU'LL FEEL MORE CONFIDENT IN YOUR ABILITY TO TACKLE COLLEGE-LEVEL ALGEBRAIC CHALLENGES AND BUILD A STRONG FOUNDATION FOR FUTURE MATHEMATICAL ENDEAVORS.

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## UNDERSTANDING VARIABLES AND EXPRESSIONS

AT THE HEART OF COLLEGE ALGEBRA LIES THE CONCEPT OF VARIABLES. A VARIABLE IS A SYMBOL, TYPICALLY A LETTER LIKE 'X', 'Y', OR 'A', THAT REPRESENTS AN UNKNOWN OR CHANGING QUANTITY. THESE SYMBOLS ARE THE BUILDING BLOCKS FOR ALGEBRAIC EXPRESSIONS. AN ALGEBRAIC EXPRESSION IS A COMBINATION OF VARIABLES, NUMBERS, AND MATHEMATICAL OPERATIONS SUCH AS ADDITION, SUBTRACTION, MULTIPLICATION, AND DIVISION. FOR INSTANCE, ' $2x + 5$ ' IS AN ALGEBRAIC EXPRESSION WHERE 'X' IS THE VARIABLE, '2' IS A COEFFICIENT, AND '5' IS A CONSTANT TERM. UNDERSTANDING HOW TO EVALUATE THESE EXPRESSIONS FOR DIFFERENT VALUES OF THE VARIABLE IS A FOUNDATIONAL SKILL.

## EVALUATING ALGEBRAIC EXPRESSIONS

TO EVALUATE AN ALGEBRAIC EXPRESSION, YOU SUBSTITUTE A GIVEN NUMERICAL VALUE FOR EACH VARIABLE AND THEN PERFORM THE INDICATED OPERATIONS FOLLOWING THE ORDER OF OPERATIONS (PEMDAS/BODMAS). FOR EXAMPLE, TO EVALUATE ' $3y - 7$ ' WHEN ' $y = 4$ ', YOU WOULD SUBSTITUTE 4 FOR 'Y', RESULTING IN ' $3(4) - 7$ '. THIS SIMPLIFIES TO ' $12 - 7$ ', WHICH EQUALS 5. PRACTICING WITH VARIOUS EXPRESSIONS AND VALUES WILL SOLIDIFY YOUR UNDERSTANDING OF THIS FUNDAMENTAL PROCESS.

## COMBINING LIKE TERMS

SIMPLIFYING ALGEBRAIC EXPRESSIONS OFTEN INVOLVES COMBINING LIKE TERMS. LIKE TERMS ARE TERMS THAT HAVE THE SAME VARIABLE RAISED TO THE SAME POWER. FOR EXAMPLE, IN THE EXPRESSION ' $5x + 3y - 2x + 8$ ', THE TERMS ' $5x$ ' AND ' $-2x$ ' ARE LIKE TERMS, AS ARE THE CONSTANT TERMS ' $3y$ ' AND ' $8$ '. COMBINING LIKE TERMS MEANS ADDING OR SUBTRACTING THEIR COEFFICIENTS. SO, ' $5x - 2x$ ' BECOMES ' $3x$ ', AND ' $3y$ ' REMAINS AS IS. THE EXPRESSION SIMPLIFIES TO ' $3x + 3y + 8$ '. THIS SKILL IS CRUCIAL FOR MANIPULATING MORE COMPLEX ALGEBRAIC EQUATIONS AND EXPRESSIONS.

## SOLVING LINEAR EQUATIONS

LINEAR EQUATIONS ARE FUNDAMENTAL TO ALGEBRA. A LINEAR EQUATION IN ONE VARIABLE IS AN EQUATION THAT CAN BE WRITTEN IN THE FORM  $Ax + B = C$ , WHERE A, B, AND C ARE CONSTANTS, AND A IS NOT ZERO. THE GOAL OF SOLVING A LINEAR EQUATION IS TO ISOLATE THE VARIABLE (USUALLY 'X') ON ONE SIDE OF THE EQUALS SIGN. THIS IS ACHIEVED BY APPLYING INVERSE OPERATIONS TO BOTH SIDES OF THE EQUATION TO MAINTAIN EQUALITY.

# THE GOLDEN RULE OF SOLVING EQUATIONS

THE MOST CRITICAL PRINCIPLE WHEN SOLVING ANY EQUATION IS THE "GOLDEN RULE": WHATEVER OPERATION YOU PERFORM ON ONE SIDE OF THE EQUATION, YOU MUST PERFORM THE EXACT SAME OPERATION ON THE OTHER SIDE. THIS ENSURES THAT THE EQUATION REMAINS BALANCED AND THE SOLUTION REMAINS VALID. FOR INSTANCE, IF YOU NEED TO UNDO ADDITION, YOU SUBTRACT; TO UNDO MULTIPLICATION, YOU DIVIDE.

## STEPS FOR SOLVING LINEAR EQUATIONS

TO SOLVE A LINEAR EQUATION, FOLLOW THESE GENERAL STEPS:

- SIMPLIFY BOTH SIDES OF THE EQUATION BY COMBINING LIKE TERMS AND DISTRIBUTING IF NECESSARY.
- ISOLATE THE VARIABLE TERM BY ADDING OR SUBTRACTING TERMS FROM BOTH SIDES OF THE EQUATION.
- ISOLATE THE VARIABLE ITSELF BY MULTIPLYING OR DIVIDING BOTH SIDES OF THE EQUATION BY THE COEFFICIENT OF THE VARIABLE.
- CHECK YOUR SOLUTION BY SUBSTITUTING THE OBTAINED VALUE BACK INTO THE ORIGINAL EQUATION.

FOR EXAMPLE, TO SOLVE ' $2x + 3 = 7$ ', FIRST SUBTRACT 3 FROM BOTH SIDES: ' $2x = 4$ '. THEN, DIVIDE BOTH SIDES BY 2: ' $x = 2$ '. SUBSTITUTING 2 BACK INTO THE ORIGINAL EQUATION, ' $2(2) + 3 = 4 + 3 = 7$ ', CONFIRMS THE SOLUTION.

## WORKING WITH INEQUALITIES

INEQUALITIES ARE MATHEMATICAL STATEMENTS THAT COMPARE TWO EXPRESSIONS USING SYMBOLS SUCH AS ' $<$ ' (LESS THAN), ' $>$ ' (GREATER THAN), ' $\leq$ ' (LESS THAN OR EQUAL TO), AND ' $\geq$ ' (GREATER THAN OR EQUAL TO). SOLVING INEQUALITIES IS SIMILAR TO SOLVING EQUATIONS, BUT THERE'S A CRUCIAL DIFFERENCE WHEN MULTIPLYING OR DIVIDING BY A NEGATIVE NUMBER.

## PROPERTIES OF INEQUALITIES

WHEN YOU ADD OR SUBTRACT THE SAME NUMBER FROM BOTH SIDES OF AN INEQUALITY, THE INEQUALITY SIGN REMAINS THE SAME. FOR EXAMPLE, IF ' $x + 5 > 10$ ', SUBTRACTING 5 FROM BOTH SIDES GIVES ' $x > 5$ '. HOWEVER, IF YOU MULTIPLY OR DIVIDE BOTH SIDES OF AN INEQUALITY BY A NEGATIVE NUMBER, YOU MUST REVERSE THE DIRECTION OF THE INEQUALITY SIGN. FOR INSTANCE, IF ' $-2x < 6$ ', DIVIDING BY  $-2$  REVERSES THE SIGN, RESULTING IN ' $x > -3$ '.

## GRAPHICAL REPRESENTATION OF INEQUALITIES

THE SOLUTIONS TO INEQUALITIES ARE OFTEN REPRESENTED ON A NUMBER LINE. AN OPEN CIRCLE IS USED FOR ' $<$ ' AND ' $>$ ' TO INDICATE THAT THE ENDPOINT IS NOT INCLUDED IN THE SOLUTION SET, WHILE A CLOSED CIRCLE IS USED FOR ' $\leq$ ' AND ' $\geq$ ' TO SHOW THAT THE ENDPOINT IS INCLUDED. THE DIRECTION OF THE INEQUALITY DETERMINES WHICH SIDE OF THE ENDPOINT THE SOLUTION SET LIES.

## EXPLORING POLYNOMIALS AND FACTORING

POLYNOMIALS ARE EXPRESSIONS CONSISTING OF VARIABLES AND COEFFICIENTS, INVOLVING ONLY THE OPERATIONS OF ADDITION, SUBTRACTION, MULTIPLICATION, AND NON-NEGATIVE INTEGER EXPONENTS OF VARIABLES. THEY ARE FUNDAMENTAL TO MANY AREAS OF MATHEMATICS. COMMON EXAMPLES INCLUDE ' $x^2 + 2x - 3$ ' AND ' $5y^3 - y$ '.

## OPERATIONS WITH POLYNOMIALS

ADDING AND SUBTRACTING POLYNOMIALS INVOLVES COMBINING LIKE TERMS, SIMILAR TO SIMPLIFYING EXPRESSIONS. MULTIPLYING POLYNOMIALS, HOWEVER, REQUIRES DISTRIBUTING EACH TERM IN THE FIRST POLYNOMIAL TO EVERY TERM IN THE SECOND POLYNOMIAL. FOR EXAMPLE, TO MULTIPLY  $(x + 2)(x + 3)$ , YOU WOULD GET  $x(x) + x(3) + 2(x) + 2(3)$ , WHICH SIMPLIFIES TO  $x^2 + 3x + 2x + 6$ , AND FURTHER TO  $x^2 + 5x + 6$ .

## FACTORING POLYNOMIALS

FACTORING IS THE PROCESS OF BREAKING DOWN A POLYNOMIAL INTO A PRODUCT OF SIMPLER POLYNOMIALS, OFTEN CALLED FACTORS. THIS IS ESSENTIALLY THE REVERSE OF MULTIPLICATION. COMMON FACTORING TECHNIQUES INCLUDE:

- FACTORING OUT THE GREATEST COMMON FACTOR (GCF).
- FACTORING QUADRATIC TRINOMIALS (POLYNOMIALS WITH THREE TERMS).
- FACTORING THE DIFFERENCE OF SQUARES AND SUM/DIFFERENCE OF CUBES.

FOR EXAMPLE, THE QUADRATIC TRINOMIAL  $x^2 + 5x + 6$  CAN BE FACTORED INTO  $(x + 2)(x + 3)$ . UNDERSTANDING FACTORING IS ESSENTIAL FOR SOLVING POLYNOMIAL EQUATIONS AND SIMPLIFYING RATIONAL EXPRESSIONS.

## RATIONAL EXPRESSIONS AND EQUATIONS

A RATIONAL EXPRESSION IS AN ALGEBRAIC FRACTION WHERE BOTH THE NUMERATOR AND THE DENOMINATOR ARE POLYNOMIALS. THESE EXPRESSIONS ARE SIMILAR TO FRACTIONS WITH NUMBERS, BUT THEY INVOLVE ALGEBRAIC TERMS. AN EXAMPLE IS  $(x + 1) / (x - 2)$ .

## SIMPLIFYING RATIONAL EXPRESSIONS

SIMPLIFYING RATIONAL EXPRESSIONS INVOLVES FACTORING BOTH THE NUMERATOR AND THE DENOMINATOR AND THEN CANCELING OUT ANY COMMON FACTORS. IT'S IMPORTANT TO NOTE ANY VALUES OF THE VARIABLE THAT WOULD MAKE THE DENOMINATOR ZERO, AS THESE ARE EXCLUDED FROM THE DOMAIN OF THE EXPRESSION. FOR INSTANCE, IN  $(x^2 - 4) / (x - 2)$ , THE NUMERATOR FACTORS AS  $(x - 2)(x + 2)$ . CANCELING OUT  $(x - 2)$  LEAVES  $x + 2$ , WITH THE RESTRICTION THAT  $x \neq 2$ .

## SOLVING RATIONAL EQUATIONS

TO SOLVE A RATIONAL EQUATION, WHICH IS AN EQUATION CONTAINING ONE OR MORE RATIONAL EXPRESSIONS, YOU TYPICALLY MULTIPLY BOTH SIDES OF THE EQUATION BY THE LEAST COMMON DENOMINATOR (LCD) OF ALL THE FRACTIONS INVOLVED. THIS CLEARS THE DENOMINATORS AND TRANSFORMS THE EQUATION INTO A SIMPLER FORM, USUALLY A POLYNOMIAL EQUATION, WHICH CAN THEN BE SOLVED USING STANDARD TECHNIQUES. ALWAYS CHECK YOUR SOLUTIONS IN THE ORIGINAL EQUATION TO ENSURE THEY ARE NOT EXTRANEIOUS (VALUES THAT MAKE A DENOMINATOR ZERO).

## INTRODUCTION TO FUNCTIONS

A FUNCTION IS A FUNDAMENTAL CONCEPT IN ALGEBRA THAT DESCRIBES A RELATIONSHIP BETWEEN AN INPUT AND AN OUTPUT, WHERE EACH INPUT HAS EXACTLY ONE OUTPUT. FUNCTIONS CAN BE REPRESENTED IN VARIOUS WAYS: THROUGH EQUATIONS, TABLES, GRAPHS, OR VERBAL DESCRIPTIONS. THE NOTATION  $f(x)$  IS COMMONLY USED TO REPRESENT A FUNCTION, WHERE  $x$  IS THE INPUT (THE INDEPENDENT VARIABLE) AND  $f(x)$  IS THE OUTPUT (THE DEPENDENT VARIABLE).

# UNDERSTANDING DOMAIN AND RANGE

THE DOMAIN OF A FUNCTION IS THE SET OF ALL POSSIBLE INPUT VALUES (X-VALUES) FOR WHICH THE FUNCTION IS DEFINED. THE RANGE OF A FUNCTION IS THE SET OF ALL POSSIBLE OUTPUT VALUES (Y-VALUES OR  $f(x)$ -VALUES) THAT THE FUNCTION CAN PRODUCE. FOR EXAMPLE, IN THE FUNCTION ' $f(x) = x^2$ ', THE DOMAIN IS ALL REAL NUMBERS, BUT THE RANGE IS ALL NON-NEGATIVE REAL NUMBERS ( $y \geq 0$ ).

## TYPES OF FUNCTIONS

COLLEGE ALGEBRA INTRODUCES VARIOUS TYPES OF FUNCTIONS, EACH WITH UNIQUE PROPERTIES AND GRAPHICAL REPRESENTATIONS. SOME COMMON TYPES INCLUDE:

- LINEAR FUNCTIONS: ' $f(x) = mx + b$ ', GRAPHED AS A STRAIGHT LINE.
- QUADRATIC FUNCTIONS: ' $f(x) = ax^2 + bx + c$ ', GRAPHED AS A PARABOLA.
- POLYNOMIAL FUNCTIONS: GENERALIZATIONS OF QUADRATIC FUNCTIONS WITH HIGHER POWERS OF  $x$ .
- RATIONAL FUNCTIONS: FUNCTIONS EXPRESSED AS A RATIO OF TWO POLYNOMIALS.
- EXPONENTIAL AND LOGARITHMIC FUNCTIONS: FUNCTIONS INVOLVING EXPONENTS AND THEIR INVERSES.

UNDERSTANDING THESE DIFFERENT TYPES AND THEIR CHARACTERISTICS IS KEY TO MASTERING ALGEBRA.

## GRAPHING LINEAR AND QUADRATIC FUNCTIONS

GRAPHING FUNCTIONS PROVIDES A VISUAL REPRESENTATION OF THEIR BEHAVIOR AND RELATIONSHIPS BETWEEN VARIABLES. THE CARTESIAN COORDINATE SYSTEM, WITH ITS X-AXIS AND Y-AXIS, IS USED TO PLOT POINTS AND VISUALIZE FUNCTION GRAPHS.

### GRAPHING LINEAR FUNCTIONS

LINEAR FUNCTIONS, OF THE FORM ' $y = mx + b$ ', ARE GRAPHED AS STRAIGHT LINES. THE ' $m$ ' REPRESENTS THE SLOPE, WHICH INDICATES THE STEEPNESS AND DIRECTION OF THE LINE, AND ' $b$ ' REPRESENTS THE Y-INTERCEPT, THE POINT WHERE THE LINE CROSSES THE Y-AXIS. TO GRAPH A LINEAR FUNCTION, YOU CAN PLOT THE Y-INTERCEPT AND THEN USE THE SLOPE TO FIND AT LEAST ONE OTHER POINT, OR SIMPLY CHOOSE TWO X-VALUES, CALCULATE THEIR CORRESPONDING Y-VALUES, AND DRAW A LINE THROUGH THESE POINTS.

### GRAPHING QUADRATIC FUNCTIONS

QUADRATIC FUNCTIONS, OF THE FORM ' $f(x) = ax^2 + bx + c$ ', ARE GRAPHED AS PARABOLAS. THE SHAPE OF THE PARABOLA (OPENING UPWARDS OR DOWNWARDS) IS DETERMINED BY THE SIGN OF THE COEFFICIENT ' $a$ '. THE VERTEX OF THE PARABOLA IS A KEY FEATURE, REPRESENTING EITHER THE MINIMUM OR MAXIMUM VALUE OF THE FUNCTION. TECHNIQUES LIKE FINDING THE X-COORDINATE OF THE VERTEX USING ' $-b/(2a)$ ' AND THEN CALCULATING THE CORRESPONDING Y-COORDINATE HELP IN ACCURATELY SKETCHING THE PARABOLA. UNDERSTANDING TRANSFORMATIONS OF BASIC QUADRATIC GRAPHS CAN ALSO SIMPLIFY GRAPHING.

FAQ SECTION:

## **Q: WHAT IS THE MOST IMPORTANT CONCEPT TO GRASP IN COLLEGE ALGEBRA BASICS?**

A: THE MOST CRUCIAL CONCEPT IS UNDERSTANDING VARIABLES AND HOW TO MANIPULATE ALGEBRAIC EXPRESSIONS AND EQUATIONS USING THEM. THIS FORMS THE FOUNDATION FOR NEARLY ALL OTHER TOPICS.

## **Q: HOW DO I KNOW IF I HAVE SOLVED AN EQUATION CORRECTLY?**

A: THE BEST WAY TO CHECK YOUR SOLUTION IS TO SUBSTITUTE THE VALUE YOU FOUND FOR THE VARIABLE BACK INTO THE ORIGINAL EQUATION. IF BOTH SIDES OF THE EQUATION ARE EQUAL, YOUR SOLUTION IS CORRECT.

## **Q: WHAT IS THE DIFFERENCE BETWEEN AN EQUATION AND AN INEQUALITY?**

A: AN EQUATION USES AN EQUALS SIGN ( $=$ ) TO STATE THAT TWO EXPRESSIONS HAVE THE SAME VALUE, WHILE AN INEQUALITY USES SYMBOLS LIKE  $<$ ,  $>$ ,  $\leq$ , OR  $\geq$  TO STATE THAT ONE EXPRESSION IS LESS THAN, GREATER THAN, LESS THAN OR EQUAL TO, OR GREATER THAN OR EQUAL TO ANOTHER.

## **Q: WHY IS FACTORING IMPORTANT IN COLLEGE ALGEBRA?**

A: FACTORING IS ESSENTIAL FOR SIMPLIFYING COMPLEX EXPRESSIONS, SOLVING POLYNOMIAL EQUATIONS, AND WORKING WITH RATIONAL EXPRESSIONS. IT ALLOWS YOU TO BREAK DOWN PROBLEMS INTO SIMPLER, MANAGEABLE PARTS.

## **Q: CAN YOU EXPLAIN THE CONCEPT OF A FUNCTION IN SIMPLER TERMS?**

A: THINK OF A FUNCTION AS A MACHINE. YOU PUT SOMETHING IN (THE INPUT, USUALLY ' $x$ '), AND THE MACHINE DOES SOMETHING TO IT, GIVING YOU A SPECIFIC OUTPUT (THE OUTPUT, USUALLY ' $f(x)$ '). FOR EVERY INPUT, THERE'S ONLY ONE OUTPUT.

## **Q: WHAT ARE THE COMMON MISTAKES STUDENTS MAKE WHEN GRAPHING FUNCTIONS?**

A: COMMON MISTAKES INCLUDE MISINTERPRETING THE SLOPE IN LINEAR GRAPHS, INCORRECTLY CALCULATING THE VERTEX FOR QUADRATIC GRAPHS, AND FORGETTING TO CONSIDER THE DOMAIN AND RANGE RESTRICTIONS FOR VARIOUS FUNCTION TYPES.

## **Q: HOW DOES THE ORDER OF OPERATIONS (PEMDAS/BODMAS) APPLY TO COLLEGE ALGEBRA?**

A: THE ORDER OF OPERATIONS IS CRITICAL FOR CORRECTLY EVALUATING EXPRESSIONS, SIMPLIFYING THEM, AND SOLVING EQUATIONS AND INEQUALITIES. IT ENSURES CONSISTENCY IN MATHEMATICAL CALCULATIONS.

## **Q: WHAT ARE EXTRANEIOUS SOLUTIONS IN THE CONTEXT OF RATIONAL EQUATIONS?**

A: EXTRANEIOUS SOLUTIONS ARE VALUES THAT APPEAR TO BE SOLUTIONS TO A TRANSFORMED EQUATION BUT DO NOT SATISFY THE ORIGINAL RATIONAL EQUATION, USUALLY BECAUSE THEY MAKE A DENOMINATOR ZERO. THEY MUST BE IDENTIFIED AND DISCARDED.

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