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## Introduction to Algebraic Expressions and Identities

### Algebraic Expressions

**Algebraic expressions** are expressions made up of **variables** and **constants** along with mathematical operators. Algebraic expressions have no sides or equal to sign like algebraic equations.
Examples of algebraic expressions are: $2x+4$, $7y-3+6x$, $3t^2+4t-1$.

### Terms

**Terms** are the **individual building blocks** of expressions. They add up to form expressions. A term is a **product** of its **factors**.
For example, the expression $5xy - 3$, is made up of two terms, $5xy$ and $(-3)$.

### Factors

**Factors** are those **variables** or **constants**, whose **product** form a **term** of an expression.
For example, $8$, $p$ and $q$ are the factors of the term $8pq$.
Factors are such that they can not be factorised further.

*The product of factors forms a term and the summation of the terms forms an expression.*

### Coefficients

The **numerical factor** of a term is called the **coefficient** of that **term**.
For the terms, $6y$ and $2xy$, the coefficient of $6y$ is 6 and the coefficient of $2xy$ is 2.

### Like Terms

**Like terms** are those terms which have **same variables** raised to the **same power**. Like terms have same **algebraic factors**. The **numerical coefficient** of like terms can be **different**.
For example, $3x^2y$ and $5x^2y$ are like terms.

### Monomial

An **expression** with only **one term** is called a **monomial**.
Examples of monomials: $6x$, $7pq$, $x^2y$, $9xyz$ , $4bc$ etc.

### Binomial

An **expression** which contains two **unlike terms** is called a **binomial**.
Examples of binomials: $4y-3z$, $x6-2$, $pq+1$, etc.

## Polynomial

**Expressions** that have more than **two terms** with **non-zero coefficients** and variables having **non-negative integral exponents** are called polynomials.
Examples: a+b+c+2, 7xy−8x+2+3y, $5t^3$−7t+k+3.

## Algebraic Identities

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

## Addition and Subtraction of Algebraic Expressions

❖ When we are **adding** or **subtracting** two **algebraic expressions**, we can only add or subtract **like terms**.

❖ The sum of two or more like terms is a like term, with a **numerical coefficient** equal to the **sum of the numerical coefficient** of all the like terms.

❖ Similarly, the difference between two like terms is a like term with a **numerical coefficient** equal to the **difference between the numerical coefficients** of the two like terms.

Suppose if we have to add $3x^2y+y+z$ and $4x^2y+7a+5z$, we will combine all the like terms and then add their numerical coefficients.

$(3x^2y + 4x^2y) + (y) + (7a) + (z + 5z) = 7x^2y + y + 7a + 6z$

## Multiplication of Algebraic Expressions

## Multiplication of Monomials

When we multiply two monomials:

- the numerical coefficient of the terms is equal to the product of the numerical coefficient of both the terms.
- the exponent or power of each algebraic factor is equal to the sum of the exponents of that algebraic factor in both the monomials.

Multiplying two monomials:

- x×3y = x×3×y = 3×x×y = 3xy
- 3x×2y = 3×x×2×y = 3×2×x×y = 6xy
- 5x×(−2z) = 5×(−2)×x×z = −10xz

Multiplying three or more monomials:

- 2x × 3y × 5z = (2x×3y) × 5z = 6xy × 5z = 30xyz
- $4xy × 5x^2y^2 × 6x^3y^3 = (4xy×5x^2y^2) × 6x^3y^3 = 20x^3y^3 × 6x^3y^3 = 120x^6y^6$

## Distributive Property of Multiplication

The distributive property is an algebraic property that is used to multiply a **single value** and two or more values within a set of parenthesis.
Consider the expression : 6 × (2+4x)
=(6×2) + (6×4x)
=12 + 24x
Here, we have used **distributive law** to multiply a monomial and a binomial.

## Multiplication of any Polynomial

When we multiply any two polynomials, we multiply **all the terms or monomials** of one polynomial with **all the terms** of another polynomial.

When we multiply two binomials, every term in one binomial multiplies every term in the other binomial.

- Multiplying a binomial by a binomial

(3a + 4b) × (2a + 3b)

= 3a × (2a + 3b) + 4b × (2a + 3b)

= (3a × 2a) + (3a × 3b) + (4b × 2a) + (4b × 3b)

= $6a^2$ + 9ab + 8ab + $12b^2$

= $6a^2$ + 17ab + $12b^2$

When we multiply a binomial by a trinomial, each of the three terms of the trinomial is multiplied by each of the two terms of the binomial.

- Multiplying a binomial by a trinomial

(p + 4) × ($p^2$ + 2p + 3)

= p × ($p^2$ + 2p + 3) + 4 × ($p^2$ + 2p + 3)

= ($p^3$ + $2p^2$ + 3p) + ($4p^2$ + 8p + 12)

= $p^3$ + $6p^2$ + 11p + 12