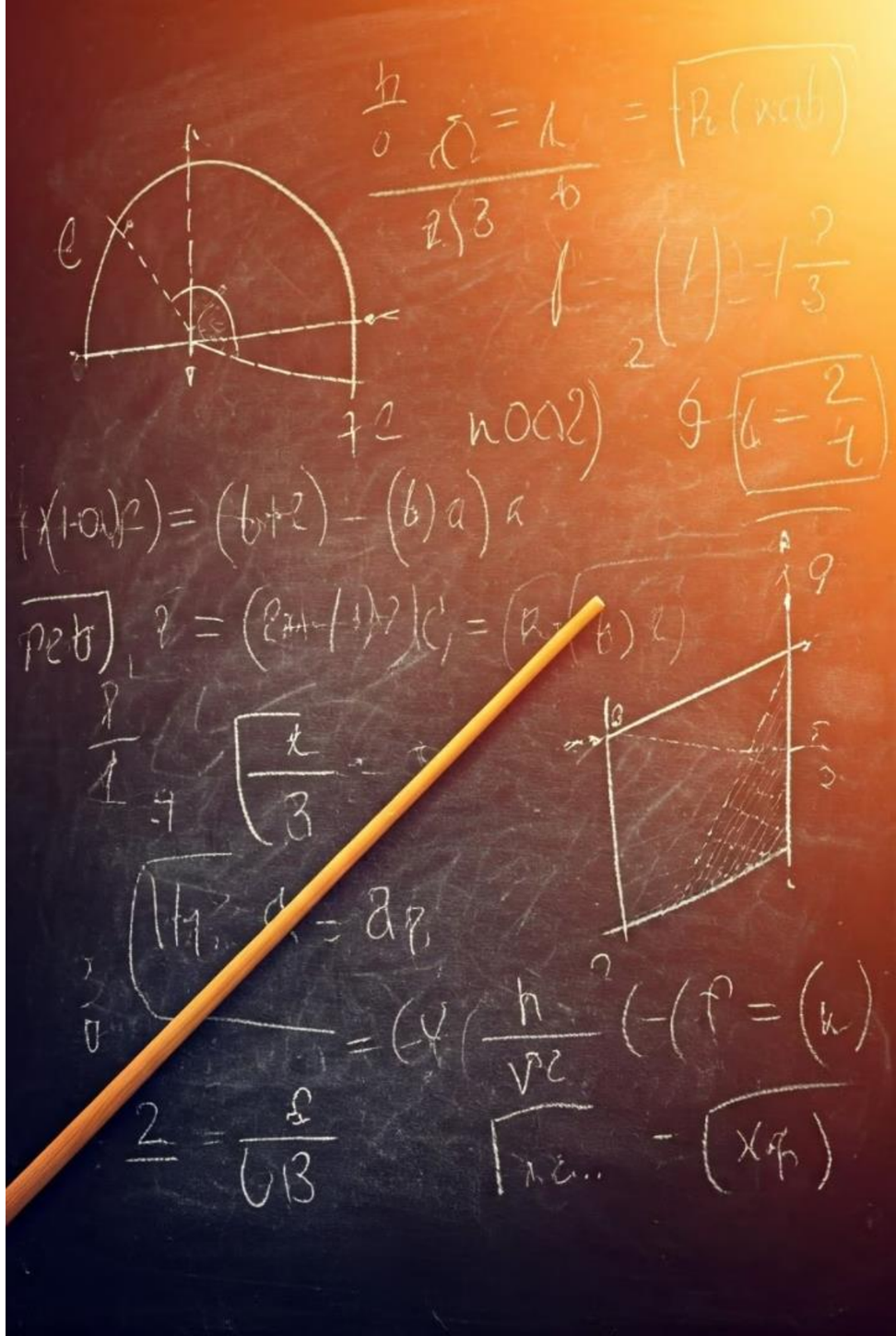
Engineering Mathematics: A Comprehensive Guide

Welcome to Engineering Mathematics for the academic year 2024-2025. This course covers essential mathematical concepts for Computer Information Technology students, taught Ahmed Mohamed Farah. Throughout the semester, we'll explore seven key chapters: Arithmetic, Introduction to Algebra, Expressions and Equations, Linear Equations, Polynomial Equations, Partial Fractions, and Trigonometry.

Your performance will be evaluated through a mid-term exam (30%), quizzes, homework and attendance (20%), and a final exam (50%). This presentation will guide you through the fundamental concepts of arithmetic that form the foundation of engineering mathematics.

AF **Ahmed Mohamed Farah**



Types of Numbers and Basic Operations

Natural and Whole Numbers

Natural numbers (N) are counting numbers from 1, 2, 3...9, while whole numbers (W) include zero: 0, 1, 2, 3...9. These can be represented as points on a number line, with order relationships (<, >) showing their relative positions.

Integers

Integers include positive and negative whole numbers and zero. When working with negative numbers, use brackets to separate the minus sign from arithmetic operations. For example, write 5 − (−3) instead of 5 − −3.

Basic Operations

Addition gives the sum, subtraction gives the difference, multiplication gives the product, and division gives the quotient. Remember that adding a negative number is the same as subtracting its positive counterpart, and vice versa.

Order of Operations and Arithmetic Laws Laws

Brackets First

Always evaluate expressions inside brackets first to remove ambiguity in calculations.

Division and Multiplication

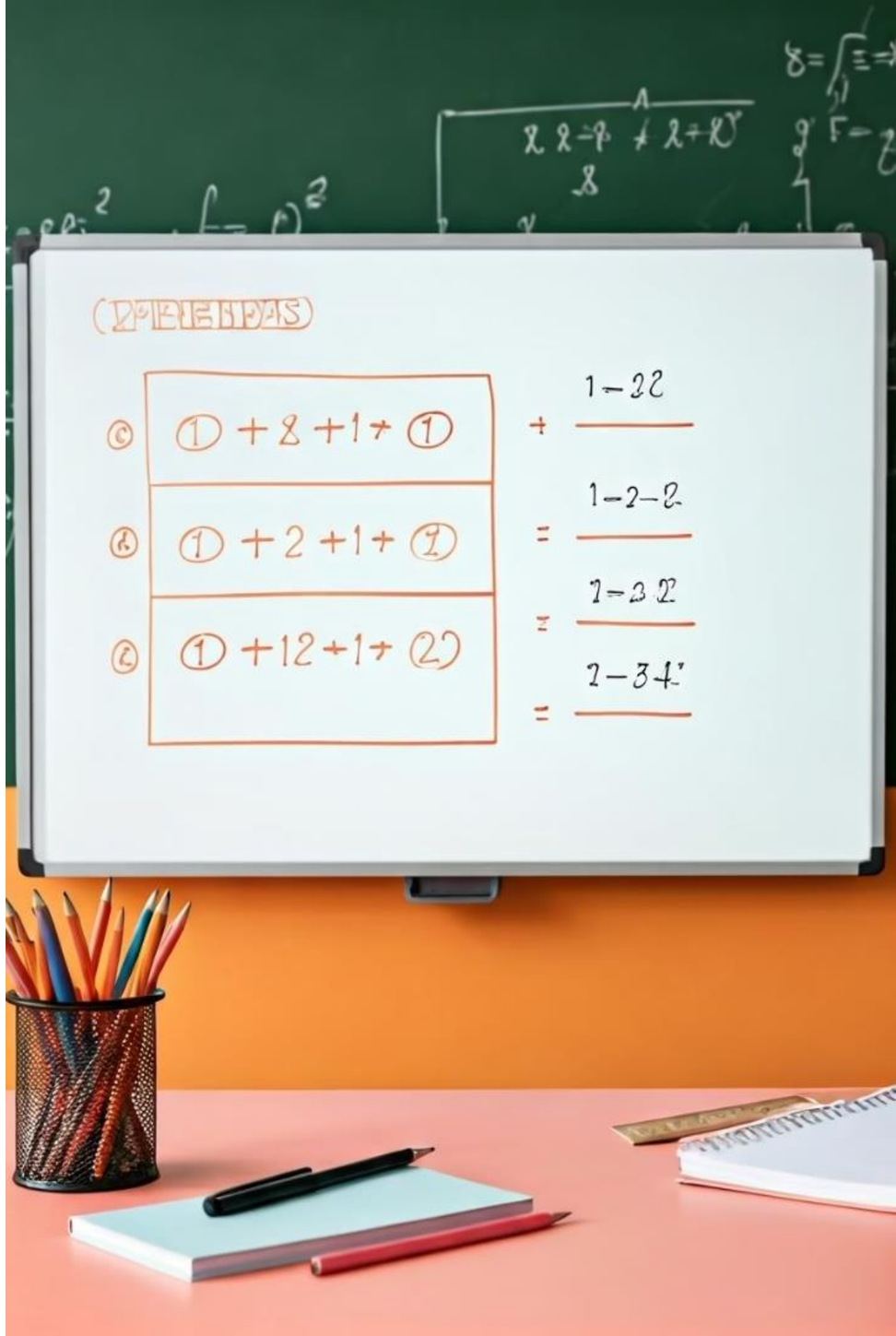
Working from left to right, evaluate divisions and multiplications as they are encountered.

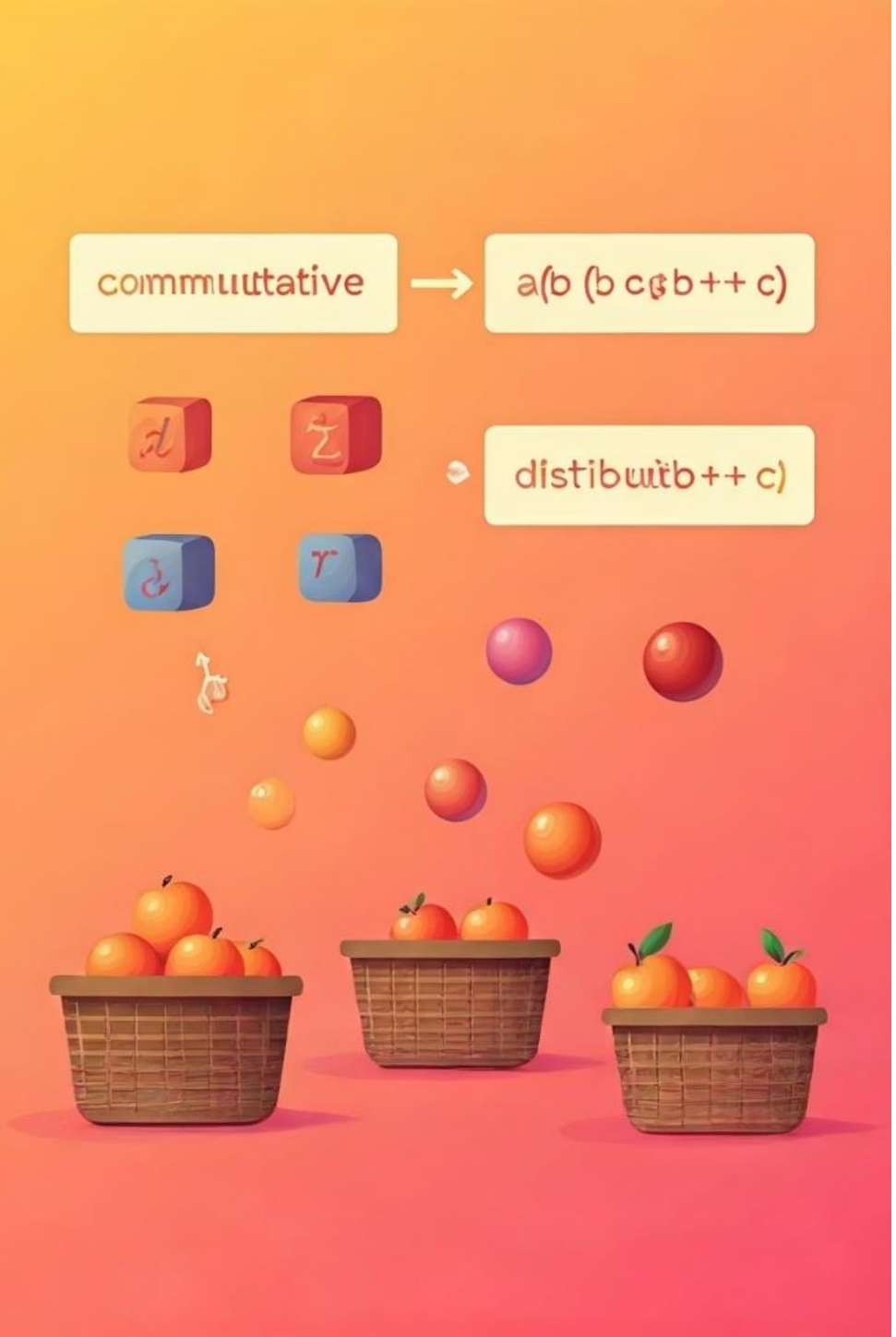
Addition and Subtraction

Finally, working from left to right, evaluate additions and subtractions as they are encountered.

BODMAS Rule

Remember the BODMAS rule: Brackets, Orders (powers), Division, Multiplication, Addition, Subtraction.





Basic Laws of Arithmetic

Commutative Law

Two integers can be added or multiplied in either order without affecting the result. For example: 5 + 8 = 8 + 5 = 13 and 5 × 8 = 8 × 5 = 40. Addition and multiplication are commutative operations.

Associative Law

The way in which three or more integers are associated under addition or multiplication does not affect the result. For example: 3 + (4 + 5) = (3 + 4) + 5 = 12 and 3 × (4 × 5) = (3 × 4) × 5 = 60.

Distributive Law

Multiplication is distributed over addition and subtraction from both left and right. For example: 3(4 + 5) = (3 × 4) + (3 × 5) = 12 + 15 = 27. Division is distributed over addition and subtraction from the right but not the left.

Factors and Prime Numbers

Factors

Any two natural numbers are called the factors of their product. For example, the factors of 18 are 1, 2, 3, 6, 9, and 18.

Prime Numbers

A prime number has only two factors: itself and 1. Examples include 2, 3, 5, 7, 11, 13, 17, 19, 23, etc. Note that 1 is not considered a prime number.

Prime Factorization

Every natural number can be written as a product involving only prime factors. For example, $126 = 2 \times 3^2 \times 7$.

HCF and LCM

The Highest Common Factor (HCF) is the largest factor common to two numbers. The Lowest Common Multiple (LCM) is the smallest number that both numbers divide into evenly.

Highest Common Factor (HCF) and Lowest Common Multiple (LCM)

Highest Common Factor (HCF)

The greatest factor shared by two numbers. Example: HCF of 144 and 66 is 6.

Finding HCF helps simplify fractions and solve problems involving ratios.

Lowest Common Multiple (LCM)

The smallest number divisible by both numbers. Example: LCM of 144 and 66 is 1584.

LCM is essential in adding and subtracting fractions with different denominators.

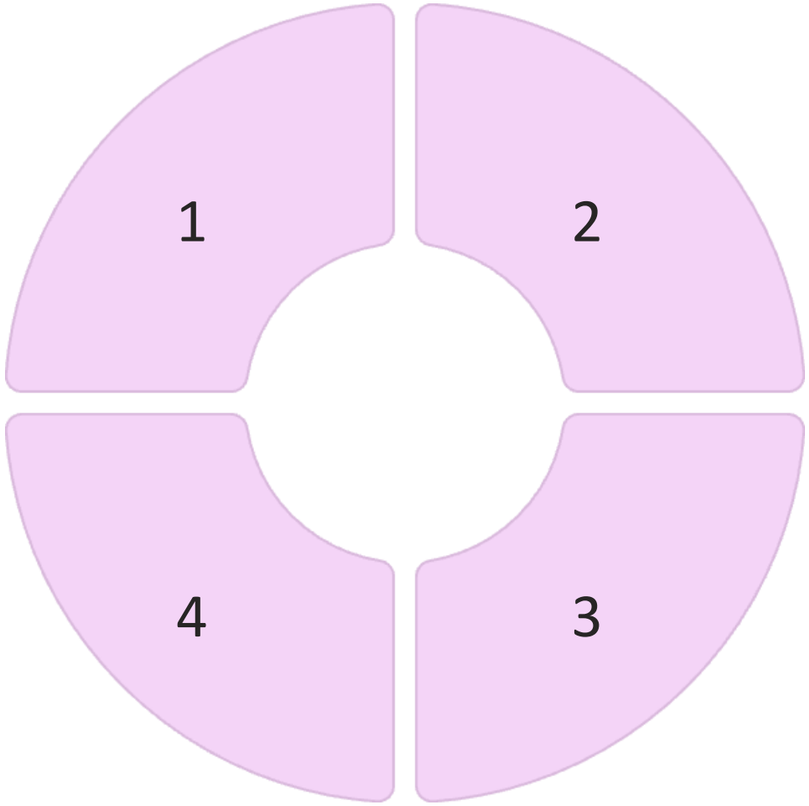
Fractions and Decimals

Types of Fractions

Fractions can be proper (numerator smaller than denominator), improper (numerator larger than denominator), or mixed (integer plus fraction).

Decimals

Fractions can be converted to decimals by division. Decimals can be rounded to a specific number of decimal places or significant figures.



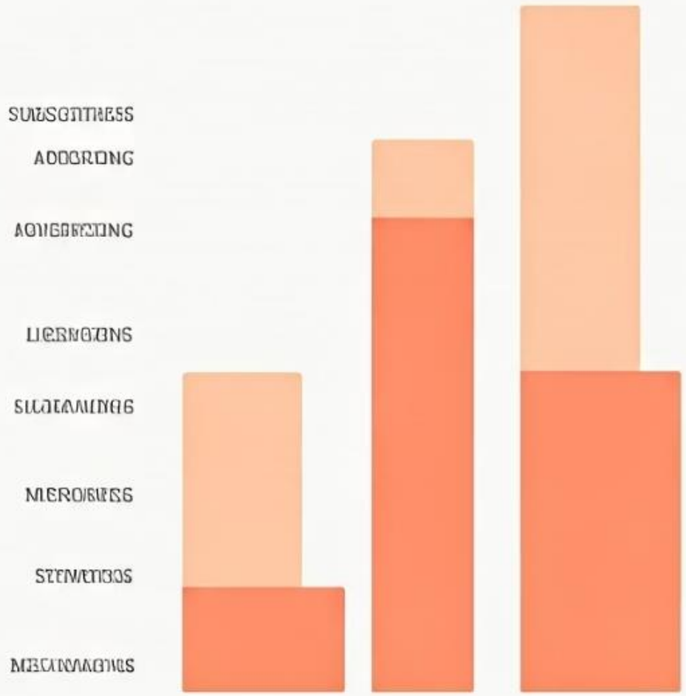
Operations with Fractions

Multiplication: multiply numerators and denominators independently.

Division: invert the divisor and multiply.

Addition and Subtraction

Fractions must have the same denominator to be added or subtracted directly. Otherwise, find equivalent fractions with a common denominator.



Ratio and Percentage Concepts in Arithmetic

Ratio

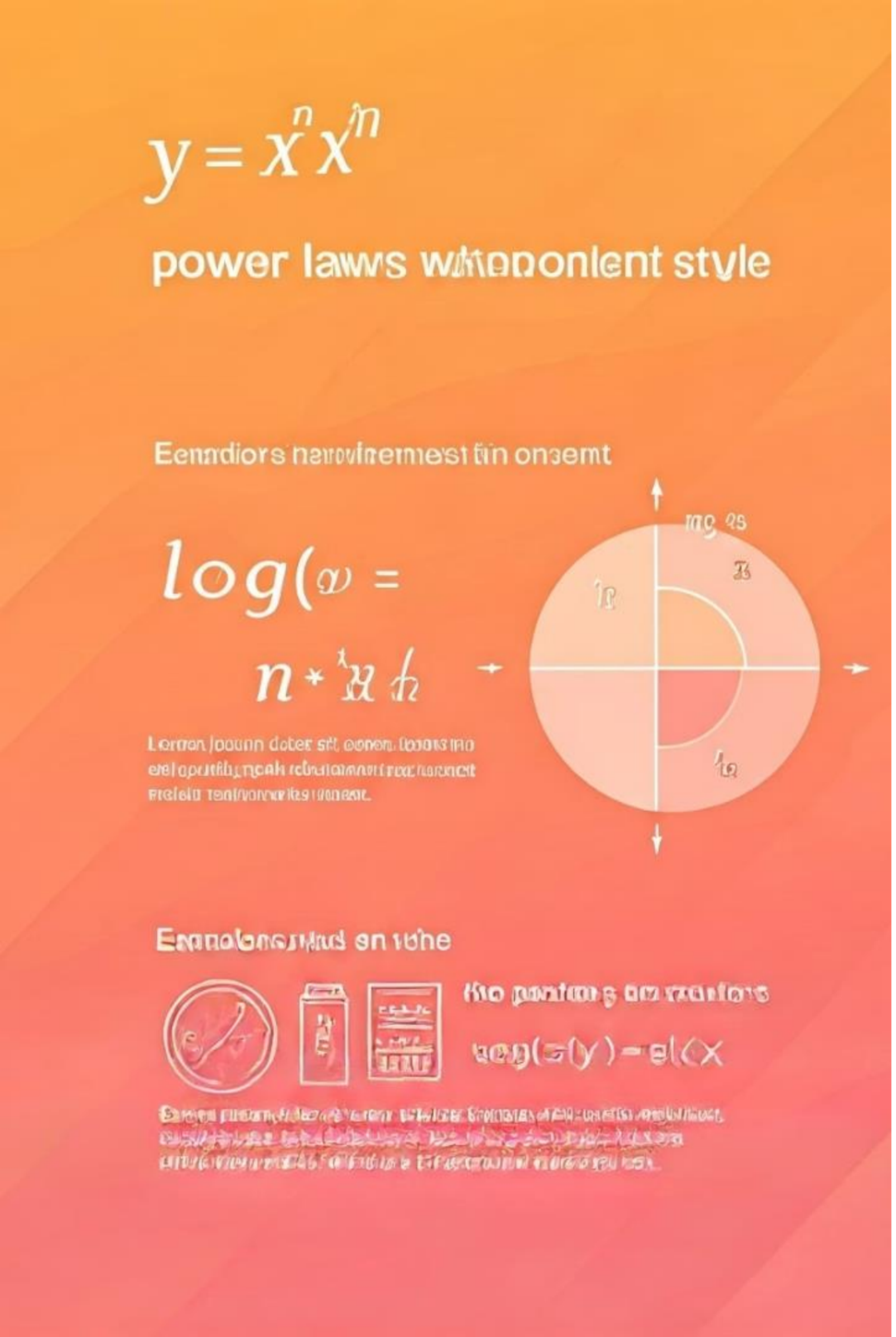
Expresses a relationship between quantities, e.g., salt to water ratio of 1:2 indicates salt is one-third of the mixture.

Percentage

A fraction with denominator 100, shown using the % symbol. For example, 5% means 5 out of 100.

Percentage Example

If 12 resistors out of 25 are defective, the defect rate is (12/25)×100% = 48% defects.



Powers and Roots

Raising to a Power

The power (or index) indicates repetitive multiplication. For example: $10^4 = 10 \times 10 \times 10 \times 10$.

Multiplication of Powers

When multiplying numbers with the same base, add the powers: a^m × a^n = a^(m+n).

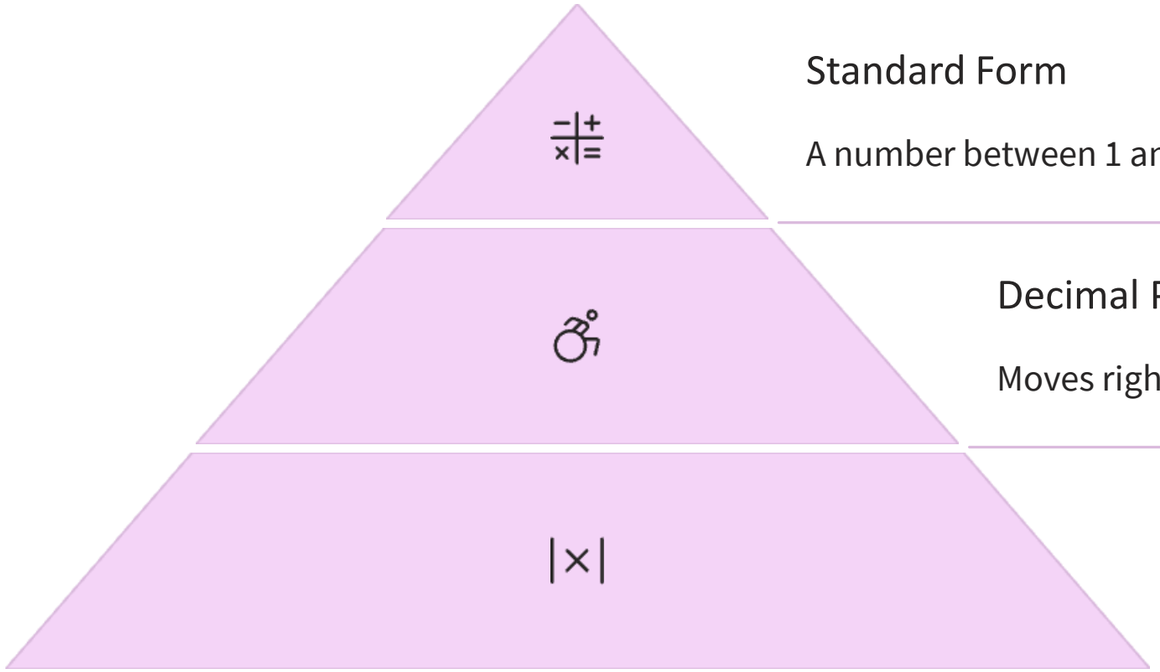
Division of Powers

When dividing numbers with the same base, subtract the powers: a^m ÷ a^n = a^(m-n).

Fractional Powers

Fractional powers denote roots. For example: 8^(1/3) = $\sqrt[3]{8}$ = 2.

Standard Form and Scientific Notation



Standard Form

A number between 1 and 10 multiplied by a power of 10

Decimal Point Movement

Moves right for positive powers, left for negative

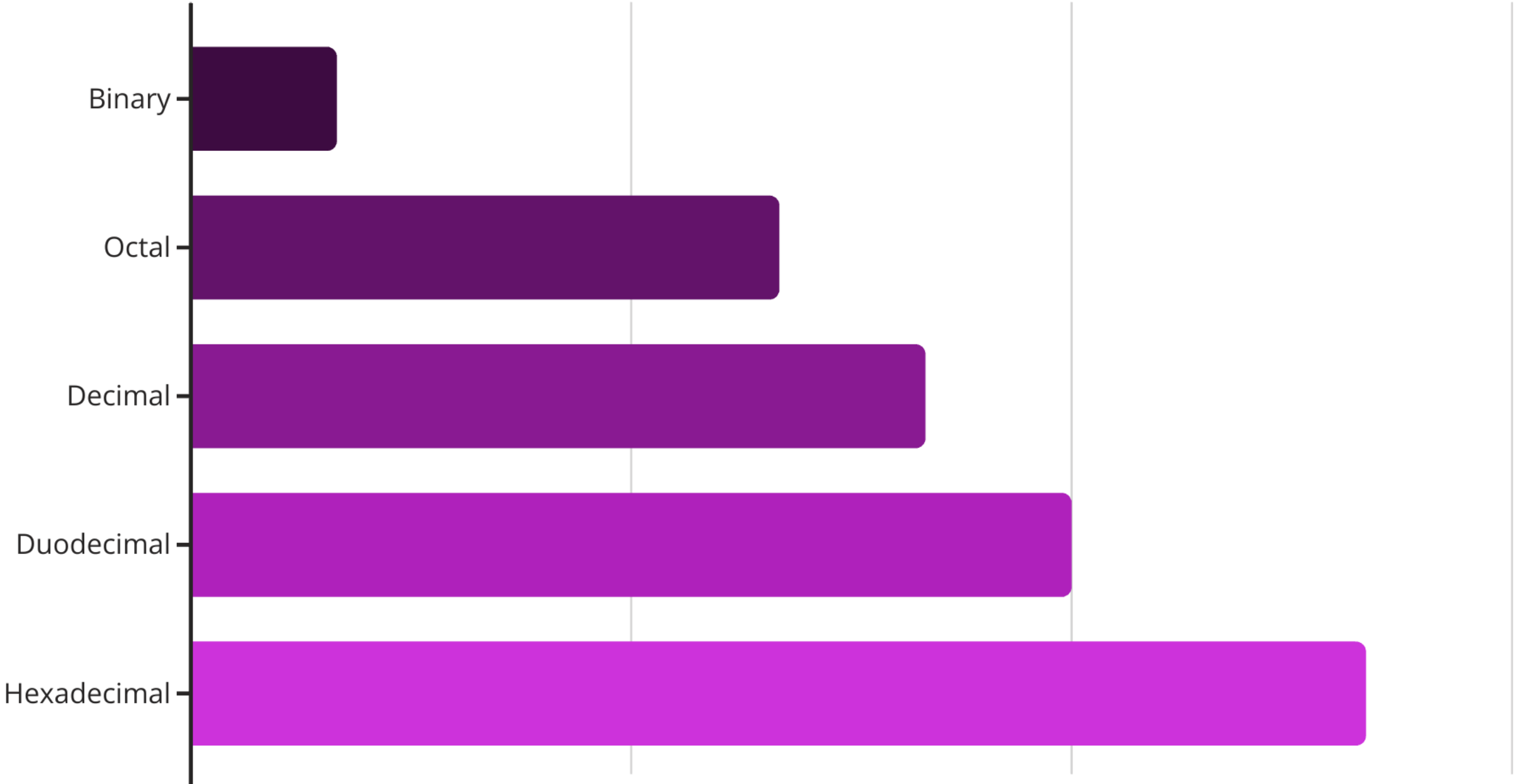
Operations in Standard Form

Multiply/divide mantissas, add/subtract exponents

Any decimal number can be written in standard form as a decimal number greater than or equal to 1 and less than 10 (the mantissa) multiplied by 10 raised to an appropriate power (the exponent). For example, $57.3 = 5.73 \times 10^{1}$, $0.267 = 2.67 \times 10^{-1}$, and $0.000485 = 4.85 \times 10^{-4}$.

When multiplying or dividing numbers in standard form, multiply or divide the mantissas and add or subtract the exponents. Preferred standard form restricts the exponent to being a multiple of 3.

Number Systems Beyond Decimal



Number Systems: Denary, Binary, Octal, Duodecimal, Hexadecimal

Denary (Base 10)

Uses digits 0-9; place values are powers of 10. Example: 246 = 2×100 + 4×10 + 6.

It's the standard counting system used daily.

Binary (Base 2)

Uses digits 0 and 1; place values powers of 2. Example: $1011.101_{2} = 11.625_{10}$.

Foundational system for digital electronics and computing.

Octal (Base 8)

Digits 0-7; place values powers of 8. Example: $357.321_{8} = 239.408_{10}$.

Duodecimal (Base 12) & Hexadecimal (Base 16)

Duodecimal uses digits and symbols for 12 units (0-9, X, etc.), Hexadecimal extends to 16 with symbols A-F.

Hexadecimal is popular in programming for concise representation of binary values.