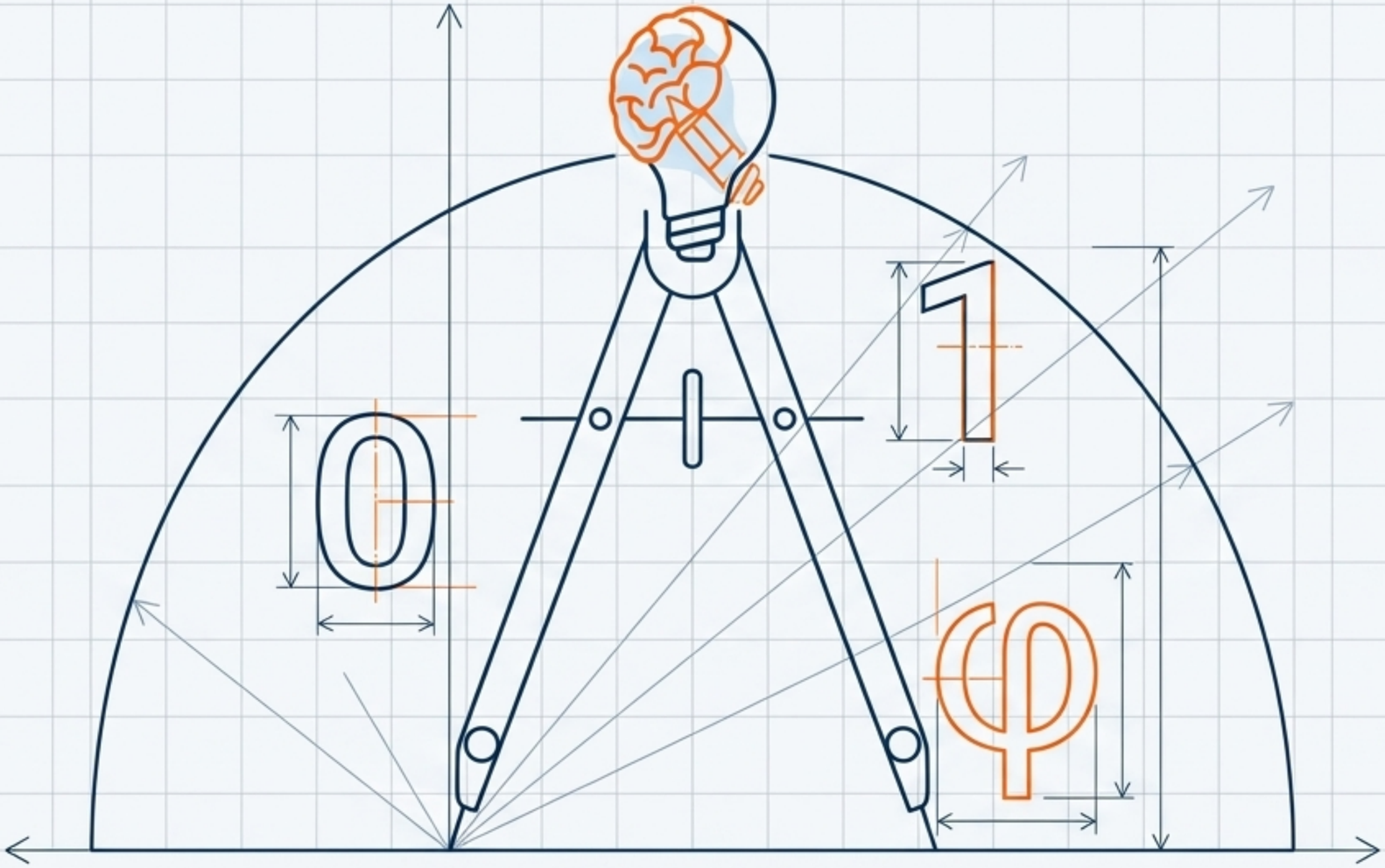
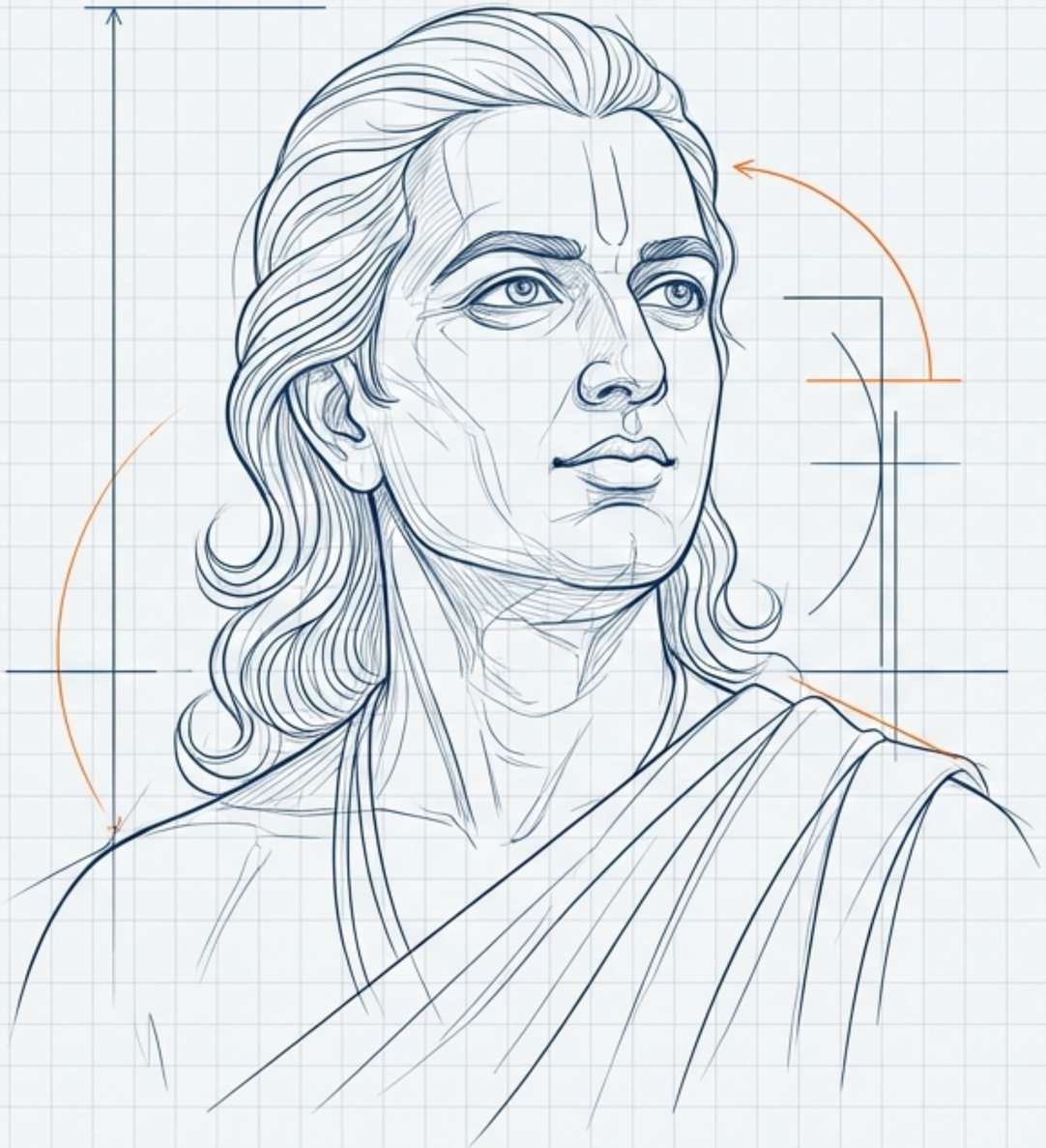


Knowing Our Numbers: The Architect’s Toolkit

A journey into the systems and strategies that build our world.



Every Great Structure Begins with a Visionary.

Introduce Aryabhata as one of the first major mathematicians and astronomers from the classical age of Indian mathematics. His major work, the ***Aryabhatiya*** (499 CE), was a compendium of mathematics and astronomy. The concept of zero as a number, first used by ancient Indian mathematicians like Aryabhata and Brahmagupta, is the foundation of our entire modern system.

The concept of zero as a number was first used by ancient Indian mathematicians like Aryabhata and Brahmagupta!

The Two Blueprints for Large Numbers.

Indian System

Indian Place-Value Chart

Periods	Places
Crores	Ten Crores (TC) Crores (C)
Lakhs	Ten Lakhs (TL) Lakhs (L)
Thousands	Ten Thousands (TTh) Thousands (Th)
Ones	Hundreds (H) Tens (T) Ones (O)

38,64,953

Commas after hundreds place, then after every two digits.

International System

International Place-Value Chart

Periods	Places
Millions	Hundred Millions (HM) Ten Millions (TM) Millions (M)
Thousands	Hundred Thousands (HTh) Ten Thousands (TTh) Thousands (Th)
Ones	Hundreds (H) Tens (T) Ones (O)

95,638,709

Commas after every three digits from the right.

Key Conversions

1 Lakh ←→ 100 Thousand

10 Lakhs ←→ 1 Million

1 Crore ←→ 10 Million

10 Crores ←→ 100 Million

The Building Blocks: Every Digit Has Two Values

75,396

Face Value

The face value of a digit is the number of objects that it always shows, irrespective of its place in a number. It is the digit's intrinsic worth.

5

Place Value

The place value of a digit depends on the place it occupies in a number.

Formula: Place Value = (Face value of the digit) × (Value of the place).

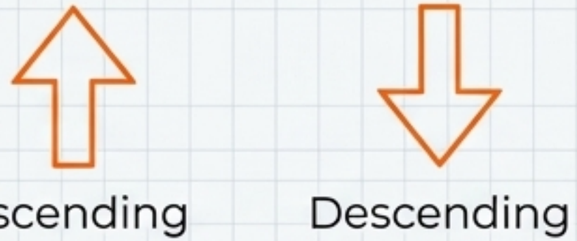
5 × 1000 = 5000

Arranging the Components with Precision

Comparing Numbers

Rule 1:
If two numbers have an unequal number of digits, the number with the greater number of digits is greater.

Rule 2:
If two numbers have an equal number of digits, compare the digits on the extreme left. The number with the greater left-most digit is greater.



Ordering Numbers

Ascending Order:
Arrangement from smallest to greatest.

Example: 35, 69, 75, 100, 200

Descending Order:
Arrangement from greatest to smallest.

Example: 200, 100, 75, 69, 35

Forming Numbers

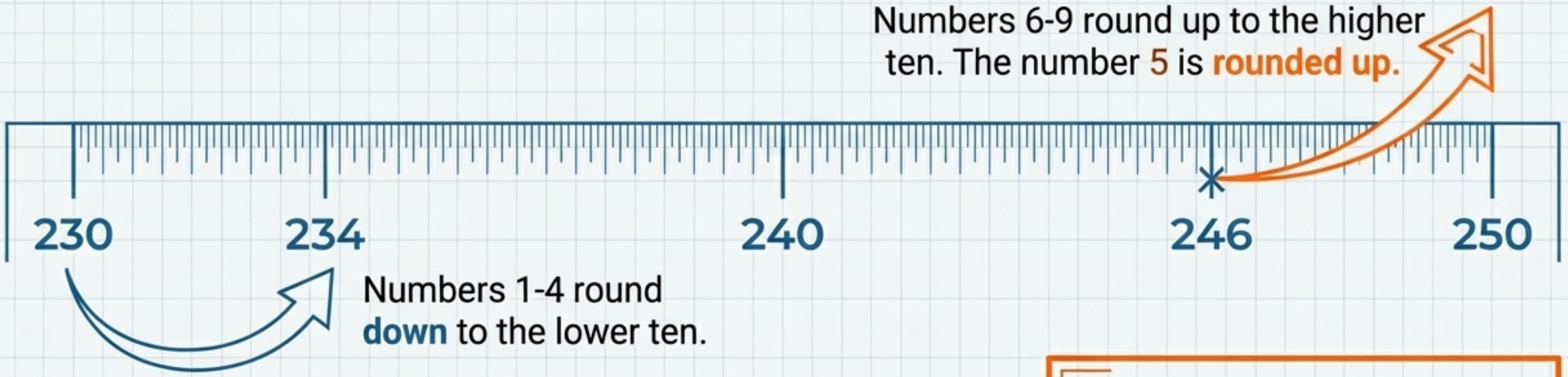
Task: To construct the smallest or greatest number from a set of digits.

Example (without repetition):
Form the smallest 4-digit number using 3, 8, 2, 0.

Answer: 2038

Estimation: Your Power Tool for Quick Calculations.

The **estimation of a number** is a reasonable guess of the actual value. It means approximating a quantity to the accuracy required.



To Nearest Hundred
Numbers 1-49 round **down**.
Numbers 50-99 round **up**.

To Nearest Thousand
Numbers 1-499 round **down**.
Numbers 500-999 round **up**.

Estimation is like **guessing with rules**—it's close enough but not exact!

Blueprinting Totals & Gaps

Estimating Sums

To estimate a sum, round off each number and then add the rounded numbers.

There are 74 coconut cookies and 48 chocolate cookies. Estimate the total.

ACTUAL	ESTIMATION
$74 + 48 = 122$	$74 \longrightarrow 70$ $48 \longrightarrow 50$ $70 + 50 = 120$

(Approximately 120 cookies).

Estimating Differences

To estimate a difference, round each number and then subtract the rounded numbers.

A library has 284 science books and 268 social sciences books. Estimate the difference.

ACTUAL	ESTIMATION
$284 - 268 = 16$	$284 \longrightarrow 280$ $268 \longrightarrow 270$ $280 - 270 = 10$

(Approximately 10 books).

Scaling Designs & Dividing Resources.

Estimating Products

Round off each factor to its greatest place, then multiply the rounded factors.

Estimate the product of 87 × 43.

ACTUAL
3741

ESTIMATION
(to nearest ten):
90 × 40 = **3600**

Estimating Quotients

Round off the divisor and the dividend, then divide.

Estimate the quotient of 95 ÷ 19.

ACTUAL
5

ESTIMATION
(to nearest ten):
100 ÷ 20 = **5**

Real-World Application

A library has 34,385 books on 34 shelves. Around how many books are on each shelf?

34,385 rounds to 30,000
34 rounds to 30

30,000 ÷ 30 = 1000
(Around 1000 books per shelf).

A Look Inside an Ancient Toolkit: Roman Numerals

Like our Hindu-Arabic system, the Roman system is an ancient method of numeration. However, it operates on different principles:

- It uses letters as symbols.
- There is no symbol for zero.
- It does not use the concept of place value.

Rule 1: Add When a Smaller Symbol Follows a Larger One

When a symbol of smaller value is written to the right of a symbol of larger value, its value gets added. This also applies to repetition.

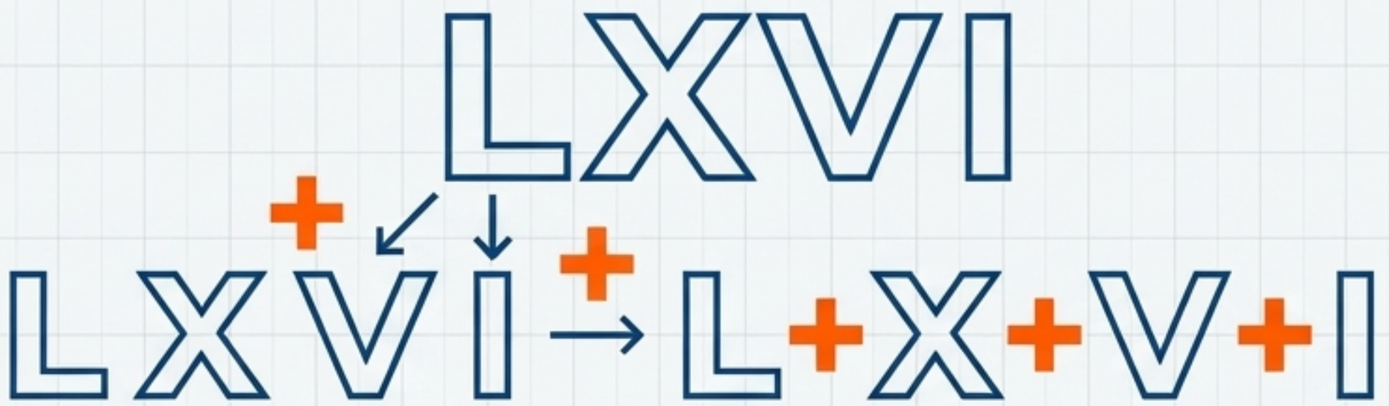
Repetition Example

When a letter is used more than once, we add its value each time.

III = 1 + 1 + 1 = 3

XXX = 10 + 10 + 10 = 30

Combination Example & Central Visual



LXVI = 50 + 10 + 5 + 1 = **66**

VI = 5 + 1 = 6

Rule 2: Subtract When a Smaller Symbol Comes Before a Larger One.

When a symbol of smaller value is written to the left of a symbol of larger value, the smaller value is subtracted from the larger value.

Simple Examples

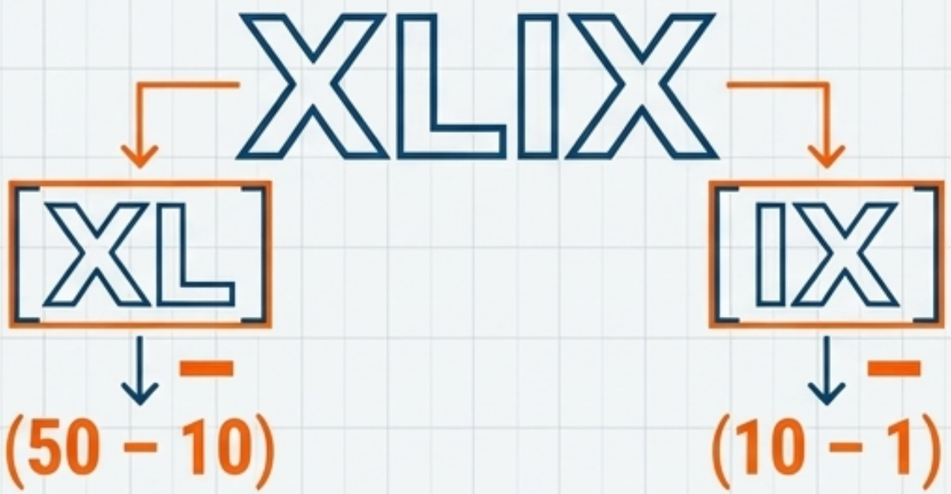
IV **IV** = 5 − 1 = **4**

IX **IX** = 10 − 1 = **9**

XL **XL** = 50 − 10 = **40**

XC **XC** = 100 − 10 = **90**

Combined Example & Central Visual



Breakdown: XL + IX

Calculation: (50 − 10) + (10 − 1) = 40 + 9 = **49**

Operating Instructions for the Ancient Toolkit.

- A symbol cannot be repeated more than 3 times together.
- The symbols V, L, and D are never repeated.
- The symbols V, L, and D are never subtracted.

Subtraction Rules

- **I** can only be subtracted from **V** and **X**.
- **X** can only be subtracted from **L** and **C**.
- **C** can only be subtracted from **D** and **M**.

Key Limitation

The absence of zero and place value makes large calculations cumbersome.

From Blueprint to Build: Translating Between Systems.

Write **99** in Roman numerals.

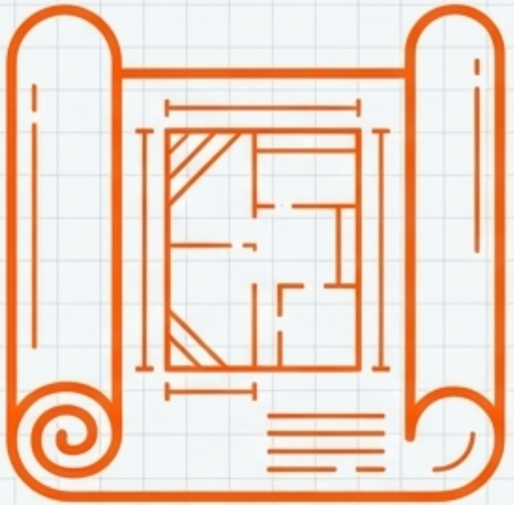
Step 1: Break down the number: 99 = **90** + **9**
Step 2: Translate each part: **90** = **XC**, **9** = **IX**
Step 3: Combine: **XC** + **IX** = **XCIX**

Write **XLV** in Hindu-Arabic numerals.

Step 1: Break down the numeral: XLV = **XL** + **V**
Step 2: Translate each part: **XL** = **40**, **V** = **5**
Step 3: Combine: **40** + **5** = **45**

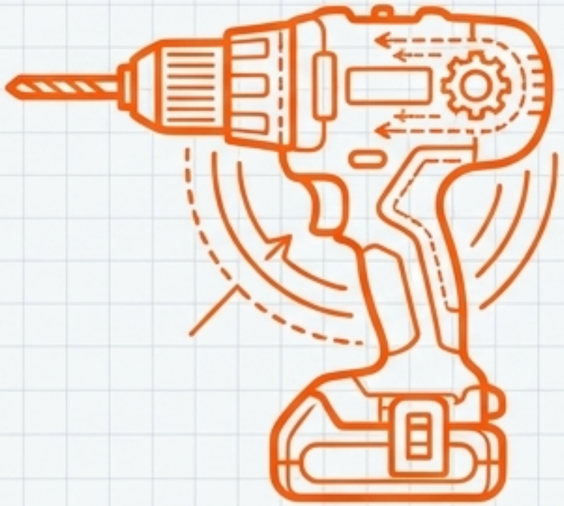
Your Completed Blueprint: The Master Toolkit.

Place Value Systems



Our number system relies on Place Value, where a digit's position determines its worth. We use two primary schematics: the Indian (Lakhs, Crores) and International (Millions) systems.

Estimation



Estimation through rounding (to 10s, 100s, 1000s) provides a reasonable guess for quick calculations. An essential skill for sums, differences, products, and quotients.

Roman Numerals

An alternative system using letters (I, V, X, L, C, D, M). Operates on additive (VI = 6) and subtractive (IV = 4) principles, with specific rules and no zero.

Now, Go Build Something.

Your understanding of numbers is the foundation for everything that follows.