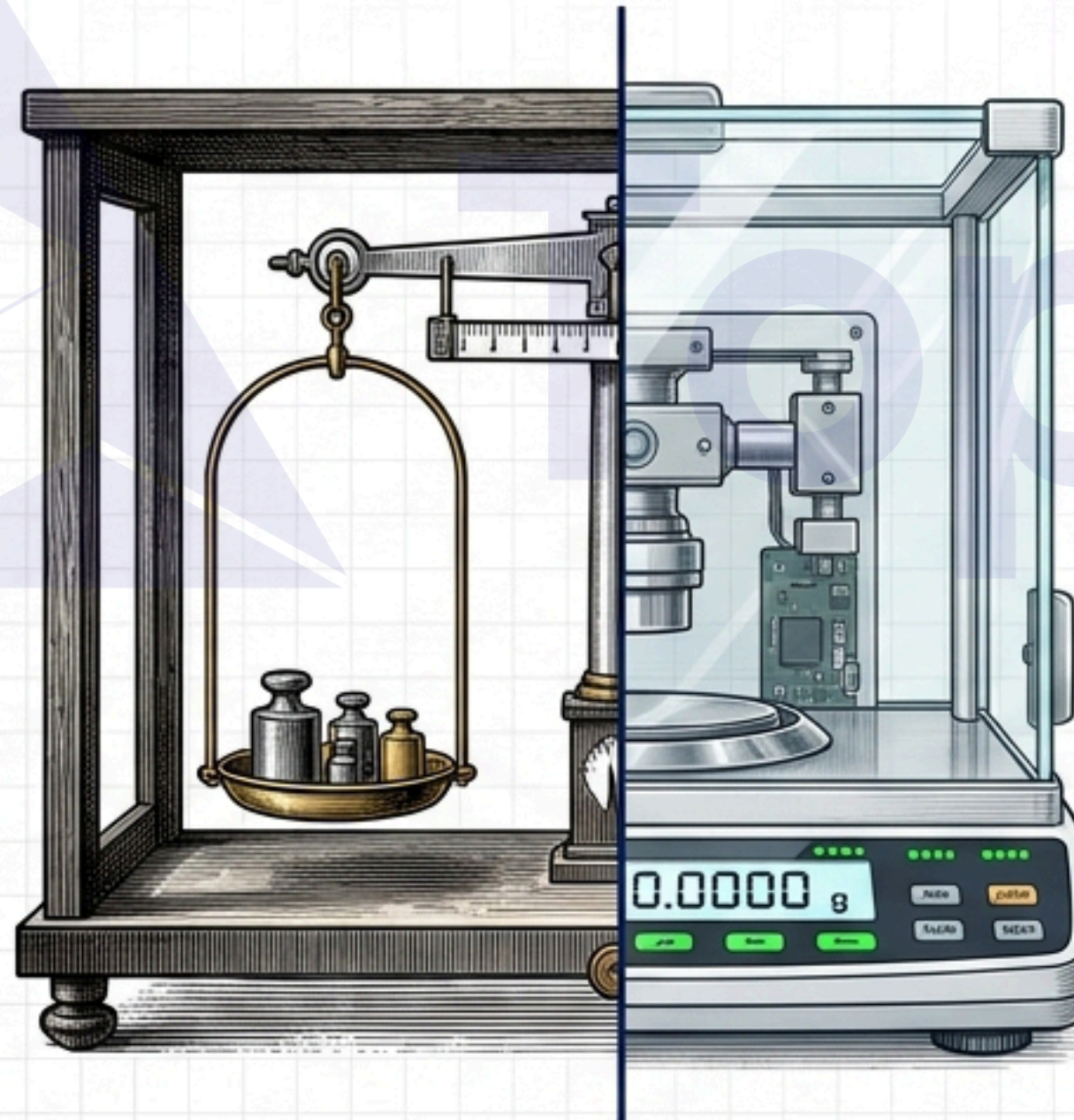


# How Much Can You Trust a Number?

The definitive guide to Measurement Uncertainty and Significant Figures.



# Every Measurement Has Limits

A number's length tells us about the physical tool used to measure it. Every valid scientific measurement consists of all digits known with certainty, plus exactly one uncertain (estimated) digit.

Platform Balance

9.4 g

- 9 is certain.
- 4 is uncertain.

**Total Significant Figures: 2**

Analytical Balance

9.4213 g

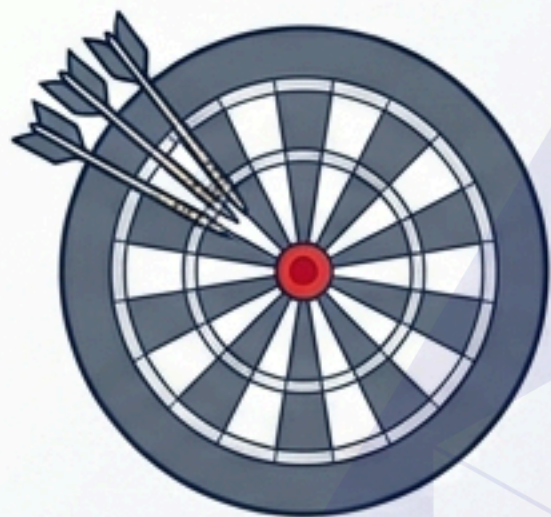
- 9.421 are certain.
- 3 is uncertain.

**Total Significant Figures: 5**

**The Golden Rule:** The uncertainty in a reported value is always assumed to be  $\pm 1$  in the last written digit unless stated otherwise.

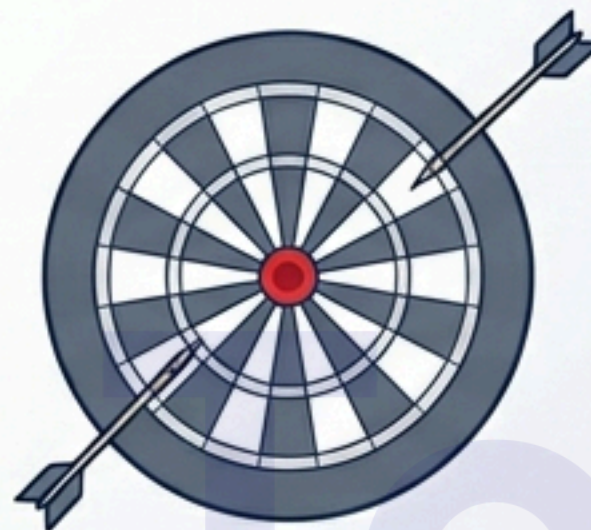
# Hitting the Target: Precision vs. Accuracy

True Value of Sample = 2.000 g



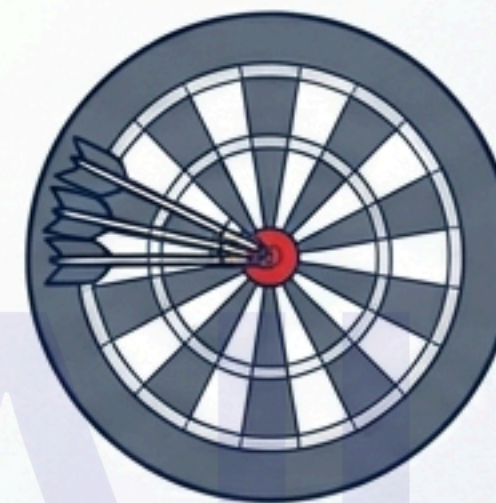
**Student A:** Precise,  
Not Accurate

Attempt 1: 1.95 g  
Attempt 2: 1.93 g  
**Average: 1.940 g**



**Student B:** Neither

Attempt 1: 1.94 g  
Attempt 2: 2.05 g  
**Average: 1.995 g**



**Student C:** Precise  
& Accurate

Attempt 1: 2.01 g  
Attempt 2: 1.99 g  
**Average: 2.000 g**

**Precision:** The closeness of various measurements for the same quantity to each other.

**Accuracy:** The agreement of a particular value to the true (or accepted) value.

# Reading the Digits: The Basics

How do we know which digits in a reported number actually carry physical meaning?

**Rule 1** All non-zero digits are always significant.

Example 1: **285** cm  $\rightarrow$  3 significant figures

Example 2: **0.25** mL  $\rightarrow$  2 significant figures

**Rule 2** Zeros preceding the first non-zero digit are **NEVER** significant.  
They merely indicate the position of the decimal point.

Example 1: **0.03**  $\rightarrow$  1 significant figure

Example 2: **0.0052**  $\rightarrow$  2 significant figures



# You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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- » Free Study Material, Videos & Infographics
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- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



# Reading the Digits: The Zero Trap

Zeros in the middle or at the end of a number require closer inspection.

**Rule 3** Zeros between two non-zero digits are always significant.

**2.005**  $\rightarrow$  **4 significant figures**

**Rule 4** Zeros at the end of a number are significant ONLY IF there is a decimal point.

Example 1: **0.200** g  $\rightarrow$  **3 significant figures**

Example 2: **100**  $\rightarrow$  **1 significant figure** (No decimal)

Example 3: **100.**  $\rightarrow$  **3 significant figures** (Decimal present)

Example 4: **100.0**  $\rightarrow$  **4 significant figures** (Decimal present)

**Exact Numbers:** Counting objects (e.g., 2 balls, 20 eggs) yields exact numbers. They have infinite significant figures ( $2 = 2.000000\dots$ ).

# Math Rules: The Weakest Link (Addition & Subtraction)



When adding or subtracting, the result is limited by the measurement with the fewest decimal places.

Calculate:  $12.11 + 18.0 + 1.012$

$$\begin{array}{r} 12.11 \quad | \quad (2 \text{ decimal places}) \\ + 18.0 \quad | \quad (1 \text{ decimal place}) \leftarrow \text{The Weakest Link} \\ + 1.012 \quad | \quad (3 \text{ decimal places}) \\ \hline 31.122 \quad | \quad (\text{Raw calculation}) \end{array}$$

Final Answer: **31.1** | (Rounded to 1 decimal place)

**Warning:** In addition and subtraction, you look at Decimal Places, NOT Total Significant Figures!

# Math Rules: The Weakest Link (Multiplication & Division)



In these operations, the result is limited by the measurement with the fewest total significant figures.

Calculate:  $2.5 \times 1.25$

Inventory:

- 2.5 has 2 significant figures. <- The Weakest Link
- 1.25 has 3 significant figures.

Raw calculation:  $2.5 \times 1.25 = 3.125$

Final Answer: **3.1** (Rounded to 2 significant figures)

Operation Rule Summary: Add/Subtract = Constrained by Decimal Places;  
Multiply/Divide = Constrained by Total Significant Figures

# The Final Polish: Rounding Rules

When trimming numbers to the correct significant figures, look at the rightmost digit to be removed.

## If > 5: Round Up

Increase the preceding digit by 1.

Target: Round 1.386 to 3 sig figs.

Digit to remove is 6.

Result: 1.39

## If < 5: Stay the Same

Do not change the preceding digit.

Target: Round 4.334 to 3 sig figs.

Digit to remove is 4.

Result: 4.33

## If = 5: Make it Even

If preceding digit is even, leave it. If odd, round up.

Example A:

6.35 (3 is odd)  $\rightarrow$  6.4

Example B:

6.25 (2 is even)  $\rightarrow$  6.2

# Significant Figures: Master Cheat Sheet



## Identification

- 1** 1-9: **ALWAYS** Significant  
(285 = 3)
- 2** Leading 0s: **NEVER** Significant  
(0.03 = 1)
- 3** Middle 0s: **ALWAYS** Significant  
(2.005 = 4)
- 4** Trailing 0s: Significant **ONLY IF** decimal is present  
(100 = 1 | 100. = 3 | 100.0 = 4)

## Math Operations

### Addition / Subtraction:

Match the lowest Decimal Places.

### Multiplication / Division:

Match the lowest Total Sig Figs.

## Rounding (The 5 Rule)

**Removing >5:** Round Up (1.386 -> 1.39)

**Removing <5:** Keep Same (4.334 -> 4.33)

**Removing exactly 5:** Make preceding digit EVEN.  
(6.35 -> 6.4 | 6.25 -> 6.2)

**Pro-Tip:** Scientific Notation solves zero ambiguity. All digits in the coefficient of a scientific notation are significant!

$4.01 \times 10^2 = 3 \text{ sig figs.}$



# You've Learned the Theory.

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