PRASHANT KIRAD

UNITS AND MEASUREMENTS

Class-11th

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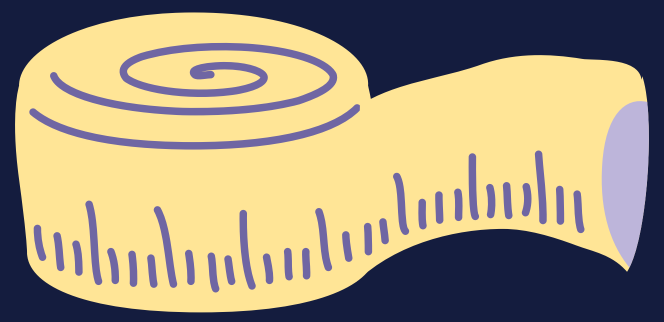
Physical Quantities

Physical Quantity refers to any property of a material or system that can be measured and expressed numerically along with a unit.

For example, mass, length, time, temperature, and velocity are physical quantities.

Components of a Physical Quantity



- **Numerical Value:** Indicates the magnitude of the quantity.
- **Unit:** Specifies the measurement standard (e.g., meter, kilogram).

Physical Quantity = Numerical Value + Unit

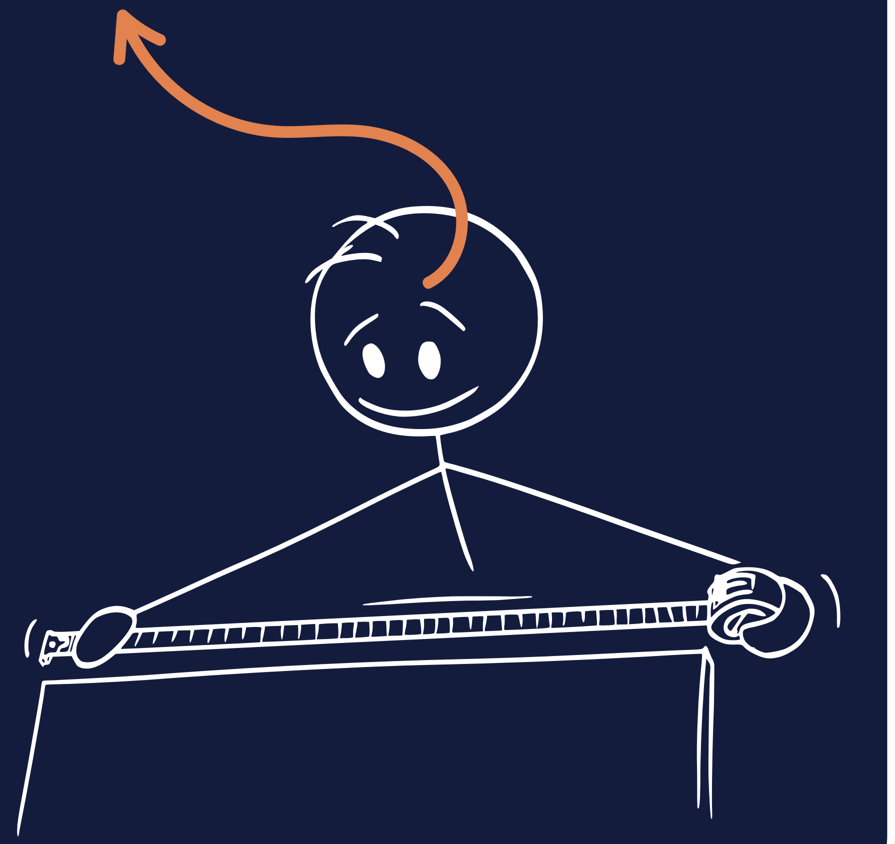
Units

A unit is an arbitrarily chosen standard that is widely accepted and used to measure physical quantities.

For example, the unit of length is the meter (m), and the unit of mass is the kilogram (kg)

Importance of Units

Why is "m" mentioned everywhere in whole scale??



- Units ensure consistency in measurements.
- They allow scientists across the world to communicate results in a standardized way.
- They form the basis for calculations and comparisons in physics

Fundamental Units

Fundamental units are standard units used to measure fundamental physical quantities such as length, mass, time, temperature, electric current, amount of substance, and luminous intensity. There are seven fundamental units, and they are independent; they cannot be derived from any other units.

Examples: Length (meter), Mass (kilogram), Time (second), Temperature (kelvin), Electric current (ampere), Amount of substance (mole), Luminous intensity (candela).

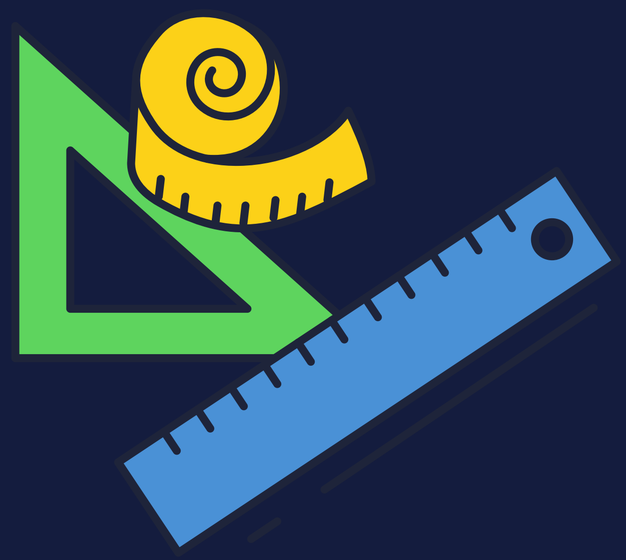
Fundamental Quantity		S.I. Unit	
Name	**Symbol**	**Name**	**Symbol**
Mass	m	kilogram	kg
Length	l	metre	m
Time	t	second	s
Current	I	ampere	A
Temperature	T	kelvin	K
Amount of Substance	n	mole	mol
Luminous Intensity	I_v	candela	cd

Derived Units

- Derived units are the units used to measure derived physical quantities, which are obtained by combining two or more fundamental quantities. These units are expressed in terms of fundamental units.

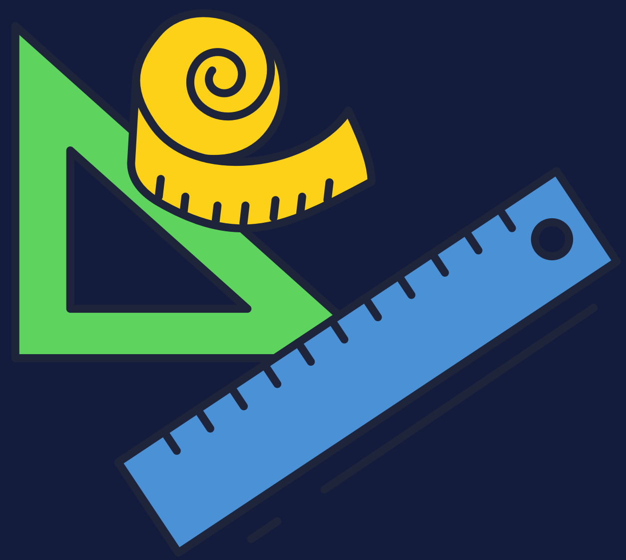
Examples:

- Area (length × length, m^2)
- Volume (length × length × length, m^3)
- Velocity (length/time, m/s)
- Acceleration (velocity/time, m/s^2)



Q. Write the SI unit of the following derived quantities:

1. Force
2. Pressure
3. Work
4. Power
5. Energy



Systems of Units

For measurements to be universally understood and comparable, we need a complete set of units for all physical quantities. This complete set is called a ***system of units.***

Major systems of units are:

- **FPS System: Foot, Pound, Second.**
- **CGS System: Centimeter, Gram, Second.**
- **MKS System: Meter, Kilogram, Second.**
- **SI System (International System of Units).**

CGS System (Centimeter-Gram-Second):

Fundamental Units:

Length: Centimeter (cm), Mass: Gram (g), Time: Second (s)

Commonly used in small-scale measurements and in older scientific literature.

FPS System (Foot-Pound-Second):

Fundamental Units:

Length: Foot (ft), Mass: Pound (lb), Time: Second (s)

Used primarily in engineering applications in the United States.

MKS System (Meter-Kilogram-Second):

Fundamental Units:

Length: Meter (m), Mass: Kilogram (kg), Time: Second (s)

Widely used in mechanics and larger-scale measurements.

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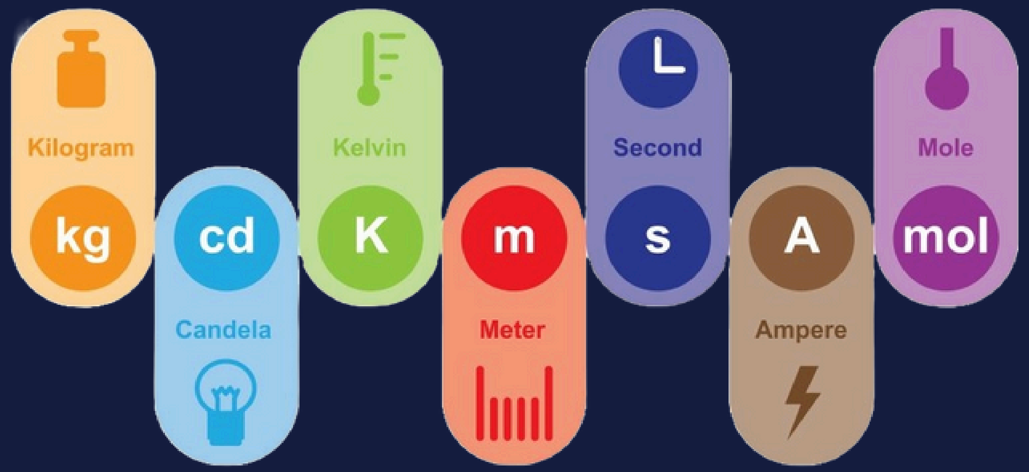
SI Units

This is the globally accepted system for scientific and technical measurements.

It consists of:

- **Seven base units**
- **Derived units.**

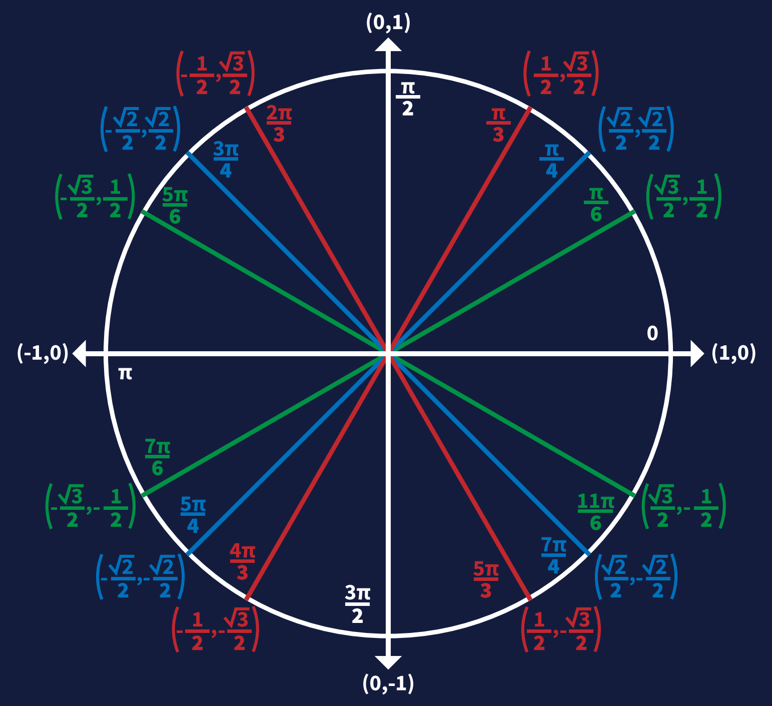


7 Fundamental SI Units

- Length: Meter (m)
- Mass: Kilogram (kg)
- Time: Second (s)
- Electric Current: Ampere (A)
- Temperature: Kelvin (K)
- Amount of Substance: Mole (mol)
- Luminous Intensity: Candela (cd)

Supplementary Quantities

Supplementary Quantities refer to quantities that are not categorized as fundamental or derived quantities but are essential for specific measurements. These quantities are purely geometrical in nature and are used to measure angles.



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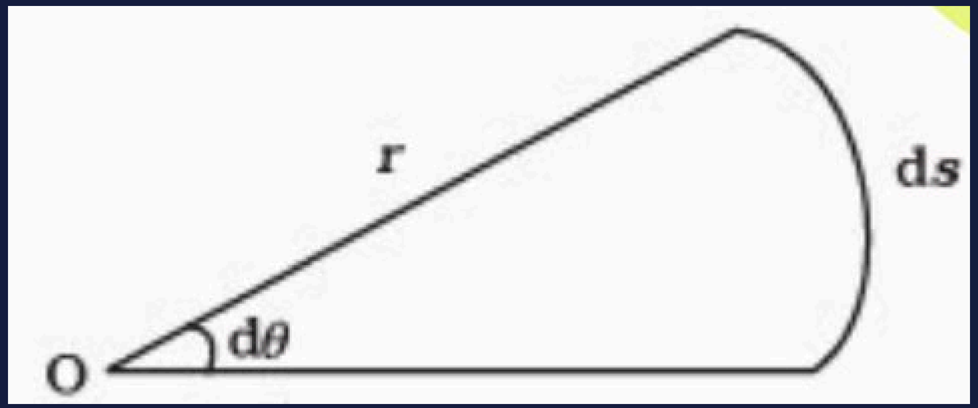
Types of Supplementary Quantities

Plane Angle: Represents the angle between two intersecting lines or surfaces.

SI Unit: Radian (rad).

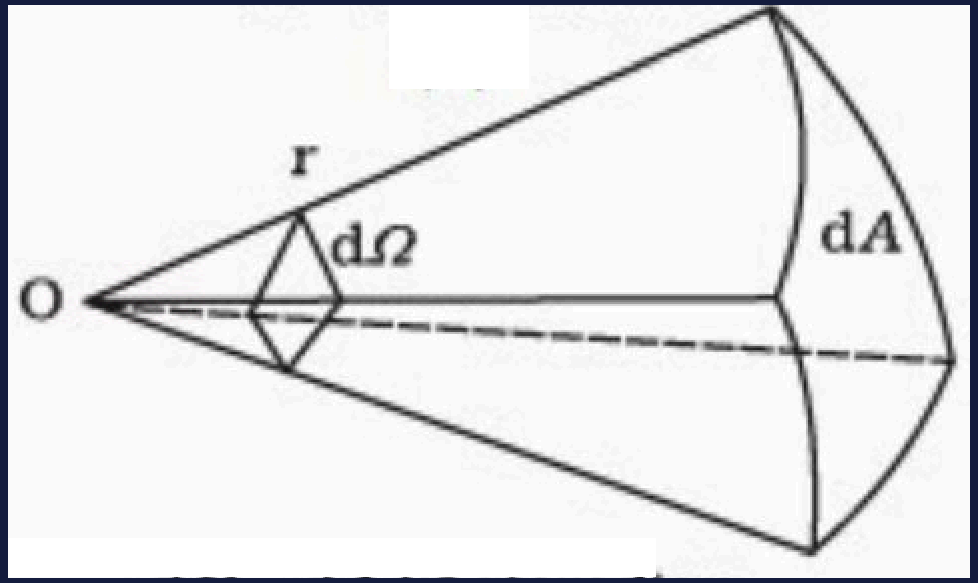
$$\theta = \frac{\text{Arc Length (s)}}{\text{Radius (r)}}$$



Solid Angle: Represents the three-dimensional angle subtended by a surface at a point.

SI Unit: Steradian (sr).

$$\Omega = \frac{\text{Area of surface (A)}}{\text{Radius}^2 (r^2)}$$



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Conversions of Units: Concept

Physical Quantity = Numerical Value + Unit

Represented as: P.q. = $n \times u$

Where:
n = Numerical value
u = Unit

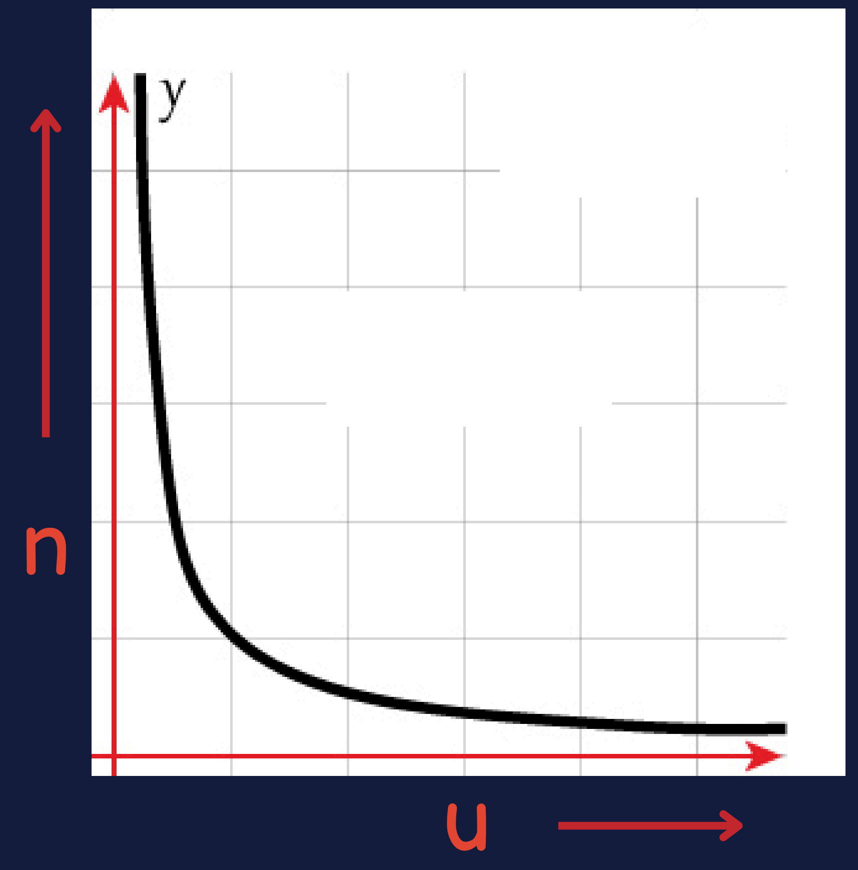
Example: Conversion of 3 meters to centimeters:

$$n_1 \cdot u_1 = n_2 \cdot u_2$$
$$3\ \text{m} = 300\ \text{cm}$$

Conclusion: Numerical value (n) is inversely proportional to the unit (u):

$$n \propto 1/u$$

For a constant physical quantity: $n \cdot u = \text{constant}$



Q. A physical quantity is measured and its value is found to be nu where n = numerical value and u = unit.

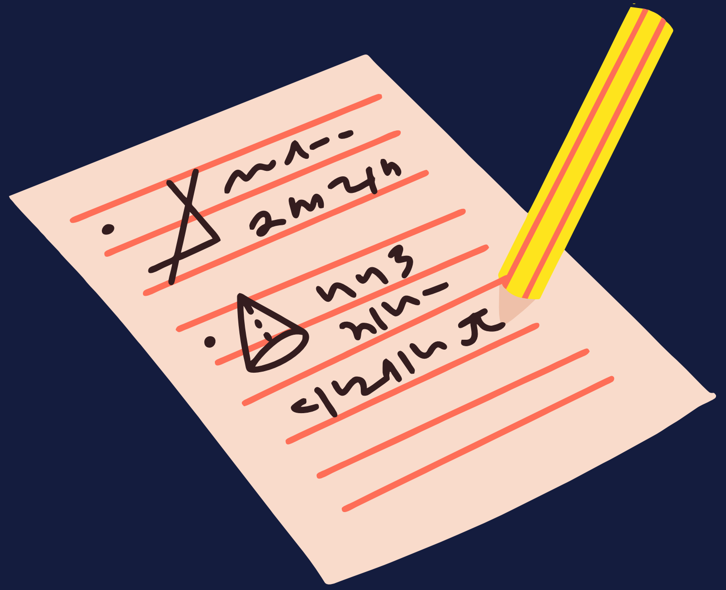
Then which of the following relations is true

(a) $n \propto u^2$

(b) $n \propto \sqrt{u}$

(c) $n \propto u$

(d) $n \propto 1/u$



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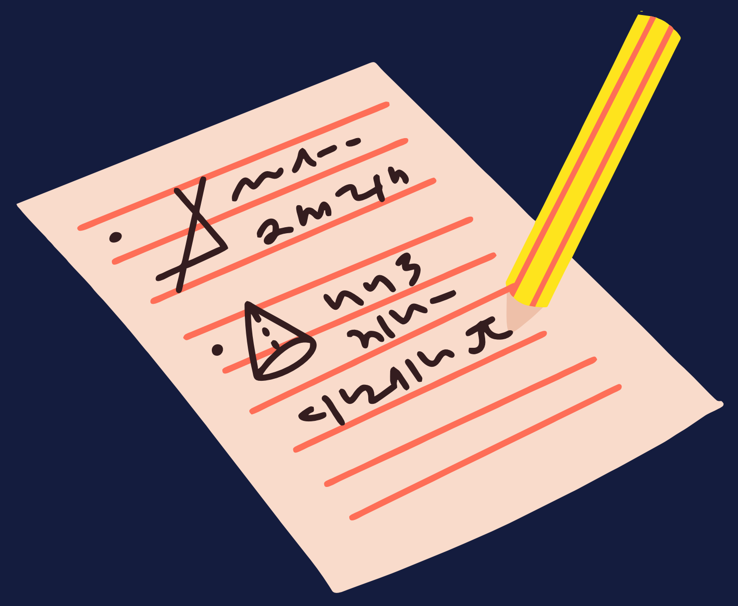
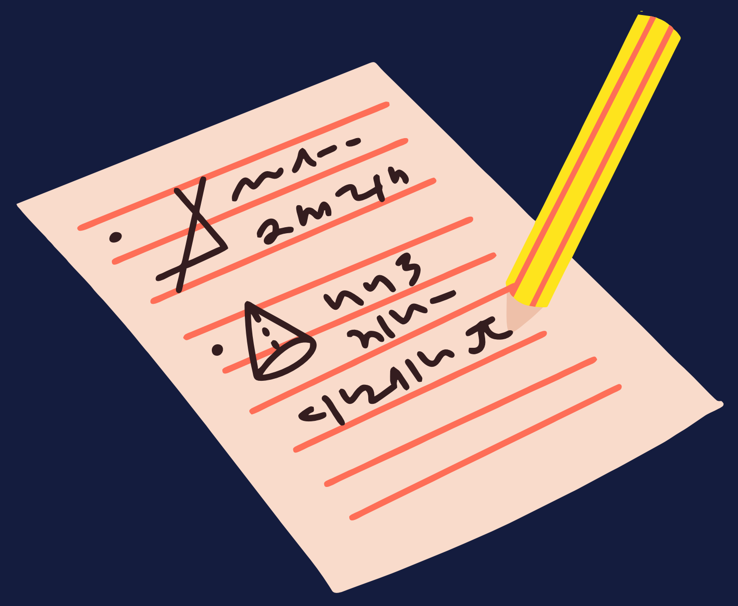
Prefixes for SI Units:

Factor	Prefix	Symbol	Example
$1{,}000{,}000{,}000 = 10^9$	giga	G	1 gigameter (Gm) $= 10^9$ m
$1{,}000{,}000 = 10^6$	mega	M	1 megameter (Mm) $= 10^6$ m
$1{,}000 = 10^3$	kilo	k	1 kilogram (kg) $= 10^3$ g
$100 = 10^2$	hecto	h	1 hectogram (hg) $= 100$ g
$10 = 10^1$	deka	da	1 dekagram (dag) $= 10$ g
$0.1 = 10^{-1}$	deci	d	1 decimeter (dm) $= 0.1$ m
$0.01 = 10^{-2}$	centi	c	1 centimeter (cm) $= 0.01$ m
$0.001 = 10^{-3}$	milli	m	1 milligram (mg) $= 0.001$ g
$^*0.000\,001 = 10^{-6}$	micro	μ	1 micrometer (μm) $= 10^{-6}$ m
$^*0.000\,000\,001 = 10^{-9}$	nano	n	1 nanosecond (ns) $= 10^{-9}$ s
$^*0.000\,000\,000\,001 = 10^{-12}$	pico	p	1 picosecond (ps) $= 10^{-12}$ s

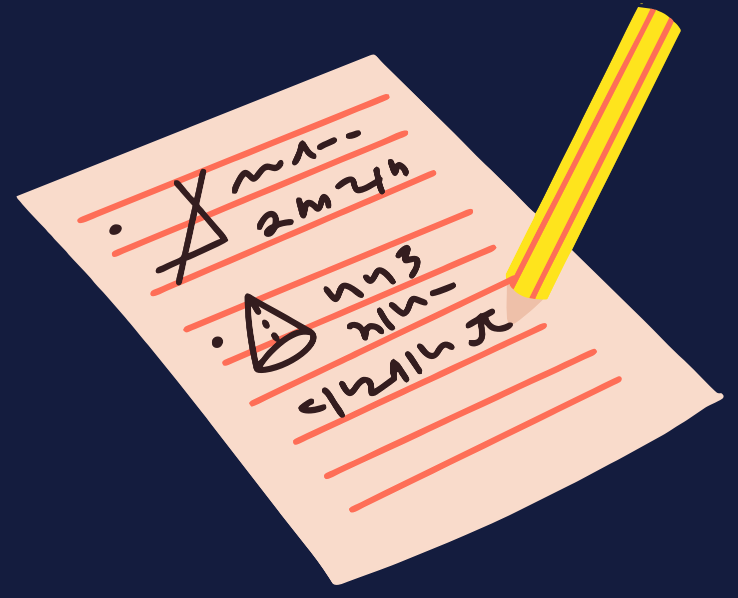
Q. Convert 72 km/h into CGS unit of velocity.



Q. The density of a substance is 5 g/cm^3. Convert it into kg/m^3.



Q. The value of acceleration due to gravity is 980 cm/s^2. What will be its value if the unit of length is kilometer and the unit of time is minute?



Dimensions

The dimensions of a physical quantity are the powers to which the fundamental quantities (mass, length, time, etc.) must be raised to represent that quantity.

Fundamental Quantities and Their Dimensions

Physical Quantity	Dimension Symbol
Length	[L]
Mass	[M]
Time	[T]
Electric Current	[A] (or [I])
Thermodynamic Temperature	[K] (or [Θ])
Amount of Substance	[mol] (or [N])
Luminous Intensity	[cd] (or [J])

Dimensional Formula

A dimensional formula represents a physical quantity in terms of fundamental quantities:

General form: $[M^a L^b T^c]$

Where:

a = power of mass (M)
b = power of length (L)
c = power of time (T)

Examples

Physical Quantity	Definition	Dimension
Velocity	Length per unit time	$[L\ T^{-1}]$
Acceleration	Change in velocity per unit time	$[L\ T^{-2}]$
Force	Mass × Acceleration	$[M\ L\ T^{-2}]$
Momentum	Mass × Velocity	$[M\ L\ T^{-1}]$
Power	Energy (Work) per unit time	$[M\ L^{2}\ T^{-3}]$
Pressure	Force per unit area	$[M\ L^{-1}\ T^{-2}]$

Dimensional Formulas of Some Important Quantities

Distance :

Speed : = d/t

Area: $l \times b$

Volume: $l \times b \times h$

Kinetic Energy: $(1/2)mv^2$

Density: m/V

Impulse : $F \times \Delta t$

Torque : (Force × Perpendicular Distance) = $F \times r$

Work → $W = F \times d \times \cos\theta$

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Stress: F/A

Strain: ΔL/L

Coefficient of Elasticity : Stress / Strain

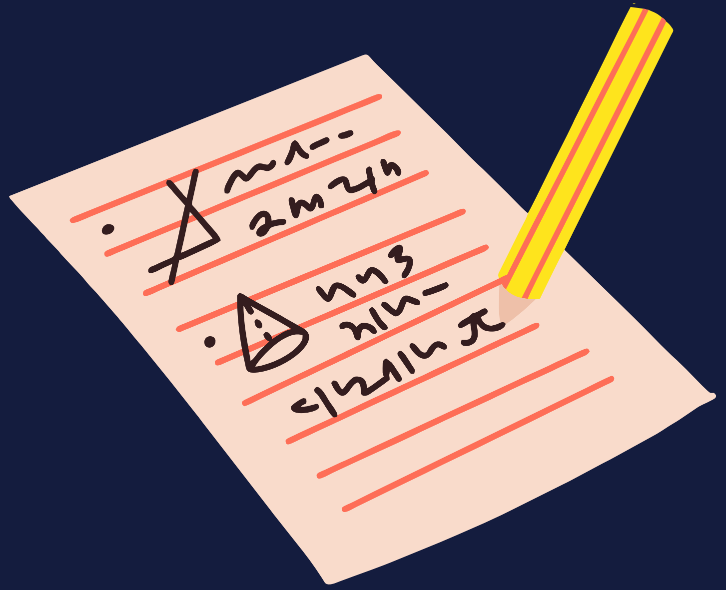
Gravitational Constant: F $\frac{Gm_1m_2}{r^2}$

Surface Tension: F/l

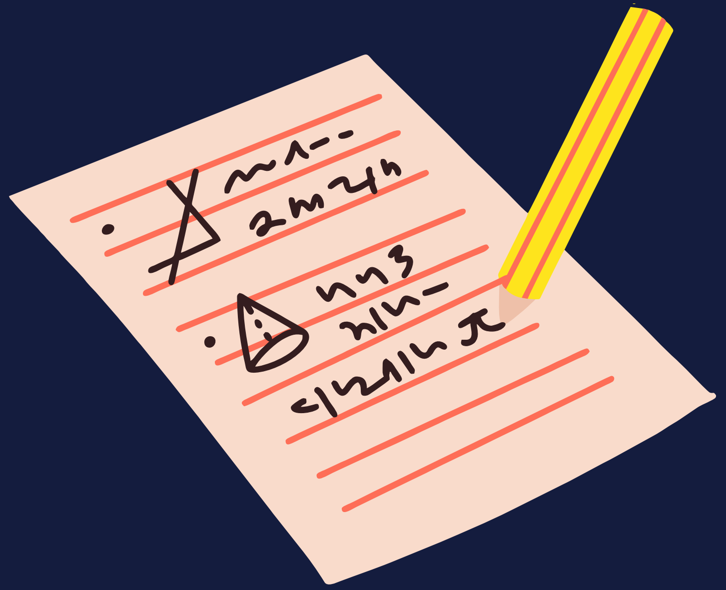
Q. Using dimensional analysis, determine the dimensions of the following physical constants:

(a) Planck's constant (h) → $E = h\nu$

(b) Universal gas constant (R) → $PV = nRT$



Q. Evaluate the dimensional formula, the dimensional equation, and the dimensions of the refractive index.



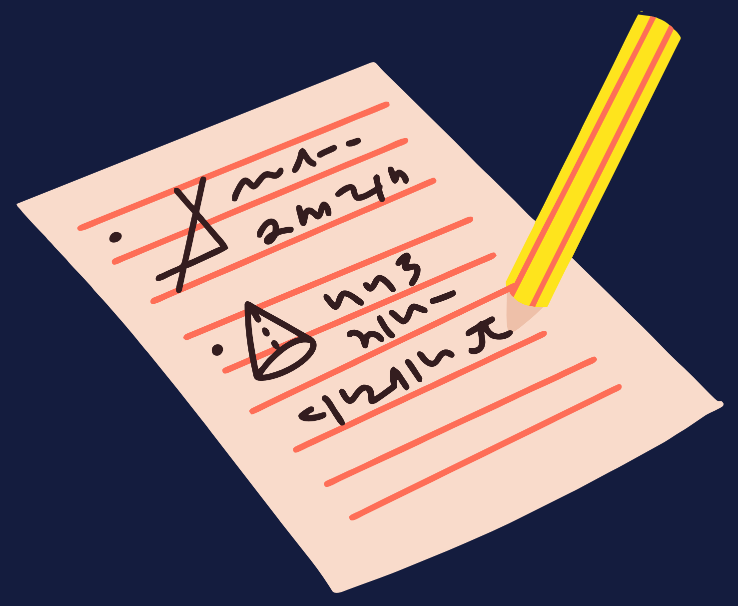
Q. Which of the following quantities is dimensionless?

(a) Pressure

(b) Strain

(c) Work

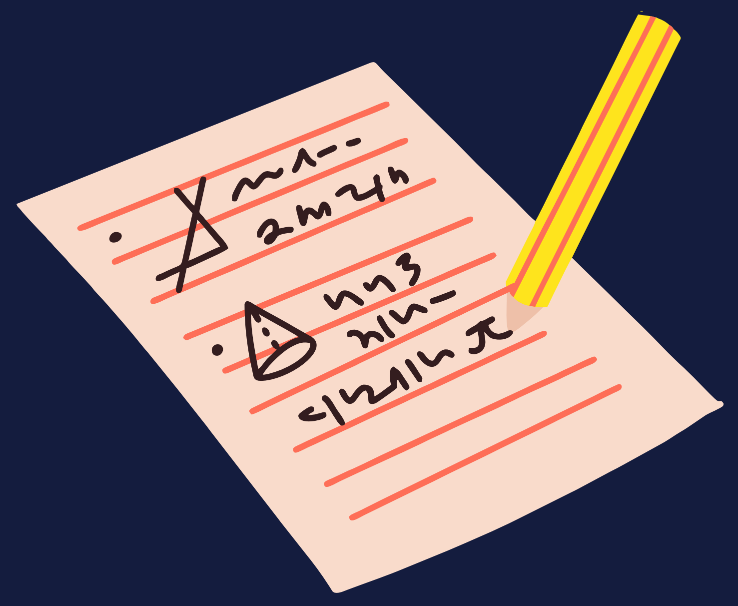
(d) Force



Q. A force F is given by:

$$F = \frac{mv^2}{r}$$

Find the dimensions of F using the given relation.

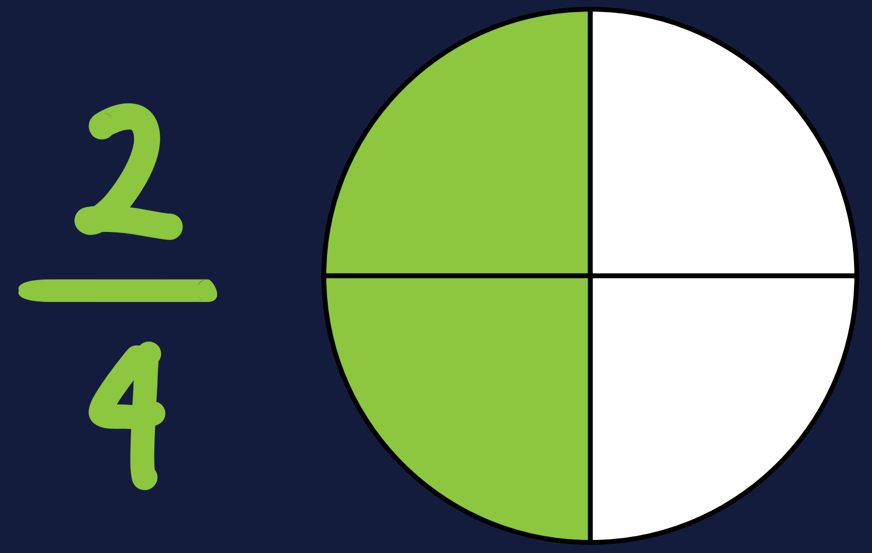


Dimensionless Quantities

Dimensionless quantities are physical quantities that have no dimensions.

i.e., their dimensional formula is $[M^0 L^0 T^0]$.

They are often ratios of two similar quantities, so the units cancel out.



Dimensionless Variables (Physical Quantities):

Strain	$\text{Strain} = \frac{\text{Change in length}}{\text{Original length}}$	$[M^0L^0T^0]$
Refractive Index	$n = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$	$[M^0L^0T^0]$
Poisson's Ratio	$\frac{\text{Lateral strain}}{\text{Longitudinal strain}}$	$[M^0L^0T^0]$
Relative Density	$\frac{\text{Density of substance}}{\text{Density of water}}$	$[M^0L^0T^0]$

Dimensionless Constants:

- π (Pi): Mathematical constant used in geometry and trigonometry.
- e (Euler's Number): Base of the natural logarithm.
- Avogadro's Number: 6.022×10^{23}, representing the number of particles in one mole.

Principle of Homogeneity

The Principle of Homogeneity of Dimensions states that:

"An equation is dimensionally correct only if the dimensions of each term on both sides of the equation are the same."

If a physical equation is: A + B = C

Then, according to the principle of homogeneity:

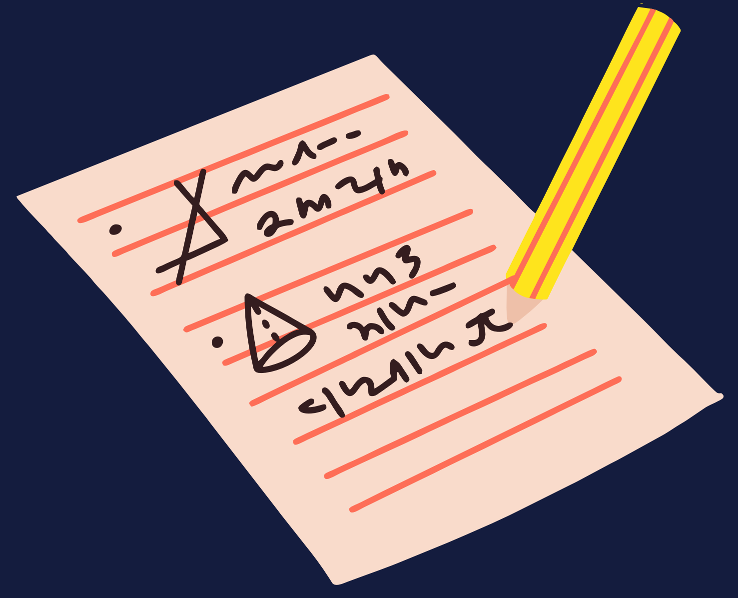
$$\boxed{\text{Dimension of } A = \text{Dimension of } B = \text{Dimension of } C}$$

Example: v = u + at , [v] = [u] = [at] = LT^{-1}

Q. Using dimensional analysis, check the correctness of the following equations:

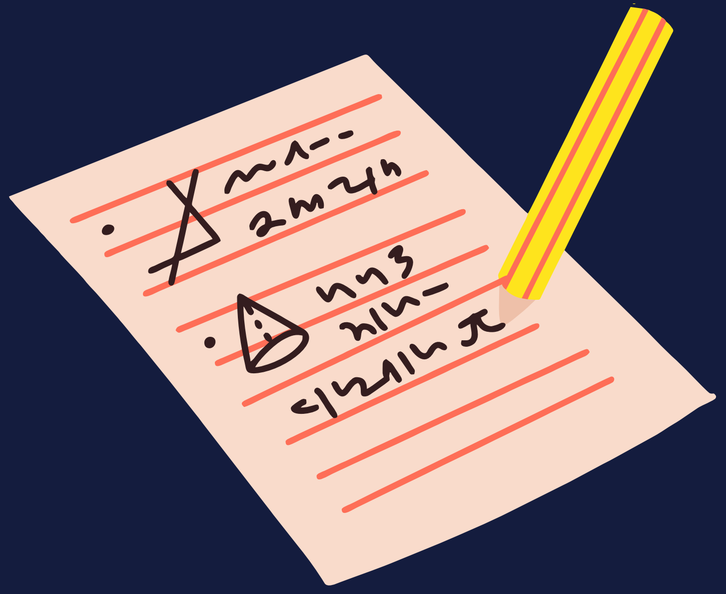
1. $s = ut + (1/2)at^2$
2. $v = u + at^2$
3. $v^2 = u^2 + 2as$

For each equation, verify if the dimensions on both sides are consistent.

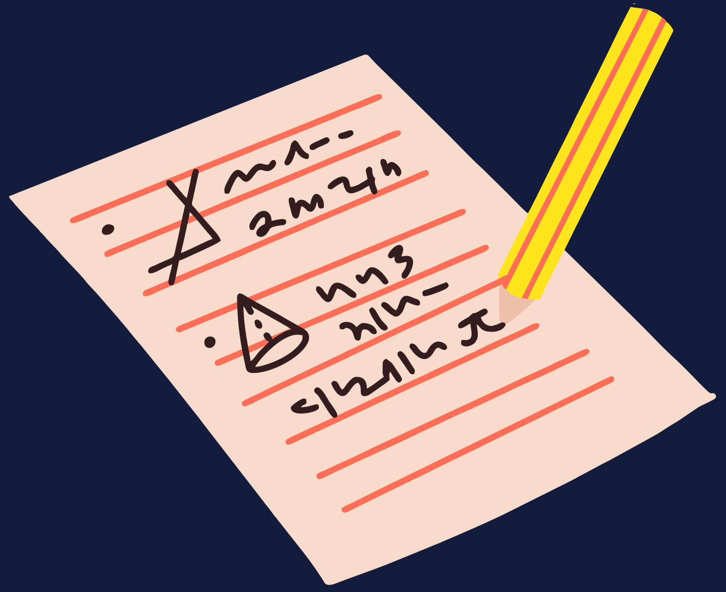


Q. Let us consider an equation $1/2mv^2=mgh$, where m is the mass of the body, v is the velocity, g is the acceleration due to gravity, and h is the height.

Check whether this equation is dimensionally correct.



Q. If x+y = Force, then find dimensions of x and y.



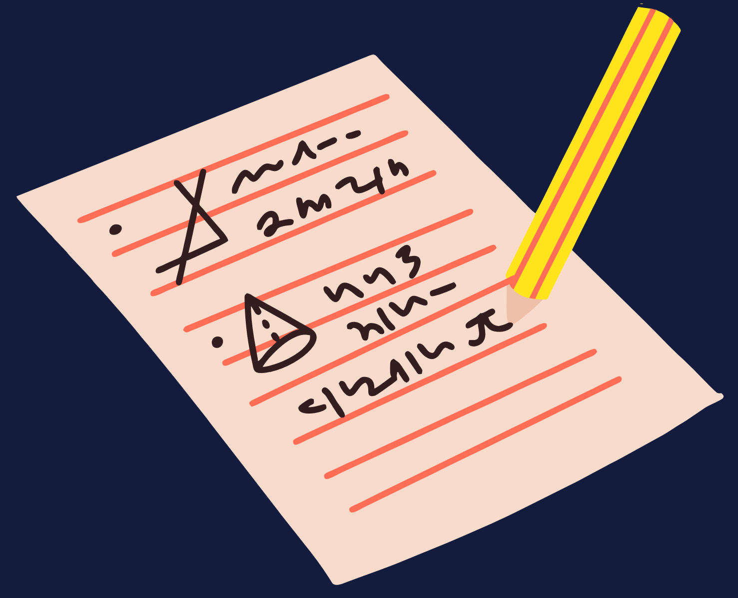
Q. If $x = at + bt^2$, where x is the distance travelled by the body in kilometre while t the time in seconds, then the units of b are

(a) km/s

(b) km-s

(c) km/s^2

(d) $km\text{-}s^{-2}$



Applications of Dimensional Analysis

Q. Derive the formula for the time period of a simple pendulum using dimensional analysis.

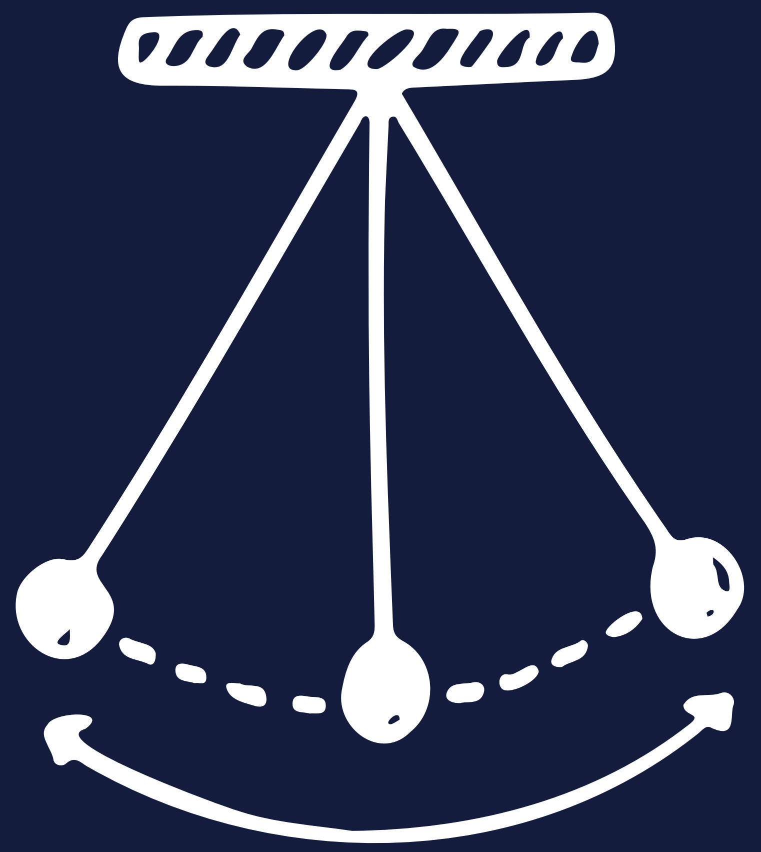
Deriving Formulas:

- Helps deduce relationships between physical quantities.

Example: **The time period (T) of a pendulum:**

Let the time period T depend on:

- Length of the pendulum l
- Acceleration due to gravity g



So, assume: $T \propto l^a g^b$

We convert this into an equation with a constant:

$$T = k \cdot l^a g^b$$

Step 1: Write dimensional formulas:

$[T] = [T]$
$[l] = [L]$
$[g] = [LT^{-2}]$

Now plug in the dimensions into the assumed equation:

$$[T] = [L]^a \cdot [LT^{-2}]^b$$

$$[T] = [L^a] \cdot [L^b T^{-2b}]$$

$$[T] = [L^{a+b} \cdot T^{-2b}]$$

Step 2: Compare both sides:

$$[T^1] = [L^{a+b} \cdot T^{-2b}]$$

Now equate powers of L and T on both sides:

- For Length (L): $0 = a+b \rightarrow (1)$
- For Time (T): $1 = -2b \rightarrow (2)$

From (2): $b = -1/2$

From (1): $a = -b = 1/2$

Step 3: Final formula:

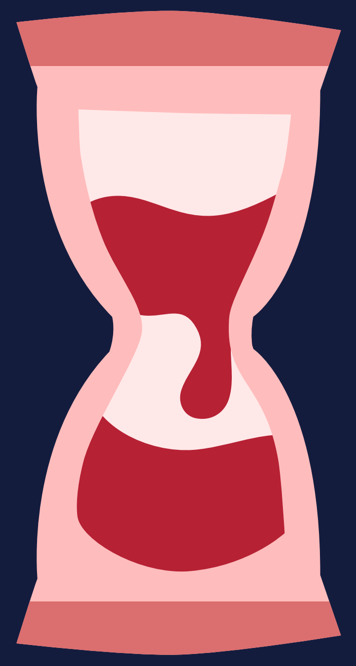
$$T = k \cdot l^{1/2} \cdot g^{-1/2}$$

$$T \propto \sqrt{\frac{l}{g}}$$

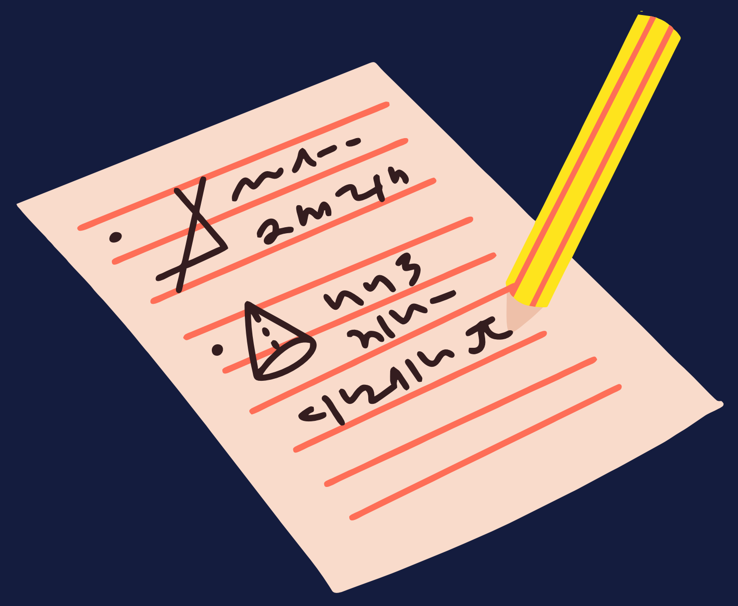
From theory and experiment, we know:

k = 2π

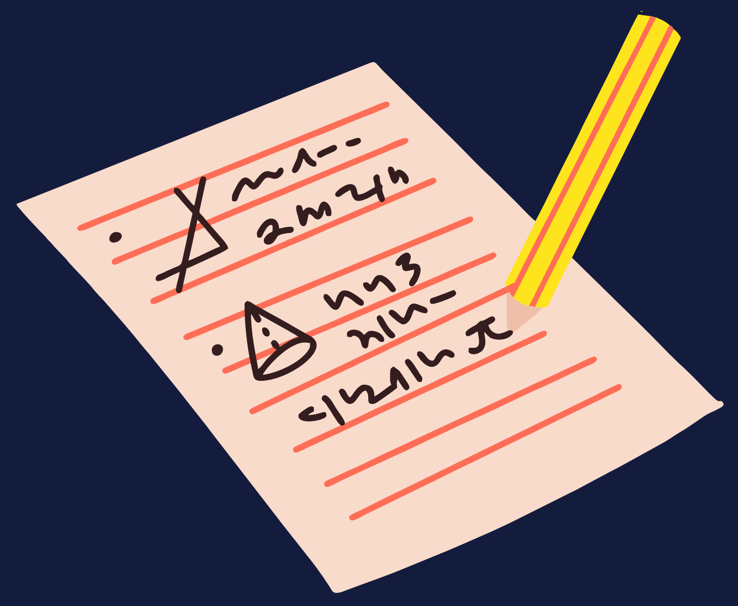
$$\boxed{T = 2\pi\sqrt{\frac{l}{g}}}$$



Q. Using dimensional analysis, derive the formula that relates centripetal force with mass, radius, and velocity.



Q. Using dimensional analysis, derive the formula that relates the frequency f of a vibrating string with tension T, linear mass density μ, and length L of the string.



Limitations of Dimensional Analysis

1. **Cannot find dimensionless constants:** Dimensional analysis cannot determine numerical constants like π, e, 1/2, 2π, etc.

2. **Cannot be Applied to Non-Algebraic Functions:** It does not work for trigonometric, logarithmic, or exponential functions because these functions are dimensionless by nature.

3. **Ignores Quantity Nature:** It does not *differentiate between scalar and vector quantities*.

4. **Fails if quantity depends on more than 3 variables:** The method typically fails when a physical quantity depends on more than three other physical quantities (related to the base dimensions like Mass, Length, and Time).

5. **Cannot Derive Equations Containing Addition or Subtraction:** Dimensional analysis only works for multiplicative relationships (like proportionality), but not for addition or subtraction.

Dimensional Correctness vs. Physical Correctness

An equation can be dimensionally correct but still physically incorrect.

Dimensional analysis can only check for dimensional consistency, not the absolute validity of the formula.

(e.g., $s = ut + (1/3)at^2$ is dimensionally correct but physically wrong).

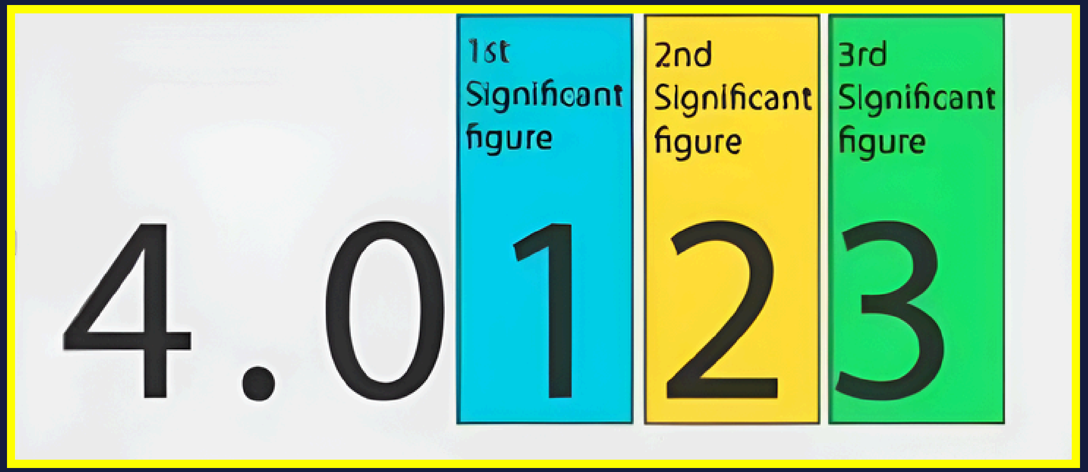
✅ **Dimensional Correctness ≠ Physical Correctness**

Significant Figures

Significant figures in a number are those digits that carry meaning, contributing to its measurement accuracy.

For example:

- In 15.6, all three digits (1, 5, and 6) are significant.
- In 0.0045, there are two significant figures (4 and 5).



Rules for Identifying Significant Figures

- **Non-Zero Digits:** All non-zero digits are significant.

Examples:

- 26 → 2 S.F.
- 844 → 3 S.F.

- **Zeroes Between Non-Zero Digits:** These are significant.

Examples:

- 206 → 3 S.F.
- 804 → 3 S.F.
- 506041 → 6 S.F.

- **Leading Zeros:** Zeros to the left of the first non-zero digit are not significant.

Examples:

- 0.75 → 2 S.F.
- 0.00681 → 3 S.F.
- 0.05084 → 4 S.F.

- **Trailing Zeros (Decimal Point Present):** Zeros at the end and to the right of a decimal point are significant.

Examples:

- 2.10 → 3 S.F.
- 6.500 → 4 S.F.
- 1.5460 → 5 S.F.

- **Trailing Zeros (No Decimal Point):** Zeros at the end of a whole number without a decimal point are not significant.

Examples:

- 210 → 2 S.F.
- 6500 → 2 S.F.
- 15460 → 4 S.F.

- **Trailing Zeros Before the Decimal Point:** If a number has trailing zeros before the decimal point with following zeros, they are significant.

Examples:

- 2.10 → 3 S.F.
- 6.500 → 4 S.F.
- 1.5460 → 5 S.F.

- **Exact Numbers:** Numbers obtained from counting or definitions have infinite significant figures.

Example:

"5 apples" → Infinite significant figures (since it's a counted value, not measured).

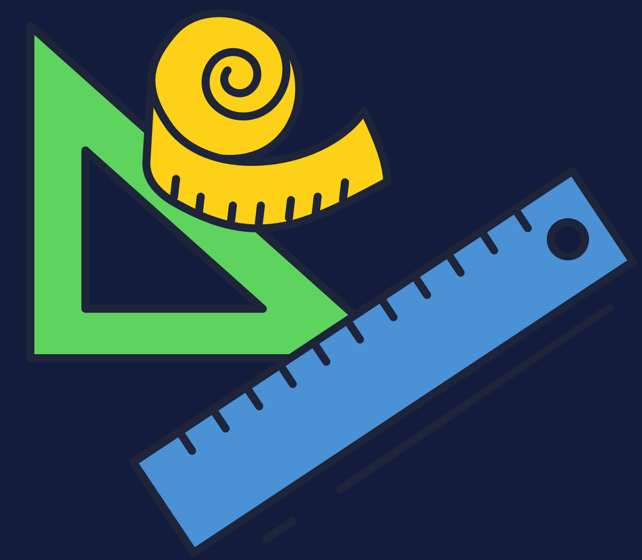
- **Scientific Notation:** In scientific notation ($a \times 10^b$), all digits in aa are significant. The powers of ten (10^b) are not counted as significant figures. They only indicate the magnitude of the number.

Example:

- 3.45×10^6 : 3 significant figures (digits in 3.45).
- 1.230×10^4 : 4 significant figures (digits in 1.230).

Q. How many significant figures are there in:

1. 0.00047 s →
2. 145.00 cm →
3. 0.006950 kg →
4. 11 students (Exact Number) →
5. 9200 m →
6. 8.30×10^4 →



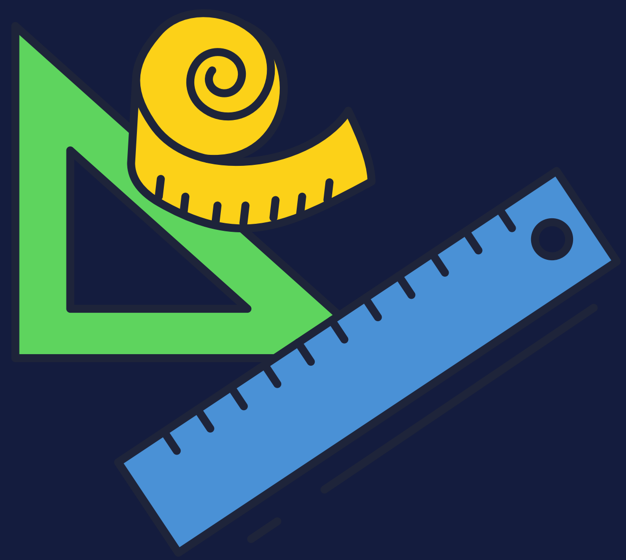
Q. Which of the following numbers has 3 significant figures?

(a) 0.00900

(b) 1.20×10^3

(c) 0.090

(d) 7.000



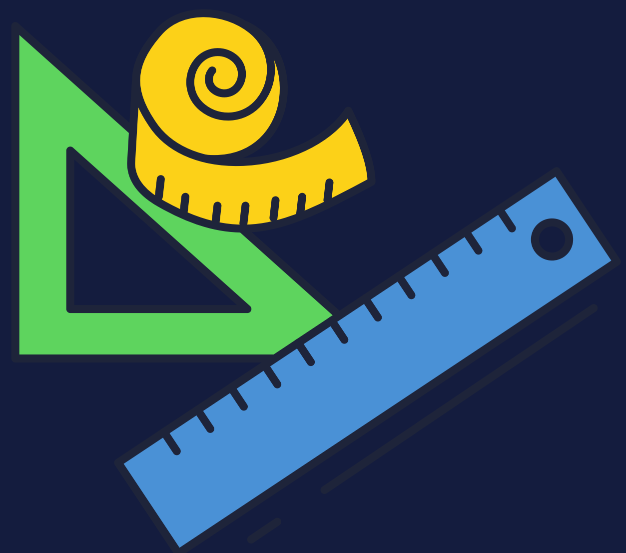
Q. The number of significant figures in 0.007 m^2 is:

(a) 1

(b) 2

(c) 3

(d) 4



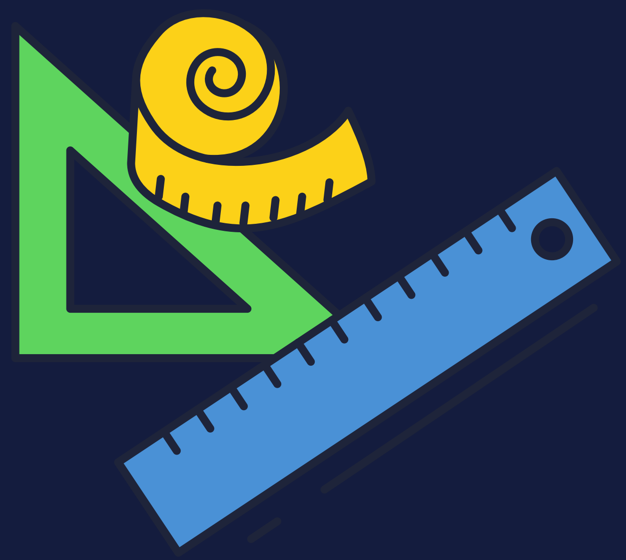
Q. The number of the significant figures in 11.118×10^{-6} V is:

(a) 3

(b) 4

(c) 5

(d) 6



Rounding of Significant Figures

- If the digit to be dropped is less than 5, then the preceding digit is left unchanged.

Example: 4.634 rounded to 3 significant figures is 4.63.

- *If the digit to be dropped is more than 5, then the preceding digit is raised by one.*

Example: 2.478 rounded to 3 significant figures is 2.48.

- *If the digit to be dropped is 5 or 5 followed by zeros, then the preceding digit is left unchanged if it is even.*

Example: 3.250 rounded to 2 significant figures is 3.2.

- If the digit to be dropped is 5 or 5 followed by zeros, then the preceding digit is raised by one if it is odd.

Example: 3.750 rounded to 2 significant figures is 3.8.

- *If the digit to be dropped is 5 followed by digits other than zero, then the preceding digit is increased by 1.*

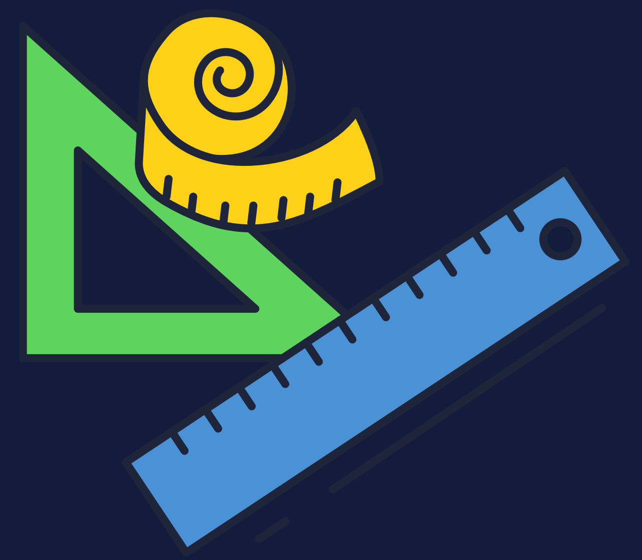
Example: 2.351 rounded to 3 significant figures is 2.35

Q. Round off the following numbers to 3 significant figures:

(a) 123.456

(b) 0.009876

(c) 5.9999



Operations with Significant Figures

- **Addition/Subtraction:** The Result should have as many decimal places as the number with the least decimal places.

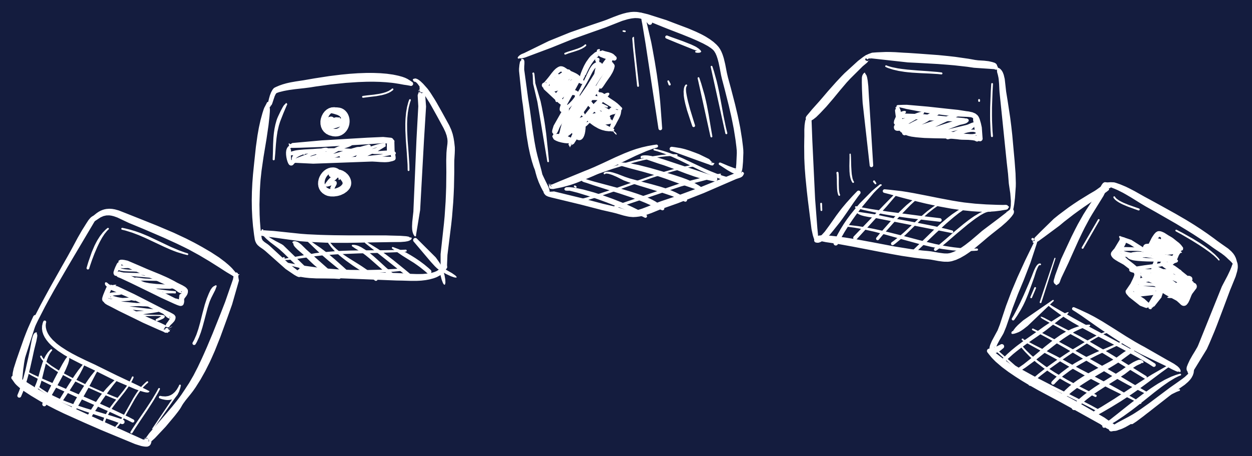
Examples:

12.11 + 0.3 = 12.4 (Only 1 decimal place)

- **Multiplication/Division:** Result should have as many significant figures as the number with the least significant figures.

Examples:

2.5 × 1.24 = 3.1 (2 significant figures)

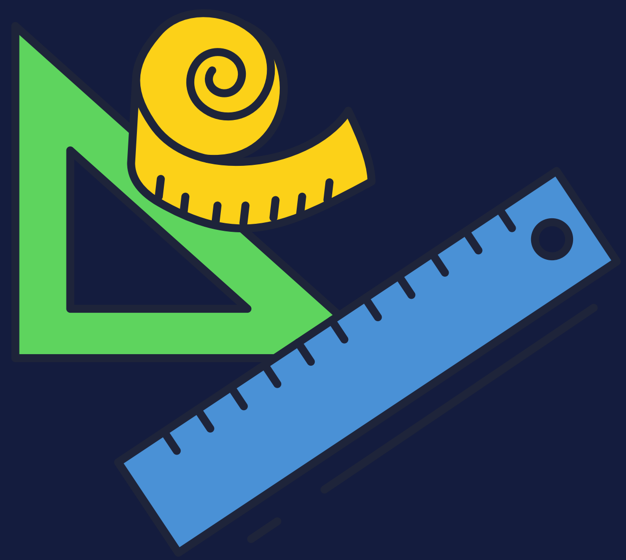


Q. Perform the following operations and give the result in proper significant figures:

(a) Addition: $12.11 + 18.0 + 1.013$

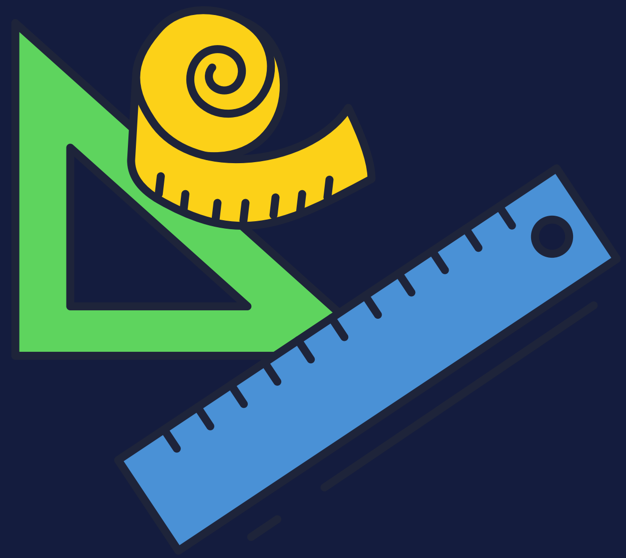
(b) Multiplication: 2.5×3.42

(b) Multiplication: $2.5 \times 3.42 = 8.55$



Q. Express the result of 0.00780×3.4 using the correct number of significant figures.

(b) Multiplication: 0.00780×3.4 = 0.02652



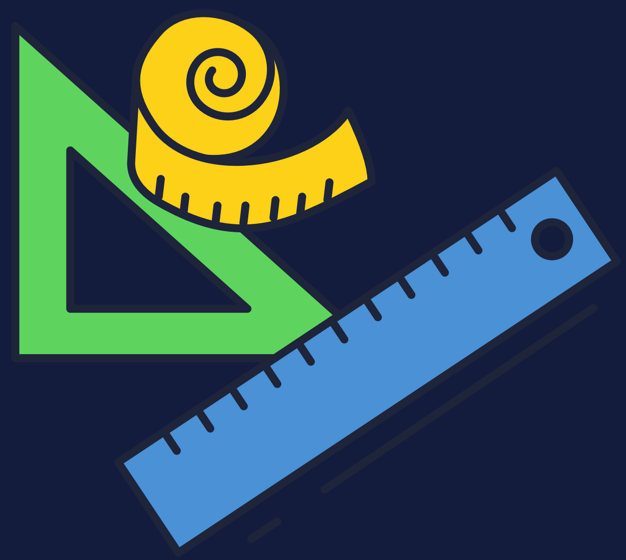
Q. The mass of a box is 2.3 kg. Two more masses 0.01129 kg and 12.39 g are added to it. The total mass of the box to the correct significant figures is:

(a) 2.340 kg

(b) 2.301 kg

(c) 2.312 kg

(d) 2.3 kg

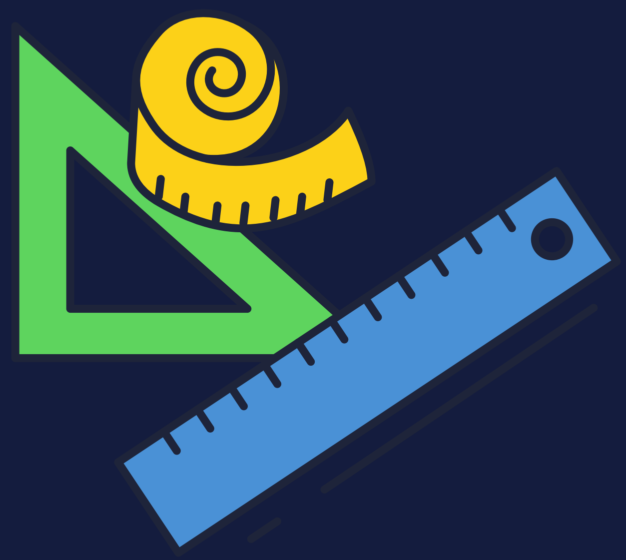


PRASHANT KIRAD

Q. Each side of a cube is measured to be 7.203 m. What are the total surface area and the volume of the cube to appropriate significant figures?

$V = 373.714 m^3$

$A = 311.262 m^2$



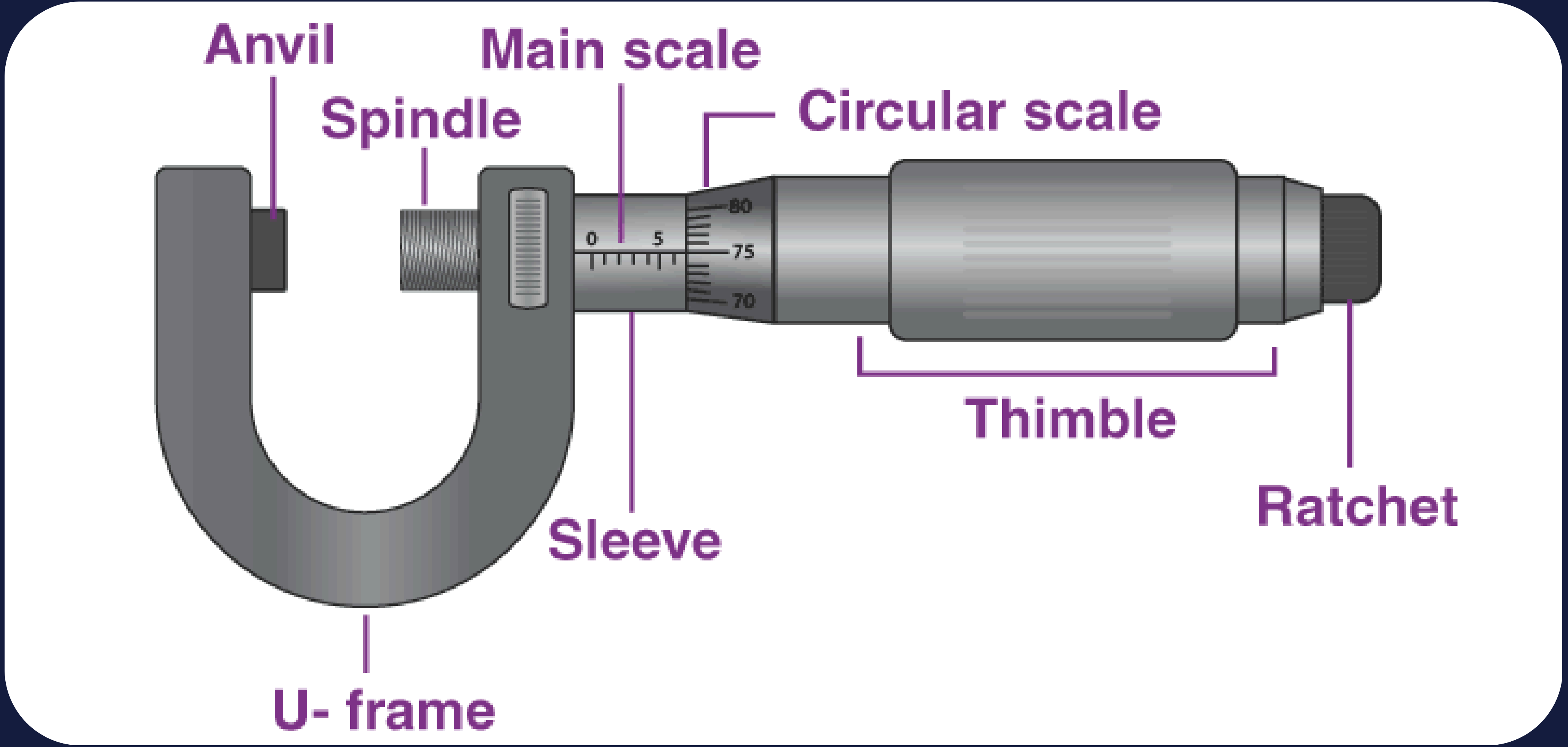
Least Count

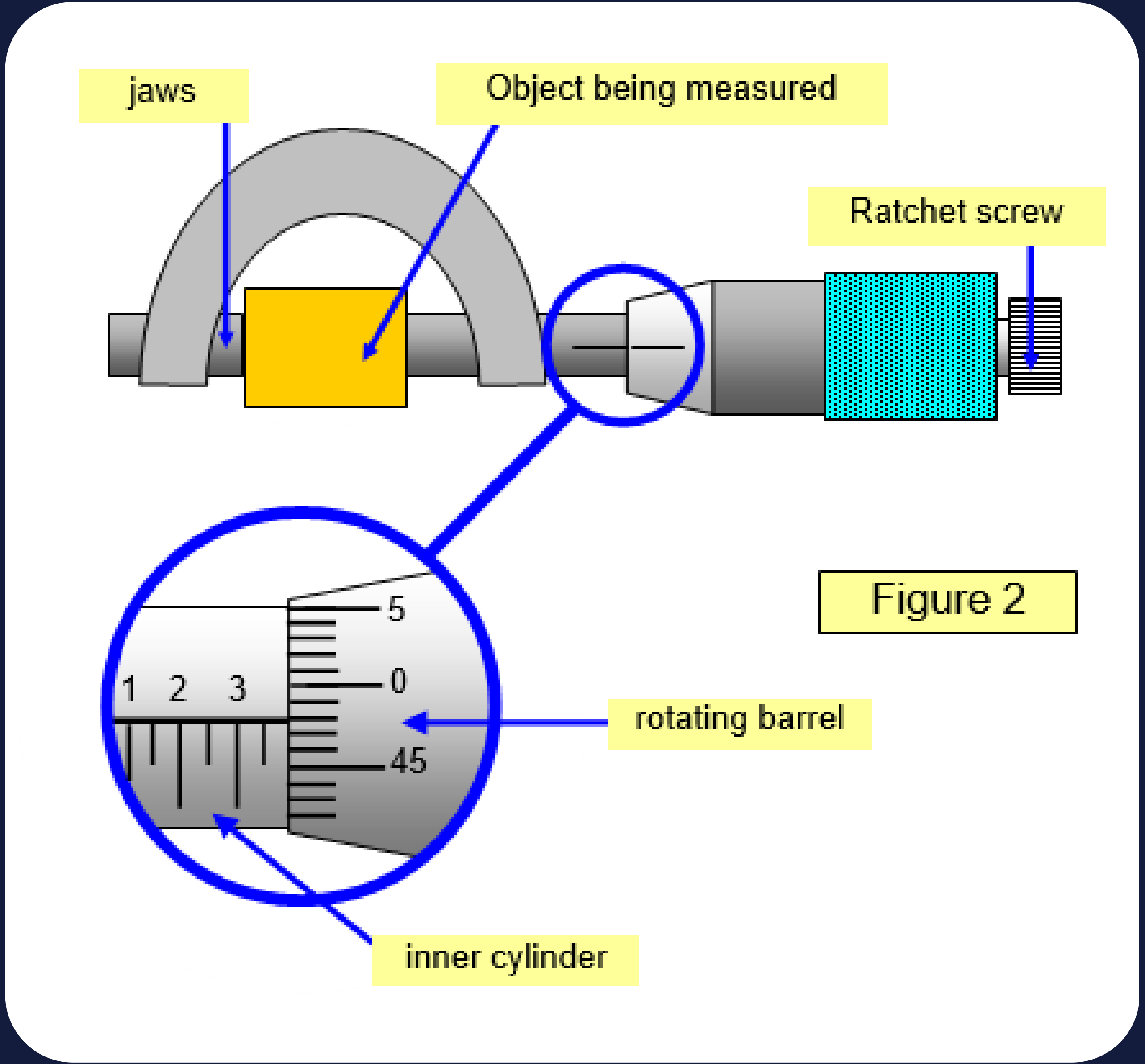
The least count is the smallest measurement that an instrument can provide with accuracy.

For example: If a ruler has divisions of 1 mm, its least count is 1 mm.

PRASHANT KIRAD

Screw Gauge





A screw gauge is a precision instrument used to measure very small lengths, such as the diameter of a wire or thickness of a sheet, with high accuracy (usually up to 0.01 mm).

Working Principle: *It works on the principle of a screw: When a screw is rotated, it moves forward or backward linearly.*

Important Terms:

1. Pitch

The pitch of a screw gauge is the distance moved by the screw in one complete rotatio

$$\text{Pitch} = \frac{\text{Distance moved by screw}}{\text{Number of rotations}}$$

2. Least Count (LC)

The least count is the smallest measurement that can be made using the screw gauge.

$$\text{Least Count (LC)} = \frac{\text{Pitch}}{\text{Number of divisions on circular scale}}$$

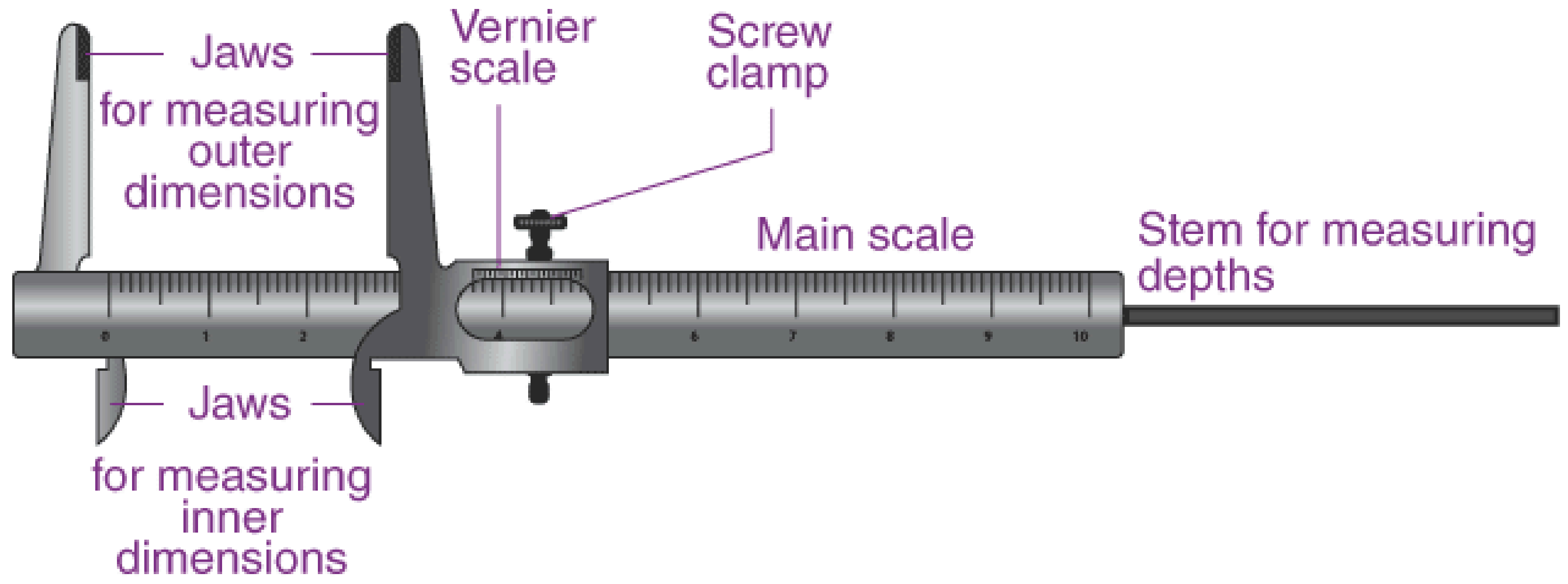
For example,

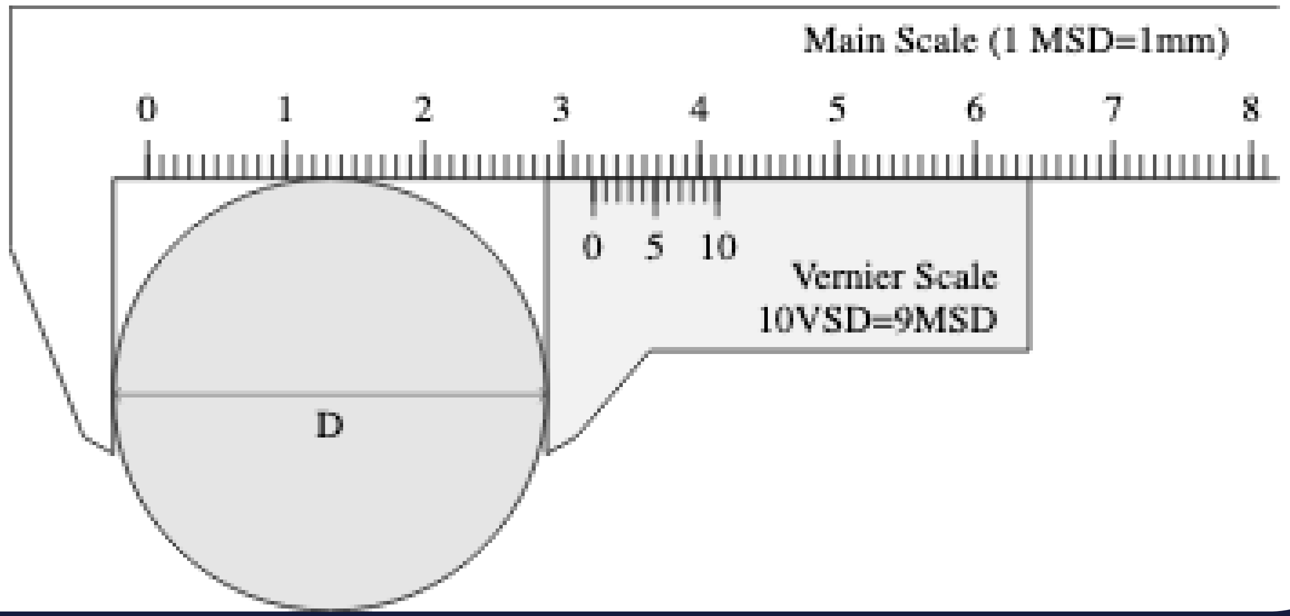
If pitch = 1 mm and circular scale has 100 divisions:

$$\text{LC} = \frac{1}{100} = 0.01 \text{ mm}$$

PRASHANT KIRAD

Vernier Caliper





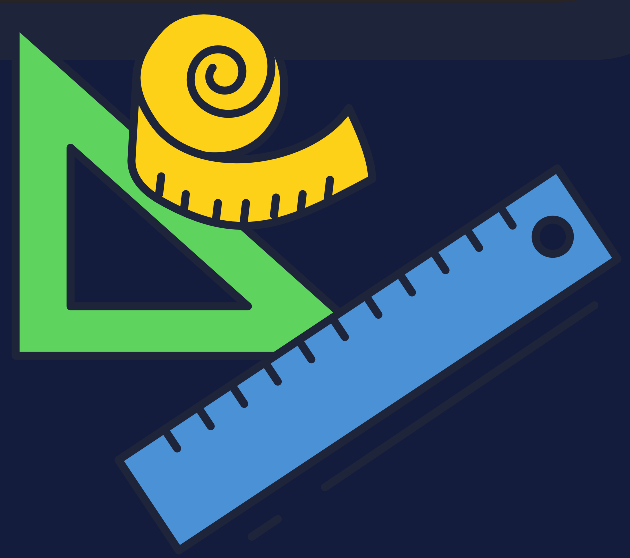
A Vernier Caliper is an instrument used to measure the internal and external dimensions and depth of an object with greater accuracy than a regular scale. It can measure up to 0.1 mm or 0.01 cm accurately.

Observed Length=Main Scale Reading (MSR)+(Vernier Scale Division (VSD)×Least Count)

Q. **NCERT**

Answer the following

1. You are given a thread and a metre scale. How will you estimate the diameter of the thread?
2. A screw gauge has a pitch of 1.0 mm and 200 divisions on the circular scale. Do you think it is possible to increase the accuracy of the screw gauge arbitrarily by increasing the number of divisions on the circular scale ?
3. The mean diameter of a thin brass rod is to be measured by vernier callipers. Why is a set of 100 measurements of the diameter expected to yield a more reliable estimate than a set of 5 measurements only ?



Errors

Error is the difference between the measured value and the true value of a physical quantity.

No measurement is perfectly exact; some error is always present.

Error = True Value - Measured Value

Types of Measurement Errors

- **Absolute Error:** Absolute error is the magnitude of the difference between the measured value and the actual value, ignoring any negative sign.

$$\Delta q_i = |q_i - q_{\text{mean}}|$$

For multiple observations, mean absolute error is:

$$\Delta q_{\text{mean}} = \frac{\sum |\Delta q_i|}{n}$$

Example: If the measured length of an object is 12.5 cm and the actual length is 12.3 cm:

Absolute Error = | 12.5 – 12.3 | = 0.2 cm

- **Relative Error:** Relative error expresses the absolute error as a fraction of the actual value, providing a sense of scale for the error.

$$\text{Relative Error} = \frac{\text{Absolute Error}}{\text{True or Mean Value}}$$

Example: Using the absolute error from above (0.2 cm) and an actual length of 12.3 cm:

$$\text{Relative Error} = \frac{0.2}{12.3} = 0.01626$$

- **Percentage Error:** Percentage error converts relative error into a percentage, making it easier to interpret.

$$\text{Percentage Error} = \left(\frac{\text{Absolute Error}}{\text{True or Mean Value}}\right) \times 100$$

Example: If a student measures a height as 5 ft when the actual height is 4.5 ft:

$$\text{Percentage Error} = \left(\frac{|5 - 4.5|}{4.5}\right) \times 100 = 11.11\%$$

PRASHANT KIRAD

Q. We measure the period of oscillation of a simple pendulum. In successive measurements, the readings turn out to be 2.63 s, 2.56 s, 2.42 s, 2.71s and 2.80 s. Calculate the absolute errors, relative error or percentage error [NCERT]

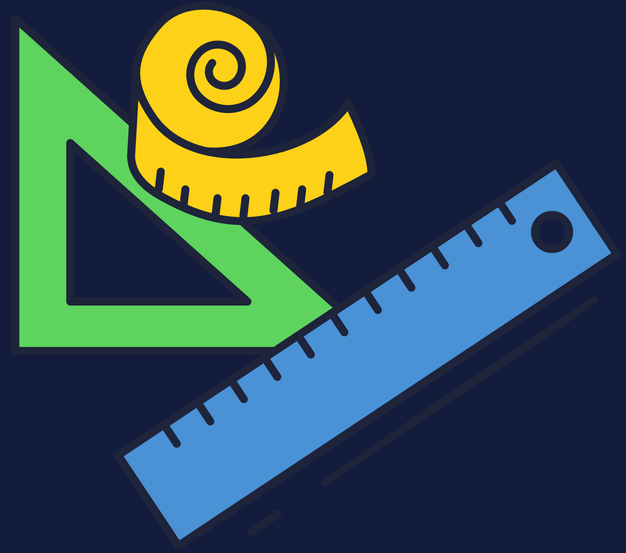
Mean Value: 2.624s

2.63 s		2.63−2.624	=0.006s
2.56 s		2.56−2.624	=0.064s
2.42 s		2.42−2.624	=0.204s
2.71 s		2.71−2.624	=0.086s
2.80 s		2.80−2.624	=0.176s

Mean Absolute Error = 0.1072s

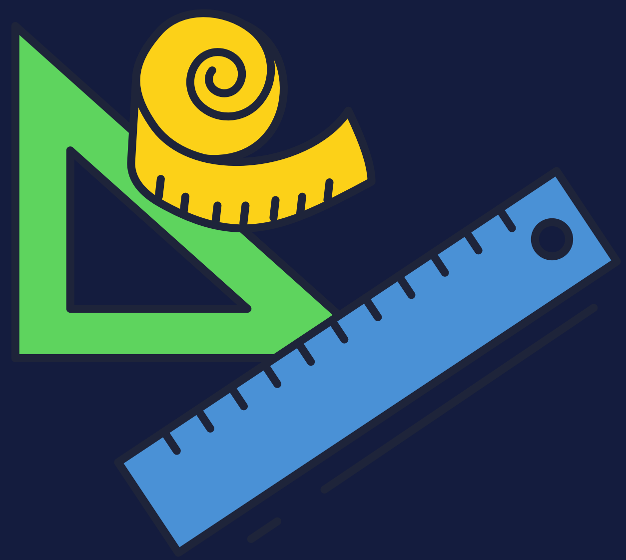
Relative error ≈ 0.0409

Percentage error ≈ 4.09%



Q. Three measurements of the length of a rod are recorded as 2.02 m, 1.99 m, and 2.00 m. If the true value of the length is 2.00 m, calculate the following:

1. Absolute errors for each measurement
2. Mean absolute error
3. Relative error
4. Percentage error



PRASHANT KIRAD

Rules of Error Propagation

- **Addition and Subtraction:**

If:

$$Z = A + B \quad \text{or} \quad Z = A - B$$

Then the absolute error in Z is:

$$\Delta Z = \Delta A + \Delta B$$

ΔA and ΔB are the absolute errors in A and B.

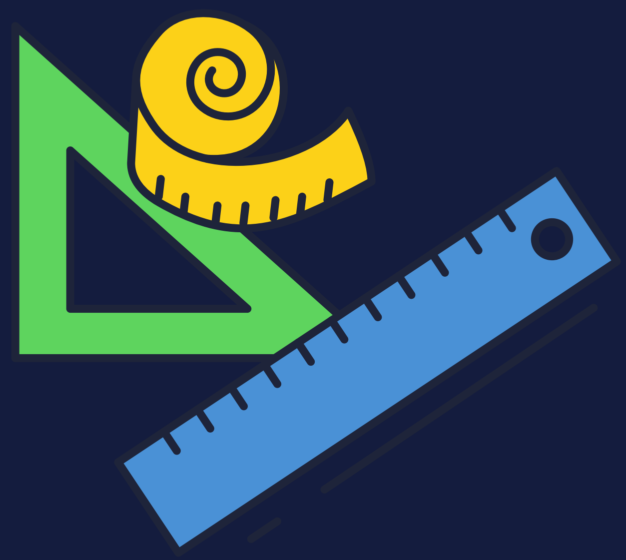
- Errors add regardless of whether the quantities are added or subtracted.
- This is because both values may contribute to uncertainty.

Q. The lengths of three rods are measured as follows:

- $A = 35.0\ \text{cm} \pm 0.2\ \text{cm}$
- $B = 20.0\ \text{cm} \pm 0.1\ \text{cm}$
- $C = 15.0\ \text{cm} \pm 0.1\ \text{cm}$

(a) Calculate the total length when all three rods are placed end to end.

(b) Calculate the difference in length between rod A and rod B.



- **Multiplication and Division:**

If:

$$Z = A \times B \quad \text{or} \quad Z = A / B$$

Then the relative error in Z is:

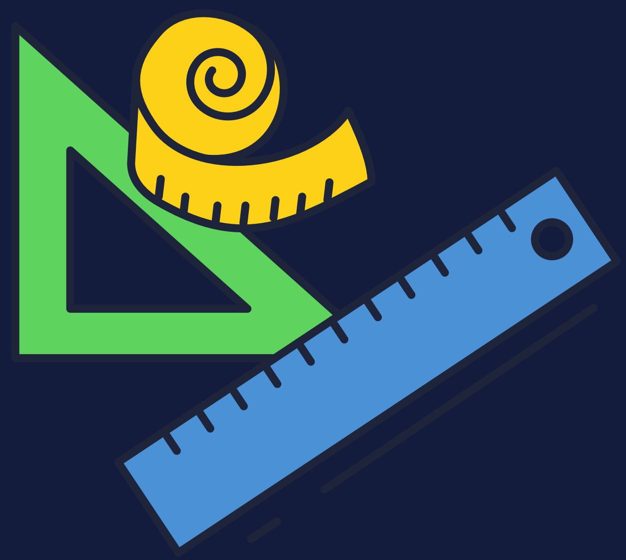
$$\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

$\Delta A/A$ and $\Delta B/B$ are the relative errors in A and B.

- In multiplication/division, relative (or fractional) errors are added.

Q. A student measures the length of a rod as L=50.0 cm±0.5 cm and its width as W=10.0 cm±0.2 cm. Find the total area of the rectangle formed by the rod and its uncertainty.

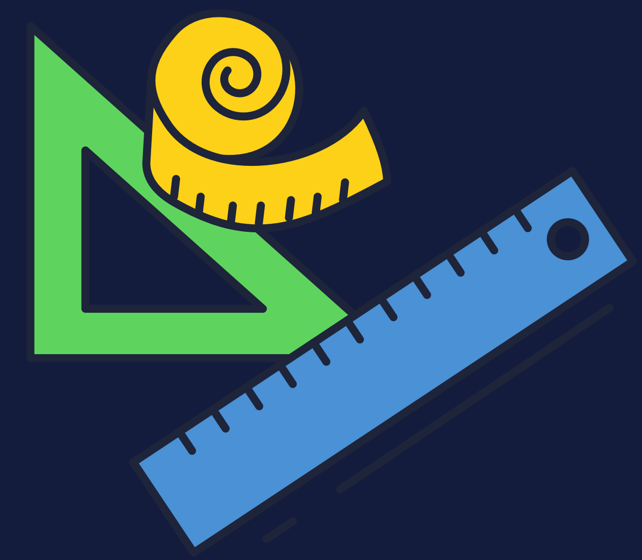
$A = 500.0cm^2 \pm 15.0cm^2$



Q.Two resistances are measured as $R_1 = 4.0 \pm 0.2\ \Omega$ and $R_2 = 6.0 \pm 0.3\ \Omega$. Find the:

a) Total resistance in series

b) Total resistance in parallel with error



- **Quantity Raised to a Power:**

If:

$$Z = A^n$$

Then:

$$\frac{\Delta Z}{Z} = n \cdot \frac{\Delta A}{A}$$

n is the power.

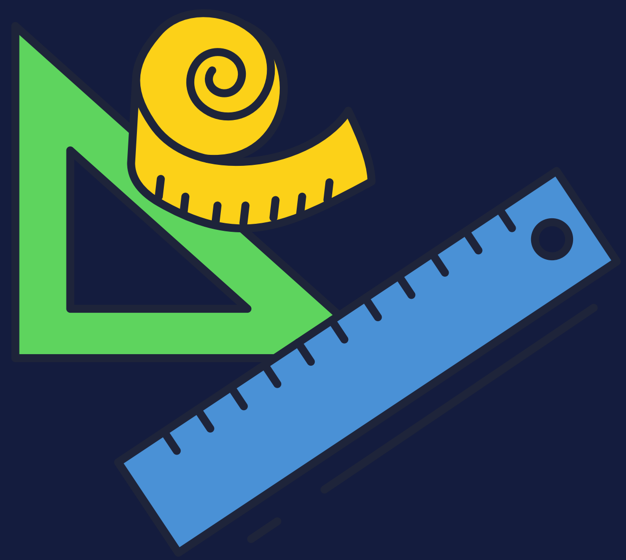
- Multiply the relative error in the base by the absolute value of the exponent.

Q. The side of a square is measured as:

$a = 4.00\ cm \pm 0.02\ cm$

Calculate the area of the square

$A = 16.00 cm^2 \pm 0.16 cm^2$



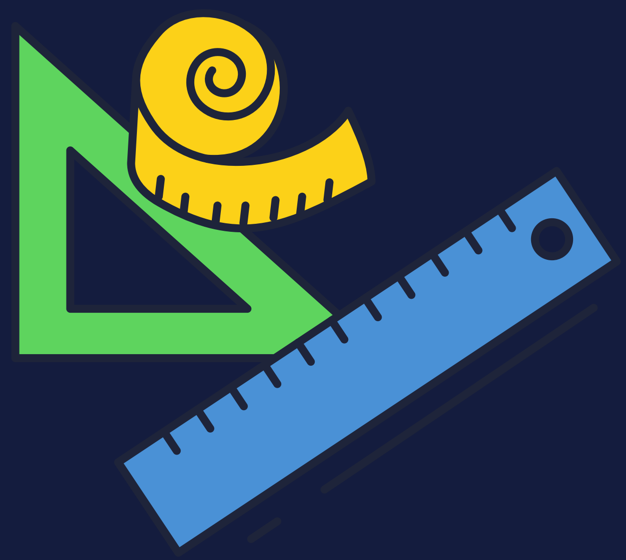
Q. The percentage errors in the measurement of mass and velocity of a body are 3% and 4%, respectively. What will be the percentage error in the calculation of kinetic energy?

A. 7%

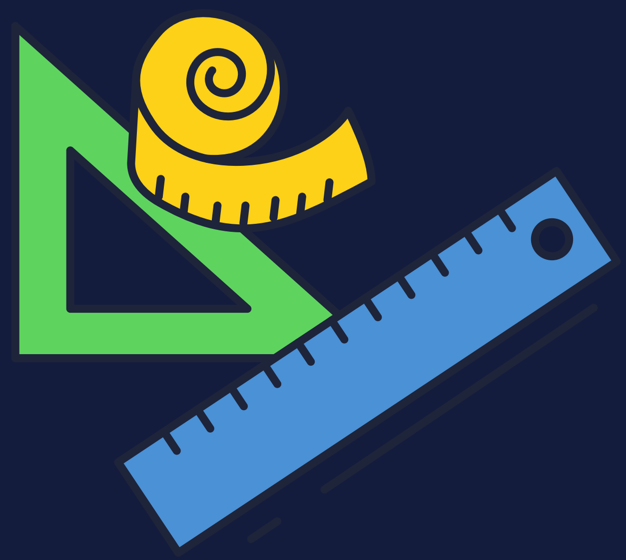
B. 11%

C. 8%

D. 10%



Q A physical quantity P is related to four observables a, b, c and d as follows :
$p = a^3 b^2 / (c\ d)$ The percentage errors of measurement in a, b, c and d are 1%, 3%, 4% and 2%, respectively. What is the percentage error in the quantity P ? If the value of P calculated using the above relation turns out to be 3.763, to what value should you round off the result ? [NCERT]



PRASHANT KIRAD

$$\text{Success} = [C] \cdot [T] \cdot [F]^{0} \cdot [E]^{-1}$$

Where:

C = Consistency

T = Time

F = Fear

E = Excuses