Date:
Page: 1

VIP Revision

Chapter 1: Units and Measurement

Complete NCERT Master-Notes (CBSE Class 11)

Index

The Core Concept

Measurement = Numerical measure × Unit

A unit is an internationally accepted, arbitrarily chosen reference standard.

Evolution of Systems

CGS:	Centimetre, Gram, Second
FPS:	Foot, Pound, Second (British)
MKS:	Metre, Kilogram, Second

★ Internationally accepted!
Replaced all others.

1.2 The 7 Base SI Units

Length	Mass	Time	Electric Current
metre (m)	kilogram (kg)	second (s)	ampere (A)

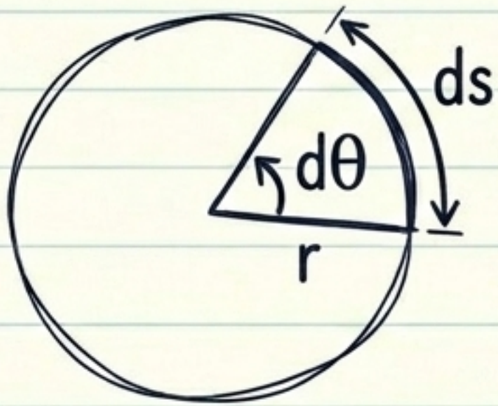
Thermodynamic Temp	Amount of Substance	Luminous Intensity
kelvin (K)	mole (mol)	candela (cd)

← Must specify the entity!

★ Exam Tip: These 7 bases are the building blocks of ALL other physics units. You do NOT need to memorize the exact constant values (like the speed of light or Planck's constant) used to define them!

1.2 Supplementary Units (The Angles)

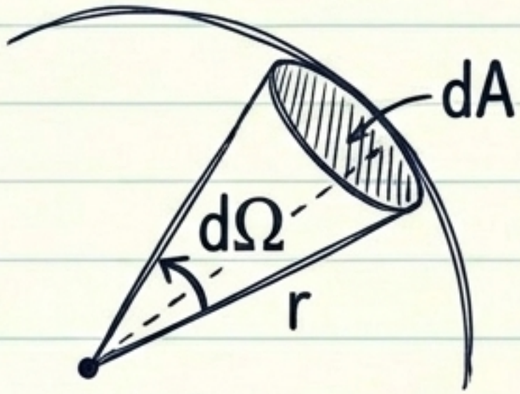
2D: Plane Angle



$$d\theta = \frac{ds}{r}$$

Unit: radian (rad)

3D: Solid Angle



$$d\Omega = \frac{dA}{r^2}$$

Unit: steradian (sr)

BOTH ARE DIMENSIONLESS QUANTITIES!
(They are just ratios of lengths or areas)

1.3 Significant Figures: The Rules

Definition: Reliable digits + 1st uncertain digit.

2.308 ← Trapped zeroes are ALWAYS significant. (4 sig figs)

Less than 1? Leading zeroes are NOT sig. (Just placeholders)

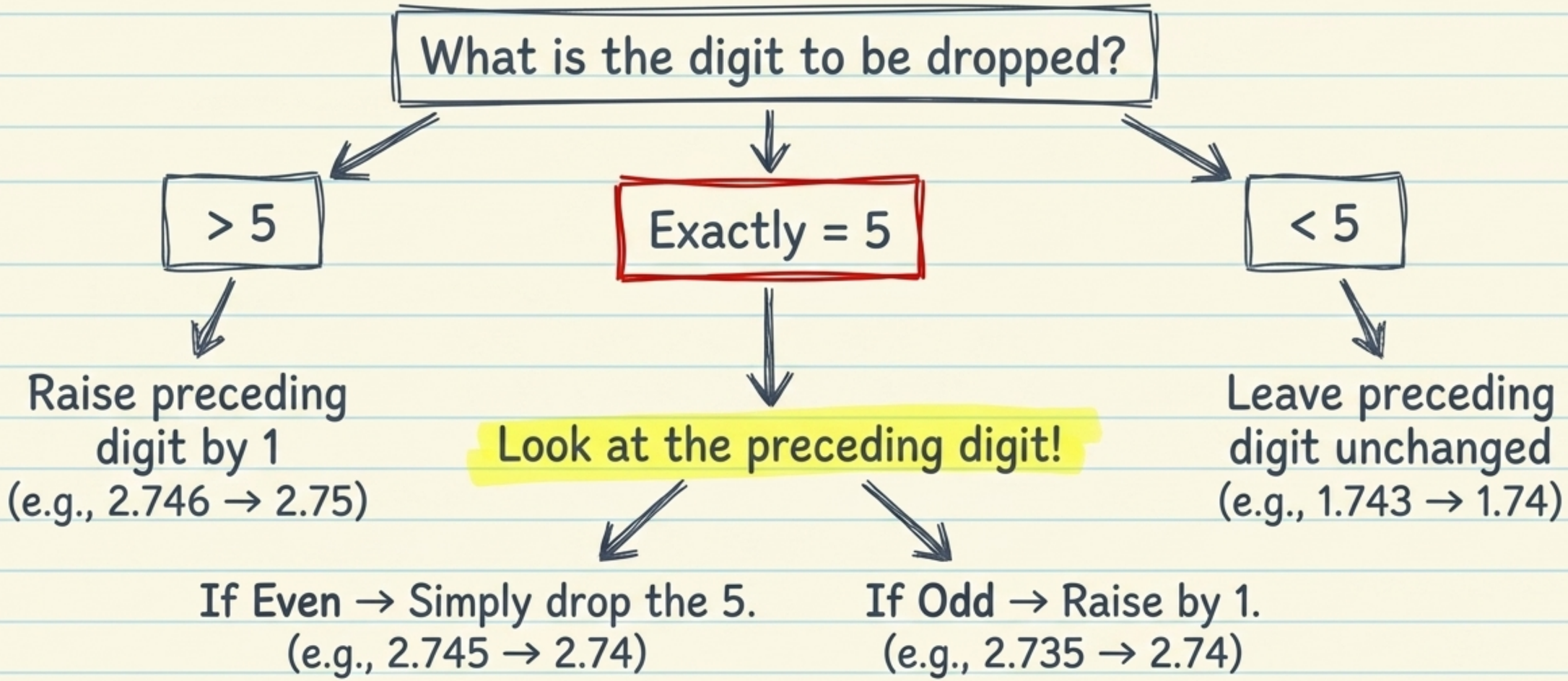
0.004700 ← Decimal present? Trailing zeroes ARE sig. (Conveys precision!) Total = 4 sig figs.

12300 ← No decimal? Trailing zeroes are NOT sig. (3 sig figs)

★ **Scientific Notation ($a \times 10^b$) prevents all confusion!**

Example: 4.700×10^2 clearly has 4 sig figs. The power of 10 is irrelevant.

1.3.2 Rounding Off Uncertain Digits



★ **Multi-step Calculation Rule**: Keep ONE extra digit during intermediate steps to prevent compounding rounding errors!

1.3.1 Math with Significant Figures

Multiply / Divide

Final result retains the *least significant figures* of original numbers.

Mass = 5.74 g (3 SF)
Vol = 1.2 cm^3 (2 SF)

$$\text{Density} = \frac{5.74}{1.2} = 4.7833...$$

Result: 4.8 g cm^{-3} (Restricted to 2 SF)

Add / Subtract

Final result retains the *least decimal places* of original numbers.

$$\begin{array}{rl} 436.32 & \text{(2 dec)} \\ + \ 227.2 & \text{(1 dec)} \\ + \quad 0.301 & \text{(3 dec)} \\ \hline 663.821 & \end{array}$$

Result: 663.8 (Restricted to 1 decimal place)

1.4 & 1.5 Dimensional Formulae

Dimensions are the powers/exponents to which base quantities are raised.

FORCE

↓

$$\text{Force} = \text{Mass} \times \text{Acceleration}$$

↓

$$\text{Force} = \text{Mass} \times \left(\frac{\text{Length}}{\text{Time}^2}\right)$$

↓

$$\text{Dimensional Formula} = [\, M^1 L^1 T^{-2} \,]$$

These powers are the Dimensions!

Quick List

- Volume: $[M^0 L^3 T^0]$
- Velocity: $[M^0 L^1 T^{-1}]$
- Density: $[M^1 L^{-3} T^0]$

★ Exam Tip: Magnitudes don't matter here! Initial velocity, final velocity, and speed ALL have the exact same dimension: $[L\, T^{-1}]$.

1.6 Application 1: Checking Equation Consistency

You can only add or subtract physical quantities that have the EXACT SAME dimensions.

~~Velocity + Force~~ ✗ Apples and Oranges!

Length − Length = Length ✓ ([L] − [L] = [L])

Boxed Analysis (Kinematics)

$$x = x_0 + v_0 t + (\tfrac{1}{2})at^2$$

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

$$[L] = [L] + [L] + [L]$$

Result: Dimensionally Consistent!

★ Warning: Dimensional consistency is a preliminary test. A formula can pass this test but still be physically wrong (e.g., missing dimensionless constants like 1/2 or π)!

How to write a Consistency Proof (Ex 1.3)

The Problem:

Check consistency of $\frac{1}{2} mv^2 = mgh$.

The Solution:

1. LHS Dimensions:

   (Note: ½ is dimensionless)

   Kinetic Energy = $\frac{1}{2} mv^2 \rightarrow [M] [LT^{-1}]^2 = [M L^2 T^{-2}]$

2. RHS Dimensions:

   Potential Energy = $mgh \rightarrow [M] [LT^{-2}] [L] = [M L^2 T^{-2}]$

3. Conclusion: LHS = RHS. Dimensionally correct!

Sidebar (from Ex 1.4)

Can we rule out
$K = ma$
for Kinetic Energy?

$[M L^2 T^{-2}]$ (Energy)
$\neq$
$[M L T^{-2}]$ (Force).

Verdict: Ruled out!

1.6 Application 2: Deducing Physical Relations

Step 1: Set up the product dependence.

$$T = k \cdot \ell^x \cdot g^y \cdot m^z$$

(where k is a dimensionless constant).

Step 2: Write dimensions for both sides.

$$[M^0 L^0 T^1] = [L]^x [LT^{-2}]^y [M]^z$$

Step 3: Equate the powers.

- For M: $z = 0$
- For L: $x + y = 0$
- For T: $-2y = 1 \rightarrow y = -\frac{1}{2} \rightarrow x = \frac{1}{2}$

Step 4: Substitute back.

$$T = k \cdot \ell^{1/2} \cdot g^{-1/2} = k\sqrt{\frac{\ell}{g}}$$

★ Exam Tip: Dimensional analysis CANNOT find the value of k. (In reality, $k = 2\pi$).
It also fails if quantities depend on each other via addition/subtraction!

Special Section: Dimensional Master-Sheet

Quantity & Formula		Dimension
Area $(\ell \times b)$	$\longrightarrow$	$[L^2]$
Volume $(\ell \times b \times h)$	$\longrightarrow$	$[L^3]$
Mass Density (M/V)	$\longrightarrow$	$[M L^{-3}]$
Speed/Velocity (d/t)	$\longrightarrow$	$[L T^{-1}]$
Acceleration (v/t)	$\longrightarrow$	$[L T^{-2}]$
Force $(m \times a)$	$\longrightarrow$	$[M L T^{-2}]$
Energy/Work $(F \times d)$	$\longrightarrow$	$[M L^2 T^{-2}]$

Dimensionless Quantities mentioned in this chapter: Plane Angle (θ), Solid Angle (Ω), Pure Numbers $(1/2, \pi)$, Relative Density, Strain.

Chapter 1 Summary: Quick Revision

1. The Foundation

Physics relies on measurement. SI System (7 Base + 2 Supplementary) is the universal standard.

2. Precision & Rules

Scientific notation ($a \times 10^b$) eliminates significant figure confusion. The precision of math results is limited by the least precise input.

3. Dimensions Reveal Nature

Square brackets [ ] indicate dimensions. They represent the nature of a quantity, ignoring pure numbers/constants.

4. The Ultimate Test

A dimensionally wrong equation is definitely wrong. A dimensionally correct equation *might* still be wrong (missing constants).

Practice Questions (VIP PYQs & NCERT)

Exam

Q1: The Einstein Trap (Ex 1.13)

A student writes $m = \frac{m_0}{(1 - v^2)^{1/2}}$. Where is the missing c (speed of light)?

Hint: Use dimensions! v^2 must be dimensionless to subtract from 1. So it must be v^2/c^2.

Exam

Q2: The Sig Fig Test (Ex 1.11)

Sheet dimensions 4.234 m, 1.005 m, 2.01 cm. Find volume to correct sig figs.

Hint: First, convert 2.01 cm to 0.0201 m! Multiplication rule: final answer limited to 3 Sig Figs (due to 2.01).

Exam

Q3: The Dimensionless Check (Ex 1.4)

Why is calling an atom 'small' meaningless?

Hint: Magnitude requires a reference standard for comparison!

Master these, and Chapter 1 is secured! Good luck!