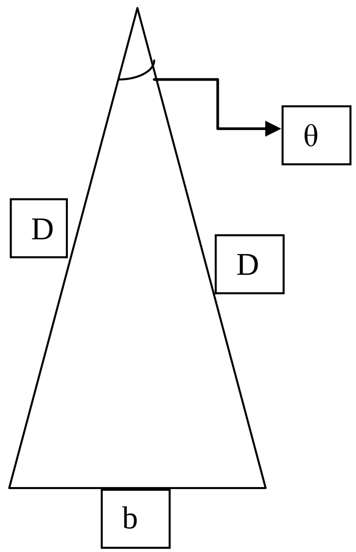
Units

- The units for the fundamental or base quantities are called **fundamental** or **base units**.
- The units of all other physical quantities can be expressed as combinations of the base units. Such units obtained for the derived quantities are called **derived units**.
- A complete set of these units, both the base units and derived units, is known as the **system of units**.

Basic Physical Quantity	Symbol for Quantity	Name of SI unit	Symbol for SI unit
LENGTH	l	metre	m
MASS	m	kilogram	kg
TIME	t	second	s
ELECTRIC CURRENT	I	ampere	A
TEMPERATURE	T	kelvin	kg
AMOUNT OF SUBSTANCE	N	mole	mol
LUMINOUS INTENSITY	I_v	candela	cd

- Large distances such as the distance of a planet or a star from the earth cannot be measured directly with a metre scale. An important method in such cases is the parallax method.
- The distance between the two points of observation is called the **basis**.

- $D = b/\theta$



- If d is the diameter of the planet and α the angular size of the planet (the angle subtended by d at the earth), we have
    - $\propto = \frac{d}{D}$

ESTIMATION OF VERY SMALL DISTANCES:

$t = (nV/(20 * 20A))$ cm

Where:

t = thickness of the layer

A= area cm^2 of the film

nV= volume of the film

ACCURACY AND PRECISION OF INSTRUMENTS AND ERRORS IN MEASUREMENT:
The **accuracy** of a measurement is a measure of how close the measured value is to the true value of the quantity.
Precision tells us to what resolution or limit the quantity is measured.

The errors in measurement can be broadly classified as
(a) systematic errors and
(b) random errors.
Examples of systematic errors are:
a) Instrumental errors
b) Imperfection in experimental technique or procedure
c) Personal errors

The **random errors** are those errors, which occur irregularly and hence are random with respect to sign and size. These can arise due to random and unpredictable fluctuations in experimental conditions (e.g. unpredictable fluctuations in temperature, voltage supply, mechanical vibrations of experimental set-ups, etc), personal (unbiased) errors by the observer taking readings, etc.
Least count error:
The **least count error** is the error associated with the resolution of the instrument.

ABSOLUTE AND RELATIVE ERRORS:
The magnitude of the difference between the true value of the quantity and the individual measurement value is called the absolute error of the measurement. This is denoted by $|\Delta a|$.
$\Delta a_1 = a_{mean} - a_1$,
$\Delta a_2 = a_{mean} - a_2$,
....
....
$\Delta a_n = a_{mean} - a_n$
The Δa calculated above may be positive in certain cases and negative in some other cases. But absolute error $|\Delta a|$ will always be positive.

Instead of the absolute error, we often use the **relative error** or the **percentage error** (δa). ***T*he relative error is the ratio of the mean absolute error Δa_{mean} to the mean value a_{mean} of the quantity measured.**
Relative error = $\Delta a_{mean}/a_{mean}$

When the relative error is expressed in per cent, it is called the **percentage error** (δa).
Thus, Percentage error=

$$\delta a = (\Delta a_{mean}/a_{mean}) \times 100\%$$

When two quantities are added or subtracted, the absolute error in the final result is the sum of the absolute errors in the individual quantities.

$$\pm \Delta Z = \pm \Delta A \pm \Delta B$$

When two quantities are multiplied or divided, the relative error in the result is the sum of the relative errors in the multipliers.

$$\Delta Z/ Z = (\Delta A/A) + (\Delta B/B).$$

The relative error in a physical quantity raised to the power k is the k times the relative error in the individual quantity.

$$\Delta Z/Z = p\,(\Delta A/A) + q\,(\Delta B/B) + r\,(\Delta C/C).$$

If $Z = A^p B^q/C^r$

SIGNIFICANT FIGURES:
The reliable digits plus the first uncertain digit are known as **significant digits** or **significant figures**.
A choice of change of different units does not change the number of significant digits or figures in a measurement.
For example, the length 2.308 cm has four significant figures. But in different units, the same value can be written as 0.02308 m or 23.08 mm or 23080 μm.
All these numbers have the same number of significant figures (digits 2, 3, 0, 8), namely four. This shows that the location of decimal point is of no consequence in determining the number of significant figures.

- **All the non-zero digits are significant.**
- **All the zeros between two non-zero digits are significant, no matter where the decimal point is, if at all.**
- **If the number is less than 1, the zero(s) on the right of decimal point but to the left of the first non-zero digit are not significant.** [In 0.00 2308, the underlined zeroes are not significant].
- **The terminal or trailing zero(s) in a number without a decimal point are not significant.**
- **The trailing zero(s) in a number with a decimal point are significant.** [The numbers 3.500 or 0.06900 have four significant figures each.]

To remove ambiguities in determining the number of significant figures, the best way is to report every measurement in scientific notation (in the power of 10).
In this notation, every number is expressed as $a \times 10^b$, where a is a number between 1 and 10, and b is any positive or negative exponent (or power) of 10.

- **For a number greater than 1, without any decimal, the trailing zero(s) are not significant.**
- **For a number with a decimal, the trailing zero(s) are significant.**

Rules for Arithmetic Operations with Significant Figures

1. In multiplication or division, the final result should retain as many significant figures as are there in the original number with the least significant figures.
2. In addition or subtraction, the final result should retain as many decimal places as are there in the number with the least decimal places.

The dimensional equations are the equations, which represent the dimensions of a physical quantity in terms of the base quantities. For example, the dimensional equations of volume [*V*], speed [*v*], force [*F*] and mass density [ρ] may be expressed as

$[V] = [M^0\ L^3\ T^0]$

$[v] = [M^0\ L\ T^{-1}]$

$[F] = [M\ L\ T^{-2}]$

$[\rho] = [M\ L^{-3}\ T^0]$

A dimensionally correct equation need not be actually an exact (correct) equation, but a dimensionally wrong (incorrect) or inconsistent equation must be wrong.