SECTION-01 - BE-01

BASICS OF SCIENCE AND ENGINEERING

PHYSICS

1. Units and Measurements
2. Classical Mechanics
3. Electric Current
4. Heat and Thermometry
5. Weave Motion, Optics and Acoustics

CHEMISTRY

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7. Acids, Bases and Salts
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COMPUTER PRACTICE

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PHYSICS

1. Units and Measurements

[1] Physical Quantities and Units :

A quantity that can be measured and by which various physical happenings can be explained and expressed in the form of laws is called a physical quantity.

For example, length, mass, time, force, Acceleration, Temperature, Pressure, Electric Current, Potential Difference, etc.

On the other hand, various happenings in life e.g., happiness, sorrow, Love, Rudeness, Proudness, Respect, Pride, Hate, Angry, Loyalty, Stupidity, etc. are not physical quantities because these cannot be measured.

A physical quantity is represented completely by its magnitude and unit. For example, The length of the playground is 150 metres means a length which is 150 times the unit of length. Here 150 represents the numerical value of the given quantity and metre represents the unit of quantity under consideration. Thus, in expressing a physical quantity we choose a unit and then find that how many times that unit is contained in the given physical quantity.

There are so many physical quantities in practice. It is not feasible to define a separate unit for each of these physical quantities. To simplify things, we make use of relations between different physical quantities.

[2] Fundamental and derived physical quantities :

- **Fundamental physical quantities :**

Out of a large number of physical quantities that exist in nature, there are seven quantities that are independent of all other quantities and do not require the help of any other physical quantity for their definition, therefore these are called absolute quantities. These quantities are also called fundamental or base quantities, and these quantities do not depend on other quantities for their measurements. All other quantities are based upon and can be expressed in terms of these quantities.

The units of fundamental quantities are called fundamental units.

For Example, mass, length, time, etc. are fundamental quantities, while their units metre, kilogram, second, etc. are fundamental units.

Fundamental units can neither be derived from one another nor can they be further resolved into other simpler units.

Fundamental /Base quantity	Typical symbol for quantity	Base unit	Symbol for unit
Length	l, x, r	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Electric current	I i	ampere	A
Thermodynamic temperature	T	kelvin	K
Amount of substance	n	mole	mol
Luminous intensity	Iv	candela	cd

Base Quantity	SI Units		
	Name	Symbol	Definition
Length	Metre	m	The metre, symbol m, is the SI unit of length. It is defined by taking the fixed numerical value of the speed of light in vacuum c to be 299792458 when expressed in the unit ms^{-1}, where the second defined in terms of the caseium frequency Δv_{cs}.
Mass	Kilogram	kg	The kilogram, symbol kg, is the SI unit of mass. It is defined by taking the fixed numerical value of the Planck constant h to be $6.62607015 \times 10^{-34}$ when expressed in the unit Js, which is equal to $kg\ m^{-2}s^{-1}$, where the metre and the second are defined in terms of c and Δv_{cs}.
Time	second	s	The second, symbol s is the SI unit of time. It is defined by taking the fixed numerical value of the ceasium frequency Δv_{es} the unperturbed ground state hyperfine transition frequency of the ceasium–133 atom to be 9192631770 when expressed in the util Hz, which is equal to s^{-1}.
Electric	ampere	A	The ampere, symbol A, is the SI unit of electric current. It is defined by taking the fixed numerical value of the elementary charge e to be $1.602176634 \times 10^{-19}$ when expressed in the unit C, which is equal to A s, where the second is defined in terms of Δv_{cs}.
Thermodynamic Temperature	Kelvin	K	The kelvin, symbol K, is the SI unit of thermodynamic temperature. It is defined by taking the fixed numerical value of the Boltzmann constant k to be 1.380649×10^{23} when expressed in the value JK^{-1}, which is equal to $kg\ m^2\ s^{-2}k^{-1}$, where the kilogram, metre and second are defined in terms of h, c and Δv_{cs}.
Amount of substance	mole	mol	The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant N_A, when expressed in the unit mol^{-1} and is called the Avogadro number. The amount of substance, symbol n, of a system is a measure of the number of sepcified elementry entities. An elementary entity may be an atom, a molecular, an ion, an electron, any other particle or specified group of particles.
Luminous intensity	candela	cd	The candela, symbol cd, is the SI unit of luminous intensity in given direction. It is defined by taking the fixed numerical value of the luminous efficacy of mono chromatic radiation of frequency 540×10^{12} Hz. K_{cd} to be 683 when expressed in the unit lm W^{-1}, which is equal to cd sr w^{-1}, or cd sr $kg^{-1}m^2s^3$, where the kilogram, metre and second are defined in terms of h, c and Δv_{cs}.

[3] Some important practical units :

1 angstrom ($\mathring{A}$) = 10^{-10} m

1 AU or 1 astronomical unit = 1.496×10^{11} m

1 light year = 9.46×10^{15} m

- 1 micron = 1μ or 1 μm = 10^{-6} m
- 1 nanometre = 1nm = 10^{-9} m
- 1 fermi or femtometer (F) = 10^{-15} m
- 1 a.m.u. = 1.66×10^{-27} kg

[4] Interconversion of Units MKS (SI) to CGS and Vice Versa :

Derived physical quantities : Apart from the seven fundamental quantities all other physical quantities can be derived by fundamental quantities, therefore, these are called derived physical quantities.

For example : Velocity = displacement/time

Area = length × length = $(\text{length})^2$

Volume = length × length × length = $(\text{length})^3$

Sr. no.	Physical quantity	Symbol of Physical quantity	Relation with other quantity SI unit	MKS unit	CGS unit	Symbol of
1.	Area	A	Length × breadth	$(\text{metre})^2$	$(\text{centimetre})^2$	m^2
2.	Volume	V	Length × breadth × height	$(\text{metre})^3$	$(\text{centimetre})^3$	m^3
3.	Density	ρ	$\frac{\text{mass}}{\text{volume}}$	$\frac{\text{kilogram}}{\text{metre}^3}$	$\frac{g}{cm^3}$	kg m^3
4.	Speed/velocity	v	$\frac{\text{distance or dispalcement}}{\text{time}}$	$\frac{\text{metre}}{\text{s}}$	$\frac{\text{cm}}{\text{s}}$	ms^{-1}
5.	Acceleration	a	$\frac{\text{change in velocity}}{\text{time}}$	$\frac{\text{metre}}{\text{s}}$	$\frac{\text{cm}}{\text{s}^2}$	ms^{-2}
6.	Force	F	Mass × acceleration	newton	dyne	N
7.	Work	W	Force × distance	joule	erg	J
8.	Power	P	$\frac{\text{work}}{\text{time}}$	$\frac{\text{joule}}{\text{s}}$	$\frac{\text{erge}}{\text{s}}$	Js^{-1}
9.	Pressure	P	$\frac{\text{foce}}{\text{area}}$	$\frac{\text{newton}}{\text{metre}^2}$	$\frac{\text{dyne}}{\text{cm}^2}$	Pa
10.	Linear Momentum	P	Mass × Velocity	Kilogram metre/second	gram–cm/second	kg ms^{-1}
11.	Frequency	f	$\frac{\text{number of vibrations}}{\text{second}}$	$(\text{second})^{-1}$	$(\text{second})^{-1}$	Hz
12.	Energy	E	Work	joule	erg	J
13.	Impulse		Force × time	newton second	dyne second	Ns
14.	Surface Tension		$\frac{\text{force}}{\text{length}}$	$\frac{\text{newton}}{\text{metre}}$	$\frac{\text{dyne}}{\text{cm}}$	Nm^{-1}
15.	Coefficient of viscosity	η	$\frac{F \times r}{A \times v}$	pascal second	pascal second	Pa. s
16.	Coefficient of elasiticity		$\frac{\text{stress}}{\text{stain}}$	$\frac{\text{newton}}{\text{metre}^2}$	$\frac{\text{dyne}}{\text{cm}^2}$	Nm^{-2}

- **Interconversion of units – MKS to cgs and vice versa :**

(1) Convert MKS units of area into cgs unit

Area $= \text{length} \times \text{length} = L \times L = L^2$

in MKS system unit of length is metre and in cgs system unit of length is centimetre

1 m = 100 cm

MKS cgs

$(1m)^2 = (100\ cm)^2$

$= (10^2)^2\ (cm)^2$

$1m^2 = 10^4\ cm^2$

(2) Convert MKS units of volume into cgs unit

volume = length × length × length = $L \times L \times L = L^3$

in MKS system unit of length is metre and in cgs system unit of length is centimetre

1 m = 100 cm

MKS cgs

$(1m)^3 = (100\ cm)^3$

$= (100\ cm)^3$

$= (10^2)^3\ (cm)^3$

$1m^3 = 10^6\ cm^3$

(3) Convert MKS units of density into cgs unit

unit of mass in MKS and cgs system is kg and cm respectively

$1m^3 = 10^6\ cm^3$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

MKS cgs

$$\frac{kg}{m^3} = \frac{10^3 g}{10^6 cm^3} = \frac{10^{-3} g}{cm^3}$$

$$1\frac{kg}{m^3} = 10^{-3}\frac{g}{cm^3}$$

(4) Acceleration due to gravity $g = 9.8\ \frac{m}{s^2}$ = ... $\frac{cm}{s^2}$

$$9.8\ \frac{m}{s^2} = 9.8\ \frac{100\ cm}{s^2}$$

$$9.8\ \frac{m}{s^2} = 980\ \frac{cm}{s^2}$$

(5) Convert MKS units of force into cgs unit

unit of force in MKS and cgs system is N and dyne respectively

$$N = \frac{kg\,m}{s^2} \text{ and dyne} = \frac{g\ cm}{s^2}$$

Force = mass × acceleration

MKS cgs

$$1N = \frac{kg\ m}{s^2} = \frac{10^3 g\ 10^2 cm}{s^2} = \frac{10^5 g\,cm}{s^2}$$

$$1\ \frac{kg\,m}{s^2} = 10^5\ \frac{g\,cm}{s^2}$$

$1\ N = 10^5$ dyne

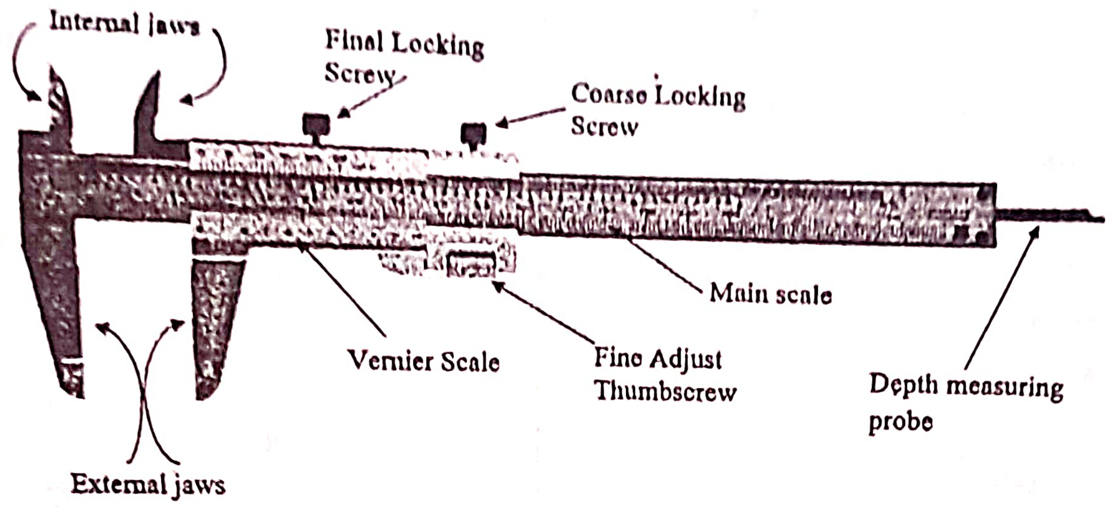
(6) $\frac{36\ km}{h} = \ldots\ldots\ \frac{m}{s}$

$$\frac{36\ km}{h} = \frac{36 \times 1000\ m}{60 \times 60\ s} = \frac{36 \times 1000\ m}{60 \times 60\ s} = 10\frac{m}{s}$$

[5] Measurement with Vernier Caliper and Micrometer Screw Gauge :

In 1631, French mathematician **Pierre Vernier** invented the Vernier scale with the help of which 10 or 20 parts of 1 mm can be measured accurately.

The instrument based on the Vernier scale is called Vernier calipers. The diagram of Vernier calipers is as follows :



There are 3 main parts in vernier calipers :

1. **Main Scale :** The upper scale on the main scale is in inches and the lower scale is in centimeters. This scale is called the main scale.
2. **Vernier scale :** A small sliding scale arranged on the main scale is called the Vernier scale.
3. **Jaws :** There are two jaws namely A and C on the left side of the main scale. The edge of both jaws A and C are in the same line.

There are two jaws namely B and D at the left side of the Vernier scale. The edge of both jaws B and D are in the same line.

The jaws A, B, C and D are used to hold the object which is to be measured.

What is Least Count ?

The smallest measurement that can be measured accurately with the given measuring instrument is called the Least Count of that instrument.

A simple metre scale can measure up to 1 mm accurately. Hence the least count (LC) of metre scale is 1 mm.

A clock without a second hand has the least count (LC) of 1 minute and A clock with a second hand has a least count (LC) of 1 second.

Normal Vernier calipers have the least count of 0.1 mm or 0.05 mm or 0.02 mm. The smaller the least count of the instrument, the higher the precision of the instrument.

Principle :

N divisions of Vernier Scale are equal to (N – 1) divisions of Main Scale.

N divisions of Vernier Scale = (N – 1) divisions of Main Scale.

N VSD = (N – 1) MSD

VSD	=	Vernier Scale Division
MSD	=	Main Scale Division

$$\therefore \quad 1\ \text{VSD} = \frac{(N-1)}{N}\ \text{MSD}$$

The least count of Vernier calipers = $\dfrac{\text{the distance between two successive divisions on the main scale}}{\text{the distance between two successive divisions on the vernier scale}}$

$$\text{LC} = 1\ \text{MSD} - 1\ \text{VSD}$$

$$= 1\ \text{MSD} - \frac{(N-1)}{N}\ \text{MSD}$$

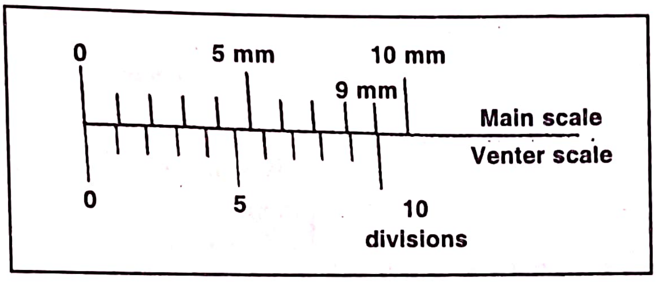
$$LC = 1/N\ MSD = \frac{S}{N}$$

S = Value of 1 division on main scale

Least Count of Vernier calipers,

$$= \frac{\text{Value of 1 division on the main scale}}{\text{number of total division on vernier scale}}$$

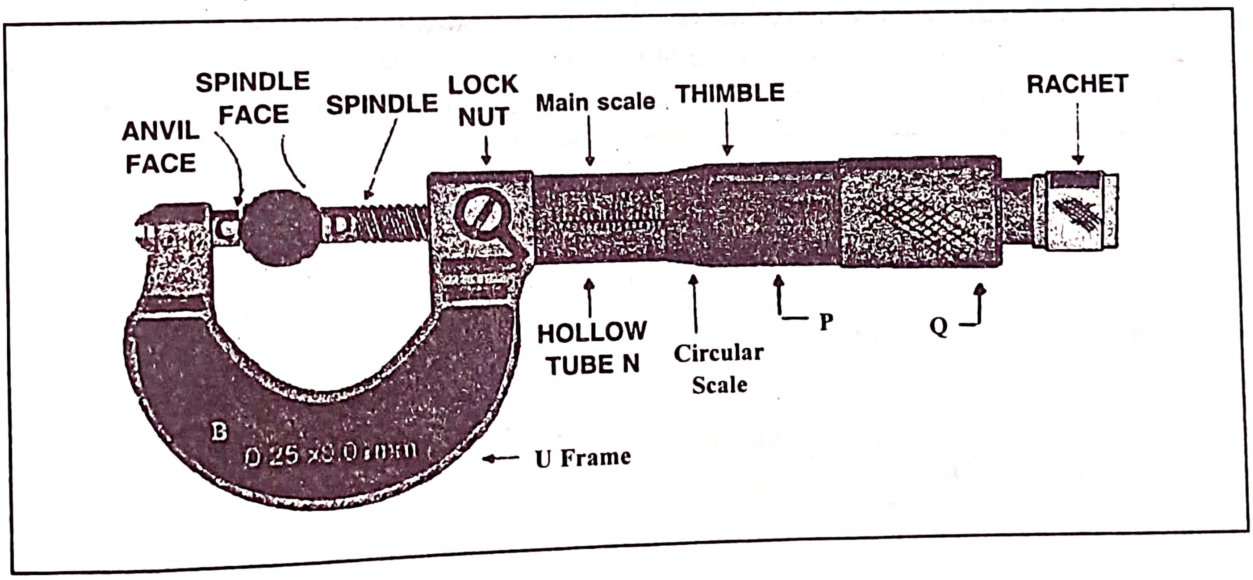
As shown in Figure 1.4, the value of 1 division on the main scale is 1 mm. The length of 10 divisions on the Vernier scale is equal to the length of 9 divisions on the main scale.



As shown in above figure least count = $\frac{1}{10}$ mm = 0.1 mm = 0.01 cm

[6] Micrometer Screw Gauge :

Using vernier calipers distance up to 0.01 cm can be measured accurately. But in science and engineering, even microscopic measurements from 0.01 cm have to be taken accurately. For this, an instrument called a micrometer screw gauge is used. This instrument is also called a micrometer.



A micrometer screw gauge is used to measure the thickness of a thin wire, paper, sheet or blade.

This instrument works on the principle of the Vernier scale as well as the screw gauge. According to the principle of screw gauge, when we rotate the screw gauge, the linear displacement of the flat end of the spindle is proportional to the angular displacement of the screw gauge. When the screw gauge completes a rotation, its flat end moves one division forward or backward This distance is called a patch.

As shown in Figure the instrument has a U–shaped or rectangular metal frame. Its both ends are hollow cylindrical. It has a strong anvil at one end and a hollow tube attached at the other end. On this tube, the base line (reference line) of the main scale is drawn and on the reference line, 25 divisions are drawn at a distance of 0.5 or 1 mm. This scale is called the main scale.

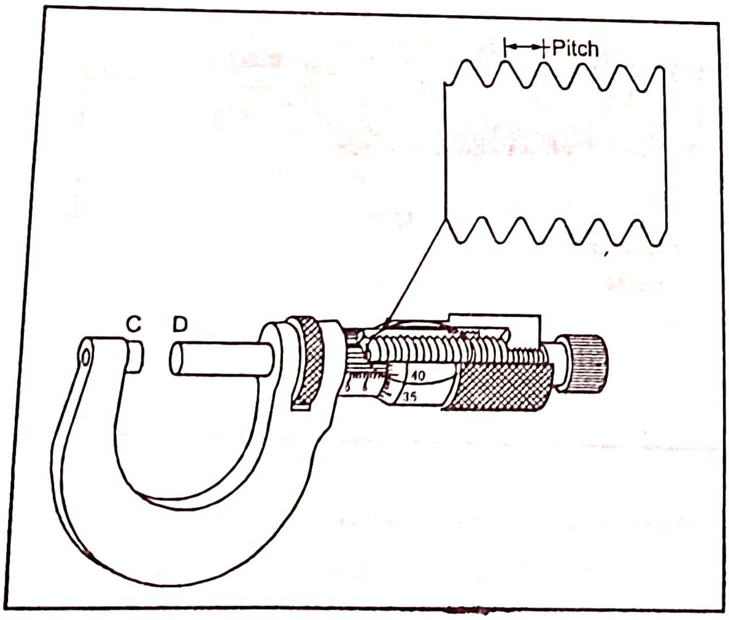
The screw gauge is passed through a hollow cylinder and connected to the other end of the frame. The D end of the screw gauge can be moved back and forth by turning the screw. Hollow cylinders have a circular scale. It has 50 or 100 divisions drawn on it at equal distances. This scale is called the head scale or circular scale.

Pitch distance :

The distance between two consecutive threads on the screw gauge is called the pitch distance, the distance between each consecutive threads of the screw gauge is the same.

When any screw completes one rotation the end of the screw D moves forward or backward equal to one pitch distance.

To determine the pitch distance, arrange the screw gauge in such a way that the zero division of the circular scale coincides with the baseline so that the edge of the circular scale coincides on any mark of the main scale.



Now giving a complete rotation to the circular scale, the distance that the edge of the circular scale moves on the main scale is called the pitch distance of the given screw gauge. If the displacement of the circular scale is 0.5 mm then the pitch distance of the screw gauge is said to be 0.5 mm.

Least Count of micrometer :

The smallest measurement that can be measured accurately with the given measuring instrument is called the Least count of that instrument. The following formula is used to calculate the Least count of the micrometer screw gauge :

Least count of micrometer screw gauge

$$= \frac{\text{pitch distance of screw (p)}}{\text{Total number of divisions on a circular scale (n)}}$$

If the circular scale has a total of 50 identical divisions and screw gauge pitch distance (p) is 0.5 mm then

$$\text{Least count} = \frac{0.5}{50} = \frac{1}{100} = 0.01 \text{ mm}$$

$$= 0.001 \text{ cm}$$

[7] Errors :

Measurement is the foundation of all experimental science and technology..

The measuring process is essentially a process of comparison. To measure any physical quantity, we compare it with a standard (unit) of that quantity. No measurement is perfect as the errors involved in the process cannot be removed completely. Hence, in spite of our best efforts, the measured value of a quantity is always some what different from its actual value or true value..

The difference in the true value and the measured value of a quantity is called error of measurement.

The errors in measurement can be broadly classified as

1. Systematic Errors
2. Random Errors

[8] Systematic Errors :

The systematic errors are those errors that tend to be in one direction, either positive or negative. It is not positive and negative both. In fact the causes of systematic errors are known. Therefore, such errors can be minimized.

- **Some of the sources of systematic errors are :**

(i) Instrumental errors

Which arise from the errors due to imperfect design or manufacture or calibration of the measuring instrument.

For example, an ordinary metre scale may be worn out at one end.

The temperature graduations of a thermometer may not be accurately calibrated.

(ii) Error due to the Imperfection in experimental technique or procedure.

For example, to determine the temperature of a human body, a thermometer placed under the armpit will always give a temperature lower than the actual value of the body temperature.

(iii) Personal errors

Personal errors arise due to the inexperience of the observer.

For example, lack of proper setting of the apparatus, reading an instrument without setting it properly, taking observations without observing proper precautions etc.

(iv) Errors due to external causes.

The external conditions such as changes in temperature, pressure, humidity, wind velocity etc. during the experiment may affect the measurements.

Systematic errors can be minimized by improving experimental techniques, selecting better instruments and removing personal errors as far as possible.

For a given experimental set up, systematic errors may be estimated to a certain extent. The necessary corrections may then be applied to the observations.

[9] Random Errors :

The random errors may arise due to random and unpredictable variations in experimental conditions e.g., temperature, pressure, voltage supply, mechanical vibrations etc. The random errors are the errors that occur irregularly. Sometimes, random errors may be positive and the other time, they may be negative.

The random errors can be minimised by repeating the observation a large number of times and taking the arithmetic mean of all the observations.

[10] Estimation of errors :

(a) Absolute error in the measurement of a physical quantity is the magnitude of the diffrence between the true value and the individual measured value of quantity.

Let a physical quantity be measured n times. Let the measured values be $a_1, a_2, a_3, \ldots a_n$. The arithmetic mean of these values is

$$\bar{a} = \frac{a_1 + a_2 + \ldots a_n}{n}$$

or $$\bar{a} = \frac{1}{n} = \sum_{i=1}^{i=n} a_i$$

Usually the arithmetic mean $\bar{a}$ is taken as the best possible / true value of quanity, if same is not known otherwise.

By definition, absolute errors in the individual measured values of the quantity are

$$\Delta a_1 = \bar{a} - a_1$$

$$\Delta a_2 = \bar{a} - a_2$$

....

$$\Delta a_n = a_m - a_n$$

The absolute errors may be positive in certain cases and negative in certain other cases. This is because individual measurements are as likely to overestimate as to underestimate the true value of the quantity.

(b) **Mean absolute error :** It is the arithmetic mean of the magnitude of absolute errors in all the measurements of the quantity. It is represented by $\Delta\bar{a}$. Thus,

$$\Delta\bar{a} = \frac{|\Delta a_1| + |\Delta a_2| + \ldots |\Delta a_n|}{n}$$

$$\Delta\bar{a} = \frac{1}{n} \times \sum_{i=1}^{i=n} |\Delta a_n|$$

Hence the final result of measurement be written as $a = \bar{a} \pm \Delta\bar{a}$.

This implies that any measurment of the quantity is likely to be between $\bar{a} + \Delta\bar{a}$ and $\bar{a} - \Delta\bar{a}$.

(c) **Relative error or Fractional error : The** realtive error or fractional error of measurement is defined as the ratio of mean absolute error to the mean value of the quantity measured. Thus,

Relative error or Fractional error

$$= \frac{\text{mean absolute error}}{\text{mean value}} = \frac{\Delta\bar{a}}{\bar{a}}$$

When the realtive / fractional error is expressed is percentage we call it percentage error. Thus,

$$\text{Percentage error, } \delta a = \frac{\Delta \bar{a}}{\bar{a}} \times 100\ \%$$

Sample problem : The refractive index of water is found to have the values 1.29, 1.33, 1.34, 1.35, 1.32, 1.36, 1.30 and 1.33. Calculate the mean value, absolute error, the realtive error and the percentage error.

Solution : Here mean value of refractive index,

$$\bar{\mu} = \frac{1.29 + 1.33 + 1.34 + 1.35 + 1.32 + 1.36 + 1.30 + 1.33}{8}$$

$\bar{\mu}$ = 1.3275 = 1.33 (rounded off to two places of decimal)

Absolute error in measurement are :

$\Delta\mu_1 = 1.33 - 1.29 = 0.04$

$\Delta\mu_2 = 1.33 - 1.33 = 0.00$

$\Delta\mu_3 = 1.33 - 1.34 = -0.01$

$\Delta\mu_4 = 1.33 - 1.35 = -0.02$

$\Delta\mu_5 = 1.33 - 1.32 = 0.01$

$\Delta\mu_6 = 1.33 - 1.36 = -0.03$

$\Delta\mu_7 = 1.33 - 1.30 = 0.03$

$\Delta\mu_8 = 1.33 - 1.33 = 0.00$

Mean absolute error,

$$\Delta\bar{\mu} = \frac{\sum_{i=1}^{i=n} |\Delta\mu|}{n}$$

$$= \frac{0.04 + 0.00 + 0.01 + 0.02 + 0.01 + 0.03 + 0.03 + 0.00}{8}$$

$$= \frac{0.14}{8} = 0.0175 = 0.02$$

$$\text{Relative error} = \pm\frac{\Delta\bar{\mu}}{\mu} = \pm\frac{0.02}{1.33} = \pm 0.015 = \pm 0.02$$

Percentage error = 0.015 × 100 = ± 1.5 %

Example-1 : In an experiement two capacitors measured are (1.3 ± 0.1) μF and (2.4 ± 0.2) μF. Calculate the total capacity in parallel with percentage error.

Solution : Here

$C_1 = (1.3 \pm 0.1)\ \mu F$ and $C_2 = (2.4 \pm 0.2)\ \mu F$

In parallel $C_p = C_1 + C_2 = 1.3 + 2.4 = 3.7\ \mu F$

$\Delta C_p = \pm(\Delta C_1 + \Delta C_2) = \pm(0.1 + 0.2) = \pm 0.3$

$$\text{percentage error} = \pm\frac{0.3}{3.7} \times 100 = \pm 8.1\ \%$$

Hence, $C_p = (3.7 \pm 0.3)\ \mu F = 3.7\ \mu F \pm 8.1\ \%$

Example-2 : The lengths of two cylinders are measured to be l_1 = (5.62 ± 0.01) cm and l_2 = (4.34 ± 0.02) cm. Calculate difference in lengths with error limits.

Solution : Here

$l_1 = (5.62 \pm 0.01)$ cm

$l_2 = (4.34 \pm 0.02)$ cm

$l = l_1 - l_2 = 5.62 - 4.34 = 1.28$ cm

$\Delta r = \pm(\Delta l_1 + \Delta l_2) = (0.01 + 0.02) = \pm 0.03$

$$\text{Percentage error} = \frac{\pm 0.03}{1.28} \times 100 = 2.34\ \%$$

Hence, difference in length = (1.28 ± 0.03) = 1.28 cm and 2.34 %.

Multiple Choice Questions (MCQs)

1. Which of the following physical quantities is a derived one ?

(A) mass (B) force
(C) plane angle (D) time

Ans. : (B)

2. Which of the following physical quantities is not a fundamental physical quantity in the SI system ?

(A) Luminous intensity
(B) Electric current
(C) area
(D) Quantity of matter

Ans. : (C)

3. $\frac{1\ \mu m}{1\ fm} = ...$

(A) 10^9 (B) 10^{-9}
(C) 10^{15} (D) 10^6

Ans. : (A)

4. Unit of Luminous intensity is ....

(A) degree (B) radian
(C) steradian (D) candela

Ans. : (D)

5. $1 \frac{g}{cm^3} = ... \frac{kg}{m^3}$

(A) 1 (B) 100
(C) 1000 (D) 0.1

Ans. : (C)

6. The diameter of a sphere is 3.458 cm. Its total surface area considering significant digits is...

(A) 37.547 (B) 37.548
(C) 37.55 (D) 37.6

Ans. : (C)

7. In 0.005308, the number of significant digits are ....

(A) 4 (B) 6
(C) 7 (D) 2

Ans. : (A)

8. In $g = 4\pi^2 \frac{L}{T^2}$, the percentage errors in T and L are 2% and 1% respectively, calculate the percentage error in g.

(A) 1% (B) 3%
(C) 5% (D) 7%

Ans. : (C)

9. If error in determination of volume of a sphere is 9%, error in its surface area is....%

(A) 9% (B) 3%
(C) 6% (D) 12%

Ans. : (C)

10. If 18.854 is rounded off up to 3 significant digits, the answer will be...

(A) 18.854 (B) 18.8
(C) 18.9 (D) 18.85

Ans. : (C)

11. The precision of an instrument depends upon its

(A) Least count (B) Careful reading
(C) Method (D) None

Ans. : (A)

12. The maximum relative error in the subtraction of two quantities =

(A) Addition of absolute error of each quantity
(B) Subtraction of absolute error of each quantity
(C) Both
(D) None

Ans. : (A)

13. The maximum relative error in the division of two quantities =

(A) Addition of absolute error of each quantity
(B) Subtraction of absolute error of each quantity
(C) Both
(D) None

Ans. : (D)

- **Fill in the blanks :**

1. 1 newton = ...dyne
2. The volume of a cube with 10 cm length = ...m^3
3. 1 kg = ...mg
4. 1 kg = ...amu [**Hint :** 1 amu = 1.66×10^{-27} kg]
5. 25 kmh = ... ms
6. 1 Nm = ... Pa
7. 1 joule = ...erg
8. 1 Å = ... m
9. 1 mm = ... m

ANSWERS

(1)	10^5	(2)	0.001
(3)	10^6	(4)	6.022×10^{26}
(5)	6.94	(6)	1
(7)	10^7	(8)	10^{-10}
(9)	10^{-3}		

★★★