DATE: 07/06/2024

Physics

Chapter#01

Physical Quantities and Measurement

Q: What is physics?

* **Physics :-** In physics we study Matter, energy and their interaction.

Physics

Matter — Energy

and their interaction

Q: What is importance of Physics in Science?

* **Physics in Science :-** Physics is the most fundamental of all sciences. In order to study biology, chemistry or any other natural science, one should have a firm understanding of the principles of Physics.

* **Example of Physics in Biology :-** Biology uses the physics principle of fluid movement to understand how blood flow through the heart, arteries and veins.

* **Example of Physics in Chemistry :-** Chemistry relies on the physics of subatomic paticles to understand why chemical reactions take place.

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Q: How is physics related to technology?

* **Physics and Technology:-** Physics is behind every technology and plays a key role in the further development of these technologies. Such as airplanes, computers, PET scans and nuclear weapons.

* **Examples of technologies based on the principles of Physics :-**

1- Rockets and space shuttles
2- Magnetically levitating trains
3- Microscopic robots that fight cancer cells in our bodies.

All these technologies, whether common places or exciting, are based on the principles of physics.

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Branches of Physics :-

Physics is vast and is therefore further subdivided in many other branches. These branches of physics include mechanics, optics, oscillation and waves, thermodynamics, electromagnetism, astrophysics, quantum physics, atomic physics and nuclear physics.

1- **:- Mechanics :-**

Branch of Physics related with "motion" It is futher divided into "Kinematic" and "dynamics". In kinematics we study motion "without cause". And in Dynamics we study motion "with cause".

2- **:- Quantum Physics :-**

Quantum physics is the study of matter and energy at the most fundamental level.

3- **:- Optics :-**

Branches of Physics that deals with study of light its behavior, properties and use of optical instrument.

4- **:- Electromagnetism :-**

Electromagnetism is a branch of physics that deals with the relation b/w electricity and magnetism it explores how electric charges and current create magnetic fields.

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5- **:: Thermodynamics ::-**

The study of flow or motion of heat.

6- **:: Oscillation and Waves ::-**

Oscillation :- The study of to & fro movement of an object or body.

Waves :- Waves are the disturbance in Medium.

7- **:: Atomic and Nuclear Physics ::-**

Atomic and nuclear physics are branches of physics that focus on the study of the stucture, behavior, and interaction of atoms and atomic nuclei, respetively.

8- **:: Relativity ::-**

Relativity describes the relation b/w space, time and gravity.

9- **:: Astrophysics ::-**

Branch of physics deals with the study of universe using the laws & principles of physics.

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-: Physics :-

Q: Differentiate b/w Physical and non-Physical Quantities

Physical Quantities	Non-Physical Quantities
Definition	
Physical Quantities are those quantities which can be observed & measured.	Non-physical Quantities are those Quantities which can not be observed & measured.
Examples	
length, mass, time temprature can be observed & measured.	Colour, taste, feelings can not be observed & measured.

Q: Define Measurement.

Measurement :- Measurement is a comparision b/w an unknown physical quantity like (length, mass, time etc) & standard to see how large and small it is compared to that standard.

Q: Define Unit.

Unit :- is standard with which physical quantities are measured.

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Q: Write Characteristics of Physical quantities also give example.

Characteristics :- Measurment of a quantity consist of "Numerical magnitude" (number representing size of the quantity) & Unit which it is measured.

Example :- If the length of a person is 1.65 meters (5 foot & 5 inches), 1.65 is the numerical magnitude and meter is the unit.

Q Differentiate b/w Base & Derived Units.

Base Units	Derived Units
Definition	
Base units are defined as the fundamental units of measurement.	Defined as units that are derived from the base units through mathamatical operations.
SI Unit	
Each SI unit is defined carefully so that accurate & reproducible measurments can be made and their are seven based units	In SI units all other physical quantities can be derived from seven base Units.
Examples	
Meter, kilogram, second, ampere, kelvin, mole, candela.	The unit of area is 'm×m = m^2', The unit of velocity is 'm/s' & accelevation is 'm/s^2'

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Q:- Define and briefly explain Scientific notation

Definition:- Scientific notation is used for expressing very large or small number in the power of 10 (10^n)

format:- $a \times 10^n$

Where "a" is a number b/w 1 and 10 (mantissa); and "n" is an integer positive or negative.

Purpose:- Scientific notation make it easier to:

* write any large or small numbers.
* Perform calculation with extreme values.
* Compare and Contrast large or small quantities.

Benefits:-

* Simplifies complex calculations
* Reduces error in calculations
* Facilitates communication and comparison of large and small values.

Common uses:-

* Physics & engineering.
* Astronomy and cosmology.
* Chemistry and biology
* Mathematics and statics.

4.693×10^{-7} m

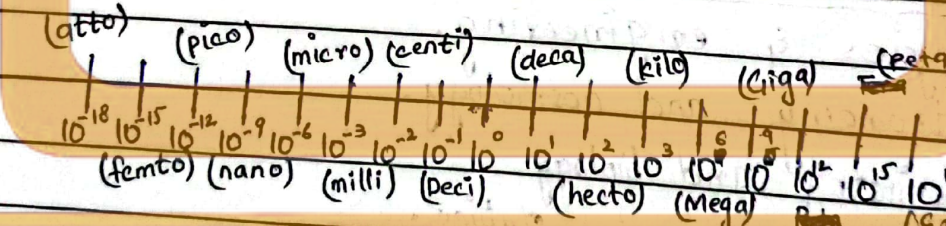
Q Define Prefixes.

Prefixes:- A mechanism through which numbers are expressed in power of 10 that are given a proper name is called "Prefix".

Q Why we need prefixes in our daily life?

Prefixes are used for many reasons in our daily life like if: want to measure thickness of paper we can write it in smaller units of milli meters instead of meters, Similarly if we want to measure or express the distance b/w two cities we can use bigger units of distance i.e kilometer.

-: Prefix Scale :-



Q Express the following to the near prifix.

27.5×10^{-10} m

$2.75 \times 10^{1} \times 10^{-10}$ m

$2.75 \times 10^{1-10}$ m

2.75×10^{-9} m

2.75 nm

0.00023×10^{-2} s

$2.3 \times 10^{-4} \times 10^{-2}$ s

$2.3 \times 10^{-4-2}$ s

2.3×10^{-6} s

2.3 μs

Q: Write the following in the power of ten and choose the prefix

a) The mass of a sun is about

1970,000,000,000,000,000,000,000,000,000,000 kg

$= 1.97 \times 10^{30}$ kg

$= 1.97 \times 10^{30} \times 10^{3}$ g

$= 1.97 \times 10^{33}$ g

$= 1.97 \times 10^{15} \times 10^{18}$ g

$= 1.97 \times 10^{15}$ Eg

b) The radius of a hydrogen atom is 0.000000000005m

$= 0.000000000005$ m

$= 5.0 \times 10^{-11}$ m

$= 50.0 \times 10^{-1} \times 10^{-11}$ m

$= 50.0 \times 10^{-1-11}$ m

$= 50.0 \times 10^{-12}$ m

$= 50.0$ pm

c) The age of earth is about 14.3,300,000,000,000,000 s.

$= 143,300,000,000,000,000$ s $= 0.143$ Es

$= 1.43 \times 10^{17}$ s

~~1.43 x~~

$0.143 \times 10^{1} \times 10^{17}$ s

$= 0.143 \times 10^{1+17}$ s

$= 0.143 \times 10^{18}$ s

__/__/__

Q: Express the following in terms of Power of ten.

a) Thickness of paper sheet is about 100,000 nanometer

= 100,000 nano meters

= $1 \times 10^{5} \times 10^{-9}$ m

= $1 \times 10^{5-9}$ m

= 1×10^{-4} m

b) Pakistan has total installed power generation capacity of over 40,000 mega watt

= 40,000 mega watt

= $4.0 \times 10^{4} \times 10^{6}$ watt

= $4.0 \times 10^{4+6}$ watt

= 4.0×10^{10} watt

c) A single hard disk capacity of computers has exceeded 30 tera byte.

= 30 tera byte

= $3.0 \times 10^{1} \times 10^{12}$ byte

= $3.0 \times 10^{1+12}$ byte

= 3.0×10^{13} byte

Q: Differentiate b/w Scalars and vectors.

Scalars	vectors
:- Definition :-	
Scalars can be express only by using magnitude	Vectors can be express by numerical magnetude + direction
:- Dependence :-	
Scalars are depend on numerical magnetiude	vectors are depend on numerical magnetude + direction.
:- Representation :-	
Scalars can be represent by numerical magnitude like 4km.	Vectors are represented by two ways first way is Symbolic $\vec{F}$, $\vec{V}$ and 2nd way is graphical.
:- Rules :-	
Scalars can be added, subtracted etc by ordinary algebra	vector can be added, subtracted etc by vector algebra.
:- Examples :-	
Following are the example of Scalars:- Temprature, time, energy.	following are the examples of vectors:- $\vec{d}$, $\vec{F}$, $\vec{V}$

Q:- What do you know about cordinate system?

Cordinate System:- A cordinate system is used to locate the position of any point and that point can be plotted as orderd pair (x, y) known as cordinates. The horizontal number line is called "x-axis" and the vertical number line is called y-axis and the point of intersaction of these two axes is known as the origin and is denoted a '0'. The reference frame is the cordinate system from with the positions of objects are described.

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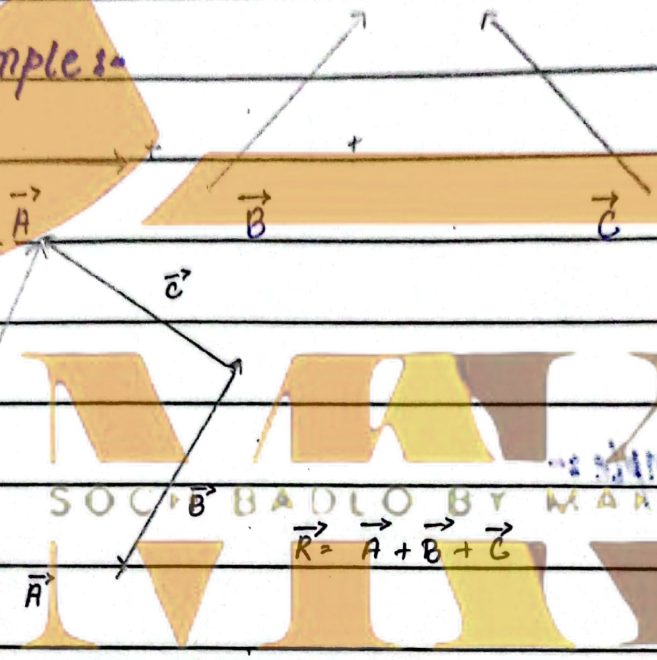
"Adding vector Quantities"

Q: Why we can't add vectors by ordinary additions methods?

Vectors cannot be added by ordinary addition methods but it can be added by head to tail rule.

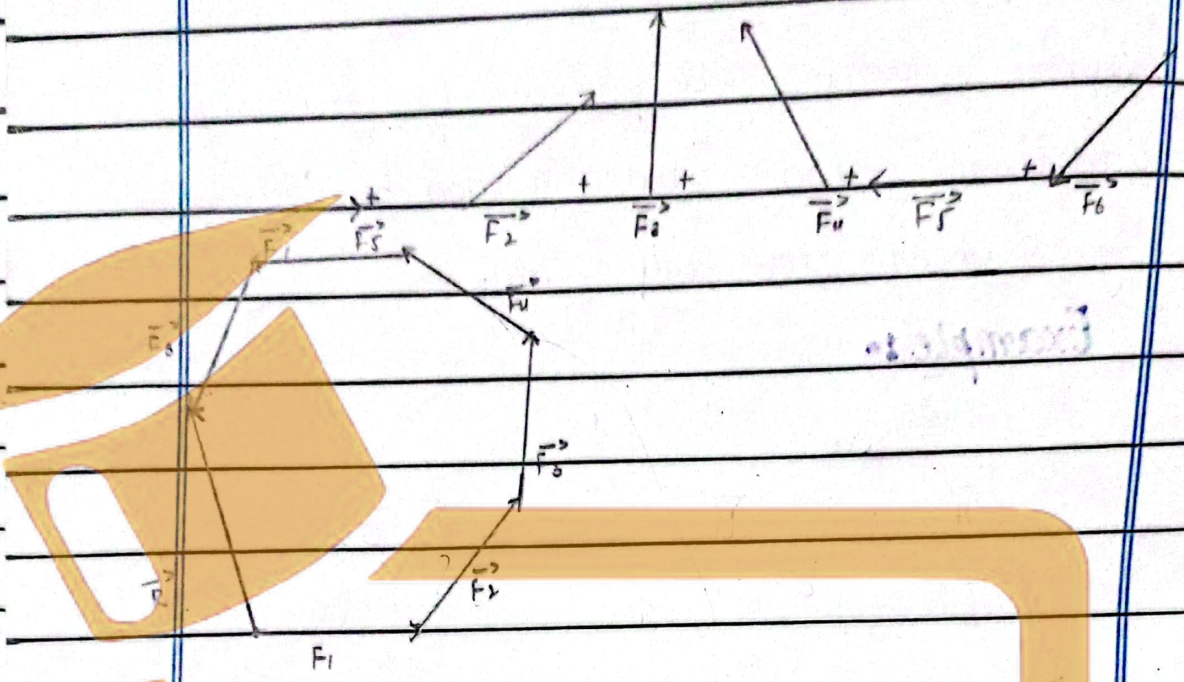
Example:-



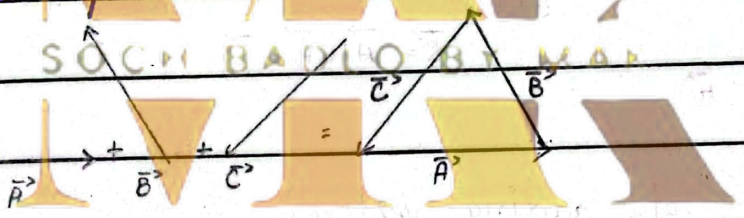
-: Steps of adding vectors :-

1. Draw the first vector (A) with its tail at the origin (starting points)
2. Draw the second vector (B) with its tail at the head (end point) of the first vector.
3. The resultant vector (R) is drawn from the tail of the first vector (A) to the head of second vector (B).

Example :-



Example :-



when the figure is closed the resultant is zero (0).

"Important Question Short"

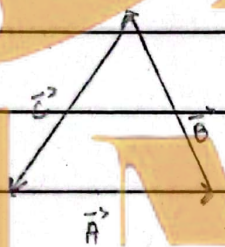
Q2:- It is possible to add 3 vectors of same magnitude but different directions to get null resultant? show with diagram.

Ans when the resultant vector is zero, it means that three vectors cancel each

out, resulting in no net force, motion or displacement :-

:- Diagram :-

In diagram will draw three vectors cancelling each other resulting in $\vec{R}=0$



:- Long Question :-

Q Describe the mechanism of addition of vectors.

Ans

:- Additions of vectors :-

The process of combining two or more vectors into single vector to determine their cumulated effect is termed as vector addition.

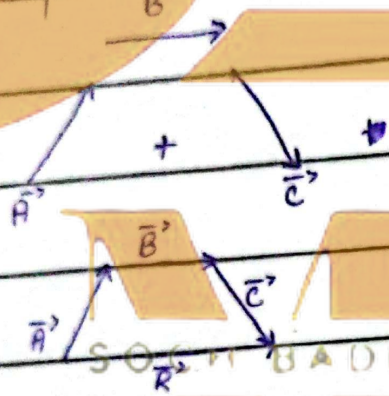
:- Head to tail Rule :-

It is a graphical method used to determine the resultant vector when

when adding two or more vectors.

- Place the tail of of second vector on the head of first vector
- Continue this process for additional vectors.
- Draw the resultant vector

:- Example :-

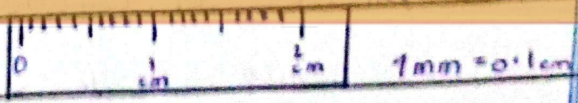


:: Measuring Instruments :-

↳ help us to measure unknown physical quantites.

↳ All measuring instruments have limitation

↳ least count



Measurement :- is the comparison of an unknown quantity with a known fixed quantity.

Measuring instrument :- Devices used to measure physical quantities like length, mass, time, temprature & pressure. Examples:- rulers, scales, clocks, thermometer & micrometers.

Atomic force microscope :- (AFM) is an advanced research tool used to analyze and characterize samples at the atomic level.

:- Scanning tunneling microscope :- (STM) is widely used in both industrial and fundamental research to obtain atomic-scale images of metal surfaces.

:- Limitation :- A restriction or boundry that prevents something from being done, achieved or exceeded, often due to physical, technological or practical constraints.

:- Compact Case :- is a small portable container designed to hold & protect a specific item or set of items. are typically made of durable materials like plastic, metals or fabric and are designed to be compact or

light weight and easy to carry. They help keep items organized.

:: Vernier Caliper :-

are precision measuring instruments used to measure linear dimensions including internal and external diameters and thickness and depths. They consist of a main scale and a sliding vernier scale, which allows for more precise measurments.

:: Accuracy & precision :-

Accuracy :- Vernier calipers are much more accurate than meter rule They can measure upto 0.1mm or even 0.05 mm, while meter rules typically have makings every 1-2mm.

Precision :- provide more precise measurment than due to their sliding vernier scale, which allows for interpolation b/w markings.

:- Formula of finding least Count :-

(Vernier calipers)

Least count = $\frac{\text{Smallest reading on main.s}}{\text{No.of division on V.s}}$

Least count = $\frac{1mm}{50} = 0.02mm$

:- Hint box :-

∵ 1cm = 10mm

$\frac{1cm}{10} = 1mm$

0.1cm = 1mm

* least count of vernier calipers depends upon the Number of division on V.S

:- Case I :-

If the number of Divisions on V.S is 10, Then least count is 0.1mm or 0.01cm.

:- Case II :-

If no. of divisions on V.S is 50, Then least is 0.02mm or 0.002cm.

:- Case III :-

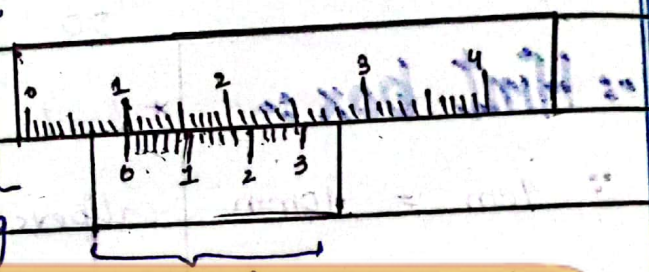
If no of divisions on V.S is 20, the least count is 0.05mm or 0.005cm

"How to Read Vernier Calipers"

Case - 01

When the zero of vernier scale is perfectly coincides with any main scale division

In this case we only take m.s reading

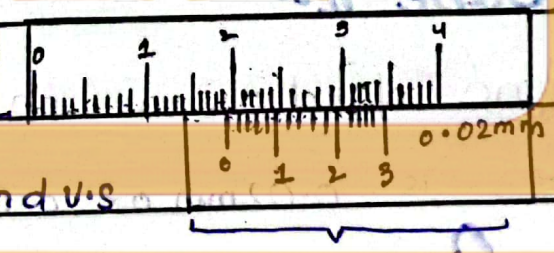


Main Scale = 10mm

Case II

When the zero of V.S is not perfectly coincides with any main scale division.

In this case we should use both scales i.e :- M.S and V.S



M.S Reading :- 17mm

V.S Reading :- 15 x 0.02 mm = 0.3mm

Total Reading = Main Scale Reading + V.S Reading

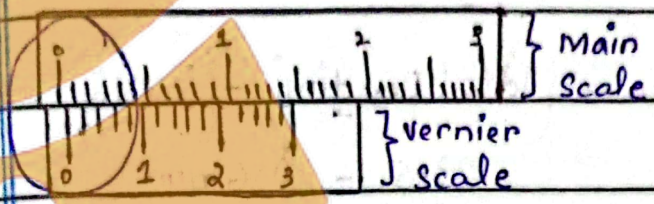
= 17 + 0.3mm

= 17.3mm

Zero error in Vernier Calipers

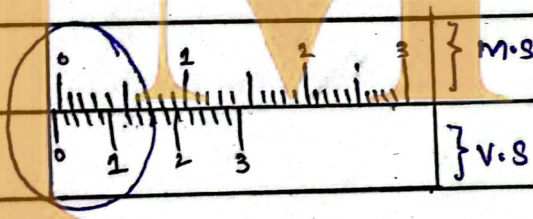
:: Positive Zero error ::

If zero of vernier scale is on the right side of zero of Main scale



:: Negative Zero Error ::

If zero of vernier scale is on left side of the zero of main scale.



" Zero Correction "

★ If we have positive zero error then, the value of error will be subtracted from final readings.

★ If we have negative zero error then, the value of error will be added in final Reading.

Positive

Zero error = 30 x 0.02mm = 0.6mm

Main Scale Reading = 23mm

Vernier Scale = 25 x 0.02mm

= 0.5mm

Total reading = {M.S reading} + {V.r reading}

= 23.5

Zero Correction = {Total Reading} - {Positive Zer

= 23.5 - 0.6mm

= 22.9mm

:: Advantages of vernier Callipers over meter rule:-

- Higher precision : Measures upto 0.02mm accurately, whereas meter ruler are less precise.
- Ideal for Small objects :- Pricisely measures small lengths, diameters, and thickness.
- Internal and external measurements :- Accurately measures both inside and outside dimensions.
- Depth Measurements :- Include depth guage for measuring, unlike meter rules.
- Ease of Readings :- Clear vernier Scale allows precise readings.
- Consistency and Repeatability :- Promotes consistent measurment crucial.

"Questions"

Q1 Why do we need vernier calipers instead of meter rule?

vernier calliper is more precise than meter rule, as the least count or minimum value it can measure is 0.1mm whevas the least count of meter rule is 1mm. The measurments taken by vernier are more precise and accurate.

Q. Can we measure distance smaller than 1mm on meter rule? why?

No, you cant measure distance smaller than 1mm on meter rule because the least count of a meter rule is 1mm therefore it cannot measure smaller distance than 1mm.

Q2- Some meter rulers are marked with inches and feet, what is the least count of meter scale on this scale?

As inches are smaller than feet, so least count will be 0.1cm or 1mm.

:· Screw guage :·

"Screw gauge is a device used to measure a fraction of a smallest division on scale by rotating circular scale over it".

:· Pitch :· The distance travelled by circular scale over main scale in one rotation is called pitch of screw gauge. "Once we rotate the circular scale & it moves 0.5mm ahead which is known as pitch.

Q1:- Define least count of screw gauge by its mathematical formula.

The least count of screw gauge is found by dividing its pitch by total number of circular scale division.

:· Mathematical formula :·

$$L.C = \frac{\text{Pitch of screw gauge}}{\text{Total circular scale divisions}}$$

$$L.C = \frac{0.5mm}{50} = 0.01mm$$

Q2. Why we prefer Screw gauge over vernier Scale?

Screw gauge is more precise then vernier calipers because least count of screw gauge (0.01mm) is less than least count of vernier calipers (0.1mm)

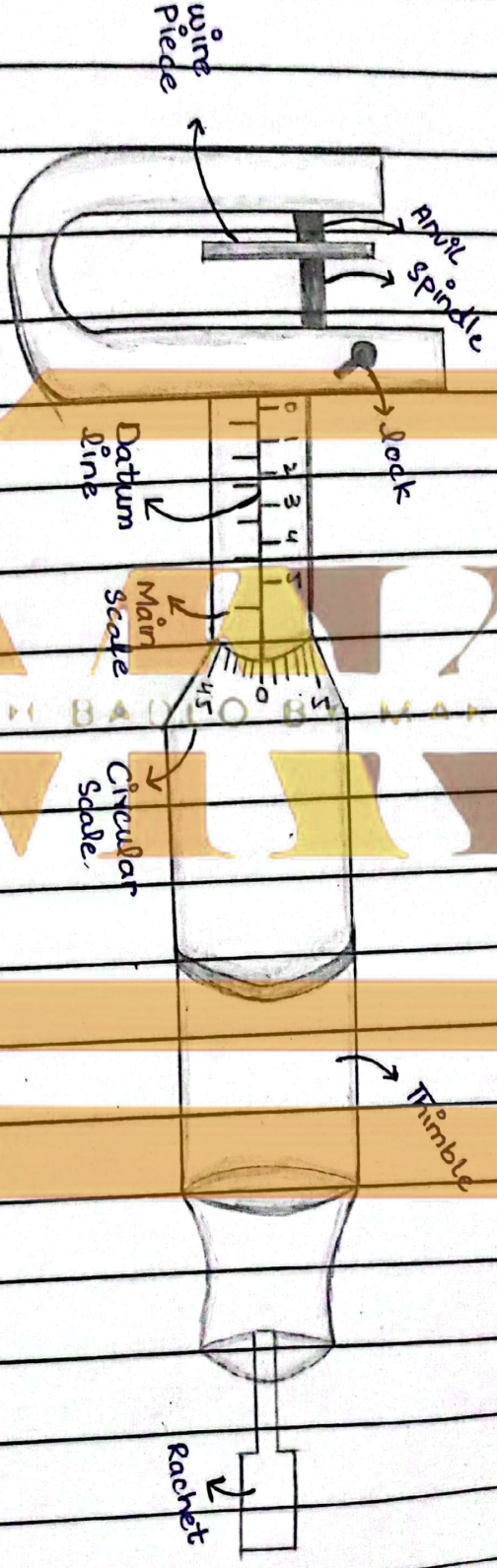
Q3 How Screw gauge help us to take smaller readings?

Screw gauge help us to take smaller readings by using a finely threaded screw to make precise adjumments and measuring tiny distance accurately.

"Comparison of Measuvments by diffevent length instvument"

	Instrment	least Count	Examples
1-	Meter ~~vernier~~ rule	1mm	5mm, 8mm, 7mm "Never in point."
2-	Vernier calipers	0.1mm	5.1mm, 7.3mm, 5.2mm "only 1 digit after point"
3-	Screw gauge	0.01mm	8.13mm, 7.31mm, 1.35mm "only 2 digits after point"

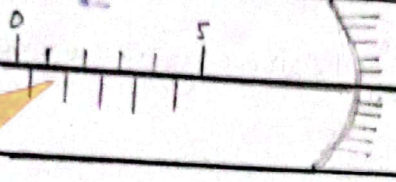
2 Explain the construction of screw gauge.



"Screw Gauge"

"Zero error in Screw gauge"

a)



"No zero error"

When zero of C.S perfectly coincides with datum line there is no zero error

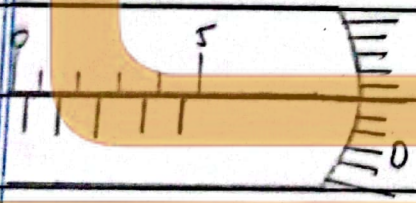
b)

"Negative zero error"

+

When zero of C.S cross the datum line there is a negative zero error.

c)

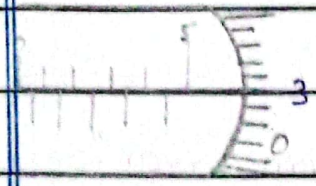


"Positive zero error"

−

When zero of C.S has not reached the datum line There is a negative zero error.

:- Finding Zero error :-

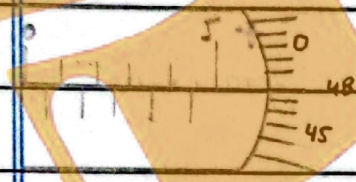
a) 

" Positive zero error "

Least count = 0.01mm

Zero error = 3 x 0.01mm

= 0.03mm

b) 

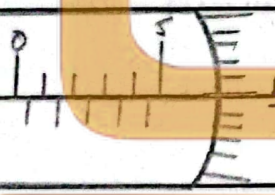
" Negative Zero error "

Least Count = 0.01mm

Zero error = 48 x 0.01mm

= 0.48mm

"Readings"



Main Scale = 5mm

C.S.R = 35 x 0.01mm

= 0.35mm

Total Reading = 5mm + 0.35mm

= 5.35mm

Physical Balance :-

Sensitive common balance with which can measure mass in (mm) order

OR

Instrument used in labortory to measure mass of various objects by comparison.

Construction :-

1- Vertical pillar with horizontal beam
2- rest on edge with 2 pans
3- pointer at mid of beam
4- levelling screws : used levelling of balance also called calliberation adjust screws with pointer at centre of scale :-
5- glase case : prevent taking inaccurate measurement
6- Weight box : standard weight (mass)
least count : 0-01g or 10mg.

Q How we can measure mass of a body by using Physical balance.

Procedure to take Measurement :-

1- Adjust Screws.
2- raise beam by turning arresting knob clock wise
3- balancing screws to bring pointer at zero
4- unknow mass on left pan
5- known mass on right pan
6- lower beam if pointer not at zero
7- keep on adding & removing standard till pointer rest at zero on raising beam
8- note Standard mass on right pan = tot. reading.

Measuring Cylinder :-

tool used in lab to measure volume of liquids, chemicals, solutions also called ~~measuring~~ graduated cylinder.

OR

glass/transparent measuring plastic cylinder with scale along its length to indicate volume.

Units :- ml or cm^3

Least count = 1ml or $1cm^3$

Regular Shaped Solid Measurement :-

1- Use height of liquid in cylinder.

2- volume of rectangular blocks = $(length)^3$

3- volume of Sphere = 4/3 (3.14...) $(radius)^3$

Q IRRegular Shaped Solid Measurement :-

1 i.e Metalic bob

2 obj. immersed in liquid

3 Vf - Vi = total reading

:- Procedure for Measurment :-

1- Position eye at menisous: level of liquid

2- avoid parallax error

3- Convex meniscus: read volume at bottom of curve intersecting making.

4- Concave meniscus: read volume at top of curve intersecting marking

Note :- 1ml = $1cm^3$

c)

__/__/__

Error:- → Mistake

↓

doubt in measurment

Uncertainty The quantification of magnitude of error or dout in a measurment is called uncertainty. Uncertainty estimates how large or small error is.

Error = Observe value - True value → formula

Define error and its types

Error:- Every measurment no matter How carefully taken has a certain amout of doubt know as error.

Systematic Error:-

Systematic error tend to occur consistently in one direction either positive or negative Some "source of systematic error include":

a) Instrumental errors, which result from Imprefections in the design or callibration of the measuring instrument, as well as zero errors

b) Imperfections in the experimental technique or procedure, such as changes in external conditions like temp, humidity, wind velocity

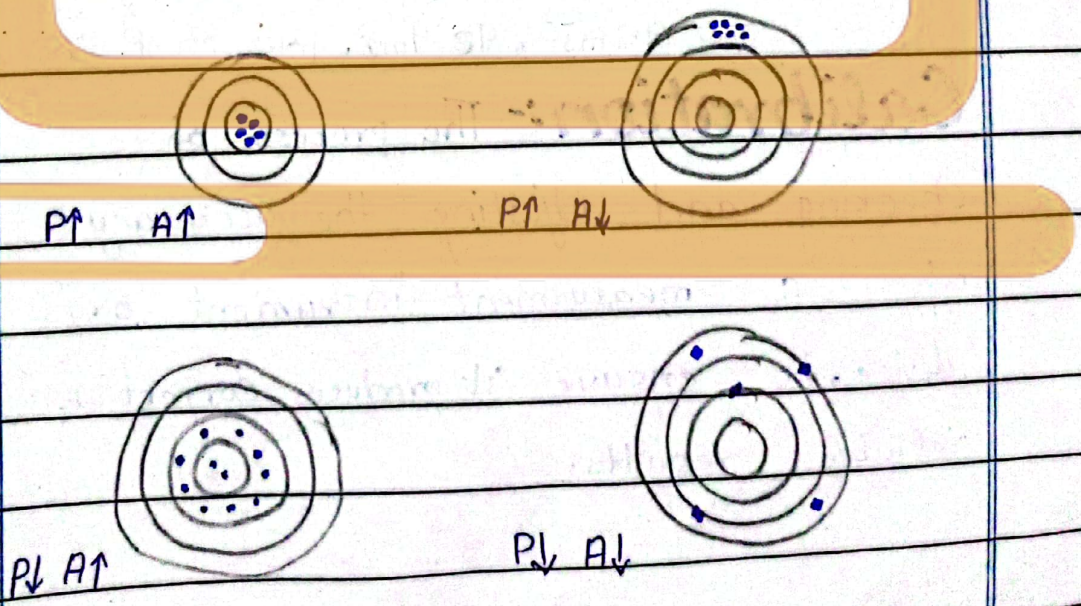
which can affect the measurement.

c) Personal errors, which arise from an individuals bias, improper setups of the apparatus or carelessness in taking observations without following proper precautions.

Random errors:-

Random error are unpredictable, uncontrollable errors that can happen irregularly. These errors ~~are~~ can caused by fluctuations in experimental conditions or imperfections in measuring instruments.

Precision and Accuracy



Qareeb Qareeb values

Precision:- Consistency and repeatability of results

Near to exact value

Accuracy:- How close we are to the standard value.

:- Precision and Accuracy :-

Both are desirable quantities in measurments. Measurement should be both precise and accurate, meaning that they are both consistent and close to the true or standard value.

:- Example :-

Exact value $9.8ms^{-2}$

$\Rightarrow 8.2ms^{-2}, 8.4ms^{-2}, 8.5m^{-2}$ P ✓ A ✗

$\Rightarrow 9.7ms^{-2}, 9.9ms^{-2}, 10ms^{-2}$ P ✓ A ✓

$\Rightarrow 4.3ms^{-2}, 11.2ms^{-2}, 15.5ms^{-2}$ P ✗ A ✗

$\Rightarrow 9.2ms^{-2}, 9.9ms^{-2}, 10.2m^{-2}$ P ✗ A ✓

Calibration:- The process of checking and adjusting the accuracy of a measurment intrument or device, to ensure it produces correct & reliable results.

Q Differentiate b/w prision & accuracy.

Precison	Accuracy
-: Definition :-	
Refers to how close individual v: measurements are to each other	Refers to how close a measurment is to the true value.
-: focus :-	
focuses on the consistency of the results	focuses on the correctness of the result
-: Aim :-	
To hit same spot every time.	Aim to hit the target (True value)
-: Example :-	
hitting same spot on target every time, even if it's not the centre	Hitting the center of the target.