Chapter = 01

PHYSICAL QUANTITIES AND MEASUREMENT

Science:-

Derivation and Meaning:- The word Science is derived from **Latin** word **Scientia** which means **Knowledge**.

Definition:- The knowledge gained through observation and experiments is known as science.

Branches of Science:- There are two main branches of science which are given below.

(1) Physical Science

(2) Biological Science

(1) **Physical Science**:- The science which deals with the non-living thing is known as Physical Science.

(2) **Biological Science**: - The science which deals with the living things is known as Biological Science.

Physics: -

Derivation and Meaning:- The word Physics is derived from **Greek** word **Physica** which means **Natural**.

Definition:- It is the branch of science that involves the study of Physical universe , energy , matter and how they are related. **OR**

The branch of science which deals with the study of properties of matter, energy and their mutual relationship is known as physics.

SOME IMPORTANT DEFINITIONS

(1) **Matter :-**

Definition:- Any things which have volume and mass is known as matter**. OR**

Any things that occupy space and has mass is known as matter

Examples:- Ball , table , chair , boy , building etc.

Volume:- The space occupied by a body is known as its volume.

Mass :- The quantity of matter in a body is known as mass.

Energy:- The ability of a body to do some work is known as energy.
Mutual Relation Ship:- Mutual relationship means inter conversion of matter and energy.
Examples:-

(1) Car + Gas ……> Motion

↓ ↓ ↓

(Matter) (Energy) (Physics)

(2) Bulb + Electricity ……> Light + Heat

↓ ↓ ↓

(Matter) (Energy) (Physics)

Importance of Physics:-

(i) It provides us source of communications i-e Radio , TV, Mobile, telephone etc.
(ii)It provides us atomic energy (bomb) which is used for defense purpose as well as energy production.
(iii) It provides us means of transportations i-e bus , car ,aero planes etc.
(iv) It provides us microscope which is used to study the micro-organisms.
(v) It provides us X-rays machine , Laser rays , CT scan, MRI etc are used in the fields of health, industry and agriculture.
(vi) It provides us loudspeaker which is used in radio, television and mobile etc.
(vii) It provides us microwave , refrigerators ,air conditioners etc which make our lives comfortable.
(vii) It provides us rockets and satellites which is used to get information about the upper atmosphere.
(viii) It provides us solar cells which is used to convert light energy into electrical energy.
(ix) It provides us electricity without which we cannot imagine any machine in working conditions.
(x) It provides us hologram which is used to get three – dimensional images.
(xii) It provides us internet which is used in the field of business , trade , education and industry.

SOME SPECIAL TERMS

(i)CT Scan stands for computer tomography.
(ii) MRI stands for Magnetic Resonance Imaging.
(iii) PET Stands for Positron Emission Tomography.

Quran and Physics:- It is generally accepted that there are more than 700 verses in the Holy Quran dealing with the natural phenomena . Many verses of Quran ask mankind to study nature, few are described below.

Translation:-The sun is not to overtake the moon, nor is the night to outpace the day. Each floats in the orbit. (Surah yaseen :40)

Translation:-O company of jinn and men , if you can (and want) to cross the limits sky and earth , then cross , you will not cross except by the authority (from ALLAH). (Surah Rahman:33

Translation:-He who created seven heavens in layers. You see no discrepancy in the creation of the compassionate. Look again can you see any fault? (Surah Mulk: 3)

Do they not think ? Do they not contemplate ? Do they (people) not look ?

Conclusion:-So from the above verses of Holy Quran we can conclude the Holy Quran stress on thinking , reasoning , observations , planning and analyzing which are the fundamental principles of physics.

CONTRIBUTION TO PHYSICAL SCIENCE BY ISLAMIC WORLD:- Scientists of the Islamic world contributed in the development of physics. Few of the notable scientists are:-

Yaqub Kindi:-

Year of birth:- He was born in 800 A.D.

Place of birth:- Busra (Iraq).

Died:-He was died in 873 A.D.

Field:- His field of research was meteorology , Specific gravity and on tides.

Contributions:-

(i)His most important work was done in the field of optics.

(ii) He discussed music from a scientific point of view.

(iii) He discovered a method to express the notes of music in

term of frequencies.
(iv) He also did valuable work on geometrical optics.
(v) His work on optics was translated in Latin.

Ibnal Haitham :-
Year of birth:- He was born in 965 A.D.
Place of birth:- He was born in Basra.
Died:-He died in 1039 A.D.
Field :- His field of research was Physics , Mathematics , Engineering , medicine and Astronomy.

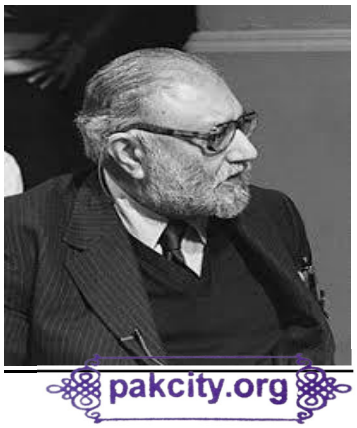
Contributions:-
(i) His famous book name is Kitab-ul-manazir about optics.
(ii) He invent the pin-hole camera.
(iii) He proposed that light is a form of energy.
(iv) He proposed the two laws of reflection of light.
(v) He also worked on the image formation by using spherical mirror.
(vi) He discussed the structure and function of eye in his Book.

Al Beruni:-
Year of birth:- He was born in 973 AD.
Place of birth:- Berun (Afghanistant).
Died:-He was died in 1048A.D.
Number of Books:- He wrote about 150 books.

Field:- His field of research was Physics , Mathematics, cosmology, geograph , history, culture, civilization, biology , chemistry, archaeology, religion and geology.
Contributions:-
(i) His famous book Qanoon Al-masudi.
(ii) He discussed the shape of earth.
(iii) He discussed the movement of sun and moon.
(iv) He discussed the phases of moon and movement of the planets.
(v) He explained to find the densities of various materials.
(vi) He explained the methods to find the longitude and latitude of a place.

FAMOUS PAKISTANI PHYSICISTS

Mohammad Abdus Salam:-



Year of birth:- He was born in 1926.
Place of birth:- Jhang (Pakistan)
Died: - 21 November 1996.
Fields:- Theoretical Physics
Education:-
(i) He studied in Government College Lahore.
(ii) He was awarded scholarship for advance studied in U.K and got Ph.D degree.
Contributions:-
(i) He was awarded Noble prize in Physics in 1979 for his work on Grand Unification Theory.
(ii) His research work was on combining two forces i-e weak nuclear force and electromagnetic force.
(iii) He established the International Centre for Theoretical Physics at Trieste, Italy.

Abdul Qadeer Khan:-

Born:- He was born in 1936.
Place of birth:- Bhopal (India).
Fields:- Metallurgical engineering.
Education:-
(i)He got MSc technology degree from Holland.
(ii) He got Ph.D degree from Leven University Belgium

Contributions:-
(i) He served as an expert with the collaboration of the government of Holland in the Ureno Enrichment plant.
(ii) He founded the uranium Enrichment program for Pakistan's atomic bomb project.
(iii)He founded and established " Kahuta Research Laboratories (KRL) in 1976.
(iv) Pakistan becomes a nuclear power under his supervision.
(v) He founded and established engineering research laboratory Islamabad and is renamed as A.Q khan laboratory.

BRANCHES OF PHYSICS

Due to vast scope and research in physics it is usually divided into a number of branches some of them given below.

Mechanics: -

Definition: - It is the study of motion of material objects under the action of forces. **OR**
It is branch of physics which deals with the study of motion of objects and its relation with the force.

Examples:-

(i) Free fall objects.
(ii) Spinning objects etc.

Heat and thermodynamics :-

Definition:- It is the branch of physics which deals with the transformation of heat energy into other forms of energy. **OR**
It is the branch of physics which deals with study of heat and temperature and their relation to energy.

Examples:-

(i) Melting and freezing processes.
(ii)Engines and refrigerators etc.

Oscillation and Waves :-

Definition:- It is the branch of physics which deals with study of to and fro motion and various properties of waves.

Examples:-

(i) Mass attached to spring.
(ii) Water Waves.
(iii) Sound waves etc.

Optics:-

Definition:- It is the branch of physics which deals with the nature of light, its propagation , reflection, refraction, dispersion and the wave properties of light. **OR**
It is the branch of physics which deals with study of light , their properties and the instrument using properties of light.

Examples:-

(i) Mirrors.
(ii) Lenses.
(iii) Telescopes
(iv) Eyes etc.

Electricity and Magnetism:-

Definition:- It is the branch of physics which deals with the study of static as well as moving charges and the physical phenomena that occurs due the effects of charges. **OR**

It is the branch of physics which deals with study of properties of charges at rest as well as in motion.

Examples:-

(i) Electricity.
(ii) Electric Current.
(iii) Magnet and electromagnet etc.

Atomic and Nuclear Physics:-

Definition:- It is the branch of physics which deals with the study of structure and properties of individual atoms and nuclei of an atom.

Examples:-

(i) X- rays .
(ii) Lasers.
(iii) Nuclear Reactor.
(iv) MRI.
(v) CT scan.
(vi) PET scan etc.

Relativity:-

Definition:- It is the branch of physics which deals with the study of moving object (including very high speed) and gravitation.

Examples:-

(i) Particle accelerators.
(ii) Nuclear Energy etc.

Quantum Physics:-

Definition:- It is the branch of physics which deals with the study of discrete, indivisible units of energy called quanta.

Examples:- The atom and its parts.

Particle Physics:-

Definition:- It is the branch of physics which deals with the study of nature of the particles that constitute matter and radiation. **OR**
It is the branch of physics which deals with the study of elementary particles.

Examples:-

(i) Quarks.
(ii) Leptons.
(iii) Photons.
(iv) Bosons etc.

Cosmology and Astro - Physics:-

Definition:- It is the branch of physics which deals with the study of the origin , evolution, and

eventual fate of the universe.

Examples:-

(i) Stars

(ii) Galaxies

(iii) Black holes etc.

Biophysics and Medical Physics:-

Definition:- It is the branch of physics which deals with the application of physics to biological processes and phenomena. OR

It is the branch of physics which deals with the study of physical interactions of biological processes and application of physics health processes such as prevention, diagnosis and treatment.

Examples:-

(i) MRI

(ii) CT Scan

(iii) Radiotracers and conduction in the living cells etc.

MEASUREMENT

Definition:- To compare some things with standard is known as measurement. **OR**

The comparison of un-known quantity with some standard is known as measurement.

Examples :-

(i) We can measure cloth in meter.

(ii) We can measure the mass of a cricket ball in grams.

(iii) We can measure the force in newton etc.

Unit:- The standard with which things are compared is known as unit.

Magnitude:- A real number with proper unit is known as magnitude.

Examples: -

(i) 20 meter long cloth.(ii) 10kg rice.(iii) 22 kilometer distance etc.

In the above examples:- (a) 20 , 10 ,22 are called magnitudes while meter ,kg and kilometer are called units.

PHYSICAL QUANTITIES

Definition:- All the quantities that can be measured are known as physical quantities.

Examples: - Mass , length , volume , weight , force ,area , density etc.

Types of Physical Quantities: - There are two types of physical quantities which are given below.

(1) Base physical Quantities.

(2) Derived Physical quantities.

(1)**Base Physical Quantities**:-

Definition:-Those physical quantities on the basis of which other quantities are expressed are known as base physical quantities.

Other Name:- They are known as fundamental Physical quantities.

Explanation:-

(i)They are seven in number.

(ii)Their units are called base units.

(iii)All the base quantities are scalars.

Examples:- Mass , Length, Time , Temperature etc.

(2)**Derived physical quantities**:-

Definition: - Those physical quantities which are expressed in terms of base quantities are known as derived physical quantities.

Other name:- They are known as non-fundamental quantities.

Explanation:-

(i)They are more than seven in number.

(ii)Their units are known as derived units.

(iii)Some of them are scalars and some are vectors.

Examples:- weight , momentum , area, volume etc.

Non-Physical Quantities:-

Definition:- Those quantities which cannot be measured are known as non-physical quantities.

Examples:- (i) Honesty (ii) Love (iii) Beauty (iv) care (v) Emotion etc.

QUICK QUIZ

(1)Distinguish between base and derived quantities?

(2) Distinguish between physical and non- physical quantities?

CAN YOU TELL ?

Are there quantities which we cannot measure ?

Ans:- Yes there are quantities which we cannot measure.

Examples:- Honesty ,Love , Beauty , care , Emotion

SYSTEM OF UNITS

Definition:- A complete set of units for all physical quantities is known as system of units.

Names of various system of units:-

(1) Centimeter-Gram-Second (c.g.s).
(2) Foot-Found-System (f.p.s) .
(3) Meter-Kilo-Second (M.K.S).
(4) S.I System.

(1) **Base Units**:-

Definition:- The units of base physical quantities are known as base units.

Explanation (i) They are also called fundamental units.
(ii) They are seven in number.

Examples:- Kilogram , Second , Kelvin ,Meter etc.

Derived Unit:-

Definition:- The units of derived physical quantities are known as derived units.

Explanation:-
(i) They are also called non-basic units.
(ii) They are more than seven in number.

Examples:- newton , watt , pascal , joule etc.

INTERNATIONAL SYSTEM OF UNITS

History: - This system was proposed by a group of physicists in Paris at France in 1960.

Definition: - The world wide acceptable system of measurements is known as International system of Units .

Abbreviation: - It is abbreviated by **SI**.

Explanation: - The SI system of units is based on seven base units from which all other units are derived. The seven basic quantities, their SI units and symbols are given below.

BASE UNITS FOR INTERNATIONAL SYSTEM OF UNITS			
Base Quantities		**SI Base unit**	
Name	Symbol	Name	Symbol
Length	L,x,r (etc)	meter	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	L	candela	cd

Applications of SI system of units:-

(i) These units are used through the world.

(ii)These units are convenient for daily use.

(iii) For larger and smaller quantities we can use prefixes with the units.

(iv)It makes calculation easier because smaller and bigger units can be obtained just by division or multiplication by a factor of ten.

QUICK QUIZ

(i) How can you differentiate between base and derived quantities ?

(2) Identify the base quantity in the following :- (i)speed (ii) Area (iii) force (iv) Distance.(3) Identify the following as base or derived quantity:- Density , force , mass, speed , speed ,time , length , temperature and volume.

STANDARD FORM

Definition: - To express a number in power of ten is known as standard form.

Other Name: - It is also called Scientific Notation.

Purpose: - To write a very large or very small number in short form.

Mathematical Form:- Number = mantissa x $10^{exponent}$

$$N = M \times 10^{n}$$

Examples:-

(i) Mass of moon=70,000,000,000,000,000,000,000 kg.

Its standard form is $7x\ 10^{22}$ kg.

(ii) Diameter of atomic nuclei is 0.00000000000001 m.

Its standard form is $1x\ 10^{-14}$ m.

STEPS FOR CONVERTING NUMBER TO STANDARD FORM

(i)In a given number N move the decimal points and place it after first non-zero digit which will make it mantissa (M).

(ii)If the decimal is moved towards left from its given initial position then the power of ten(10) will be positive and whatever is the number of digits through which the decimal point has

been moved that will be the value of exponent (Power of ten).
(iii)Similarly if the decimal point is moved towards the right from its given position then power of 10 will be negative.

PREFIXES

Definition:-A symbol of power of ten is known as prefixes. **OR**
The word or letter added before a unit and stand for the multiples or sub-multiples of that unit is known as prefixes. OR
It is a word / words which is used internationality to multiplied with basic units.
Purpose: - To find the multiples or sub-multiples of a unit.

TABLE OF PREFIXES					
Prefix	**Decimal Multiplier**	**Symbol**	**Prefix**	**Decimal Multiplier**	**Symbol**
Exa	10^{18}	E	deci	10^{-1}	d
Peta	10^{15}	P	centi	10^{-2}	c
Tera	10^{12}	T	milli	10^{-3}	m
Giga	10^{9}	G	micro	10^{-6}	μ
Mega	10^{6}	M	nano	10^{-9}	n
Kilo	10^{3}	K	pico	10^{-12}	p
hecto	10^{2}	H	femto	10^{-15}	f
deca	10^{1}	da	atto	10^{-18}	a

CAN YOU TELL ?

Name the convenient unit use to measure .
(a)Width of a book.
Ans:- We can measure the width of book in centimeter (cm)
(b)Length of a room.
Ans:- We can measure the the length of a room in meter.
(c)Diameter of a wire.
Ans:- We can measure the diameter in millimeter (mm).
(d) Mass of candy.
Ans:- We can measure the mass of candy in milligrams(mg).
(e) Mass of cricket ball.
Ans:- We can the mass of cricket ball in grams.

MEASURING INSTRUMENTS

Definition: - Measuring instruments are device to measure physical quantities. OR
Any instrument which is used for the measurement of physical quantities is known as measuring instruments.

Examples:-

i. Metre Rule.
ii. Vernire Caliper.
iii. Screw gauge.
iv. Physical Balance.
v. Stop Watch.

Least Count:-

Definition:- The minimum value that can be measured on a scale of measuring instrument**.**
OR
the minimum value which can be measured with the help of an instrument is called least count of the instruments.

Examples:-

(i) Least count of Metre Rule is 1mm.
(ii) Least count of vernier caliper is 0.1mm or 0.01cm.
(iii) Least count of Screw Gauge is 0.01mm or 0.001cm etc.

METRE RULE

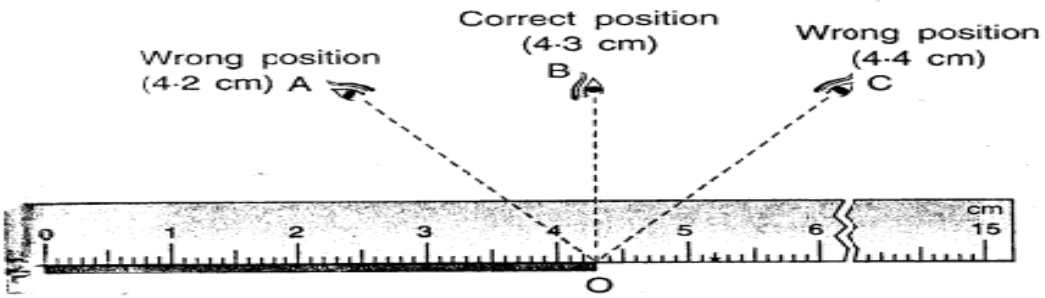
Definition: - A metre rule is a length measuring instrument**.** OR
It is a device which is used to measure the lengths or the distance between two points.
Construction:- It is made from different materials (wood , plastics , metal) and in a wide range of sizes.

Explanation: - It is commonly used in the laboratories to measure length of an object or distance between two points. Meter rules are one metre long as compared to the standard

metre. It is usually have 1000 small divisions on them called millimeters.

Least Count of Metre Rule: - Its least count is 1mm or 0.1cm.

Precautions While Using Metre Rule:- While measuring length or distance, eye must be kept vertically above the reading point. The reading becomes doubtful if the eye is pointed either left or right to the reading point.



PARALLAX ERROR:- The error which occurs due to incorrect position of the eye is known as parallax error as shown in figure.

VERNIER CALLIPERS

History:- It was invented by a French Mathematicians Pierre Vernier in 1631.

Definition:- An instrument which is used to measure small length, diameter etc of small objects accurately is known as Vernier Callipers . OR

It is an instruments which is used to measure small lengths up to 0.1mm or 0.01 cm.

Construction:- A Vernier Calliper consists of

i. Outside jaws

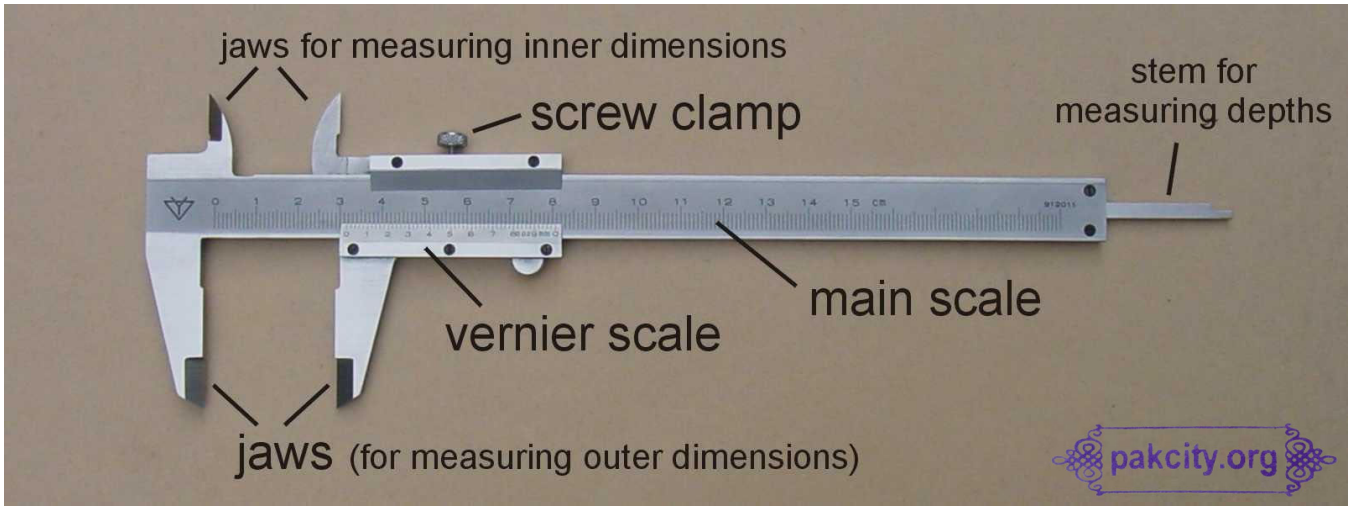
ii Inside jaws.

Iii. Depth probe.

iv. Main Scale (M.S) (Graduated in centimeter or millimeter).

v. Vernier scale (V.S) (Length is 9mm and divided into 10 equal parts).

vi. Retainer.



Least Count of Vernier Callipers:-

Definition:-The difference between one small division on main scale division and one vernier scale division is 0.1 mm. It is called least count (LC) of the Vernier Callipers.**" OR**

The minimum length which can be measured accurately with the help of vernier calliper is known as least count of vernier calliper.

Other Name:- It is also called vernier constant.

Abbreviation:- It is abbreviated by L.C .

Calculation of least count of vernier caliper:- Least count of the Vernier Callipers can be calculated by two method which are given below.

Method 1:- The difference between the value of one main scale division and the value of one vernier scale division.

Number of divisions on vernier scale is 10.

Least Count = One main scale division – one vernier scale division.

Least Count = 1mm – 0.9mm = 0.1mm.

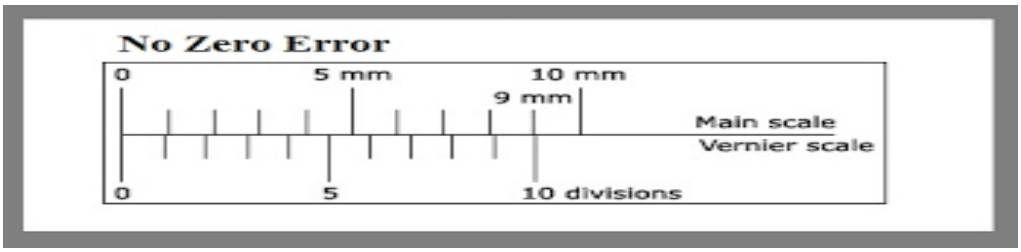
Method 2:- The least count of Vernier Callipers can be obtained by dividing one (1) division of main scale by total number of divisions on vernier scale.

$$\text{Least Count} = \frac{Smallest\ division\ on\ main\ scale}{Total\ number\ of\ division\ on\ vernier\ scale}$$

$$\text{Least Count} = \frac{1mm}{10} = 0.1\ \text{mm} = 0.01\ \text{cm}.$$

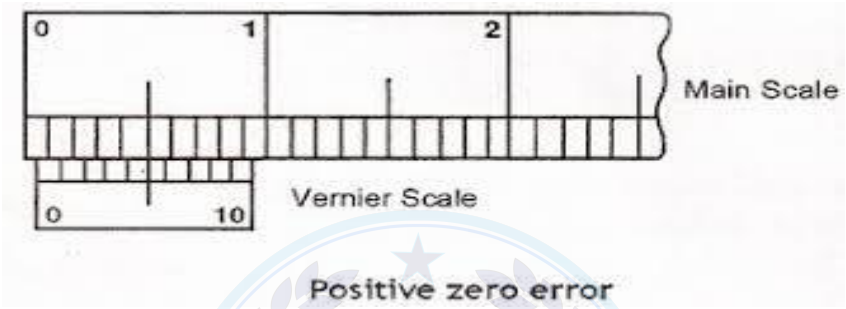
Zero Error and Zero Correction: -

To find the zero error, close the jaws of Vernier Callipers gently. If zero of the vernier scale coincides with the zero of the main scale then there will be no zero error. Zero error will exist if zero line of the vernier scale is not coinciding with the zero line of main scale.



Positive Zero Error: -

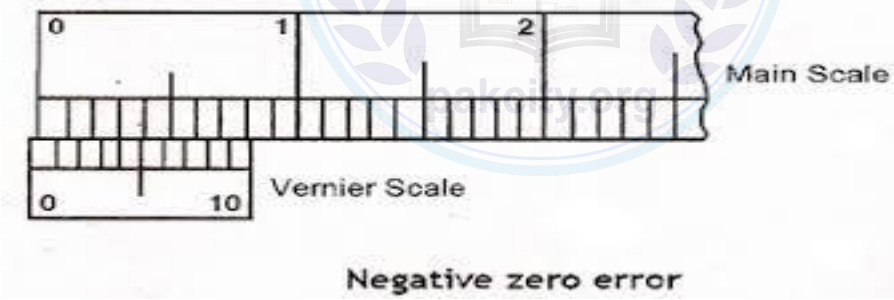
Definition:- Zero error will be positive if the zero of the vernier scale remains right side to the zero of the main scale as shown in figure.



Correction of positive zero error :-For correct measurement in this case we subtract the positive error from actual reading.

Negative Zero Error:

Zero error will be negative if zero of the vernier scale remains left to the zero of the main scale as shown in figure.



Correction of negative zero error:- For correct measurement in this case we add the negative error from actual reading.

Taking a Reading on Vernier Calliper : -

Let us find the diameter of a solid cylinder using Vernier Callipers.

(1). Note the least count of the vernier caliper.

(2) Check the error.

(3). Place the solid cylinder between jaws of the Vernier Callipers. Close the jaws till they press the opposite sides of the object gently.

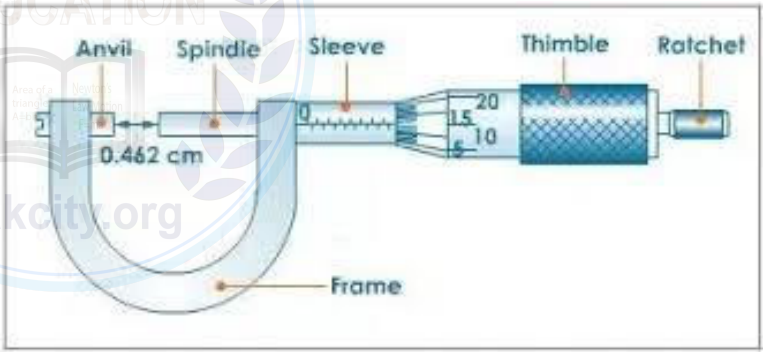
(4). Note the complete divisions of main scale past the vernier scale zero in a tabular form.

(5). Next find the vernier scale division that is coinciding with any division on the main scale multiply it by least count of Vernier Callipers.
(6). Now add main scale reading and vernier scale reading. This is equal to the diameter of the solid cylinder.
(7). Add zero correction (Z.C) to get correct measurement.
(8). Repeat the above procedure and record at least three observations with the solid cylinder displaced or rotated each time.

Digital Vernier Callipers:-
Digital vernier callipers has greater precision than mechanical vernier calipers.
Least count of digital vernier callipers is 0.01 mm.

SCREW GAUGE

Definition:-"A screw gauge is an instrument that is used to measure small lengths with accuracy greater than a vernier callipers. **OR**
It is an instrument which is used to measure a fraction of smallest scale division by rotatory motion of circular scale over it. **OR**
It is a device with the help of which we can measure the thickness of small objects accurately upto 0.01 mm.



Other Name: - It is also called micro meter screw gauge**.**
Construction:-A simple screw gauge consists of
(1) U-shaped metal frame.
(2)Circular Scale.
(3) Main Scale .
(4)Spindle .
(5) Ratchet.
(6) Datum line or Central line or Sleeve.
Pitch of the Screw Gauge:- The distance traveled by the circular scale on linear scale in one rotation is known as pitch of the screw gauge.
Least Count of Screw Gauge: -
Definition:- The minimum length which can be measured accurately by a screw gauge is known as least count of screw gauge.
Calculation Least Count of Screw Gauge :- The least count of screw gauge is founded by dividing its pitch by the number of circular scale divisions.

$$\text{Least Count} = \frac{Pitch\ of\ Screw\ Gauge}{Total\ number\ of\ division\ on\ circular\ scale}$$

If the pitch of screw gauge is 0.5 mm and the number of divisions on circular scale is 50 then

$$\text{Least Count} = \frac{0.5\ mm}{50} = 0.01\ \text{mm}$$

Zero Error of Screw Gauge:

If zero of circular scale is not coincides with the horizontal line on the linear scale then there will be an error in the instrument which is known as zero error.

Positive Zero Error:-

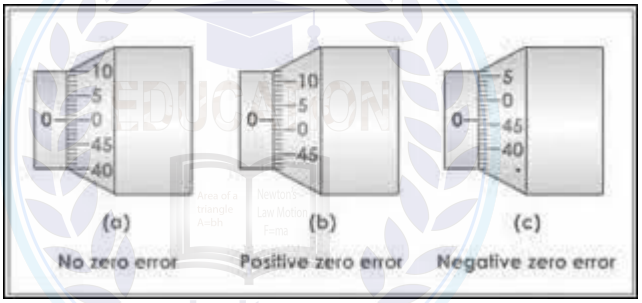
Zero error will be positive if the zero of circular scale remains below (ahead) the datum line.

Correction of positive zero error:- For correct measurement in this case we subtract the positive error from the actual reading.

Negative Zero Error:-

Zero error will be negative if zero of circular scale remains above (behind) the datum line.

Correction of negative error:- For correct measurement in this case we add the negative error to the actual reading.



Taking a Reading Using a Screw Gauge:-The diameter of given wire can be found as follows:

(1). Close the gap between the spindle and the stud of the screw gauge by turning the ratchet in clockwise direction.

(2). Note main scale as well as circular scale readings to find the error and hence zero correction of the screw gauge.

3. Open the gap between stud and spindle of the screw gauge by turning the ratchet in anti-clockwise direction. Place the given wire in the gap. Turn the ratchet so that the object is pressed gently between studs and the spindle.

4. Note main scale as well as circular scale readings to find the diameter of the given wire.

5. Apply zero correction to get the correct diameter of the wire.

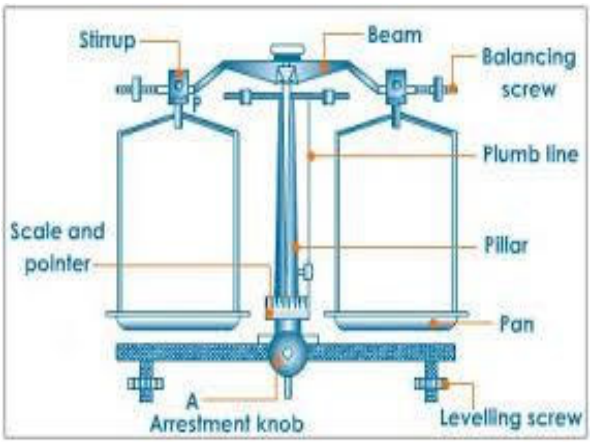
6. Repeat steps 3, 4 and 5 at different places of the wire to obtain its average diameter.

PHYSICAL BALANCE

Definition:- It is a very sensitive common balance while measure mass in milligrams order.

OR

It is an instrument which is used in laboratory to measure the mass of various small objects accurately.



Construction:- It consists of

(i) Two pans.
(ii) Pointer
(iii) Leveling screw
(iv) Arrestment knob
(v) Pillar.

Figure:-

Working:- It is a common balance which consists of two pans and we can measure the mass of an object by putting it in one pan and a known mass in the other.

Note:- It is placed in a protective glass case so that even dust and wind cannot affect the accuracy of the instrument.

STOP WATCH

Definition: - It is an instrument which is used to measure the time interval of an event.

Types of stop watch: - There two types of stop watch which are given below.

Mechanical stop watch: -

Definition: - A mechanical stopwatch can measure a time interval up to a minimum 0.1 second.

Other Name: - It is also called Analogue stop watch.

Working:- A mechanical stopwatch has a knob that is used to wind the spring that powers the watch. It can also be used as a start-stop and reset button. The watch starts when the knob is pressed once. When pressed second time, it stops the watch while the third press brings the needle back to zero position.

Digital Stopwatch:-

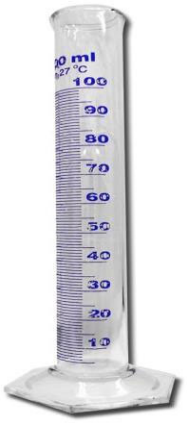
Definition:- Digital stopwatches is commonly used in laboratories and can measure a time interval as small as 1/100 second or 0.01 second.

Working:-The digital stopwatch starts to indicate the time lapsed as the start/stop button is pressed. As soon as start/stop button is pressed again, it stops and indicates the time interval

recorded by it between start and stop of an event. A reset button restores its initial zero setting.

MEASURING CYLINDER

Definition:- It is a device which is used to measure the volume of a liquid and irregular solid objects.



Construction:- It is made from transparent plastics or glass and it has vertical scale in millimeter (ml) or cubic centimeter (cm^3).

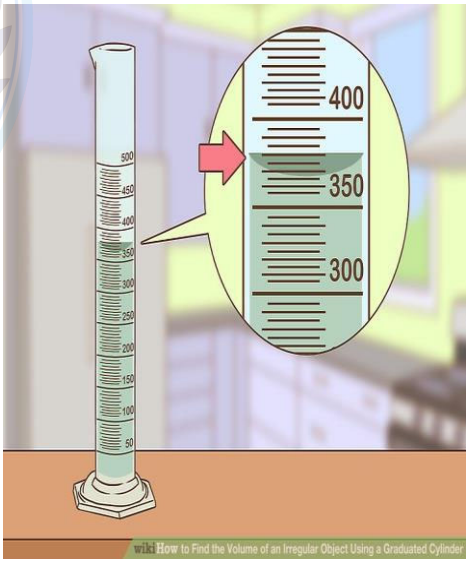
Working:-

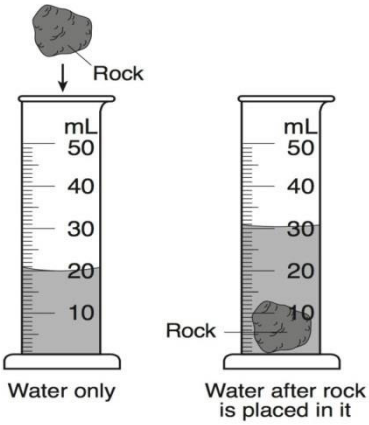
To find the volume of water:-

(i) Take the measuring cylinder.
(ii) Place it vertically on the table.
(iii) Pour some water into it.
(iv) Note the volume of water from the scale on the side of the cylinder.
(v) For accurate measurement the eye must be leveled with the bottom of the meniscus.

To find the volume of irregular body:-

(i) Take the measuring cylinder.
(ii) Place it vertically on the table.
(iii) Pour some water into it until the cylinder is half full.
(iv) Note the volume of water and call it V_1.
(v) An irregular shaped object is lowered gently into it.
(vi) Note the volume again and call it V_1.
(vii) The volume of object =V = $V_2 - V_1$.





POINT TO PONDER

Why 20 ^{0}C is written on measuring cylinders?

Ans :- Statement:- 20 ^{0}C is written on measuring cylinders .
Reason:- Because it give accurate measurement at 20 ^{0}C.
Explanation:- As we know that the measuring cylinder is an instruments which is used to measure the volume of a liquid and irregular solid objects. But the measuring cylinder expands on heating and contracts on cooling depends upon the temperature. So the measurement will be less accurate at a temperature other than 20 ^{0}C.
Conclusion:- So as a result 20 ^{0}C is written on measuring cylinders because it is a standard and a reminder that cylinder is design to give accurate measurement at 20 ^{0}C.

Significant Figures:-

Definition:- The number of accurately figure and the first doubtful figure is known as significant figure.

Explanation:- Supposes three persons want to measure the length of pencil with an ordinary meter ruler. Let's its length be measured by them 11.63cm, 11.64cm and 11.65 respectively.

In this case they are agreed with 11.6 so these are called accurately known digits. But there is a doubt in the fourth one. We are in suspense that which one among 3, 4 and 5 is accurate digit such digit is known as doubtful digit.

General rules for writing significant figures:- The following rules are helpful in identifying the significant figures.
(1)Non-zero digits i-e 1,2,3……9 are always are significant.
Examples:-
(1)The number of significant figure in 47.73 is 4.
(2) The number of significant figure in 334455 is 6.
(3) The number of significant figure in 123456789 is 9 etc.
(4)Zeros between two significant figures are always significant.
(i) The number of significant figure in 33054 is 5.
(ii) The number of significant figure in 100000023 is 9.
(iii) The number of significant figure in 30405 is 5 etc.
(5)Zeros to the left of significant figures are not significant.
(i) The number of significant figure in 0.00467 is 3.
(ii) The number of significant figure in 0.000000004 is 1.
(iii) The number of significant figure in 0.01 is 1 etc.

(6) All the zeroes to the right of the decimal point that appear after non-zero digits are significant.

Examples:-

(i) The number of significant figure in 5.0 is 2.

(ii)The number of significant figure in 5.000000 is 7.

(iii) The number of significant figure in 87.5000 is 6 etc.

(7) In non- decimal numbers , zeros to the right of a significant digit may or may not significant depends upon the counting unit of the measuring instruments.

(i) Examples:- The number is 6000 kg , if the measuring scale has a least count 1kg then there are four significant digits i-e

6000 kg …… 1kg …… 4 digits .

Similarly if the least count is 10kg then

6000 kg …… 10kg …… 3 digits.

If the least count is 100kg then

6000 kg …… 100kg …… 2 digits.

(6) When a measurement is recorded in scientific notation, the figure other than power of ten is significant figure.

Examples:-

(i) The number of significant figure in 2.80×10^3 kg is 3.

(ii) The number of significant figure in 6.67×10^{-11} is 3 etc.

ROUNDING OFF:-

Definition:- The process of deleting or dropping of an insignificant digit is known as rounding off.

Rules for rounding off significant figures:- In dropping non-significant figures we follow the following rules.

(1) If the last digit is less than 5 then it will be ignored.

Examples: -

(i) 93.83 is rounded to 93.8.

(ii) 2.6573 is rounded to 2.657.

(iii) 999.94 is rounded is 999.4 etc.

(2) When the dropping digit is greater than 5 then the last retained digit increased by 1.

Examples:-

(i) 9.68 is rounded to 9.7.

(ii) 67.77 is rounded to 67.8.

(iii) 2.6578 is rounded to 2.658 etc.

(3)When the dropping digit is 5 and the last retained digit is even then the last digit i-e 5 will be dropped without affecting the next one.

Examples:-
(i) 2.6585 is rounded to 2.658.
(ii) 9.945 is rounded to 9.94 etc.
(4) If the last digit is 5 and the 2nd last is an odd digit then the 2nd last digit is increased by 1 in order off 5.
Examples:-
(i) 9.6575 is rounded to 9.658. (ii). 2.6535 is rounded to 2.654 etc.

Assignments

Assignment # 1.1 (Page no 11)

The mass of earth is 5,980,000,000,000,000,000,000,000 kg; write this number in standard from/ scientific notation.

Ans:-Solution:-

Given Data:-
Mass of earth = M_e = 5,980,000,000,000,000,000,000,000 kg
Required Data:- To express the mass of earth in scientific form.
Formula:- As we know that $N = M \times 10^n$
As N= 5,980,000,000,000,000,000,000,000, M = 5.98, n = 24
Then 5,980,000,000,000,000,000,000,000 kg = 5.98×10^{24} kg
Result :- So the mass of earth in scientific form can be written as 5.98×10^{24} kg.

Assignment # 1.2 (Page no 11)

Calculate the number of seconds in week. Express the number in power of 10 notations.

Ans:- **Solution**:-
Given data:-
Time= t=1 week
Required Data:-
(i) To find the number of seconds in one week
(ii) To express the number of seconds in one week in scientific forms

(i) **Number of seconds in one week**:- As we know that
1 day = 24 hours
1 day = 24 x 3600 sec
1 day = 86400 sec
Now 1 week = 7 days
1 week = 7 x 86400 sec = 604,800 sec.

(ii) Number of seconds in one week in scientific forms:-
N=604,800 sec , M = 6.048 , n = 5

Then 604,800 sec = 604,800 sec = 6.048×10^5 sec

Result:- So the 604,800 sec in scientific form can be written as 6.048×10^5 sec

Assignment # 1.3 (Page no12)

Adult housefly (Musca domestica) is having a mass of only about 0.000,0214 kg. Express this number in standard form / scientific notation.

Answer:- **Solution**:-

Given Data:- Mass of adult housefly = m= 0.000,021 kg.

Required Data:- To express the mass of adult housefly in standard form.

Formula:- $N = M \times 10^n$

As N=0.000,0214 kg , M = 2.14 , n = -5 then

0.000,0214 kg= $N = 2.14 \times 10^{-5}$ kg.

Result:- So the mass of adult housefly 0.000,021 kg in scientific form is 2.14×10^{-5} kg.

Assignment # 1.4 (Page no 13)

The smallest bird is bee hummingbird. Males measure only 0.057m. Convert this number to standard form and write this number in millimeter.

Solution:-

Given data:-

Size of bee = 0.057m

Required Data :-

(i) Express the size of bee in standard form.

(ii) Express the size of bee in millimeter.

(i) The size of bee in standard form:-

Formula:- $N = M \times 10^n$

As N = 0.057, M = 5.7, n = - 2 then

0.057m = $N = 5.7 \times 10^{-2}$ m.

(ii) **The size of bee in millimeter**:- As we know that

1 meter = 1000mm = 10^3

The size of bee = 5.7×10^{-2} m = $5.7 \times 10^{-2} \times 1000$mm

The size of bee = 5.7×10^{-2} m = $5.7 \times 10^{-2} \times 10^3$ mm

The size of bee = 5.7×10^{-2} m = $5.7 \times 10^{-2+3}$ mm

The size of bee = 5.7×10^{-2} m = 5.7×10^1 mm

The size of bee = 5.7×10^{-2} m = 5.7×10 = 57mm

Result:-

(i) The size of bee in standard form is 5.7×10^{-2} m.

(ii) (ii) The size of bee in millimeter is 57mm.

Assignment # 1.5 (Page no 14)

The distance from Peshawar to Lahore is 489 km, convert this distance into millimeters.

Ans :- **Solution**:-

Given data:-

Distance from Peshawar to Lahore = S= 489 km.

Kilo = K = 10^3 m

Required Data:-

To convert 489 km into millimeter (mm).

As we have given S = 489 km

$S = 489 \times 10^3$ m

Meter = m= 10^3 mm

$S = 489 \times 10^3 \times 10^3$mm

$S = 4.89 \times 10^2 \times 10^3 \times 10^3$mm.

$S = 4.89 \times 10^{2+3+3}$ mm = 4.89×10^8 mm.

Result:- So the distance from Peshawar to Lahore in millimeter = 4.89×10^8 mm.

Assignment # 1.6 (Page no 20)

Which of the following is the accurate device for measuring instrument length?

a. A vernier calipers with main scale of 1mm marking and 50 divisions on the sliding scale

b. A screw gauge of pitch 1mm and 25 divisions on the circular scale .Solution:-

(a) For Least Count of vernier calipers :-

c. Formula:- $L.C = \frac{Smallest\ division\ on\ main\ scale}{Total\ number\ division\ on\ vernier\ scale}$

$L.C = \frac{1}{50} = 0.02$ mm.

(b) For Least Count of Screw gauge :-

Formula:- $L.C = \frac{Pitch\ of\ Screw\ gauge}{Total\ number\ of\ division\ on\ circular\ scale}$

$L.C = \frac{1}{25} = 0.04$ mm.

Result :- So in this case the vernier caliper will give more accurate measurement than th screw gauge because small least count.

Assignment # 1.7 (Page no 23)

A beaker contains 200 mL of water, what is volume of water in cm^3 and m^3.

Solution:-

Given Data:-

Volume of water = V = 200 mL

Required Data:-

(i)Volume of water in cm^3 = V = ?

(ii) Volume of water in m^3 = V =?

milli = m= 10^{-3}

(i) **For Volume of water in cm^3 = V** :- V = 200 mL

$V = 200 \times 10^{-3} \times 10^3\ cm^3$

1 Liter = L = 10^3 cm^3

$V = 200 \times 10^{-3+3}\ cm^3$

$V = 200\ cm^3$.

(ii) **For Volume of water in m^3 = V** :- As we know that

$V = 200\ cm^3$

$V = 200 \times \left(\frac{1}{100}\ m\right)^3$

$V = 200 \times \left(\frac{1}{10^2}\ m\right)^3$

$V = 200 \times (10^{-2}\ m)^3$

$V = 200 \times 10^{-2 \times 3}\ m^3$

$V = 200 \times 10^{-6}\ m^3$

$V = 0.0002\ cm^3$.

Results:-

(a) The volume of water in cm^3 is $V = 200\ cm^3$.

(b) The volume of water in m^3 is $V = 0.0002\ cm^3$.

CONCEPTUAL QUESTIONS

Give a brief response to the following questions.

1.How technology is shaped by Physics ?

Ans:- **Statement:-**Technology is shaped by Physics.

Reason:- It is because most of the technology is based on Physics Principles.

Explanation:-

i) It provides us source of communications i-e Radio, TV, Mobile, telephone etc.

(ii)It provides us atomic energy (bomb) which is used for defense purpose as well as energy production.

(iii) It provides us means of transportations i-e bus, car, aero planes etc.

(iv) It provides us microscope which is used to study the micro-organisms.

(v) It provides us X-rays machine, Laser rays, CT scan, MRI etc which are used in the fields of health, industry and agriculture.

Conclusion:- So from the above discussion it is cleared that technology is shaped by Physics.

(2) Physics and biology are considered different branches of Science, how Physics links with biology?

Ans:- Statement:- Physics and biology are considered different branches of Science but

Physics links with biology.

Reason:- It is because Physics provides basic understanding for developing biological applications.

Explanation:-

(i) It provides us microscopes which is used for the study of microorganisms.
(ii) It provides us X – ray, C T Scan, MRI and laser which are used for various purposes .
(iii) It provides us greenhouse which is used for the growth of plants.
(iv)It provides us stethoscope which is used for the measurement of heart beating.
(v) It provides us radio-isotopes which is used for the treatment of diseases.

Conclusion:- As conclusion we find that Physics and biology are considered different branches of Science but Physics links with biology.

(3)Why are measurement important?

Ans:-Statement:- Measurements are important in Physics.

Reason:- It is because physics deals with the physical quantities.

Explanation:- As we know that in physics we are study those quantities which can be defined and measured. Quantities like length, mass, time, density etc can be measured therefore they are called physical quantities.

Examples:-

(i) The length of book can be measured.
(ii) The mass of a box can be measured.
(iii) The duration of our stay at school is measurable.

Conclusion:- As conclusion we find that Physics is the science of measurement.

(4)Why area is a derived quantity?

Ans:-Statement:- Area is a derived quantity.

Reason:- Because it is obtained from base physical quantities.

Explanation:- As we know that derived physical quantities are obtained from base physical quantities. For example area is a derived physical quantity in which the base physical quantity "Length" occurs twice (in the form of length and breath).

Area = Length x length

$A = L \times L$

Conclusion:- As conclusion we find that area is a derived quantity.

(5)Name any four derived units and write them as their base units?

Ans:-

Unit	Symbol	In term of base units
Newton	N	Kg ms^{-2}
Pascal	Pa	Kg $m^{-1}s^{-2}$

Watt	W	Kg m^2s^{-3}
Coulomb	C	A s

(6)Why in Physics we need to write in Scientific notation?

Ans:-Statement:- In Physics we need to write in Scientific notation.

Reason:- It is because in Physics we deal with numbers that are very small or very large.

Explanation:- As we know that Scientific notation is a way of writing numbers that are too big or too small to be easy written in decimal form. It has a number of useful properties and commonly used by scientist in the field of Physics , Mathematics etc.

Example:- The mass of moon is 70,000000000000000000000 kg which in Scientific notation is 7 x 10^{22} kg.

Conclusion:- As conclusion we find that in Physics we need to write in Scientific notation.

(7)What is least count? How least count for vernier caliper and Screw gauge are defined?

Ans :-

Definition :- The minimum possible value that can be measured with the help of an instrument is called least count.

(a) Least Count of Vernier Calliper:-

Definition:-The difference between one small division and one main scale division is known as least count.

Number of divisions on vernier scale is 10.

Least Count = One main scale division – one vernier scale division.

Least Count = 1mm – 0.9mm = 0.1mm.

(b) Least count of Screw Gauge:-

Definition:- The minimum length which can be measured accurately by a screw gauge is known as least count of screw gauge.

Calculation Least Count of Screw Gauge :- The least count of screw gauge is founded by dividing its pitch by the number of circular scale divisions.

$$\text{Least Count} = \frac{Pitch\ of\ Screw\ Gauge}{Total\ number\ of\ division\ on\ circular\ scale}$$

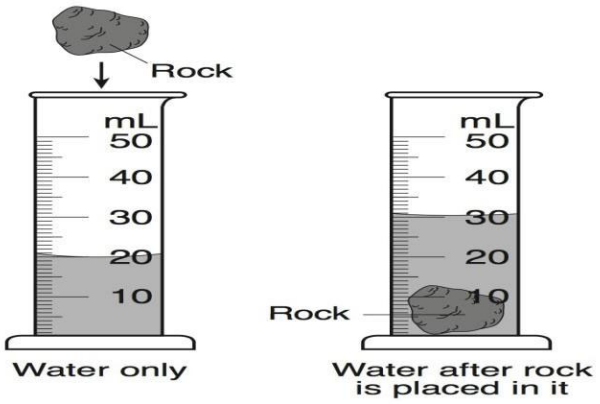
If the pitch of screw gauge is 0.5 mm and the number of divisions on circular scale is 50 then

$$\text{Least Count} = \frac{0.5\ mm}{50} = 0.01\ \text{mm}$$

8. How can we find the volume of a small pebble with the help of measuring cylinder?

Ans:- To find the volume of irregular body:-

(i) Take the measuring cylinder.
(ii) Place it vertically on the table.
(iii) Pour some water into it until the cylinder is half full.
(iv) Note the volume of water and call it V_1.
(v) An irregular shaped object is lowered gently into it.
(vi) Note the volume again and call it V_2.
(vii) The volume of object $=V = V_2 - V_1$.



NUMERCAL QUESTIONS

Problem #1:-Write the number in prefix to power of ten
(a) Mechanical nano - oscillators can detect a mass change as small as 10^{-21}kg. (b) The nearest neutron star (a collapsed star made primarily of neutrons) is about 3.00×10^{18}m away from earth.
(c). Earth to sun distance is 149.6 million km.

Ans:- Solution:-
(a) Given data:-
Mass = m = 10^{-21}kg
Mass = m =10^{-21}kg = 10^{-21} x 10^{3} g = 10^{-21+3} g
Mass = m = 10^{-18} g = 1 atto gram

Kilogram = kg = 1000 g = 10^{3} g

10^{-18} g = 1 atto gram

(b) Given Data:-
Distance = S = 3.00×10^{18} m
Distance = S = 3.00×10^{18} m = 3.0 exa meter

10^{18} =exa=e

(c) Distance = S = 149.6 million km = 149.6 x 10^{6} x 10^{3} m
Distance = S = 149.6 x 10^{6+3} m= 149 .6 x 10^{9} m = 149.6 Gm

Million = 10^{6}

Giga = G = 10^{9}

Problem #2:- An angstrom (symbol A^0) is a unit of length (commonly used in atomic physics), defined as 10^{-10}m which is of the order of the diameter of an atom.
(a) How many nanometers are in 1.0 angstrom?
(b) How many femtometers or fermis (the common unit of length in nuclear physics) are in 1.0 angstrom?
(c) How many angstroms are in 1.0m?
Ans:- **Solution**:-
Given Data:- 1 angstroms = A^0 = 10^{-10}m.
Required Data:- (a) Number of nanometers in 1.0 angstrom = ?

(b) Number of femtometers or fermis in 1.0 angstrom =?
(c) Number of angstroms in 1.0 meter= ?
(a) **For number of nanometers in 1.0 angstrom**:- As we know that

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

$1 \text{ angstrom} = 10^{-1}$ nano-meter

$1 \text{ angstrom} = \frac{1}{10}$ nano-meter.

Nano =n=10^{-9}

$\frac{1}{10} = 0.1$

1 angstrom = 0.1 nm.

(b) **For number of femtometers or fermis in 1.0 angstrom**:- As we know that

$1 \text{ angstrom} = 10^{-10} \text{ m}$

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

$10^{-5} \times 1 \text{ angstrom} = 10^{-5-10}$

$10^{-5} \times 1 \text{ angstrom} = 10^{-15} \text{m}$

10^{-5} angstrom = Femto-meter.

10^{-15} =Femto

$\frac{10^{-5}}{10^{-5}}$ angstrom = $\frac{1}{10^{-5}}$ Femto-meter

Divide both sides by 10^{-5}

1 angstrom = 10^{5} Femto-meter.

(c) For number of angstroms in 1.0 meter :- As we know that

$1 \text{ angstrom} = 10^{-10} \text{ m}$

$\frac{1}{10^{-10}}$ angstrom = $\frac{10^{-10}}{10^{-10}}$ m

Divide both sides by 10^{-10}

$\frac{1}{10^{-10}}$ angstrom = 1m

10^{10} angstrom = 1m

OR

1m = 10^{10} angstrom

Problem #3:-The speed of light is c = 299,792458 m/s.
(a) Write this value in scientific notation.
(b) Express the speed of light to

i. Five significant figures ii. Three significant figures.

Solution:-
(a) **Given Data**:-
Speed of light = C = 299,792458 m/s.
Required Data:- To express 299,792458 m/s in standard form.

Formula: - $N = m \times 10^n$

As N = 299,792458 , M = 2.99792458 , n = 8 then

$N = 2.99792458 \times 10^8$ m/s

(b) Given Data :-

Speed of light = C = 299,792458 m/s.

Required Data:-

(i) To express Speed of light =C = 299,792458 m/s to five significant figure.

Ans:- $C = 2.9979 \times 10^8$ m/s

(ii) To express Speed of light =C = 299,792458 m/s to three significant figure.

Ans:- $C = 2.99 \times 10^8$ m/s

Problem #4:-Express the following in terms of powers of 10.

a.7 nanometer **b.** 9 megawatt **c.** 2 gigabits **d.** 43 Pico farad **e.** 2 millimeter.

Ans:- **(a) Given data**: 7 nanometer.

Required Data:- To 7 nanometer in power of 10.

Solution:- As " nano" stands for 10^{-9}m then

7 nanometer :- $7x\ 10^{-9}$ m.

Result:- 7 nanometer when express in power of 10 is 10^{-9}m.

(b) **Given data**: 9 megawatt :-

Required data:- To express 9 megawatt in power of 10.

Solution:- As "mega" stands for 10^6 then

9 megawatt = 9×10^6 watt

Result:- 9 megawatt when expressed in power of 10 is 9×10^6 watt

(c) **Given data**: 2 gigabits :- 2×10^9 .

Required Data:- To express 2 gigabits in power of 10.

Solution:- As "giga" stands for 10^9 then

2 gigabits :- 2×10^9 bites.

Result: - 2 gigabits when expressed in power of 10 is 2×10^9 bites.

(d) Given Data: 43 Pico farad .

Required data:- To express 43 Pico farad in power of ten.

Solution:- As "pico" stands for 10^{-12} then

43 Pico farad = 43×10^{-12} Farad.

Result:- 43 Pico farad when expressed in power of 10 is 43×10^{-12} Farad

(e) **Given data**: 2 millimeter

Required data :- To express 2 millimeter in power of 10.

Solution:- As "milli" stands for 10^{-3} then

2 millimeter = 2×10^{-3}

Result:- 2 millimeter when expressed in power of 10 is 2×10^{-3}m.

Problem #5:- Write the following numbers in standard form:-
(a) Mass of Bacterial cell: 0.000,000,000,005 kg**.**
(b) Diameter of Sun: 1,390,000,000 m.
Solution :-
(a)Given Data:-
Mass of bacteria = m = 0.000,000,000,005 kg.
Required data:- To express 0.000,000,000,005 kg in standard form.
Formula:- $N = m \times 10^{n}$
As N = 0.000,000,000,005 kg , M = 5.0 , n = -12 then
$N = 5.0 \times 10^{-12}$ kg
(b) **Given data**:-
Diameter of Sun = D = 1,390,000,000 m.
Required data:- To express 1,390,000,000 in standard form.
Formula:- $N = m \times 10^{n}$
As N = 1,390,000,000 , M = 1.39 , n = 9 then
$N = 1{,}390{,}000{,}000 = 1.39 \times 10^{9}$ m
Result:- So 1,390,000,000 m in scientific form can be written as 1.39×10^{9} m.