UNIT -1

Physical Quantities and Measurement

Q.1.1: Define science and describe how science was divided into various branches.

Ans: **Science:**

The knowledge gained through observations and experimentations is called Science. The word science is derived from the Latin word "scientia", which means knowledge. Science was divided into various branches initially as described below:

Natural philosophy:

Not until eighteenth century various aspects of material objects were studied under a single subject called natural philosophy.

OR

Knowledge before eighteenth century is known as natural philosophy.

Later on as knowledge increased natural philosophy was divided into two branches.

(i) Biological sciences (ii) Physical sciences

Biological sciences:

The branch of natural philosophy which deals with the study of living things is called as biological sciences.

Physical sciences:

The branch of natural philosophy which deals with the study of non-living things is called physical sciences. Physical sciences were divided into five distinct disciplines:

(i) Physics (ii) Chemistry (iii) Geology
(iv) Astronomy (v) Meteorology

Q.1.2: Define physics and explain its branches.

Ans: **Physics:**

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

Branches of Physics:

1. **Mechanics:**
   The branch of physics which deals with the study of motion of object, its causes and effects is called mechanics.
2. **Heat:**
   The branch of physics which deals with the nature of heat, modes of transfer and effects of heat is called heat.
3. **Sound:**
   The branch of physics which deals with the study of physical aspects of sound waves, their production, properties and applications is called sound.
4. **Light (Optics):**
   The branch of physics which deals with the study of physical aspects of light, its properties, working and use of optical instruments is called light (optics).
5. **Electricity and Magnetism:**
   The branch of physics which deals with the study of charges at rest and in motion, their effects and their relationship with magnetism is called electricity and magnetism.

6. **Atomic Physics:**
   The branch of physics which deals with the study of structure and properties of atoms is called atomic physics.
7. **Nuclear Physics:**
   The branch of physics which deals with the study of properties and behaviour of nuclei and the particles within nuclei is called nuclear physics.
8. **Plasma Physics:**
   The branch of physics which deals with the study of production, properties of ionic state of matter-the fourth state of matter, is called plasma physics.
9. **Geo Physics:**
   The branch of physics which deals with the study of internal structure of the Earth is called geo physics.

Q.1.3: What is the importance of physics in our daily life?

Ans: Laws and principles of physics help us to understand nature.

The rapid progress in science during the recent years has become possible due to discoveries and inventions in the field of Physics. The technologies are the applications of scientific principles. Most of the technologies of our modern society throughout the world are related to physics. For example, car is made on the principles of mechanics and a refrigerator is based on principles of thermodynamics. In our daily life there are lots of applications of physics. For example in electrical appliances (air conditioners, washing machine), means of transport (cars, aeroplanes), means of communication (radio,T.V, Telephone) etc.

Q.1.4: Define physical quantities and explain its types.

Ans: **Physical Quantities:**

All measurable quantities are called physical quantities.

Examples:

length, mass, time, temperature etc.

Characteristics:

A physical quantity possesses at least two characteristics:

(i) Numerical magnitude (ii) A unit in which it is measured

Example:

If length of student is 104 cm then 104 is numerical magnitude and cm is unit of measurement.

Types:

Physical quantities are of two types:

(i) Base quantities (ii) Derived quantities

1. Base Quantities:

Base quantities are the quantities on the basis of which other quantities are expressed.

Examples:

There are seven base quantities i.e. length, mass, time, temperature, electric current, intensity of light, amount of a substance.

1. Derived Quantities:

The derived quantities are those quantities which are expressed in terms of base quantities.

Examples:

Area, volume, speed, force, work, energy, power, electric charge, electric potential etc.

Q.1.5: Define unit and what is International system of units.

Ans: Unit:

A standard quantity needed for measuring unknown quantities is called unit.

Example:

Standard unit for measurement of mass is kilogram(kg), for length is meter(m) and for time is second(s).

System of Units:

A set of base and derived units is called system of units.

International System of Units:

A world wide acceptable system of measurements is called international system of units. It is commonly reffered as S.I.

It was adopted in 11th General conference on weight and measures held in 1960 in paris.

Types:

There are two types of units

(1) Base units (2) Derived units

1. **Base Units:**

The units that describe base quantities are called base units.

Following table shows the S.I units of base quantities and their symbols.

Quantities		Units	
Names	**Symbols**	**Names**	**Symbols**
Length	l	Metre	m
Mass	m	Kilogramme	kg
Time	t	Second	s
Electric current	I	Ampere	A
Intensity of light	L	Candela	cd
Temperature	T	Kelvin	K
Amount of substance	n	Mole	mol

2. Derived Units:

Units used to measure derived quantities are called derived units.

Derived units are defined in terms of base units and are obtained by multiplying or dividing one or more base units with each other. The unit of area (metre)^2 and the unit of volume (metre)^3 are based on the unit of length, which is metre. Thus the unit of length is the base unit while the unit of area and volume are derived units. Speed is defined as distance covered in unit time, therefore its unit is metre per second. In the same way the unit of density, force, pressure, power etc. can be derived using one or more base units.

Some derived units and their symbols are given in following table.

Quantities		Units	
Names	**Symbols**	**Names**	**Symbols**
Speed	v	metre per second	ms^{-1}
Acceleration	a	metre per second per second	ms^{-2}
Volume	V	cubic metre	m^3
Force	F	Newton	N or kg ms^{-2}
Pressure	P	Pascal	Pa or N m^{-2}
Density	ρ	kilogramme per cubic metre	kgm^{-3}
Charge	Q	Coulomb	C or As

Q.1.6: What are prefixes? Explain it with examples.

Ans: **Prefixes:**

The words or letters added before a unit and stand for multiples or sub-multiples of that unit are known as prefixes.

Examples:

kilo, mega, nano, micro etc.

Note:

The prefixes are useful to express very large or small quantities.

Double prefixes are not used for example no prefix is used with kilogramme as it already contain prefix kilo.

1. $200,000 \text{ ms}^{-1} = 200 \times 10^3\, ms^{-1} = 200\, kms^{-1}$
2. $4800000\, W = 4.8 \times 10^6\, W = 4.8\, MW$
3. 3300000000 Hz = 3.3×10^9 Hz = 3.3 GHz
4. 0.00002 g = 20×10^{-6} g = 20 μg
5. 0.0000000081 m = 8.1×10^{-9}m = 8.1nm
6. 20000g = 20×10^3 g = 20 kg

Some prefixes are given in following table:

Prefix	Symbol	Multiplier
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Q.1.7: Define scientific notation. Describe it with examples.

Ans: **Scientific Notation:**

In scientific notation a number is expressed as some power of ten multiplied by a number between 1 and 10.

A simple but scientific way to write large or small numbers is to express them in some power of ten.

The Moon is 384000000 metres away from the Earth. Distance of the moon from the Earth can also be expressed as 3.84×10^8 m. This form of expressing a number is called the standard form or scientific notation. This saves writing down or interpreting large numbers of zeros.

Multiples and Sub multiples of length

1 km	$10^3 m$
1 cm	$10^{-2} m$
1 mm	$10^{-3} m$
1 μm	$10^{-6} m$
1 nm	$10^{-9} m$

Examples:

1. $62750 = 6.275 \times 10^4$ 2. $0.00045\,s = 4.5 \times 10^{-4}\,s$

Standard Form:

Number that has one non-zero digit before the decimal preferable be taken as standard form.

Q.1.8: What are measuring instruments? Write the name of some length measuring instruments.

Ans: Measuring Instruments:

Measuring instruments are used to measure various physical quantities such as length, mass, time, volume etc. Measuring instruments used in the past for example, sundial, water clock and other time measuring devices used around 1300 AD were quite crude. On the other hand, digital clocks and watches used now-a-days are highly reliable and accurate.

Length Measuring Instruments:

Length measuring instruments are following

(i) Metre rule (ii) Measuring tape
(iii) Vernier caliper (iv) Screw guage

Q.1.9: Explain the construction and use of metre rule and measuring tape.

Ans: Metre Rule:

Metre rule is a length measuring instrument and is commonly used in laboratories to measure length of an object or distance between two points.

Construction:

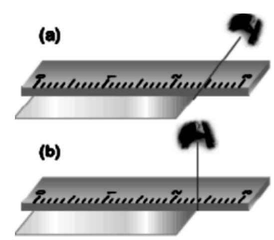
It is one metre long which is equal to 100 cm. Each centimetre is divided into 10 small divisions called millimeter (mm). Thus one millimeter is the smallest reading on metre rule.

Least Count:

Smallest measurement that can be taken by an instrument is called least count of that instrument. One millimetre is the smallest reading that can be taken using a metre rule so least count of metre rule is 1 mm.

Precaution:

While measuring length, or distance eye must be kept vertically above the reading point. The reading becomes doubtful if eye is positioned either left or right to reading point.



(a) Wrong position of the eye to note the reading. (b) Correct position of the eye to note the reading from a metre rule

Measuring Tape:

It is a length measuring instrument which is used to measure length in metres and centimetres. A measuring tape used by blacksmith and carpenters.

Construction:

A measuring tape consists of a thin and long strip of cotton, metal or plastic generally10m,20m, 50 m or 100 m long. We can measure the length in centimetres as well as in inches by measuring tape.

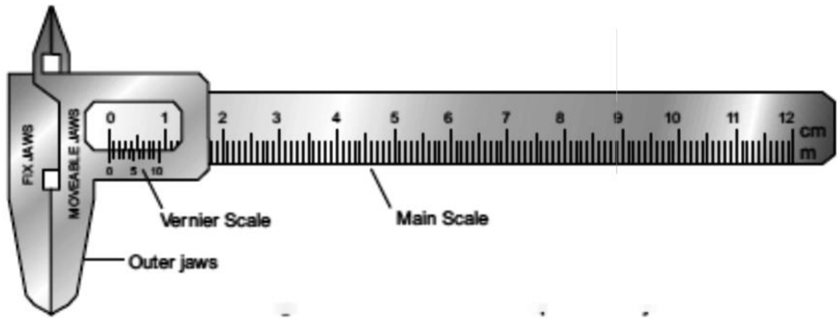
Q.1.10: Give construction and use of a Vernier Callipers.

Ans: Definition:

An accuracy greater than 1mm can be obtained by using instruments such as Vernier Callipers. **OR**

An instrument which can measure length correct upto 0.1mm is called Vernier Calliper.

Figure:



Vernier Calliper with jaws closed

Construction:

Vernier Calliper consists of two jaws. One is a fixed jaw, with main scale attached to it. Main scale has centimetre and millimetre marks on it. The other jaw is a moveable jaw. It has vernier scale having 10 divisions over it. Such that each of its division is 0.9mm.

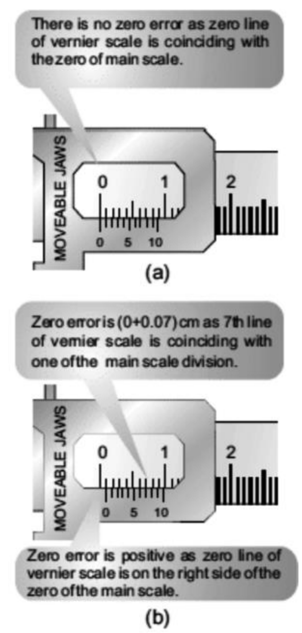
Pitch:

The distance between two small divisions on main scale of vernier callipers is called pitch of vernier callipers.

Least Count:

The difference between one small division on main scale division and one vernier division is 0.1mm is called least count (LC) of the Vernier Calliper It is also called as vernier constant. Such that

1mm-0.9 mm = 0.1 mm = 0.01 cm.



Formula:

Least count of Vernier Callipers

$$= \frac{\text{smallest reading on main scale}}{\text{no. of divisions on vernier scale}} = \frac{1\text{mm}}{10} = 0.1\text{mm} = 0.01\text{cm}$$

Conclusion:

This is the minimum length which can measure accurately with the help of Vernier Callipers.

Note:

Vernier Calliper is used to find out radius and diameter.

Q.1.11: Describe the working of Vernier Callipers.

Ans: Zero Error:

The defect present in any instrument is called its zero error. To find zero error, close the jaws of vernier callipers gently. If zero line of the vernier scale coincides with the zero of the main scale then the zero error is zero. Fig (a)

Positive Zero Error:

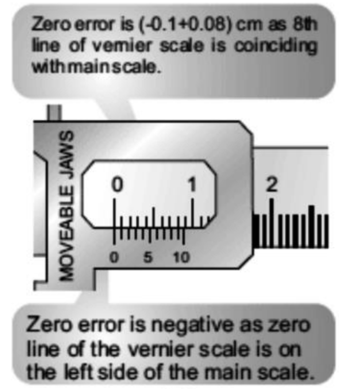
Zero error will be positive if zero line of vernier scale is on the right side of the zero of the main scale. Fig (b)

Negative Zero Error:

If the zero line of vernier scale is on the left side of zero of the main scale so it is negative zero error. Fig (c)

Zero Correction:

Knowing zero error, necessary correction can be made to find the corrected measurement. Such correction is called zero correction of the instrument. **OR** The inverse of zero error is called zero correction.



(c)

NOTE:

Zero correction will be positive or negative.

Taking a reading on Vernier Callipers:

Let us find the diameter of a solid cylinder using Vernier Callipers. Place the solid cylinder between jaws of the Vernier Callipers as shown in fig.

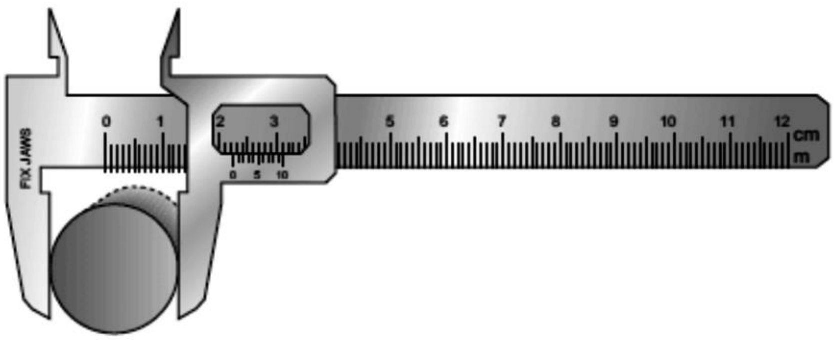


Figure: A cylinder placed between the outer jaws of Vernier Callipers

Close the jaws till they press the opposite sides of the object gently. Note the complete divisions of main scale past the vernier scale zero. Now find vernier scale division that is coinciding with any division on the main scale. Multiply it by least count of Vernier Callipers and add it in the main scale reading. This is equal to the diameter of the solid cylinder. Add zero correction (Z.C) to get correct measurement. Repeat the above procedure and record at least three observations with the solid displaced or rotated each time.

Q.1.12: What is screw gauge? How a Screw Gauge is used to measure diameter of thin wire?

Ans: **Definition:**

An instrument which can measure length correct upto 0.01mm or 0.001cm is called a screw gauge.

Micrometer Screw Gauge:

An instrument which can measure length correct upto 100^{th} part of millimeter is called micrometre screw gauge.

Construction:

A simple screw gauge consists of a U-shaped metal frame with a metal stud at its one end. A hollow cylinder (or sleeve) has a millimetre scale over it along a line called index line parallel to its axis. The hollow cylinder acts as a nut. It is fixed at the end of U- shaped frame opposite to the stud. A thimble has a threaded spindle inside it.

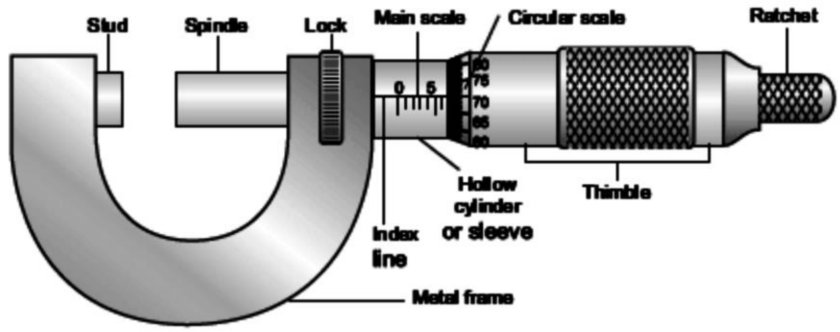
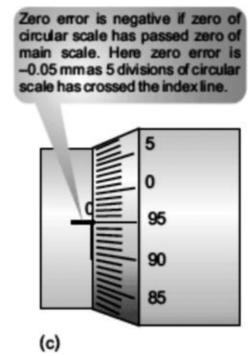


Figure: A micrometer screw gauge

Pitch of screw Gauge:

The distance moved by spindle along index line as the thimble complete one rotation is called pitch of screw gauge. i.e. 1mm. spindle has 100 divisions around its one end. It is the circular scale of the screw gauge. As thimble completes one rotation, 100 divisio pass the index line and the thimble moves 1 mm along the main scale



Least count of the Screw Gauge:

Least count of a screw gauge can also be found by dividing pitch of screw gauge on number of divisions on circular scale.i.e. 0.01 mm or 0.001 cm. Least count = $\frac{\text{Pitch of screw guage}}{\text{no. of divisions on circular scale}}$

Zero Correction:

Knowing zero error, necessary correction can be made to find the correction measurement. Such correction is called zero correction of the instrument.

OR

The inverse of zero error is called zero correction.

NOTE:

Zero correction will be positive or negative.

Q.1.13: Write a note on mass measuring instruments.

Ans: Introduction:

Pots were used to measure grain in various part of the world in the ancient times. However, balances were also in use by Greeks and Romans.

Beam Balance:

Beam balances are still in use at many places. In a beam balance, the unknown mass is placed in one pan. It is balanced by putting known masses in the other pan.

Figure: A beam balance

Today people use many types of mechanical and electronic balances.

You might have seen electronic balances in sweet and grocery shops. These are more precise than beam balances and are easy to handle.

Physical Balance:

A physical balance is used in the laboratory to measure the mass of various objects by comparison.

Construction:

It consists of a beam resting at the centre on a fulcrum. The beam carries scale pans over the hooks on either side. Unknown mass is placed on the left pan. Find some suitable standard masses that cause the pointer to remain at zero on raising the beam.

L.C: Its least count is 0.01 g or 10 mg.

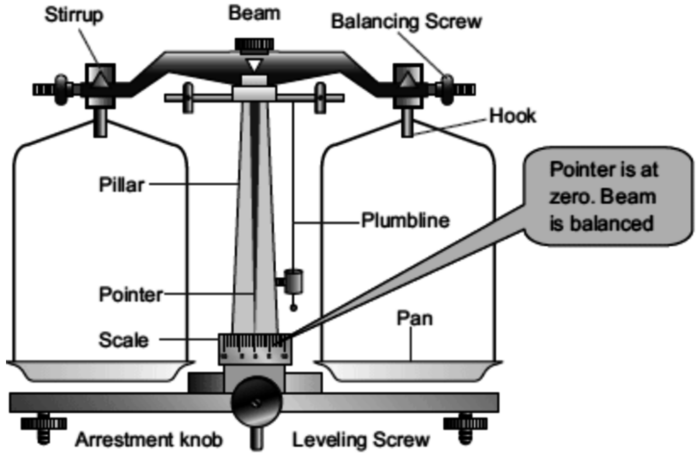


Figure: A physical balance

Lever Balance:

A lever balance consists of a system of levers. When lever is lifted placing the object in one pan and standard masses on the other pan, the pointer of the lever system moves. The pointer is brought to zero by varying standard masses.

Lever Balance

Electronic Balance:

Electronic balance comes in various ranges; milligram ranges, gram ranges and kilogram ranges. Before measuring the mass of a body, it is switched on and its reading is set to zero. Next place the object to be weighed. The reading on the balance gives you the mass of the body placed over it.

Electronic Balance

L.C:

Its least count is 0.001 g or 1 mg.

Q1.14: Which is the most accurate balance? Explain with examples.

Ans: The mass of one rupee coin is done using different balances as given below.

a) Beam Balance:

Let the balance measures coin's mass = 3.2 g

A sensitive beam balance may be able to detect a changes as small as of 0.1 g or 100 mg.

b) Physical Balance:

Let the balance measures coin's mass = 3.24 g Least count of the physical balance may be as small as 0.01 g or 10 mg. therefore, its measurement would be more precise than a sensitive beam balance.

c) Electronic Balance:

Let the balance measures coin's mass = 3.247 g Least count of an electronic balance is 0.001 g or 1 mg. Therefore, its measurement would be more precise than a sensitive physical balance.

Conclusion:

Thus electronic balance is the most sensitive balance in the above balances.

Q.1.15: Write a note on stopwatch and its types.

Ans: **Definition:** A stopwatch is used to measure the time interval of an event.

Types of Stopwatch:

There are two types of stopwatches:

a. Mechanical Stopwatch b. Digital Stopwatch

a. Mechanical Stopwatch:

A mechanical stopwatch can measure a time interval up to a minimum 0.1 second. It contains a knob that is used to wind the spring that powers the watch. It also used as start-stop and reset button. When the knob pressed once the watch start. When the button is pressed second time, the watch stops. When the button is pressed third time, the needle comes back to zero position.

Mechanical Stopwatch

b. Digital Stopwatch:

Digital stopwatch commonly used in laboratories can measure a time interval as small as $\frac{1}{100}$ second or 0.01 second. 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 noted by it between start and stop of an event. A reset button restores its initial zero setting.

Digital Stopwatch

Q.1.16: What is measuring cylinder? Explain it.

Ans: Measuring cylinder:

A measuring cylinder is a graduated glass cylinder used to measure the volume of liquid and also to find the volume of an irregular shaped solid object.

Construction:

It is a glass or transparent plastic cylinder. It has a scale along its length that indicates the volume in milliliter (mL). Measuring cylinders have different capacities from 100 mL to 2500 mL.

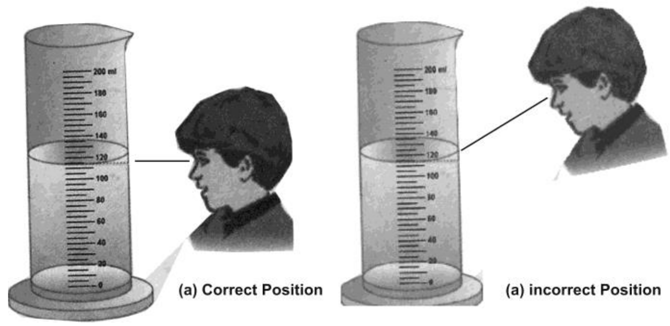
Uses:

It is used to measure volume of liquid or powdered substance. It is also used to find volume of irregular shaped solid insoluble in liquid by displacement method.

How to use measuring cylinder:

Take a measuring cylinder, place it vertically on table. Pour some water into it. Note that the surface of water will be curved. Meniscus of most liquids curves downward while meniscus of mercury curves upward. Correct method to note level of liquid in cylinder is to keep eye at same level as the meniscus of liquid. It is incorrect to keep eye above or below the liquid level.

When eye is above liquid level meniscus appears higher on scale. When eye is below liquid level, the meniscus appears lower than actual height of liquid.



Measuring volume of irregular shaped solid:

Let us find the volume of a small stone. Take some water in a graduated measuring cylinder. Note the volume V_i of water in cylinder and tie the stone with a thread. Lower the solid into cylinder till it is fully immersed in water. Note the volume V_f of water and stone. Volume of solid will be $V_f - V_i$.

Q.1.17: Write a note on significant figures.

Ans: Significant Figure:

All the accurately known digits and the first doubtful digit in an expression are called significant figures. It reflects the precision of a measured value of a physical quantity.

Explanation:

The value of a physical quantity is expressed by a number, along with suitable units. The accuracy in the measurement of a physical quantity depends upon.

i) The quality of the measuring instrument.
ii) The skill of the observer.
iii) The number of observations made.

The improvement in the quality of measurement can be made by using better measuring instrument. The less is value of least count of the measuring instrument, the more is value of precision more significant figure means greater precision.

Rules of Significant Figure:

Following rules are helpful in identifying significant figure.

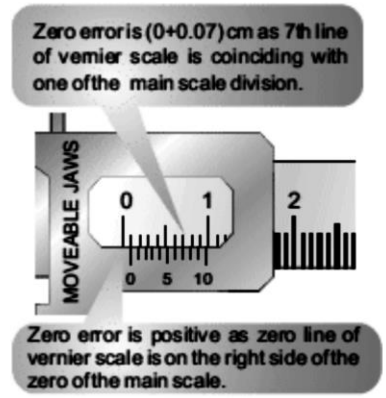
(i) Non-zero digits are always significant.
(ii) Zeros between two significant figures are also significant.
(iii) Final or ending zeros on the right in decimal fraction are significant.
(iv) Zeros written on the left side of the decimal point for the purpose of spacing the decimal point are not significant.
(v) In whole numbers that end in one or more zeros without a decimal point these zeros may or may not be significant. In such cases, it is not clear which zeros serve to locate the position of value and which are actually parts of the measurement. In such a case, express the quantity using scientific notation to find the significant zeros.

Examples:

(i) 27 has two significant figures.
(ii) 2705 has four significant figures.
(iii) 275.00 has five significant figures.
(iv) 03 has one significant figures.
(v) 0.002070 has four significant figures.
(vi) 3.404×10^{32} has four significant figures.

EXAMPLE

Example 1: Find the diameter of a cylinder placed between the outer jaws of Vernier Callipers as shown in figure.



(b)

Solution:

Zero correction:

On closing the jaws of Vernier Callipers, the position of vernier scale as shown in figure.

Main scale reading = 0.0 cm

Vernier division coinciding with main scale =7 div.

Vernier scale reading = 7 × 0.01 cm
= 0.07 cm

Zero error = 0.0 cm + 0.07 cm
= + 0.07 cm

Zero correction (Z.C) = - 0.07 cm

Diameter of the Cylinder:

Main scale reading = 2.2 cm

(when the given cylinder is kept between the jaws of the vernier callipers as shown in figure)

Vernier div. coinciding with main scale div. = 6 div.

Vernier scale reading = 6 × 0.01 cm
= 0.06 cm

Observed diameter of the cylinder = 2.2 cm + 0.06 cm

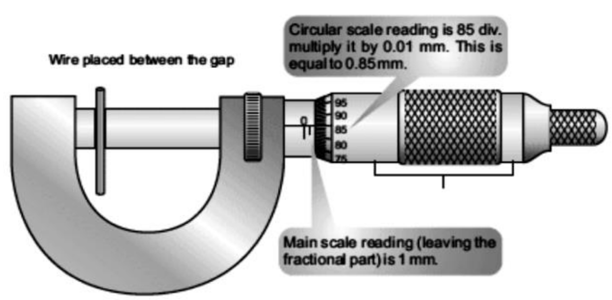
= 2.26 cm

Correct diameter of the cylinder = 2.26 cm - 0.07 cm = 2.19 cm

Thus, the correct diameter of the given cylinder as found byVernier Callipers is 2.19 cm.

Example 2: Find the diameter of a wire using screw gauge.

Solution: The diameter of given wire can be found as follows:



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

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

(iii) Open the gap between stud and spindle of the screw gauge by turning the ratchet in the anticlockwise direction. Place the given wire in the gap as shown in figure. Turn the ratchet so that the object is pressed gently between the studs and the spindle.

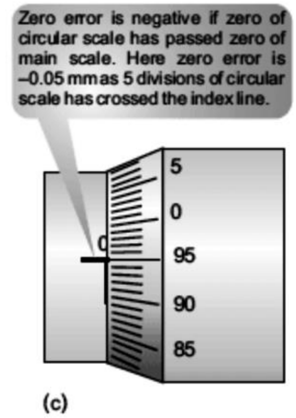
(i) Note main scale as well as circular scale readings to find the diameter of the given wire.

(ii) Apply zero correction to get the correct diameter of the wire.

(iii) Repeat steps (c, d, e) at different places of the wire to obtain its average diameter.

Zero Correction:

On closing the gap of screw gauage, the position of circular scale as shown in figure.



Main scale reading = 0 mm
Circular scale reading = 24 × 0.01 mm
= 0.24 mm
Zero error of the screw gauge = 0 mm + 0.24 mm
= + 0.24 mm
Zero correction (Z.C) = - 0.24 mm

Diameter of the Cylinder

Main scale reading = 1 mm
(when the given wire is pressed by the stud and spindle of the screw gauge)
No. of division on circular scale = 85 div.
Circular scale reading = 85 × 0.01 mm
= 0.85 mm
Observed diameter of the given wire = 1 mm + 0.85 mm
= 1.85 mm
Correct diameter of the given wire = 1.85 mm - 0.24 mm = 1.61 mm
Thus, the correct diameter of the given wire is 1.61 mm.

Example 3: Find the mass of a small stone by a physical balance.

Solution:

Follow the steps to measure the mass of a given object.

(i) Adjusting the leveling screws with the help of plumbline to level the platform of physical balance.
(ii) Raise the beam gently by turning the arresting knob clockwise.
Turn the arresting knob to bring the beam back on its supports. Place the given object (stone) on its left pan.
(iii) Place suitable standard masses from the weight box on the right pan. Raise the beam. Lower the beam if its pointer is not at zero.
(iv) Repeat adding or removing suitable standard masses in the right pan till the pointer rests at zero on raising the beam.
(v) Note the standard masses on the right pan. Their sum is the mass of the object on the left pan.

Example 4: Find the number of significant figures in each of the following values. Also express them in scientific notations.

(a) 100.8 s (b) 0.00580 km (c) 210.0 g

Solution:

1. All the four digits are significant. The zeros between the two significant figures 1 to 8 are significant. To write the quantity in scientific notation, we move the decimal point two places to the left, thus 100.8 s = 1.008×10^2 s

2. The first two zeros are not significant. They are used to space the decimal point. The digit 5, 8 and the final zero are significant. Thus there are three significant figures. In scientific notation, it can be written as 0.00580 km = 5.80×10^{-3} km.

3. The final zero is significant since it comes after the decimal point. The zero between last zero and 1 is also significant because it comes between the significant figures. Thus the number of significant figures in this case is four. In scientific notation, it can be written as.
210.0 g = 2.100×10^2 g

NUMERICAL PROBLEMS

P.1.1: Express the following quantities using prefixes.

1. 5000 g

$= 5 \times 1000$ g

$= 5 \times 10^3$ g $\quad \therefore 10^3$ g = 1kg

= 5 kg

2. 2 000 000 W

$= 2 \times 10^6$ W $\quad \therefore 10^6$ W = 1MW

= 2 MW

3. 52×10^{-10} kg

$= 52 \times 10^{-10} \times 10^3$g

$= 52 \times 10^{-10+3}$g

$= 52 \times 10^{-7}$g

$= 5.2 \times 10^{+1} \times 10^{-7}$ g

$= 5.2 \times 10^{-6}$ g $\quad \therefore 10^{-6}$ g = 1μg

= 5.2 μ g

4. 225×10^{-8} s

$= 225 \times 10^{-8}$ s

$= 225 \times 10^{-6} \times 10^{-2}$ s

$= 2.25 \times 10^2 \times 10^{-6} \times 10^{-2}$ s

$= 2.25 \times 10^{-6}$ s $\quad \therefore 10^{-6}$ s = 1μs

= 2.25 μs

P.1.3: Relation of micro, nano and pico.

$\mu = 10^{-6}$

$n = 10^{-9}$

$p = 10^{-12}$

Relation of micro and nano

$10^{-6} = 10^{-9} \times 10^{+3}$

1 μ = 1000 n

Relation of μ and p

$10^{-6} = 10^{-12} \times 10^{+6}$

1 μ = 1000 000 p

Relation of n and p

$10^{-9} = 10^3 \times 10^{-12}$

1n = 1000 p

P.1.4: Your hair grow at the rate of 1 mm per day. Find their growth rate in nms^{-1}.

Given Data:

Growth rate = $\frac{1\ mm}{day}$

To convert $\frac{mm}{day}$ into ms^{-1}

Required:

Hair growth rate in nms^{-1}=?

Solution:

P. 1.2: Rewrite in standard form.

a. 1168×10^{-27}

$= 1.168 \times 10^{+3} \times 10^{-27}$

$= 1.168 \times 10^{+3-27}$

$= 1.168 \times 10^{-24}$

b. 32×10^5

$= 3.2 \times 10^5 \times 10^{+1}$

$= 3.2 \times 10^6$

c. 725×10^{-5} kg

$= 7.25 \times 10^2 \times 10^{-5}$ kg

$= 7.25 \times 10^{-3}$ kg

$= 7.25 \times 10^{-3} \times 10^3$ g = 7.25 g

d. 0.02×10^{-8}

$= 0.02 \times 10^{-8}$

$= 2.0 \times 10^{-8} \times 10^{-2}$

$= 2.0 \times 10^{-10}$

P.1.5: Write the following quantities in standard form

a. 6400 km

= 6400 km

$= 6.400 \times 10^3$ km

$= 6.4 \times 10^3$ km

$= 6.4 \times 10^3$ km

b. 380 000 km

$= 3.8 \times 100000$ km

$= 3.8 \times 10^5$ km

c. 300 000 000 ms^{-1}

$= 3 \times 10^{+8}$ ms^{-1}

d. Seconds in a day

$= 24 \times 60 \times 60$

= 86400 sec

$= 8.64 \times 10^4$ sec

P.1.6: On closing the jaws of a Vernier Callipers, zero of the vernier scale is on the right to its main scale such that 4th division of its vernier scale coincides with one of the main scale division. Find its zero error and zero correction.

Solution:

Vernier division coinciding with main scale = 4 div.

Vernier scale reading = 4 × 0.01 cm = + 0.04 cm

Since zero of the vernier scale is on the right side of the zero of the main scale, thus the instrument has measured more than the actual reading. It is said to

Growth rate = $\frac{1\ mm}{day}$

Growth rate = $\frac{1 \times 10^{-3}}{86400}$ ms^{-1}

Growth rate = $1.157 \times 10^{-8}\ ms^{-1}$

Growth rate = $11.57 \times 10^{-1} \times 10^{-8}\ ms^{-1}$

Growth rate = $11.57 \times 10^{-9}\ ms^{-1}$

Growth rate = $11.57\ nms^{-1}$

P.1.7: A screw Gauge has 50 divisions on the circular scale. The pitch of the screw gauge is 0.5 mm. What is its least count?

Given Data:

Divisions = 50 divisions

Pitch of screw gauge = 0.5 mm

Required:

Least count of screw gauge = L.C. =?

Solution:

we know that

Least count = $\frac{\text{Pitch}}{\text{No.of divs. on circular scale}}$

Thus Least count = $\frac{0.5\ mm}{50}$

= 0.01mm

= $0.01 \times \frac{1}{10}$ cm

Least Count = 0.001cm

P.1.9: What are the significant figures in the following measurement?

a. 1.009 m = 4 significant figure

b. 0.00 450 kg = 3 significant figure

c. 1.66 × 10^{-27} kg = 3 significant figure

d. 2001 s = 4 significant figure

be positive zero error.

Zero correction is the negative of zero error. Thus

Zero error = + 0.04 cm

And Zero Correction = – 0.04 cm

P.1.8: Which of the following quantities have three significant figures?

a. 3.0066 m **b.** 0.00309 kg **c.** 5.05 ×10^{-27} kg **d.** 301.0 s

Solution:

a. 3.0066 m

Zeros between significant digits are significant. Therefore, there are 5 significant figures in 3.0066 m.

b. 0.00309 kg

Zeros used for spacing the decimal point are not significant. Therefore, there are 3 significant figures in 0.00309 kg.

c. 5.05 ×10^{-27} kg

Only the digits before the exponent are considered, thus there are 3 significant figures.

d. 301.0 s

Final zeros or zeros after the decimal are significant. Therefore, there are 4 significant figures.

P.1.10: A chocolate wrapper is 6.7 cm long and 5.4 cm wide. Calculate its area upto reasonable number of significant figures.

Given Data:

Length of chocolate wrapper = l =6.7 cm

Width of chocolate wrapper = W= 5.4 cm

Required:

Area A=?

Solution:

we know that

Area = Length × Width **Or**

A = $l \times W$

Putting the values, we get

A = 6.7 cm × 5.4 cm

= 36.18 cm^2

A = 36 cm^2

SHORT QUESTION

1. What is difference between base quantities and derived quantities also give examples?

Base Quantities	Derived Quantities
The quantities on the base of which other quantities are expressed are called base quantities. **Examples:** There are seven base quantities which are as follows: Length, mass, time, electric current, intensity of light, temperature, amount of substance.	The quantities that are expressed in term of base quantities are called derived quantities. **Examples:** Work, energy, power, speed, electric potential, area and volume.

2. Pick out the base units in the following: Joule, Newton, kilogramme, hertz, mole ampere, metre, kelvin, coulomb and watt.

Ans: Base Units:

kilogramme, mole, ampere, metre, kelvin.

3. Find the base quantities involved in each of the following derived quantities

(a) speed (b) volume (c) force (d) work

Ans:

(a) Speed: $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ **(b)Volume:** Volume = Length × Width × Height

(c) Force: Force = Mass × Acceleration **(d) Work:** Work = Force × Distance

4. Estimate your age in seconds.

Let suppose your age is 13 years

Age in years = 13 years

Age in days = 13 × 365

= 4745 days

We know that there are 86400 seconds in one day

Seconds in a day = 24 × 60 × 60

= 86400 sec

Age in seconds = 4745 × 86400

= 409968000 sec

5. What role SI unit has play in the development of science?

Ans: The SI units are internationally acceptable units. They are very helpful to exchange scientific and technical information. They have brought consistency and uniformity in measurements and calculations by different scientist in different part of the world.

6. What is meant by vernier constant? OR Least count of vernier callipers.

Ans: The vernier constant is defined as the difference between one main scale division and one vernier scale division.

Formula:

L.C = 1 main scale div. - one vernier scale div.

L.C = 1 mm - 0.9 mm

L.C = 0.1 mm

7. What do you understand by zero error of measuring instrument?

Ans: Zero error means the minimum error found in a measuring instrument.

8. Why is the use of zero error necessary in a measuring instrument?

Ans: We use zero error in an instrument to get accurate reading.

9. Define stop watch. What is L.C of mechanical stopwatch?

Ans: The instrument used to calculate the time interval of an event is called stop watch. L.C of mechanical stopwatch = 0.1 second.

10. Why do we need to measure extremely small interval of times?

Ans: In physics most of the physical quantities are related to time like speed, velocity, acceleration etc. So to measure a quantity with great precision we need to measure extremly small interval of time.

11. What is meant by significant figures of a measurement?

Ans: In any measurement all accurately known digits and first doubtful digit are called significant figures.

12. How is precision related to the significant figures in a measured quantity?

Ans: More significant figures mean greater precision. For example two students measure the length of a book 18.42 cm and 18.425 cm respectively with a vernier calliper and screw gauge respectively. The measurement 18.425 cm is more precision because it has greater significant figures.

13. What is Andromeda?

Ans: Andromeda is one of the billions of galaxies nearest to our milky way galaxy.

14. Why do we study physics?

Ans: Laws and principles of physics help us to understand nature. Rapid progress in science during recent years is due to discoveries and inventions in physics.

15. What are physical quantities?

Ans: All measureable quantities are called physical quantities. For example mass, length and temperature.

16. Give characteristics of physical quantities.

Ans: There are two characteristics of physical quantities.

- A physical quantities have magnitude
- A physical quantities have a suitable unit in which it is measured

17. Define physics.

Ans: Branch of science which deals with matter , energy and their mutual relationship. There are many branches of physics.

18. Enlist the main branches of physics.

Ans:

(i) Mechanics	(ii) Heat & thermodynamics	(iii) Atomic physics
(iv) Nuclear physics	(v) Plasma physics	(vi) Light
(vii) Sound	(viii) Geophysics	(ix) Electricity and magnetism

19. Define mechanics.

Ans: It is the study of motion of objects its causes and effects.

20. Define heat.

Ans: Branch of physics which deals with the nature of heat, modes of transfer and effects of heat.

21. Define sound.

Ans: The branch of physics which deals with the physical aspects of sound waves, their production, properties and applications.

22. Define optics/light.

Ans: The branch of physics which deals with the study of physical aspect of light. Its properties, working and use of optical instruments.

23. Define electricity and magnetism.

Ans: The branch of physics which deals with the study of charges at rest and in motion, their effects and their relationship with magnetism.

24. Define atomic physics.

Ans: The branch of physics which deals with the study of structure and properties of atoms.

25. Define nuclear physics.

Ans: The branch of physics which deals with the properties and behaviour of nuclei and particles within the nuclei.

26. Define plasma physics.

Ans: The branch of physics which deals with the study of production, properties of the ionic state of matter, the forth state of matter.

27. Define geo physics.

Ans: The branch of physics which deals with the study of internal structure of the earth.

28. What are prefixes? Also give examples.

Ans: There are some numbers which are very large or small. To write them using some suitable multiples or submultiples is called prefixes. **OR**

Prefixes are letters or symbols used before SI unit as addition to express very large or small quantities.

Examples:

Centi (c) , milli (m), mega (M).

29. What is meant by multiple and sub multiples?

Ans: A unit can be increased or decreased by multiplying or dividing with 10 or some suitable power of 10. A positive power of 10 is called multiple and negative power of 10 is called sub multiples.

30. Write the uses of prefixes?

Ans: Some quantities are either very large or very small. Prefixes are used to express very large or very small quantities. It makes these quantities to be express and understand easily.

31. Name five prefixes most commonly used.

Ans: There are prefixes most commonly used centi (c), milli (m), kilo (k), mega (M), giga (G), micro (μ).

32. Name the two scales of vernier calliper.

Ans: There are two scales in vernier callipers.

(i) Main scale (ii) Vernier scale

33. What is screw gauge, why is it used?

Ans: A screw gauge is an instrument used to measure small lengths with accuracy greater than a vernier callipers it is also called micrometer screw gauge.

34. What is meant by pitch of screw gauge give its value.

Ans: The distance between two consecutive threads on a spindle of a screw gauge is called pitch. Its value is 1mm.

35. Define physical balance.

Ans: A physical balance is used in laboratory to measure the mass of various objects by comparison. Its least count is 10 mg.

36. Convert 0.000097 in scientific notation.

Ans: $0.000097 = 9.7 \times 10^{-5}$

37. Write 0.0030m by using suitable prefixes.

Ans:

$= 0.0030$ m

$= 3.0 \times 10^{-3}$ m

$\therefore 10^{-3}$= mili (m)
= 3.0 mm

38. What do you mean by unit and system of unit?

Ans:

Unit: A standard quantity needed for measuring unknown quantities is known as unit.

System of units: A set of base and derived units is called system of units.

39. What is international system of units?

Ans: The worldwide acceptable system of measurements is called international system of units. It was adopted in the 11^{th} General Conference on weight and measures held in Paris in 1960.

40. What is importance of physics in our daily life?

Ans: The rapid progress in science during the recent years has become possible due to discoveries and inventions in the field of physics. For example, A car is made on the principles of mechanics and refrigerator is based on the principle of thermodynamics. Similarly, the means of communication such as radio, TV, Telephone, Computer are result of application of physics.

41. What are the advantages of vernier calliper over meter rule?

Ans: Vernier calliper can measure up to 0.1mm i.e. up to one tenth of millimeter whereas meter rule can measure up to 1mm.

42. What is the function of balancing screws in a physical balance?

Ans: Balancing screw are used to equalize the pans when the balance is empty.

43. How numbers do are rounded off?

Ans: There are some rules to round of the numbers.

(i) If the last digit is less than 5, then it is simply dropped. For example 1.943 is rounded to 1.94.

(ii) If the last digit is greater than 5, then the digit on its left side is increased by one. For example 1.47 is rounded to 1.5.

(iii) If the last digit is 5, then it is rounded to nearest even number. For example 1.35 is rounded to 1.4.

44. What is meant by scientific notation? Give example.

Ans: A way of writing numbers by using the power of ten or prefixes and there is only one non-zero digit before the decimal is called scientific notation. For example, a number 62750 can be expressed as 6.275×10^4, similarly, the standard form of 0.000450 s is 4.5×10^{-4} s.

45. What is the difference between Biological sciences and Physical sciences?

Biological Sciences:	Physical Sciences:
The branch of natural philosophy in which we study about living things is called biological sciences.	The branch of natural philosophy in which we study about non-living things is called physical sciences.

46. Show that $1mL = 1cm^3$.

Ans: we know that

47. Express $1m^3$ in litres.

Ans: we know that

$1\ L = 1000\ cm^3$ $\qquad \therefore 1c = 10^{-2}$

$1\ L = 1000(10^{-2})^3 m^3$

$1\ L = 1000 \times 10^{-6} m^3$

$1\ L = 10^{-3} m^3$

$1L = 1000\ mL$

$1L = 10^3\ mL$ $\therefore 1\ dm = 10\ mL$

$1L = (1\ dm)^3$ $1\ dm^3 = 10^3 mL$

$1L = (10\ cm)^3$

$1L = 10^3\ cm^3$

multiply both sides by 10^{-3}

$1\times 10^{-3} L = 10^{-3}\times 10^3 cm^3$

$1\ mL = 1\ cm^3$ $\therefore 10^{-3} = 1\ m$

Multiply both sides by 10^3

$1\times 10^3 L = 10^3\times 10^{-3} m^3$

$1000\ L = 1\ m^3$

$1\ m^3 = 1000\ L$

48. Identify following as base or derived quantity.
Density, force, mass, speed, time, volume, temperature, length

Ans: Identifies are following:

Base Quantities	Derived Quantites
Mass	Density
Time	Force
Length	Speed
Temperature	Volume

49. Sun is one hundred and fifty million kilometre away from earth write this in
(i) As an ordinary whole number(ii) In scientific notation

Ans: 1) As an ordinary whole number:
150,000,000 km

2) 150,000,000 km = $1.5\times 10^8\ km$

50. Write the following in scientific notation.

Ans: 1) 3,000,000,000 $ms^{-1} = 3\times 10^9\ ms^{-1}$ 2) 6,400,000 m = $6.4\times 10^6\ m$

3) 0.000,000,0016 g = 1.6×10^{-9} g 4) 0.000,0548 s = $5.48\times 10^{-5} s$

51. What is Hubble space telescope?

Ans: Hubble space telescope orbits around earth. It provided information about astronomic (stars, planets and galaxies).

52. What is least count of digital vernier callipers.

Ans. Digital vernier callipers has greater precision than mechanical vernier callipers. Least count of digital vernier callipers is 0.01 mm.

53. Which one of following two instruments is more precise and why? Vernier Callipers and screw guage.

Ans: Least count of vernier callipers is 0.1 mm or 0.01 cm, and L.C of screw guage is 0.01 mm (0.001 cm). So, screw guage is more precise than vernier callipers because screw gauge can take small reading more accurately.

54. Write the name of laboratory safety equipments.

Ans: The laboratory safety equipments are following.

(i) Waste-disposal basket
(ii) Fire extinguisher
(iii) Fire alarm
iv) First Aid box
(v) Sand and water buckets
(vi) Fire blanket to put off fire.

55. Define least count of screw gauge.

Ans: Least count of screw gauge can also be found by dividing pitch of screw gauge on number of divisions on circular scale i.e 0.01 mm or 0.001 cm.

56. Differentiate between base units and derived units.

Ans:

Base units: The units that describe base quantities are called base units e.g kg.	**Derived units:** Units used to measure derived quantities are called derived units. e.g N.

57. Why a screw gauge measures more accurately than a vernier callipers?

Ans: Because least count of screw gauge is 0.01 mm and divide 1 mm into 100 equal parts. But least count of vernier calipers is 0.1 mm. and 1 mm divide into 10 equal parts.

58. Write down two rules to find the significant digits in measurement.

Ans: Rules to find significant digits are following:

(i) Non-zero digits are always significant.

(ii) Zero between significant figures are always significant.

59. Write scientific notations. (i) 100.8 s (ii) 0.00580 km

Ans: (i) 100.8 s

$= 1.008 \times 10^{2}$ s

(ii) 0.00580 km

$= 5.8 \times 10^{-3}$ km

60. Define least count and write meter rod's least count.

Ans: Smallest measurement hat can be taken by an instrument is called least count of that instrument.

Least Count:

The least count of meter rod is 1 mm.

61. What are the disadvantages of scientific inventions?

Ans: **Disadvantages**: The scientific inventions have also caused harms and destruction environemtnal pollution and other is deadly weapons.

62. Write in standard form 384000000m and 0.000458s.

Ans: 384000000m

$= 3.84 \times 10^{8}$m

0.000458 sec

$= 4.5 \times 10^{-4}$s

MULTIPLE CHOICE QUESTION

1. The number of base unit in SI are:
(a) 3 (b) 6 (c) 9 (d) 7

2. Which one of the following unit is not a derived unit?
(a) pascal (b) kg (c) N (d) watt

3. Amount of a substance in terms of numbers is measured in:
(a) mole (b) gram (c) newton (d) kilogram

4. An interval of 200 μ sec is equivalent to:
(a) 0.2 sec (b) 0.02 sec (c) 2×10^{-4} sec (d) 2×10^{-6} sec

5. Which one of the following is smallest quantity?
(a) 0.01 g (b) 2 mg (c) 100 mg (d) 5000 ng

6. Which instrument is most suitable for measuring internal diameter of a test tube?
(a) meter rule (b) vernier calliper (c) measuring tap (d) screw Gauge

7. A student claim the diameter of a wire as 1.032 cm using vernier callipers up to what extent do you agree write it:
(a) 1cm (b) 1.0 cm (c) 1.03 cm (d) 1.032 cm

8. A measuring cylinder is used to measure…………… of liquid:
(a) mass (b) volume (c) area (d) level of liquid

9. A student noted the thickness of glass sheet using a screw gauge on the main scale, it reads 3 div while 8th division of the circular scale coincides with index line. Its thickness is:
(a) 3.8 cm (b) 3.08mm (c) 3.8mm (d) 3.08m

10. Significant figures in an expression are:
(a) all digits
(b) all accurately known digits
(c) all accurately known digit and the first doubtful digit
(d) all the accurately known digits and all the doubtful digits

11. ……………….. is a derived quantity.
(a) work (b) intensity of light (c) mass (d) length

12. 0.0002g is written in prefixes:
(a) 0.2mg (b) 200 μ g (c) 0.002mg (d) a and b both

13. 19735 m is written in scientific notation as:
(a) 1.9735×10^4m (b) 19.735×10^5m (c) 1.9735×10^6m (d) all

14. L.C of vernier callipers is:
(a) 0.01cm (b) 0.001mm (c) a and b (d) None

15 L.C of screw gauge is:
(a) 0.001cm (b) 0.01cm (c) 0.1cm (d) 1mm

16. 1.47 is rounded to two significant digits:
(a) 1.5 (b) 1.4 (c) 1.7 (d) all of these

17. L.C of mechanical stopwatch is:
(a) 0.01s (b) 0.1s (c) 1s (d) 10 s

18. L.C of digital stopwatch is:
(a) 0.1 min (b) 0.1sec (c) 0.01sec (d) 10 sec

19. Kilogram is a ……………. Unit:
(a) base (b) physical (c) derived (d) a and b both

20. Least count of physical balance is:
(a) 10 mg (b)100 mg (c) 1 mg (d) 1000 mg

21. Least count of electronic balance is:
(a) 10 mg (b) 100 mg (c)1 mg (d) 1000 mg

22. 1.35 is rounded off as in two digits:
(a) 1.4 (b) 1.3 (c) both right (d) none

23. 1.65 is rounded off as in 2 digits
(a) 1.6 (b) 1.7 (c) 1.8 (d) none

24. Which one is the base quantity?
(a) speed (b) area (c) force (d) distance

25. Refrigerator is application of:
(a) nuclear physics (b) thermodynamics
(c) mechanics (d) kinematics

26. One giga gram is equal to:
(a) 10^9g (b) 10^6g (c) 10^3g (d) 10^{-6}g

27. Weight is measured by:
(a) spring balance (b) mass (c) beam balance (d) lever balance

28. Base unit is:
(a) watt (b) Newton (c) kilogramme (d) Pascal

29. The study of internal structure of earth is _____ physics.
(a) nuclear (b) atomic (c) plasma (d) geo

30. Volume of 1 litre is equal to:
(a) 1 cm^3 (b) 10 cm^3 (c) 10 cm^2 (d) 1000 cm^3

31. Least count of metre rod is:
(a) 0.1 mm (b) 0.001 mm (c) 1 mm (d) 0.01 mm

32. Length of meter rod is.
(a) 1meter (b) 0.5meter (c) 2 meter (d) Non

MCQ's Key

1	d	6	b	11	a	16	a	21	c	26	a	31	c
2	b	7	c	12	d	17	b	22	a	27	a	32	a
3	a	8	b	13	a	18	c	23	a	28	c		
4	c	9	b	14	a	19	a	24	d	29	d		
5	d	10	c	15	a	20	a	25	b	30	d		