UNIT 01

PHYSICAL QUANTITIES AND MEASUREMENT

Introduction

In this chapter we will learn about the measurement of length, mass, time and volume in daily life activities by using various measuring instruments and brief description about the various branches of physics.

Q1. Define science.

091301001

Ans. *"The knowledge gained through observations and experimentations is called Science."*

The word science is derived from the Latin word **"Scientia"** which means knowledge. *"Various aspects of material objects were studied under a single subject* called **natural philosophy"**. But as the knowledge increased, it was divided into two main streams; **Physical sciences** *which deal with the study of non-living things* and **Biological sciences** *which are concerned with the study of living things.*

Q2. Define physics and explain its branches.

091301002

Ans. *"The branch of science which deals with the study of matter, energy and their interaction."* The laws and principles of Physics help us to understand the nature.

BRANCHES OF PHYSICS

i. **Mechanics** **(F.B. 2016)**

It is the study of motion of objects, its causes and effects, which influence motion.

ii. **Heat**

It deals with the nature of heat, modes of transfer and effects of heat.

iii. **Sound** → Sound always produces by vibrating body

It deals with the physical aspects of sound waves, their production, properties and applications.

iv. **Light (Optics)**

It is the study of physical aspects of light, its properties, working and use of optical instruments.

v. **Electricity and Magnetism**

It is the study of the charges at rest and in motion, their effects and their relationship with magnetism.

vi. **Atomic Physics** **(F.B. 2018)**

It is the study of the structure and properties of atoms.

vii. **Plasma Physics**

It is the study of production, properties of the ionic state of matter – the fourth state of matter.

viii. **Geophysics** **(F.B. 2016)**

It is the study of the internal structure of the Earth.

ix. **Nuclear Physics** **(F.B. 2018)**

It deals with the properties and behaviour of nuclei and the particles within the nuclei.

Q3. Write the importance of physics in our daily life.

091301003

(OR) Describe the role of Physics in Science and Technology.

Ans. The rapid progress in science during the recent years has become possible due to the 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.

Development in the field of Physics has changed the outlook of mankind. Computer network connection made easy to contact with one another. In our daily life, we hardly find a device where physics is not involved.

A Car is made on the principle of mechanics.

A refrigerator is based on the principles of thermodynamics.

The pulleys that make easy to lift heavy loads.

Electricity is used not only to get light and heat but also mechanical energy that drives fans and electric motors etc.

The means of transportation Such as car and aeroplanes all work on the basic principle of physics.

Domestic appliances Such as air-conditioners, refrigerators, vacuum cleaners, washing machines and microwave ovens etc. All these appliances work on the basic principles of Physics.

The means of communication Such as radio, TV, telephone and computer are the result of applications of Physics. These devices have made our lives much easier, faster and more comfortable than the past.
A mobile phone allows us to contact people anywhere in the world and to get latest world wide information. We can take and save pictures, sent and receive messages of our friends. We can also receive radio transmission and can also use it as a calculator as well. All these are the fruits by the hard work of physicists.

Q4. What is the harmful effect of scientific invention on environment? 091301004

Ans. The scientific inventions have also caused harms and destruction of serious nature. One of which is the environmental pollution and the other is the deadly weapons.

Q5. Define physical quantities. Also write its types. (OR) What is difference between base and derived quantities? 091301005

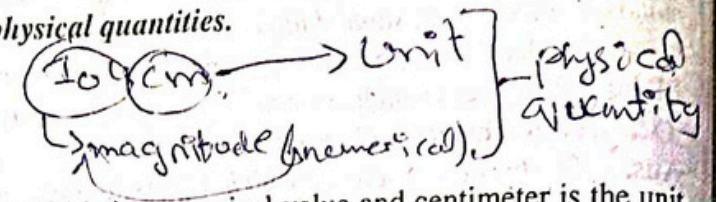
Ans. Physical Quantities;

Those quantities which can be measured are called ***physical quantities.***

For example: length, mass, time and temperature etc.

A physical quantity possesses at least two characteristics.

(i) Its numerical value
(ii) Unit in which it is measured.



For example, if the length of a student is 104 cm then 104 is its numerical value and centimeter is the unit of measurement. Physical quantities are divided into two quantities

i. BASE QUANTITIES

"There are seven physical quantities which form the foundation of other physical quantities. These physical quantities are called the base quantities".

For example: length, mass, time, electric current, temperature, intensity of light and the amount of a substance.

ii. DERIVED QUANTITIES

"Those physical quantities which are expressed in terms of base quantities are called the derived quantities".

For example: area, volume, speed, force, work, energy, power, electric charge, electric potential, etc.

Q6. What is International system of units?
(OR) What role SI Units have played in the development of Science? 091301006

Ans. With the development in the field of science and technology, the need for a commonly acceptable system of units was seriously felt all over the world particularly to exchange scientific and technical information. The eleventh General Conference on Weight and Measures was held in Paris in 1960 adopted a world-wide system of measurements called **International System of Units.** The International System of Units is commonly named as **SI.**

Q7. What are base units and derived units?
(OR) What is the difference between base and derived Units? 091301007

Ans. i. BASE UNITS

The units that describe base quantities are called base units. Each base quantity has its SI unit.

Example:
Unit of length is metre.
Unit of mass is kilogram.

Base quantities, their SI units with symbols

Quantity		Unit	
	Symbol	Name	Symbol
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 a substance	n	Mole	mol

ii. DERIVED UNITS

"The units used to measure derived quantities are called derived units".

These are derived in terms of base units and are obtained by multiplying or dividing one or more base units with each other.

Examples: (1) 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. (2) Speed is defined as distance covered in unit time; therefore its unit is metre per second. Some derived units and their symbols are given below

Derived quantities, their SI units with symbols			
Quantity		**Unit**	
Name	**Symbol**	**Name**	**Symbol**
Speed	v	metre per sec.	ms^{-1}
Acceleration	a	metre per sec per second.	ms^{-2}
Volume	*V*	cubic metre	m^3
Pressure	*P*	Pascal	Pa or ($N\ m^{-2}$)
Density	ρ	kg per cubic metre	$Kg\ m^{-3}$
Charge	*Q*	Coulomb	C or (As)

Q8. Define prefixes and give example. **(F.B. 2014)** **091301008**

Ans. Prefixes: *"The words or letters added before SI units and stand for multiples and sub multiples of that unit are known as prefixes".* For example kilo, mega, giga etc. The prefixes are useful to express very large or small quantities.

For example: Divide 20,000 g by 1000 to express it into kilogramme, since kilo represents 10^3 or 1000.

Thus $20{,}000\ g = \frac{20{,}000}{1000} kg = 20kg$ Or $20{,}000\ g = 20 \times 10^3 g = 20kg$

Let few more examples are:

(i) $200000\ ms^{-1} = 200\times10^3\ ms^{-1} = 200\ kms^{-1}$

(ii) $4800000\ W = 4800\times10^3\ W = 4800\ kW$
$= 4.8\times10^6\ W = 4.8\ MW$

(iii) $3300000000\ Hz = 3300\times10^6\ Hz = 3300\ MHz$
$= 3.3\times10^3\ MHz = 3.3\ GHz$

(iv) $0.00002\ g = 0.02\times10^{-3}\ g = 20\times10^{-6} g$
$= 20\mu g$

(v) $0.0000000081 m = 0.0081\times10^{-6}\ m = 8.1\times10^{-9} m$
$= 8.1 nm$

Double prefixes are not used. For example, no prefix is used with kilogramme since it already contains the prefix kilo.

Some Prefixes

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}

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

091301009

Q9. Define Scientific Notation and give examples.

Ans. Scientific Notation: *"In scientific notation a number is expressed as some power of ten multiplied by a number between 1 and 10".*

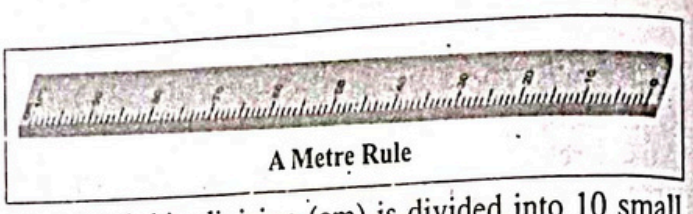
For example, a number 62750 can be expressed as 6.275×10^{4} preferably be taken as the standard form. In standard form or scientific notation, a number has only one non-zero digit before the decimal. Similarly the standard form of 0.00045 s is 4.5×10^{-4}s.

Q10. What are measuring instruments? Explain metre rule and measuring tape. 091301010

Ans. Measuring instruments are used to measure various physical quantities such as length, mass, time, volume, etc.

THE METRE RULE

"A metre rule is a length measuring instrument as shown in figure. It is commonly used in the daily life to measure length of an object or distance between two points". Least count of metre rule is 0.1 cm (or) 1mm



A Metre Rule

Construction: It is one metre long and have100 centimetres. Each big division (cm) is divided into 10 small divisions called millimetre (mm). One millimetre is the smallest reading that can be taken by using a metre rule and is called its **least count**.

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

i. THE MEASURING TAPE

"Measuring tapes are used to measure length in metres and centimetres. A measuring tape is used by blacksmith and carpenters".

Construction: A measuring tape consists of a thin and long strip of cotton, metal or plastic generally 10 m, 20 m, 50 m or 100 m long. Measuring tapes are marked in centimetres as well as in inches. At least count is equal to 0.1cm (or) 1mm.

Q11. What is meant by vernier callipers? Write its construction and working. 091301011

Ans. Vernier Callipers: "An instrument used to measure small lengths such as internal (or) external diameter or length of a cylinder is called Vernier Callipers".

The accuracy obtained in measurements using a metre rule is upto 1 mm. However an accuracy greater than 1 mm can be obtained by using some instrument called vernier callipers.

"It is an instrument which is used to measure the 10^{th} part of mm".

Construction

A Vernier Callipers consists of two jaws. One is a fixed jaw with main scale. It has marks centimetre and millimetre. The other jaw is a moveable jaw. It has vernier scale having 10 divisions over it and each of its division is 0.9 mm.

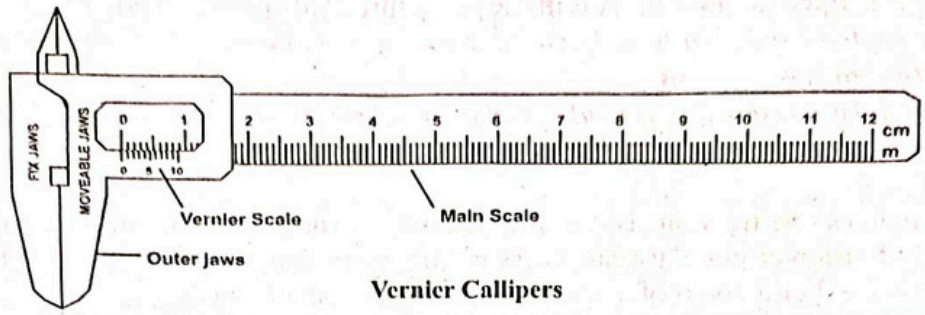
Vernier Constant:

The difference between one small division on main scale division and one vernier scale division is 0.1 mm is vernier constant or ***Least count (LC) of the Vernier Callipers.*** Least count of the Vernier Callipers can also be found as given below:

$$\text{Least count of vernier callipers} = \frac{\text{smallest reading on main scale}}{\text{no. of divisions on vernier scale}}$$

$$= \frac{1\,\text{mm}}{10} = 0.1\,\text{mm}$$

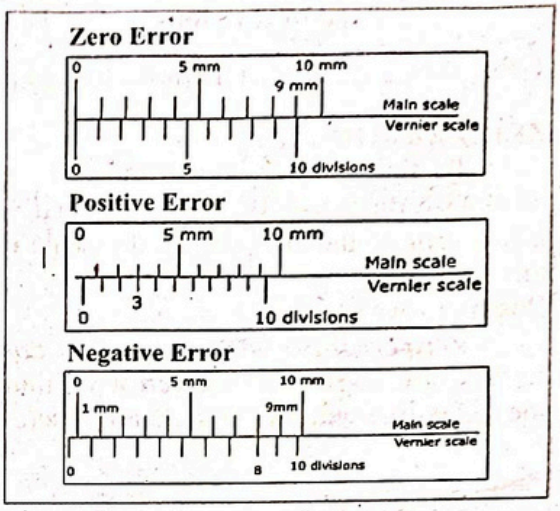
Hence $L.C = 0.1$ mm $= 0.01$ cm



Vernier Callipers

Working:

First of all, find the zero error if any in the measuring instrument. Knowing the zero error, necessary correction can be made to find the correct measurement. Such a correction is called zero correction of the instrument. Zero correction is negative of the zero error. Then open the jaws and place solid cylinder between the jaws and note main scale and vernier scale reading. Then apply the necessary zero correction.



Zero Error

To find the zero error, close the jaws of Vernier Callipers. If zero of the vernier scale coincides with the zero of the main scale then there is no zero error in the instrument.)

Definition

Zero error will exist if zero of the vernier scale is not coinciding with the zero of main scale. There are two types of errors.

i. Positive Zero Error

Zero error will be positive if zero of vernier scale is on the right side of the zero of the main scale.

ii. Negative Zero Error

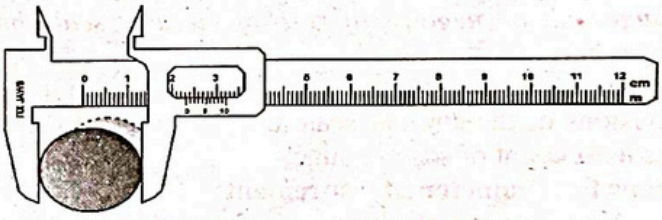
If zero line of vernier scale is on the left side of zero of the main scale then zero error will be negative.

Q12. How can we take reading on Vernier Callipers? 091301012

Ans. Taking reading on Vernier Callipers

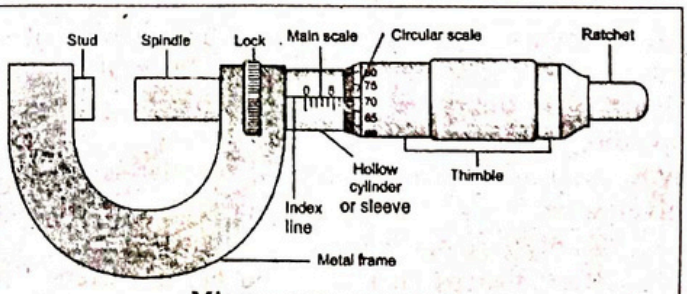
To find the diameter of a solid cylinder by using Vernier Callipers place the solid cylinder between jaws of the Vernier Callipers. Close the jaws till they press the opposite sides of the object gently.

Now, find the complete divisions of main scale before the vernier scale zero and note the 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 will be equal to the diameter of the solid cylinder. Apply zero correction, if any (Z.C), to get correct measurement.


A cylinder placed between the outer jaws of vernier callipers.

Q13. Define "SCREW GAUGE" and write its construction and working. 091301013

Ans. Screw Gauge: *"A screw gauge is an instrument that is used to measure small lengths with accuracy greater than a Vernier Callipers."* It is an instrument which is used to measure 100^{th} part of mm. It is also called as ***micrometer screw gauge***.



Micrometer 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. The hollow

cylinder acts as a nut. It is fixed at one end. A thimble has a threaded spindle inside it.

Pitch: *The thimble completes one rotation, hundred division, spindle moves 1 mm distance. This distance is called the* ***pitch of screw gauge.*** **or**

The distance between consecutive threads on the spindle is 1mm. This distance is called ***pitch of screw gauge.***

Least Count:

As thimble completes one rotation, 100 divisions pass the index line the thimble moves 1 mm along the main scale. Thus each division of circular scale crossing the index line moves the thimble through 1/100 mm or 0.01 mm on the main scale. Least count of a screw gauge can be calculated as:

$$\text{Least count} = \frac{\text{pitch of the screw gauge}}{\text{no. of divisions on circular scale}}$$

$$= \frac{1\text{mm}}{100} = 0.01 \text{ mm} = 0.001 \text{ cm}$$

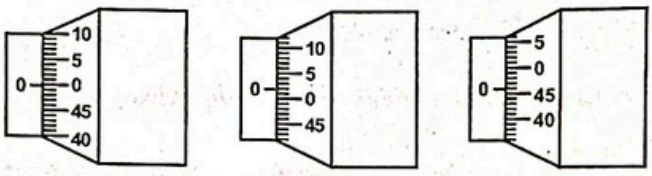
ZERO ERROR

To find the zero error, close the gap between the spindle and the stud by rotating the ratchet in the clockwise direction. If zero of circular scale coincides with the index line, then there is no zero error in the instrument. If the zero of circular scale cross or below the index line then there is zero error. In screw gauge, there are two types of error.

Positive zero error

Zero error of instrument will be positive if zero of circular scale is behind the index line.

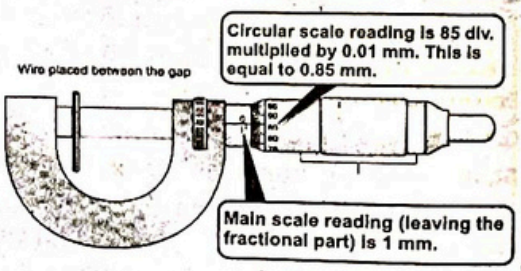
In this case, to find the zero error we multiply the number of divisions of the circular scale that has not crossed the index line with the least count of screw gauge.



Negative zero error

Zero error of screw gauge will be negative if zero of circular scale has crossed the index line.

In this case, to find the zero error we multiply the number of divisions of the circular scale that has crossed the index line with the least count of screw gauge.



Measuring the diameter of a wire using a micrometer

Steps for Diameter Measurement:

The diameter of a 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.

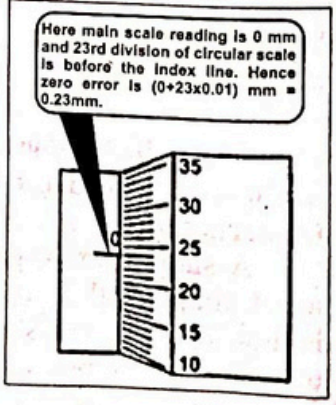
ii. Note main scale as well as circular scale readings to find zero error and hence zero correction of the screw gauge.

iii. Open the gap between stud and spindle of the screw gauge by turning the ratchet in anti-clockwise 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.

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

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

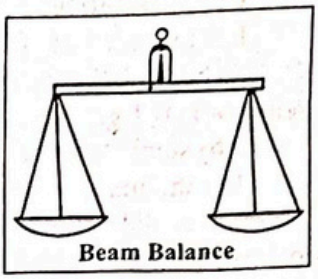
vi. Repeat steps (iii), (iv) and (v) at different places of the wire to obtain its average diameter.



Q14. What are mass measuring instruments? 091301014

Ans. *The instruments that are used to measure the mass of different objects are called mass measuring instruments.*

Pots were used to measure grain in various parts of the world in the ancient times. However, balances were also in use by Greeks and Romans such as **beam balance**. In a beam balance, the unknown mass is placed in one pan and is balanced by putting known masses in the other pan. Today we use many types of mechanical and electronic balances. Such as physical balance, lever balance, Electronic Balance etc.



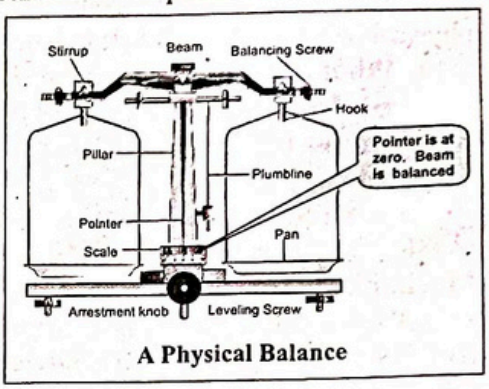
Beam Balance

Q15. What is physical balance? Write its construction and working. 091301015

Ans. Physical Balance: *"A physical balance is used in the laboratory to measure the mass of objects".*

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 and some standard masses are placed in right pans to bring the pointer at zero position.



A Physical Balance

Working:

Following steps are used to measure the mass of an object.

i. First of all adjust the leveling screws with the help of plumb line to level the platform of physical balance by placing it on horizontal surface.

ii. Raise the beam by turning the arresting knob clockwise. Balance the pans by screw level and bring the pointer at zero.

iii. Bring beam back on its support by knob. Place the given object (stone) on its left pan.

iv. Place standard masses in the right pan. Raise the beam. Lower the beam if its pointer is not at zero.

v. Repeat adding or removing standard masses in the right pan till the pointer rests at zero position.

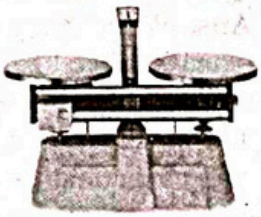
vi. Note the standard masses on the right pan. Their sum is the total mass of the object on the left pan.

Mass of Various Objects

6×10^{27}g	Mass of Earth
5.3×10^{21}g	Earth's atmosphere to 2500 km
1.4×10^{24}g	Ocean
5×10^{6}g	Elephant
7.5×10^{4}g	Average human
10^{3}g	1.0 Litre of water
3.0×10^{-4}g	Grain of Table salt
6.0×10^{-18}g	Typical protein molecule
3.98×10^{-25}g	Uranium atom
2.9×10^{-23}g	Water molecules

Q16. What is the Lever Balance? 091301016

Ans: 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.



Q17. What do you know about Electronic Balance? 091301017

Ans: Electronic Balance: Electronic balances come in various ranges, milligram ranges, gram ranges and kilogramme 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 is the most precise balance.

Q18. Show by an example which one is the most accurate balance?

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

(a) Beam Balance

Let the mass of coin be 3.2 g by using beam balance.

A beam balance is able to detect a change as small as of 0.1 g or 100 mg i.e. the least count of beam balance is 0.1 g.

(b) Physical Balance

Let the mass of coin be 3.24g by physical balance.

Since the least count of the physical balance is 0.01 g or 10 mg. Therefore, its measurement is more precise than a sensitive beam balance.

(c) Electronic Balance

Let the mass of coin be 3.247 g by electronic balance.

Least count of an electronic balance is 0.001 g or 1 mg. Therefore, its measurement is more precise than a physical balance, so electronic balance is the most sensitive balance in the above balances.

091301019

Q19. What is meant by Stopwatch? Write its types and their working.

OR How can a mechanical and digital stop watch be used?

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

Mechanical Stopwatch

Types of stop watches

There are two types of stopwatches.

i. Mechanical stopwatch **ii.** Digital stopwatch

Mechanical Stopwatch

A mechanical stopwatch can measure a time interval up to minimum 0.1 second. So its least count is 10^{th} part of a second or 0.1 sec.

A mechanical stopwatch has a knob. It is 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 Stop Watch

Digital Stopwatch

Digital stopwatch used in laboratories to measure a time interval as small as 0.01 second. So its least count is 100^{th} part of a second or 0.01s.

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 shows the time interval recorded by it between start and stop of an event. A reset button brings it to zero setting.

091301020

Q20. What is a measuring cylinder? Explain.

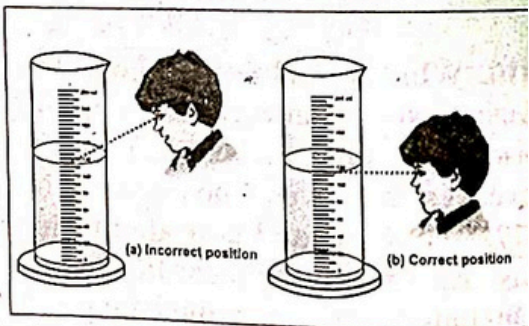
Ans. *A measuring cylinder is made of a glass or transparent plastic material. It has a scale that indicates the volume in millilitre (mL). It has different capacities from 100 mL to 2500 mL. They are used to measure the volume of a liquid or powdered substance.*

It can also be used to find the volume of an irregular shaped solid which is insoluble in a liquid by displacemen method. The solid object is lowered into a measuring cylinder containing liquid. The level of liquid rises. Th increase in the volume of liquid is the volume of the given solid object.

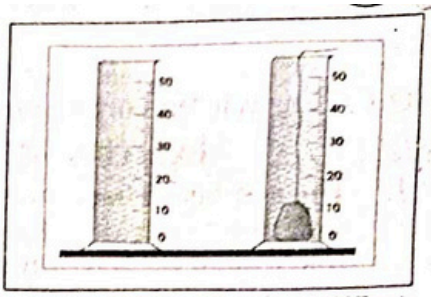
Q21. How can we use a measuring cylinder?

091301021

Ans. While using a measuring cylinder, it must be kept vertical on a plane surface. Take a measuring cylinder place it vertically on the table. Pour some water into it. The meniscus of the most liquids curve downwards while the meniscus of mercury curves upwards. The correct method to note the level of a liquid in the cylinder is to keep the eye at the same level as the meniscus of the liquid. It is incorrect to note the liquid level keeping the eye above the level of liquid level, the meniscus appears higher on the scale. Similarly when the eye is below the liquid level, the meniscus appears lower than actual height of the liquid. correct position of eye to note t liquid level keeping eye at liquid level.



Q22. How can we measure the volume of an irregular shaped solid object? 091301022



Ans. Measuring cylinder can be used to find the volume of a small irregular shaped solid that sinks in water. Suppose we want to find the volume of a small stone. Take some water in a graduated measuring cylinder. Note the volume V_i of water in the cylinder. Tie the solid with a thread and lower the solid into the cylinder till it is fully immersed in water. Note the volume V_f of water. Volume of the solid will be $V_f - V_i$.

Q23. Define Significant Figures and upon what factors does accuracy of physical quantity depend? What are the rules to find the significant figures in a measurement? (F.B. 2015) 091301023

Ans. Significant Figures *All the accurately known digits and the first doubtful digit in a measurement are called significant figures."*

It reflects the precision of a measured value of a physical quantity. The accuracy of measured physical quantity depends upon following factors

- The quality of the measuring instrument
- The experience of the observer
- The number of observations made

For example, a student measures the length of a book as 18cm by using a measuring tape. The numbers of significant figures in the measurement are two. The left digit 1 is the accurately known digit. While the digit 8 is the doubtful digit for which the student may not be sure.

Rules to find the significant digits in a measurement

i. Digits other than zero are always significant.
For Example: 27 has 2 significant digits and 275 has 3 significant digits.
ii. Zeros between significant digits are also significant.
For Example: 2705 has 4 significant digits.
iii. Final zero or zeros after decimal are significant.
For Example: 275.00 has 5 significant digits.
iv. Zeros used for spacing the decimal point are not significant. Here zeros are place holder only.
For Example: 0.03 has 1 significant digit and 0.027 has 2 significant digits.
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 value and which are actually parts of the measurement. In such a case, express the quantity using scientific notation to find the significant zero. If numbers are recorded in scientific notation then all the digits before the power of 10 are significant.
For example: In 1.50×10^6, the numbers of significant figures are three.

Q24. On closing the stud and spindle of a screw gauge, if the zero of the circular scale is behind the index line and 8^{th} division of the circular scale coincides with the index line. There are 50 divisions on the circular scale and the distance between two consecutive threads on the spindle is 0.5 mm. Find the zero error and zero correction. (F.B. 2018) 091301024

Ans: Pitch of screw gauge = 0.5 mm
Total divisions on circular scale = 50 division

$$\text{Least count of screw gauge} = \frac{\text{Pitch of screw gauge}}{\text{Total division on circular scale}}$$

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

$$L.C = 0.01\text{ mm}$$

Zero Error:

On closing the stud and spindle of screw gauge if the zero line of circular scale is behind the index line then error will be positive.

The division on circular scale coincide with index line = n = 8^{th} division.

Positive zero error = $n \times L.C$
= $8^{th} \times 0.01$ mm
Positive zero error = 0.08 mm

Zero Correction:

Zero correction is negative of zero error.
Zero correction = –0.08 mm

Multiple Choice Questions

Q.1.1 Encircle the correct answer from the given choices:

Exercise MCQs

1. The number of base units in SI are:
(a) 3 (b) 6 091301025
(c) 7 (d) 9

2. Which one of the following unit is not a derived unit? 091301026
(a) pascal (b) kilogramme
(c) newton (d) watt

3. Amount of a substance in terms of numbers is measured in: (F.B. 2015) 091301027
(a) gram (b) kilogramme
(c) newton (d) mole

4. An interval of 200 μs equivalent to: (F.B. 2015) 091301028
(a) 0.2s (b) 0.02s
(c) 2×10^{-4}s (d) 2×10^{-6}s

5. Which one of the following is the smallest quantity? 091301029
(a) 0.01g (b) 2mg
(c) 100μg (d) 5000ng

6. Which instrument is most suitable to measure the internal diameter of a test tube? (F.B. 2017) 091301030
(a) Metre rule (b) Vernier Callipers
(c) Measuring tape (d) Screw Gauge

7. A student claimed the diameter of a wire as 1.032cm using Vernier callipers. Upto what extent do you agree with it? 091301031
(a) 1 cm (b) 1.0 cm
(c) 1.03 cm (d) 1.032 cm

8. A measuring cylinder is used to measure: (F.B 2107) 091301032
(a) mass (b) area
(c) volume (d) level of liquid

9. A student noted the thickness of glass sheet using screw gauge. On the main scale it reads 3 divisions while 8^{th} division on the circular scale coincides with index line. Its thickness is. (F.B. 2017) 091301033
(a) 3.8 cm (b) 3.08 mm
(c) 3.8 mm (d) 3.08 m

10. Significant figures in an expression are:
(a) all the digits 091301034
(b) all accurately known digits
(c) all the accurately known digits and the first doubtful digit
(d) all the accurately known digits and all the doubtful digits

Additional MCQs

11. 1micro(μ)= 091301035
(a) 10^{-3} (b) 10^{-6}
(c) 10^{-12} (d) 10^{-2}

12. 1nm have meters. 091301036
(a) 10^{-3}m (b) 10^{-6} m
(c) 10^{-9}m (d) 10^{-10}m

13. In measurement 1.032 numbers of significant figure are: 091301037
(a) 1 (b) 2
(c) 3 (d) 4

14. The unit of electric current is: 091301038
(a) candela (b) metre
(c) second (d) ampere

15. Andromeda is one of the billions of galaxies of known. 091301039
(a) star (b) asteroid
(c) pole (d) universe

16. The study of the structure and properties of atom is called: 091301040
(a) Electricity (b) nuclear physics
(c) geo physics (d) atomic physics

17. The eleventh general conference was held in Paris in: 091301041
(a) 1959 (b) 1961
(c) 1660 (d) 1960

18. The unit of electric charge is. 091301042
(a) coulomb (b) ampere
(c) volt (d) joule

19. The least count of vernier callipers is: 091301043
(a) 0.01mm (b) 0.1mm
(c) 0.001mm (d) 0.01m

20. The least count of screw gauge is:
(a) .01mm (b) 0.1mm 091301044
(c) .001mm (d) .01m

21. A thimble of circular scale consists of equal division. 091301045
(a) 100 (b) 10
(c) 1000 (d) 01

22. In screw gauge if zero of circular scale is behind the index line then error is: 091301046
(a) positive (b) zero
(c) negative (d) no error

23. The number 275.00 consists of significant figures: (F.B. 2016) 091301047
(a) 3 (b) 5
(c) 4 (d) 2

24. Science is that word which is derived by Latin word: 091301048
(a) scient (b) scientis
(c) scientia (d) scincet

25. The number 0.00580 in scientific notation is: 091301049
(a) 5.80×10^{5} (b) 5.80×10^{-4}
(c) 5.80×10^{-3} (d) 5.80×10^{-2}

26. The unit of force is: 091301050
(a) newton (b) m^3
(c) ms^{-2} (d) ms^{-1}

27. The study of internal structure of Earth is called: 091301051
(a) Atomic physics (b) Plasma physics
(c) Nuclear physics (d) Geo physics

28. One cubic metre is equal to: 091301052
(a) 100litre (b) 1000 litre
(c) 10000 litre (d) $\frac{1}{1000}$ litre

29. The base quantity is: 091301053
(a) mass (b) volume
(c) torque (d) momentum

30. The smallest division that can be taken by a meter rule is: 091301054
(a) 1cm (b) 1mm
(c) 1 dm (d) 1km

31. Least count of digital vernier callipers is:
(a) 0.01cm (b) 0.01mm 091301055
(c) 0.1mm (d) 0.1cm

32. For balancing the beam balance, pointer must be at : 091301056
(a) zero (b) extreme position
(c) the right side (d) the left side

33. Least count of physical balance is: 091301057
(a) 0.001g (b) 0.01g
(c) 0.1g (d) 0.001g

34. Least count of electronic balance is: 091301058
(a) 0.001g (b) 0.01g
(c) 0.1g (d) 0.0001g

35. Least count of digital stop watch is: 091301059
(a) 0.01 sec (b) 0.1sec
(c) 1 sec (d) 10 sec

36. Mechanical stop watch can measure up to part of a second: 091301060
(a) 1 (b) $1/10^{th}$
(c) $1/100^{th}$ (d) $1/1000^{th}$

37. Meniscus of which liquid curves upward: 091301061
(a) Water (b) Honey
(c) Milk (d) Mercury

38. While rounding the numbers if last digit is 5, then: 091301062
(a) It is simply dropped
(b) The digit on its left is increased by 1
(c) It is rounded to get nearest even number.
(d) It remain same

39. The value we get after rounding 1.47 is: 091301063
(a) 1.4 (b) 1.5
(c) 1.47 (d) 1.46

40. In vernier callipers if zero line of vernier scale is on the left side of zero of the main scale then the error will be: 091301064
(a) positive (b) negative
(c) zero (d) nil error

41. 1mm = : 091301065
(a) 10^{3} m (b) 10^{-2} m
(c) 10^{-3}m (d) 10^{-6} m

42. A car is made on the principles of: 091301066
(a) Mechanics
(b) Electricity
(c) Thermodynamics
(d) Electronics

43. A refrigerator is based on the principles of: 091301067
(a) Mechanics
(b) Electricity
(c) Thermodynamics
(d) Electronics

44. In the nineteenth century, physical sciences were divided into how many distinct discipline? 091301068
(a) 4 (b) 5
(c) 6 (d) 7

45. A physical quantity possesses -characteristics:
(a) 2 (b) 3 091301069
(c) 4 (d) 5

46. The word science means: 091301070
(a) Intelligence (b) Nature
(c) Knowledge (d) Philosphy

47. The skull and crossbones is a classic warning sign,  but can you name the type of danger? 091301071
(a) General danger
(b) Flammable material
(c) Toxic or poisonous material
(d) Dangerous to eat/drink otherwise safe

48.  Symbol is used for describing hazard. Which type of hazard this symbol shows? 091301072

(a) Bio hazard
(b) Radiation hazard
(c) Electric hazard
(d) Radioactive biological hazard

49.  This symbol is often confused with a similar-looking symbol. What does it mean? 091301073

(a) Flammable, keep away from heat or flame
(b) Oxidizer
(c) Heat-sensitive explosive
(d) Fire goes here / Don't expose to sunlight

50. The warning sign used for radioactivity is:

(a)  (b)  091301074

(c)  (d) 

51. The warning sign used for flammable is:

(a)  (b)  091301075

(c)  (d) 

52. The sign used for electric hazard is:

(a)  (b)  091301075

(c)  (d) 

53. The sign used for poison is: 091301077

(a)  (b) 

(c)  (d) 

$1dm^3 = 1000cm^3$

54. The warning sign  is used for: 091301078

(a) Radioactivity (b) Poision
(c) Explosive (d) Electric hazards

55. The warning sign  represents: 091301079

(a) General danger (b) Poision
(c) Explosive (d) Electric hazards

56. What are the significant in the measurement 0.00450 kg? (F.B. 2017) 091301080

(a) 2, (b) 3
(c) 5 (d) 6

57. 1 L = _____ : (F.B. 2017) 091301081

(a) 1000 dm^3 (b) 100 dm^3
(c) 10 dm^3 (d) 1 dm^3

58. The least count of screw gauge having pitch 0.5mm and 50 divisions on its circular scale is: (F.B. 2017) 091301082

(a) 0.001 cm (b) 0.01 cm
(c) 0.0 cm (d) 1.0 cm

59. 1mm per day is equal to: (F.B. 2017) 091301083

(a) $11.57m5^{-1}$ (b) $11:57nms^{-1}$
(c) $1.57pms^{-1}$ (d) $11.57lms^{-1}$

60. 10^{-12} stands for: (F.B. 2016) 091301084

(a) Micro (b) Pico
(c) Femto (d) Nano

61. The Least Count of a measuing cylinder is: (F.B. 2018) 091301084(a)

(a) 1 m^3 (b) 0.01 mL
(c) 0.1 mL (d) 1mL

Answer Key

1.	c	2.	b	3.	d	4.	c	5.	d
6.	b	7.	c	8.	c	9.	b	10.	c
11.	b	12.	c	13.	d	14.	d	15.	d
16.	d	17.	d	18.	a	19	b	20	a
21.	a	22.	a	23.	b	24.	c	25.	c
26.	a	27.	d	28.	b	29.	a	30.	b
31.	b	32.	a	33.	b	34.	a	35.	a
36.	b	37.	d	38.	c	39.	b	40.	b
41.	c	42.	a	43.	c	44.	b	45.	a
46.	c	47.	c	48.	c	49.	a	50.	d
51.	a	52.	b	53.	c	54.	c	55.	a
56.	b	57.	d	58.	a	59.	b	60.	B
61.	d								

Q1.2 What is the difference between base quantities and derived quantities. Give three examples in each case. 091301085

Ans. Base Quantities: There are seven physical quantities which form the foundation for other physical quantities called base quantities.

Examples: Length, mass, time and temperature etc.

Derived Quantities: Those physical quantities which are expressed in terms of base quantities are called derived quantities.

Examples: Work, energy and power.

Q1.3 Pick out the base units in the following. 091301086

Ans. joule, newton, kilogramme, hertz, mole, ampere, metre, kelvin, coulomb and watt.

Base Units	Derived Units
Kilogramme	Joule
Mole	Newton
Ampere	Hertz
Meter	Coulomb
Kelvin	Watt

Q1.4. Find the base quantities involved in each of the following derived quantities: (F.B. 2013) 091301087

(a)speed (b) volume

(c)force (d) work

Ans.

(a) Speed:

It is distance covered per unit time. i.e.

$$v = \frac{\text{Distance}}{\text{Time}}$$

So, in speed, base quantities involved are length (distance) and time

(b) Volume:

Volume = Length × height × width

= Length × length × length

So, the base quantity in volume involved is length.

(c) Force:

We know that

$$F = ma = \text{mass}\ \frac{\Delta v}{\Delta t} = m \times \frac{l}{t} \times \frac{d}{t}$$

In the formula of force the base quantities mass of object, length and time are involved.

(d) Work:

We know that.

Work = F × distance

= ma × distance

$$= m\left(\frac{\Delta v}{\Delta t}\right)S \quad = m \times \frac{d}{t} \times \frac{l}{t} \times S$$

In the formula of work, base quantities mass, length (distance) and time are involved.

Q1.5 Estimate your age in seconds. 091301088

Ans. Suppose the age of Student is 15 years

Age=15 year

Age in days = 15 × 365 = 5475 days

Age in hours = 5475 × 24= 131400 hours

Age in minutes = 131400 × 60

= 7884000 minutes

Age in seconds is = 7884000 × 60

= 473040000 seconds

= 4.73040×10^8 seconds

Q1.6 What role SI units have played in the development of science? 091301089

Ans. With the development in the field of science and technology the need for commonly acceptable system of units was seriously felt all over the world particularly to exchange scientific and technical information. So, in 1960 International Bureau of Weight and Measurements were decided to introduce worldwide system of measurements that is called international system of unit and is commonly written as SI.

Q1.7 What is meant by vernier constant? 091301090

Ans. The least count of vernier callipers is also called vernier constant. It is defined as "the difference between one main scale division and one vernier scale division is called vernier constant or least count." i.e.

1 mm – 0.9 mm = 0.1 mm

Q1.8 What do you understand by the zero error of a measuring instrument? 091301091

Ans. In measuring instruments there may be systematic error, due to which a measurement may be less or greater than actual measurement. Zero error influence all the measurements equally. Zero error is caused by incorrect position of zero point.

Q1.9 Why is the use of zero error necessary in a measuring instrument? 091301092

Ans. Since zero error of instruments affect all the measurements, so it must be necessary that we have to calculate the zero error of an instrument before taking measurements. If we don't calculate the zero error then consistent difference in the reading will be calculated.

Q1.10 What is a stopwatch? What is the least count of a mechanical stopwatch you have used in the laboratories? (F.B. 2015) 091301093

Ans. A stop watch is used to measure time interval of an event. The mechanical stop watch has least count 0.1 second.

Q1.11 Why do we need to measure extremely small interval of time? 091301094

Ans. In most of experiments and in scientific calculations, time is recorded for very short intervals. So, we need to measure small interval of time.

Q1.12 What is meant by significant figures of a measurement? 091301095

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

Q1.13 How is precision related to the significant figures in a measured quantity? 091301096

Ans. In any measurement, greater the number of significant figures, greater is precision. An improvement in the quality of measurement by using better instrument increases the significant figures in the measured result. The significant figures are all the digits that are known accurately and the one estimated digit. More significant figures means greater precision. e.g. measurements taken by screw gauge is more precise than vernier callipers and meter rule.

Additional Answer Questions

Q14. What do you know about Andromeda? 091301097

Ans. Andromeda is one of the billions of galaxies of known universe.

Q15. Change 16 years age into seconds. 091301098

Ans. Suppose the age is 16 year

Age=16 years

Age in days $=16\times 365 = 5840$ days

Age in hours $= 5840 \times 24 = 140160$ hours

Age in minutes $=140160 \times 60$

$= 8409600$ minutes

Age in seconds $= 8409600 \times 60$

$= 504576000$ seconds

$= 5.0457 \times 10^8$ seconds

Q16. Define physics. 091301099

Ans. The branch of science which deals with the study of matter, energy and their interaction. The laws and principles of physics help us to understand nature.

Q17. What is meant by zero error and zero correction of vernier callipers? 091301100

Ans. Zero error

Zero error will exist if zero of the vernier scale is not coinciding with the zero of main scale. There are two types of errors.

i. Positive Zero Error

Zero error will be positive if zero of vernier scale is on the right side of the zero of the main scale.

ii. Negative Zero Error

If zero line of vernier scale is on the left side of zero of the main scale then zero error will be negative.

Zero Correction

(i) To correct the positive zero error subtract the value of error from final answer

(ii) To correct negative zero error add the value of error into the final answer.

Q18. Define metre rule. 091301101

Ans. "A metre rule is a length measuring instrument. It is commonly used in the daily life to measure length of an object or distance between two points".

It is one metre long which is equal to 100 centimetres. Each centimeter (cm) is divided into 10 small divisions called (millimeter (mm). Thus one milimetre is the smallest reading that can be taken using a metre rule and is called its least count.

Q19. Define measuring tape. 091301102

Ans. "Measuring tapes are used to measure length in metres and centimetres. A measuring tape is used by blacksmith and carpenters". A measuring tape consists of a thin and long strip of cotton, metal or plastic generally 10 m, 20 m, 50 m or 100 m long. Measuring tapes are marked in centimeters as well as in inches.

Q20. Define vernier callipers. 091301103

Ans. "It is an instrument which is used to measure the 10^{th} part of mm" Least count of the Vernier Callipers is 0.1 mm or 0.01 cm.

Q21. Define screw gauge. Write its Least Count. 091301104

Ans. "A screw gauge is an instrument that is used to measure small lengths with accuracy greater than a Vernier Callipers". It is used to measure the 100^{th}

part of one millimetre least count of screw gauge 0.01mm or 0.001cm.

Q22. Define physical balance. 091301105

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

Q23. Define measuring cylinder. 091301106

Ans. A measuring cylinder is made of a glass or transparent plastic material. It is used to measure volume of a liquid or powdered substance. It has a scale that indicates the volume in millilitre (mL). It has different capacities from 100 mL to 2500 mL.

Q24. What is meant by international system of units (SI)? 091301107

Ans. In 1960 international Bureau of weight and measures decided to introduce worldwide system of measurements that is called international system of unit and is commonly written as SI.

Q25. Name the telescope which orbits around the Earth? 091301108

Ans. Hubble space telescope orbits around the Earth. It provides information about stars.

Q26. What do you know about digital vernier callipers? 091301109

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

Q27. How precision of a balance varies in measuring mass of an object with different balances? 091301110

Ans. The precision of a balance varies in measuring mass of an object is different for different balances. A sensitive balance cannot measure large masses. Similarly a balance that measures large masses cannot be sensitive.

Some digital balances measure even smaller differences of the order of 0.0001g or 0.1 mg. Such balances are considered the most precise balance.

Q28. Write the laboratory safety rules.

(F.B. 2017) 091301111

Ans. The students should know what to do in case of an accident. The charts or posters are to be displayed in the laboratory to handle situations arising from any mishap or accident. For your won safety and for the safety of others in the laboratory, follow safety rules given below:

- Do not carry out any experiment without the permission of your teacher.
- Do not eat, drink, play or run in the laboratory.
- Read the instructions carefully to familiarize yourself with the possible hazards before handling equipments and materials.
- Handle equipments and materials with care.
- Do not hesitate to consult your teacher in case of any doubt.
- Do not temper with the electrical appliances and other fittings in the laboratory.
- Report any accident or injuries immediately to your teacher.

Q29. How can we round the number? 091301112

Ans. (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 is increased by 1. For example 1.47 is rounded to 1.5

(iii) If the last digit is 5 then it is rounded to get nearest even number. For example 1.35 rounded to 1.4 and 1.45 is also rounded to 1.4.

Q30. Write the names of the necessary laboratory safety equipments.

(F.B. 2015) 091301113

Ans. Laboratory Safety Equipments:

A school laboratory must have safety equipments such as:

- Waste-disposal basket
- Fire extinguisher.
- Fire alarm.
- First Aid Box.
- Sand and water buckets.
- Fire blanket to put off fire.
- Substances and equipments that need extra care must bear proper warning signs.

Q31. Convert of the following:

a) 10km/h into ms^{-1}

b) 100 μ m into nm

c) 5 litre into m^3 (F.B. 2017) 091301114

Ans.

a) $10\text{km/h} = \frac{10\times10^3\text{m}}{60\times60\text{s}} = \frac{10\times10^3\text{m}}{3600}\text{ms}^{-1} = 2.77\text{ms}^{-1}$

b) $100\mu\text{m} = 100\times10^{-6}\text{m} = \frac{100\times10^{-3}\times10^{-6}\text{m}}{10^{-3}}\text{ms}^{-1}$

$= \frac{100}{10^{-3}}\times10^{-9}\text{m} = 100,000\times10^{-9}\text{m} = 100000\text{nm}$

c) 5 litre $= 5\times10^{-3}\text{m}^3$ $\therefore$ 1 litre $= 10^{-3}\text{m}^3$

Quick Quiz

Q32. Name five prefixes commonly used. 091301115

Ans. Milli, micro, mega, kilo, nano, pico are commonly uses prefixes.

Q33. Identify the base quantity in the following:
(i) Speed (ii) Area 091301116
(iii) Force (iv) Distance

Ans. Distance (length) is the base quantity.

Q34. Identify the following as base or derived quantity: 091301117

Density, force, mass, speed, time, length, temperature and volume.

Ans. Base quantities:

Base quantities are mass, time, length, temperature.

Derived Quantities

Derived quantities are density, force, speed and volume.

Q35. The Sun is one hundred and fifty million kilometers away from the Earth. Write this (F.B. 2017) 091301118

(a) as an ordinary whole number.

(b) In scientific notation.

Ans. (a) 150,000,000 km

(b) 15×10^7 km

$= 1.5 \times 10^8$ km $\quad \therefore 1k = 10^3$

$= 1.5 \times 10^8 \times 10^3$ m

In scientific notation $= 1.5 \times 10^{11}$ m

Q36. Write the number given below in scientific notation. 091301119

(a) 3000000000 ms^{-1} (b) 6400000 m

(c) 0.00000000 16g (d) 0.0000548 s

Ans. (a) $3.0 \times 10^9 ms^{-1}$

(b) 6.4×10^6 m

(c) 1.6×10^{-9} g

(d) 5.48×10^{-5} s

Q37. What is the least count of vernier callipers? 091301120

Ans. The difference between one small division on main scale and one vernier scale division is 0.1mm. It is called least count of vernier callipers.

$$\text{Least count of vernier callipers} = \frac{\text{smallest reading on M.S}}{\text{no. of div. on V.S}}$$

$$= \frac{1mm}{10 \text{ divisions}}$$

L.C = 0.1mm or 0.01cm

Q38. Why do we study Physics? 091301121

Ans. Physics is the most fundamental Branch of science. We study Physics to understand the nature, properties of matter, energy and their mutual relationship. Today most of progress in the field of science and technology has become possible due to invention in the field of physics. Physics explains most of Phenomena of the universe.

Q39. What is the range of vernier callipers used in your physics laboratory? 091301122

Ans. The range of vernier callipers in physics laboratory is 120mm or 12cm.

Q40. Name any five branches of Physics. 091301123

Ans. Mechanics, Heat, Sound, Light, Geophysics.

Q41. How many divisions are there on its veriner scale? 091301124

Ans. There are 10 divisions on the vernier scale of the vernier callipers.

Q42. Why do we use zero correction? 091301125

Ans. We use zero correction to get an accurate and error free measurement. By applying zero correction, the readings will not be doubtful.

Mini Exercise

Q43. What is the least count of a screw gauge? 091301126

Ans. When thimble of screw gauge completes one rotation, 100 divisions pass the index line and the thimble moves 1mm along the main scale. Thus each division of circular scale crossing the index line move the thimble through 1/100mm or 0.01mm on the main scale.

$$\text{Least Count} = \frac{\text{pitch of screw gauge}}{\text{no. of div. on circular scale}} = \frac{1mm}{100}$$

L.C. = 0.01mm or 0.001cm

Q44. What is the pitch of your laboratory screw gauge? 091301127

Ans. The pitch of laboratory screw gauge is 1mm.

Q45. What is the range of your laboratory screw gauge? 091301128

Ans. The range of laboratory screw gauge is 0.25mm.

Q46. What is the function of balancing screws in a physical balance? 091301129

Ans. There are two screws on the physical balance named as balancing screw, their function is to bring

the pointer of the scale at zero position and to balance the pans.

Q47. On what pan we place the object and why? 091301130

Ans. We usually place the object on the left pan and standard masses on the right pan. It is just for the human convenience. Because majority of people are right handed.

Q48. How many seconds are in a year? 091301131

Ans.

1 Year = 365 days

= 365 × 24 hours

= 365 × 24 × 60 min

= 365 × 24 × 60 × 60 seconds

= 31536000 seconds

= 3.1536×10^7 seconds

One year has 3.1536×10^7 seconds.

Q49. Which source gives us pollution free electricity? 091301132

Ans. Wind turbines used to run the electric generator gives us pollution free electricity.

Q50. What is digital vernier calipers? 091301133

Ans. A digital vernier calipers has greater precision then mechanical vernier calipers. Least count of digital vernier calipers is 0.01mm.

Q51. Which one of the two instruments is more precise and why? 091301134

(a) Vernier Callipers

(b) Screw gauge

Ans. Screw gauge is more precise than vernier callipers because it measure 100^{th} part of a millimeter while vernier callipers measures 10^{th} part of a millimeter.

Least counts of Measuring Instruments:

1)	Meter Rule = 1mm or 0.1cm	2)	Measuring tape = 1mm or 0.1 cm
3)	Vernier callipers = 0.1mm or 0.01cm	4)	Screw Gauge = 0.01mm or 0.001cm
5)	Physical Balance = 0.01g or 10mg	6)	Beam Balance = 0.1g or 100mg
7)	Electronic Balance = 0.001g or 1mg	8)	Mechanical stop watch = 0.1 sec
9)	Digital Stop watch = 0.01 sec		

Mini Exercise:

Volume is a derived quantity

1 L = 1000 mL

1 L = 1 dm^3

= $(10\ cm)^3$

= 1000 cm^3

∴ 1 mL = 1 cm^3

Express 1 m^3 in litres = 1000 L.

Solved Examples

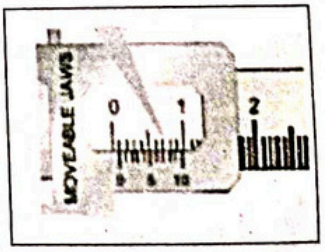
Example 1.1

Find the diameter of a cylinder placed between the outer jaws of Vernier Callipers as shown in figure. 091301135

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

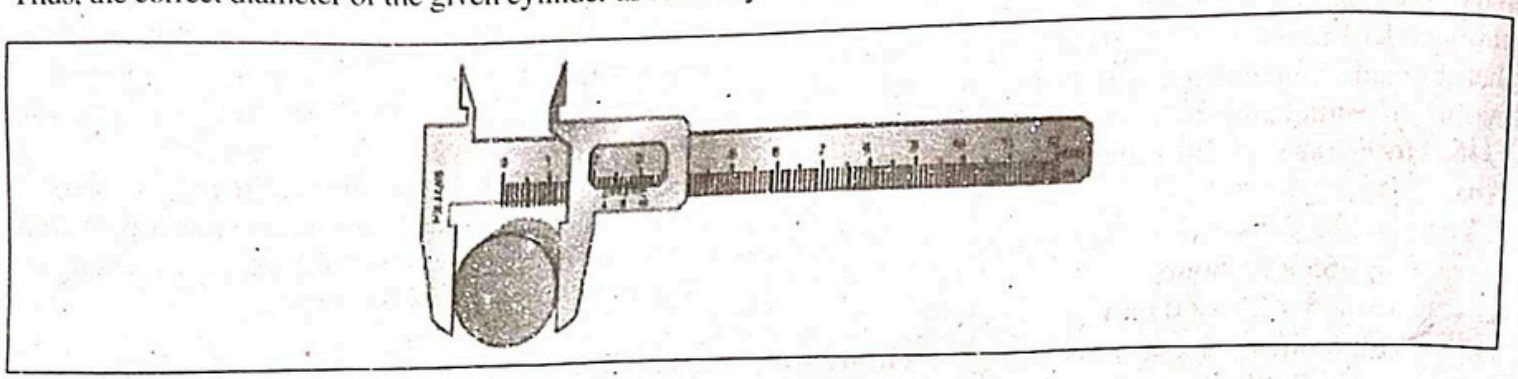
Diameter of the cylinder

Main scale reading = 2.2cm

(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 = 2.19cm
Thus, the correct diameter of the given cylinder as found by Vernier Callipers is 2.19 cm.



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Example 1.2: Find the diameter of a wire using a screw gauge.

Solution:

The diameter of a 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 anti-clockwise direction. Place the given wire in the gap as shown in figure 1.11. Turn the ratchet so that the object is pressed gently between the studs and the spindle.

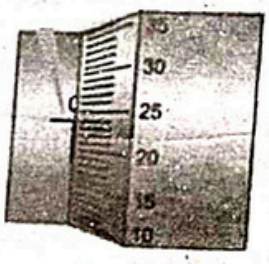
(iv) Note main scale as well as circular scale readings to find the diameter of the given wire.

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

(vi) Repeat steps iii, iv and v at different places of the wire to obtain its average diameter.

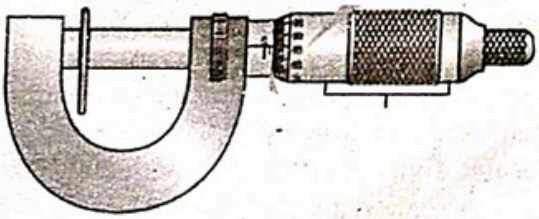
Zero correction:

Closing the gap of the screw gauge
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 wire

Main scale reading = 1 mm
(when the given wire is pressed by the stud and spindle of the screw gauge)
No. of divisions of 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 diameter of the given wire is 1.61 mm.

Example 1.3: Find the mass of a small stone by a physical balance.

091301137

Solution:

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

(i) Adjusting the levelling screws with the help of plumbline to level the platform of physical balance.
(ii) Raise the beam gently by turning the arresting knob clockwise. Using balancing screws at the ends of its beam, bring the pointer at zero position.
(iii) Turn the arresting knob to bring the beam back on its supports. Place the given object (stone) on its left pan.
(iv) 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.
(v) Repeat adding or removing suitable standard masses in the right pan till the pointer rests at zero on raising the beam.
(vi) Note the standard masses on the right pan. Their sum is the mass of the object on the left pam.

Example 1.4: Find the number of significant figures in each of the following values. Also express them in scientific notations. 091301138

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

Solution:

(a) In 100.8s all the four digits are significant. The zeros between the two significant figures 1 and 8 are significant. To write the quantity in scientific notation, we move the decimal point two places to the left, thus

$100.8\ s = 1.008 \times 10^2\ s$

(b) In 0.00580 km 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. In scientific notation, it can be written as

5.80×10^{-3} km.

(c) In 210.0g 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 are four. In scientific notation, it can be written as

$210.0\ g = 2.100 \times 10^2\ g$

Numerical Problems

Q1.1. Express the following quantities using prefixes. 091301139

(a) 5000 g (b) 2000 000 W
(c) 52×10^{-10}kg (d) 225×10^{-8} s

Solution

(a) 5000g
$= 5 \times 10^3$g
= 5kg

$\therefore$ 1 kilo = 10^3

(b) 2000, 000 W
$= 2 \times 10^6$W.
= 2 mega watt,
= 2MW.

$\therefore$ 1 Mega = 10^6

10^6W=1MW

(c) 52×10^{-10} kg
$=5.2 \times 10^{+1} \times 10^{-10}$ kg
$=5.2 \times 10^{1-10}$ kg
$=5.2 \times 10^{-9}$ kg
$=5.2 \times 10^{-9} \times 10^3$ g
$=5.2 \times 10^{-9+3}$ g
$=5.2 \times 10^{-6}$ g
$=5.2\ \mu$ g

$\therefore$ 1 Kilo = 10^3

$\therefore$ 1micro = 10^{-6}
1 $\mu = 10^{-6}$

(d) 225×10^{-8} sec
$=2.25 \times 10^2 \times 10^{-8}$ sec
$=2.25 \times 10^{2-8}$ sec
$=2.25 \times 10^{-6}$ sec
$=2.25\ \mu$ sec
$=2.25\ \mu$s

$\therefore 10^{-6} = 1\mu$

Q1.2 How do the prefixes micro, nano and pico relate to each other? 091301140

Solution:

1 micro = 10^{-6}
1 nano = 10^{-9}
1 pico = 10^{-12}

Take1 micro = 10^{-6}
Multiplying on both sides by 10^{-3}
10^{-3} micro = $10^{-6} \times 10^{-3}$
$10^{-3} \times$ micro = 10^{-9}
10^{-3}micro = 1nano

and

One micro = 10^3 nano

Now, 1 nano = 10^{-9}
Multiplying on both sides by 10^{-3}
10^{-3}nano = $10^{-9} \times 10^{-3}$
10^{-3} nano = 10^{-12}
10^{-3} nano = 1 pico

and

1 nano = 10^3 pico

Q1.3 Your hair grow at the rate of 1mm per day. Find their growth rate in nms^{-1}. 091301141

Solution:

Rate of hair growth $= \frac{1mm}{day}$

To Find:

Growth rate in nms^{-1} = ?

Solution:

1 day have seconds $= 24 \times 60 \times 60$ s

$= 86400 s = 8.64 \times 10^{4}$ s

$\because 1mm = 10^{-3}$ m

Hair growth rate $= \frac{1 \times 10^{-3}}{8.64 \times 10^{4}} ms^{-1}$

$= \frac{1}{8.64} \times 10^{-3} \times 10^{-4} ms^{-1}$

$= 0.1157 \times 10^{-7} ms^{-1}$

$= 11.57 \times 10^{-2} \times 10^{-7} ms^{-1}$

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

so, hair growth rate in $nms^{-1} = 11.57 nms^{-1}$

Q1.4 Rewrite the following in standard form. 091301142

(a) 1168×10^{-27} **(b)** 32×10^{5}

(c) 725×10^{-5} kg **(d)** 0.02×10^{-8}

Solution

(a) 1168×10^{-27}

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

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

(b) 32×10^{5}

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

$= 3.2 \times 10^{6}$

(c) 725×10^{-5} kg

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

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

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

$= 7.25$ g

$\therefore$ 1 Kilo $= 10^{3}$

(d) 0.02×10^{-8}

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

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

Q1.5 Write the following quantities in standard form. 091301143

(a) 6400 km **(b) 380 000km**

(c) 300, 000, 000ms^{-1} **(d) seconds in a day**

Solution

(a) 6400km

$= 6.4 \times 10^{3}$ km

(b) 380000 km

$= 38 \times 10^{4}$ km

$= 3.8 \times 10^{+5}$ km

(c) 300, 000, 000 ms^{-1}.

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

(d) Seconds in a day are $= 24 \times 60 \times 60$ sec

$= 86400$ s

$= 864 \times 10^{2}$ sec

$= 8.64 \times 10^{2} \times 10^{2}$ sec

$= 8.64 \times 10^{4}$ sec

Q1.6 On closing the jaws of a Vernier Callipers, zero of the vernier scale is on the right to its main scale such that 4^{th} division of its vernier scale coincides with one of the main scale division. Find its zero error and zero correction. 091301144

Solution

Since the zero of vernier scale is on the right side of the main scale. So the error is positive and its correction will be negative.

Zero error of vernier $= 4 \times 0.01$cm

$= 0.04$ cm

Correction will be $= -0.04$ cm

Q1.7 A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5mm. What is its least count? 091301145

Solution

Division on circular scale = 50

pitch of screw gauge is 0.5mm

Least count = ?

Least Count $= \frac{pitch\ of\ screw\ guage}{division\ on\ circular\ scale}$

$= \frac{0.5mm}{50} = \frac{1mm}{100}$

$= 0.01$mm.

Least Count $= 0.01$mm

Or $= \frac{0.01}{10} cm$

$= 0.001cm$.

$\therefore 1cm = 10$ mm

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

Q1.8 Which of the following quantities have three significant figures? 091301146

(a) 3.0066m **(b) 0.00309kg**

(c) 5.05×10^{27}kg **(d) 301.0 s**

Solution

(a) 3.0066m

As zero between the digits are significant, so

Its significant figures are = 5

(b) 0.00309 kg

Zero written on the left side of the decimal point for the purpose of spacing the decimal point are not significant. So,

Its significant figures are = 3

(c) 5.05×10^{-27} kg

In standard form the digits before the power of 10 are considered significant.

Its significant figures are = 3.

(d) 30.10 sec

Zero on the right in the decimal fraction are significant.

Its significant figures are = 4

So (b) and (c) have 3 significant figures.

Q1.9 What are the significant figures in the following measurements? 091301147

(a) 1.009m **(b) 0.00450kg**

(c) 1.66×10^{27}kg **(d) 2001 s**

Solution:

(a) 1.009 m.

Significant figures are = 4

(b) 0.00450 kg

Significant figures are = 3

(c) 1.66×10^{-27} kg

Significant figures are = 3

(d) 2001 sec

Significant figures are = 4

Q1.10 A chocolate wrapper is 6.7 cm long and 5.4 cm wide. Calculate its area upto reasonable number of significant figures.

Given data: 091301148

Length of chocolate wrapper = 6.7cm.

Width of chocolate wrapper = 5.4cm.

To Find:

Area = ?

Solution:

Area = Length × Width

$= 6.7 \times 5.4$

$= 36.18\ cm^2$

$A = 36\ cm^2$

Area in the reasonable number of significant figures is $36cm^2$.