Unit 1: Physical Quantities and Measurement

Textbook Exercise Questions

1.1 Encircle the correct answer from the given choices.

i. The number of base units in SI are:

(a) 3 **(b)** 6

(c) 7 ✓ **(d)** 9

ii. Which one of the following unit is not a derived unit?

(a) Pascal **(b) kilogram ✓**

(c) Newton **(d)** watt

iii. Amount of a substance in terms of numbers is measured in: (LHR 2011)

(a) Gram **(b)** kilogram

(c) Newton **(d) mole ✓**

iv. An interval of 200 μs is equivalent to: (LHR 2015)

(a) 0.2 s **(b)** 0.02 s

(c) 2×10^{-4} s ✓ **(d)** 2×10^{-6} s

v. Which one of the following is the smallest quantity?

(a) 0.01 g **(b)** 2 mg

(c) 100 μg **(d) 5000 ng ✓**

vi. Which instrument is most suitable to measure the internal diameter of a test tube?

(a) Meter rule **(b) Vernier callipers ✓**

(c) Measuring tap **(d)** screw gauge

vii. A student claimed the diameter of a wire as 1.032 cm using Vernier calipers. Up to what extent do you agree with it?

(a) 1 cm **(b)** 1.0 cm

(c) 1.03 cm ✓ **(d)** 1.032 cm

viii. A measuring cylinder is used to measure:

(a) Mass **(b)** area

(c) Volume ✓ **(d)** level of a liquid

ix. A student noted the thickness of a glass sheet using a screw gauge. On the main scale, it reads 3 divisions while 8th division on the circular scale coincides with index line. Its thickness is:

(a) 3.8 cm **(b)** 3.08 cm

(c) 3.08 mm ✓ **(d)** 3.08 m

x. Significant figures in an expression are:

(a) All the digits

(b) All the accurately known digits

(c) All the accurately known digits and the first doubtful digit ✓

(d) All the accurately known and all the doubtful digits

xi. Identify the base quantity in the following:

(a) Speed **(b)** Area

(c) Force **(d) Distance ✓**

1.2: What is the difference between base quantities and derived quantities? Give three examples in each case.

Base Quantities	Derived Quantities
The quantities on the basis of which other quantities are expressed are known as base quantities. **Examples** Length, time, mass	Physical quantities which can be described in terms of base quantities are known as derived quantities. **Examples** Force, area, volume

1.3: Pick out the base units in the following:

Joule, Newton, kilogram, hertz, mole, ampere, meter, Kelvin, coulomb and watt.

Base units

- Kilogram (unit of mass)
- Mole (unit of quantity of substance)
- Ampere (unit of electric current)
- Metre (unit of length)
- Kelvin (unit of temperature)

1.4: Find the base quantities involved in each of the following derived quantities:

(a) Speed (b) Volume (c) Force (d) Work

Ans: (a) <u>Speed</u>

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$= \frac{\text{Length}}{\text{time}}$$

So base quantities involved in speed are length and time.

(b) <u>Volume:</u>

Volume = length × width × height

= length × length × length

So base quantities involved in volume is length.

(c) Force:

Force = mass × acceleration

$$= \text{mass} \times \frac{\text{Change in velocity}}{\text{time}}$$

$$= \text{mass} \times \frac{\text{distance}}{\text{time} \times \text{time}}$$

$$= \text{mass} \times \frac{\text{Length}}{\text{time} \times \text{time}}$$

So base quantities involved in force are length mass and time.

(d) Work:

Work = Force × distance

= mass × acceleration × distance

$$= \text{mass} \times \frac{\text{Change in velocity}}{\text{time}} \times \text{distance}$$

$$= \text{mass} \times \frac{\text{distance}}{\text{time} \times \text{time}} \times \text{distance}$$

$$= \text{mass} \times \frac{\text{Length}}{\text{time} \times \text{time}} \times \text{Length}$$

So base quantities involved in work are length, mass and time.

1.5: Estimate your age in seconds. (LHR 2014, 2015)

Ans: Let present age = 15 years

= 15 × 365 days

= 5475 days

= 5475 × 24 hours

= 131400 hours

= 131400 × 3600 second

= 473040000 second

1.6: What role SI units have played in the development of science? (LHR 2013)

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. To fulfil this need a world-wide system of measurements called international system of units was adopted.

1.7: What is meant by vernier constant? (LHR 2014, 2015)

Ans: "The difference between one small division on main scale and one vernier scale division is called vernier constant. This is the minimum length which can be measured accurately with the help of a vernier callipers. That is why it is also called the least count of vernier callipers".

1.8: What do you understand by the zero error of a measuring instrument? (LHR 2014)

Ans: The error in a measuring instrument due to non-uniform or wrongly marked graduation due to which a measurement may be less or greater than actual measurement is called zero error of the measuring instrument.

1.9: Why is the use of zero error necessary in a measuring instrument? (LHR 2013)

Ans: If a measuring instrument has a zero error, readings taken by it will not be correct. By knowing the zero error first, necessary correction can be made to find the correct measurement. Such a correction is called zero correction.

1.10: What is a stopwatch? What is the least count of a mechanical stopwatch you have used in the laboratories?

Ans: "An instrument used to measure the time interval or specific period of an event is known as stop watch". Least count of mechanical stop watch is 0.1 second.

1.11: Why do we need to measure extremely small interval of times?

Ans: We need to measure extremely small interval of times to get accurate and error free results of experiments.

1.12: What is meant by significant figures of a measurement? (GRW 2013)

Ans: In any measurement all the accurately known digits and first doubtful digit is known as significant figure.

1.13: How is precision related to the significant figures in a measured quantity?

Ans: An improvement in the quality of measurement by using better instrument increases the significant figures in the measured result. More significant figure means greater precision. E.g. measurement of vernier callipers would be more precise than a metre rule, therefore measurements taken by vernier callipers would have more significant figures than that taken by metre rule.

Unit 1: Physical Quantities and Measurement

Long Questions

Q.1 Define Science.

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 a subject called natural philosophy. But as the knowledge increased, it was divided into two main streams:

(i) **Physical sciences:** It deals with the study of non-living things.

(ii) **Biological sciences:** It is concerned with the study of living things.

Q.2 Define the branches of Physics.

Ans: There are different branches of physics that are given as under:

1) **Mechanics**

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

2) **Heat**

It is the branch of physics that deals with the nature of heat, modes of transfer and effects of heat.

3) **Sound**

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

4) **Light**

It is the branch of physics that deals with the physical aspects of light, its properties, working and use of optical instruments.

5) **Electricity and Magnetism**

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

6) **Atomic Physics**

It is study of the structure and properties of atoms.

7) **Nuclear Physics**

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

8) **Plasma Physics**

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

9) **Geophysics**

It is the study of the internal structure of Earth.

Q.3 Describe the importance of Physics in our daily life.

Ans: **Positive Aspects:**

1) Electricity is used not only to get light and heat but also mechanical energy that drives fans and electric motors etc. This is possible due to knowledge of physics.

2) The means of transportation such as car and airplanes; domestic appliances such as air conditioners, refrigerators, washing machines and microwave ovens etc. are the gifts of knowledge of physics.

3) The mean of communication such as radio, T.V, telephone and computer are the result of applications of physics.

4) A mobile phone allows us to contact people anywhere in the world and to get latest worldwide information. We can take and save pictures, sent and receive messages of our friends. We can also receive radio transmission and can use it as a calculator as well. All this is possible due to knowledge of physics.

Negative Aspects:

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.

Q.4 Define physical quantities. Also describe its types.

Ans: **Physical quantities:**

All measurable quantities are called physical quantities. A physical quantity possesses at least two characteristics in common. One is its numerical magnitude and the other is the unit in which it is measured.

Physical quantities are divided into two types:

Base quantities: The quantities on the basis of which other quantities are expressed are known as base quantities. For example length, mass, time, electric current, temperature, intensity of light and amount of substance.

Derived quantities: The quantities that are expressed in terms of base quantities are called derived quantities. For example area, volume, speed, force, work etc.

Q.5 What is international system of units? Briefly discuss.

Ans: There is a need of some standard quantities for measuring/comparing unknown quantities. Once a standard is set for a quantity then it can be expressed in terms of that standard quantity. This standard quantity is called a unit.

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 held in the Paris in 1960 adopted a world-wide system of measurement called international systems of units commonly referred as SI.

Q.6 Differentiate between base and derived units.

Ans: **Base units:** The units that describe base quantities are called base units. Each base quantity has it SI unit.

Quantities		Units	
Name	**Symbol**	**Name**	**Symbol**
Length	*l*	Meter	m
Mass	m	Kilogram	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

Derived units: The units use 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. For example the unit of area $(meter)^2$ and the unit of volume $(meter)^3$.

Q.7 Define prefixes. Also give examples.

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

Examples: Kilo (10^3), Mega (10^6) micro (10^{-6}) nano (10^{-9}) etc.

Q.8 Define scientific notation. Also give examples.

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

For example: 62750 in scientific notation can be expressed as 6.275×10^4 .

Distance of moon from earth is 384000000 metres. In scientific notation it can be expressed as 3.84×10^8 metres.

Q.9 Briefly describe a metre rule and measuring tape.

Ans: **Metre Rule:** A metre rule is a length measuring instrument. It is commonly used in the laboratories to measure length of an object or distance between two points.

Construction: It is one metre long which is equal to 100 centimetres. Each centimetre is divided into 10 small divisions called milimetre(mm). Thus one millimetre or 0.1 cm is the smallest reading that can be taken using a metre rule and is called its least count.

How can we avoid errors in the measurement?

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 point.

Measuring Tape: Measuring tapes are used to measure length in metres and centimeters.

Construction:

A measuring tape consists of a thin and long strip of cotton, metal or plastic generally 10m, 20m, 50, or 100 m long. Measuring tapes are marked in centimetres as well as in inches.

Q.10 Write a detail note on vernier callipers.

Vernier Calipers is a device which is generally used to measure length as small as $\frac{1}{10}$th of a milimetre (0.1 mm).

Construction

A Vernier Calipers consist of two jaws One is the fixed 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 0.9 mm.

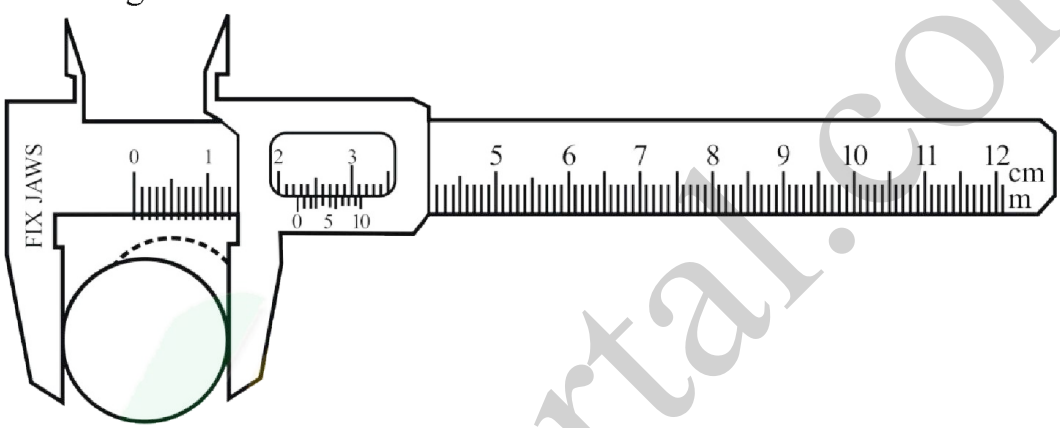

Figure 1.8: A cylinder placed between the outer jaws of Vernier Callipers.

Vernier constant: The difference between one small division on main scale and one vernier Scale division is called vernier constant or lest count of vernier calipers.

One small division on main scale = 1 ,

One small division on main scale = 1 0.9 mm

$\therefore$ Least count = 1 mm – 0.9 mm

= 0.1 mm

Least count of vernier callipers can be also be found as follows

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

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

$$= 0.1 \text{ mm}$$

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

$$= 0.01 \text{ cm}$$

Working of vernier callipers: First of all find the error in the measuring instrument known as zero error.

To find the zero error, close the jaws of vernier callipers gently. If the zero line of the vernier scale coincide with the zero of the main scale then the zero error is zero. (Nil)

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

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.

Negative zero error: Zero error will be negative if zero line of vernier scale is on the left side of the zero of the main scale.

Zero correction: 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 the negative of zero error.

Taking a reading on vernier callipers:

To find the diameter of a solid cylinder using a 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. Note the complete division of the main scale before the vernier scale zero. Next find 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 give the diameter of the solid cylinder. Add zero correction to get the correct measurement.

Q.11 Write a note on the Screw Gauge.

Ans: A screw gauge is an instrument used to measure small lengths accurately up to one-hundredth part of a millimeter. It is also called micrometer screw gauge. It accuracy is greater than a vernier calipers.

Construction

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

Circular Scale

The thimble has 100 divisions around one end. It is circular scale of the screw gauge. As thimble completes one rotation, 100 divisions pass the index line and 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. Thus each division of circular scale crossing the index line moves the thimble through 1/100 mm or 0.01 mm.

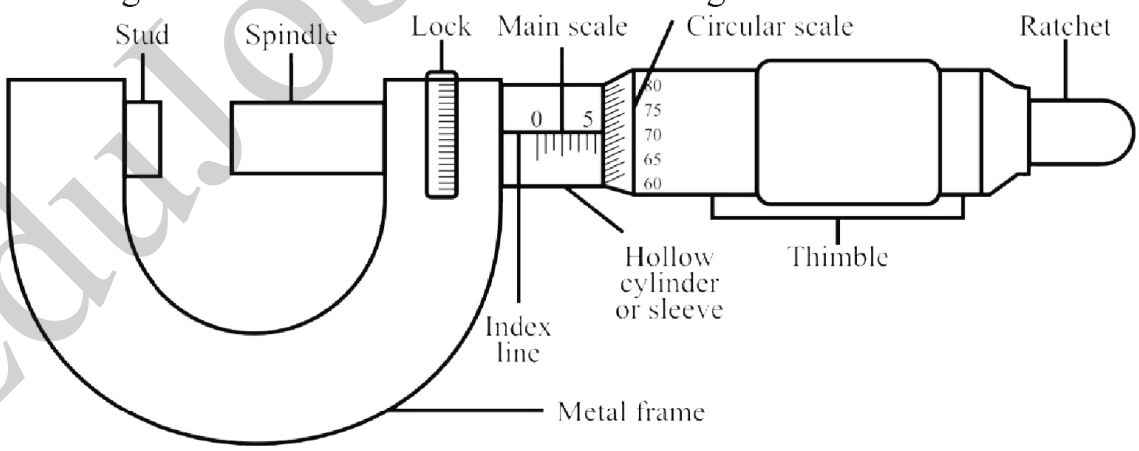

Figure 1.9: A micrometer screw gauge

Pitch

As the thimble completes one rotation, the spindle moves 1 mm along the index line. It is because the distance between consecutive threads on the spindle is 1 mm; the distance is called the pitch of screw gauge on the spindle.

Least count

Least count of a screw gauge can also be found as given below:

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

$$= \frac{1\,\text{mm}}{100}$$

$$= 0.01\ \text{mm} = 0.001\ \text{cm}$$

The least count of the screw gauge is 0.01 mm or 0.001 cm.

Working of a Screw Gauge

The first step is to find the zero error of the screw gauge. Close the gap between the spindle and the stud of the screw gauge by rotating the ratchet in clockwise direction. If zero of circular scale coincides with the index line, then zero error will be zero. If zero of circular scale does not coincide with index line, then there will be zero error in the screw gauge.

There are two types of zero errors:

(i) Positive Zero Error

(ii) Negative Zero Error

Positive Zero Error

Zero error will be positive if the zero of circular scale is behind the index line. In this case multiply the number of divisions on the circular scale that has not crossed the index line with the least count of the screw gauge to find positive zero error.

Negative Zero Error

Zero error will be negative if the zero of circular scale has crossed the index line. In this case multiply the number of divisions on the circular scale that has crossed the index line with the least count of the screw gauge to find negative zero error.

Taking reading on a screw gauge:

To find the diameter of a given wire place the given wire in the gap between stud and spindle of the screw gauge. Turn the ratchet so that the object is pressed gently between the stud and the spindle. Note main scale as well as circular scale readings to find the diameter of the given wire. Multiply circular scale reading with least count and add it in the main scale reading. This will give diameter of wire. Add zero correction to get the correct measurement.

Mass Measuring Instruments

Q.12 What is Physical Balance? And how it is used?

Ans: A common physical balance is a laboratory instrument that is used to measure the mass of various objects by comparison.

Construction

It consists of a beam resting at the center on a fulcrum as shown in the figure. 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.

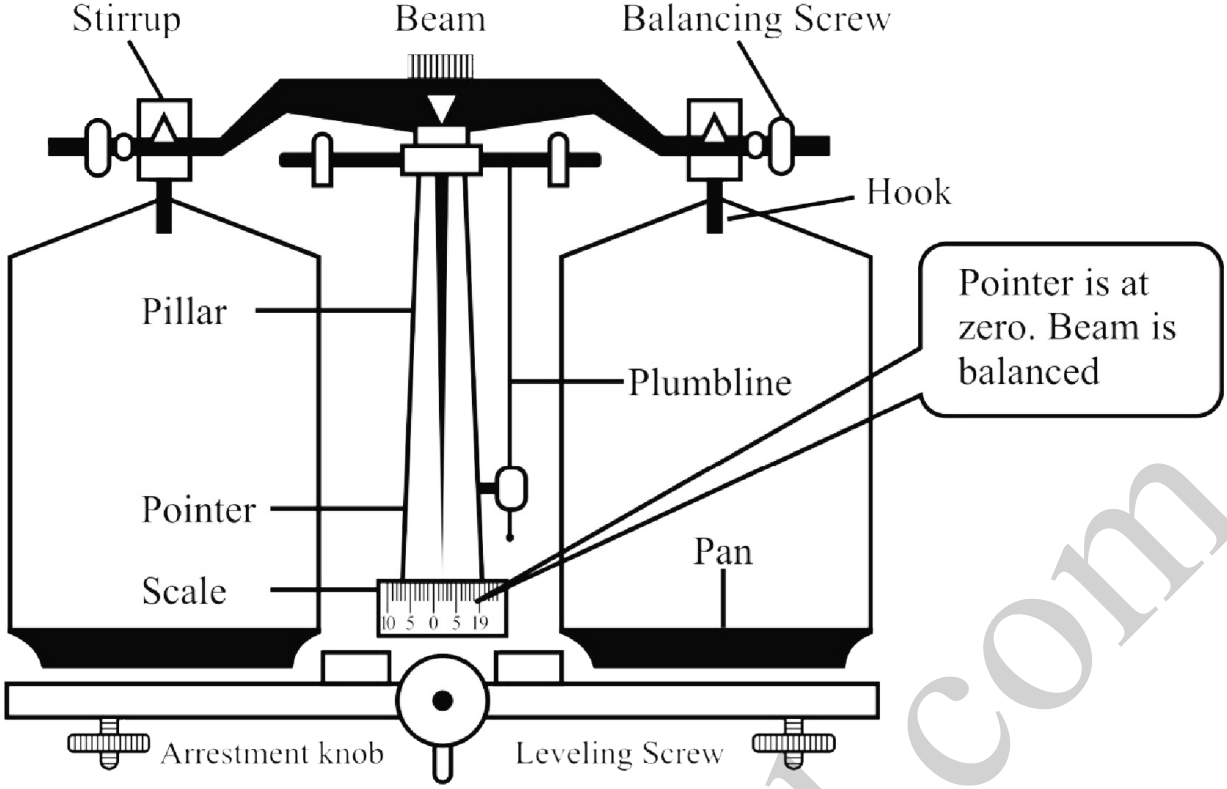

Figure 1.14: A physical balance

Example:

Find the mass of a small stone by a physical balance

Solution

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

(i) Adjusting leveling screws with the help of plumb line 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 support. 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 object on the left pan.

Q.13 Briefly explain lever balance and electronic balance?

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. The sum of these standard masses is the mass of object.

Electronic Balance:

Electronic balances come 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.

Q.14 Which one of the following is the most accurate?
Beam balance, Physical balance, and Electronic balance

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

(a) Beam Balance

Mass of coin = 3.2 g

A sensitive beam balance may be able to measure mass accurately as small as 0.1 g or 100 mg. i.e. least count of beam balance is 0.1 g or 100 mg.

(b) Physical balance

Mass of the coin = 3.24 g

Least count of physical balance is 0.01 g or 10 mg. therefore, measurement taken by physical balance would be more precise than a sensitive beam balance.

(c) Electronic balance

Mass of coin = 3.247 g

Least count of electronic balance is 0.001 g or 1 mg. Therefore, its measurement would be more precise than a sensitive physical balance. The electronic balance is most sensitive balance than all the balances given above.

Q.15 Write a note on the Stop Watch.

Ans: "An instrument used to measure the time interval or specific period of an event is known as stop watch".

Types of stop watch

There are two types of stop watch.

(i) Mechanical stop watch

(ii) Digital stop watch (Electronic stop watch)

(i) Mechanical Stop Watch

A mechanical stop watch can measure a time interval up to a minimum 0.1 second.

How to use

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

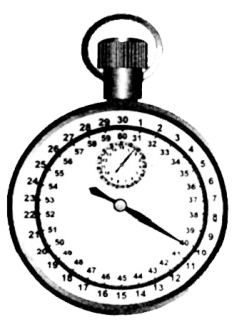

Figure 1.17: A mechanical stopwatch

(ii) Electronic/Digital Stop Watch

Digital stop watch commonly used in laboratories can measure a time interval accurately up to 1/100 second or 0.01 second.

How to use

The digital stop watch starts to indicate the time lapsed as start/stop button is pressed. As soon as start/stop button is pressed again, it stops and indicates the time interval recorded by it between start and stop of an event. A reset button restores its initial zero setting.

Named as stop watch

This watch is named stopwatch because it can be started or stopped at will as required when the duration of the time is to be measured.

Q.16 What do you know about Measuring Cylinder? How volume of liquids is measured by using this cylinder?

Ans: A measuring cylinder is a cylindrical tube that is used to measure the volume of the liquid or powdered substance. It is also used find the volume of an irregular shaped solid insoluble in a liquid by displacement method.

Construction

It is made of transparent plastic or glass, which has a vertical scale in milliliter (ml) or cubic centimeter (cm^3). Measuring cylinders have different capacities from 100 mL to 2500 mL.

Measurement of Volume

When a liquid is put in measuring cylinder, the volume is noted on the scale in front of the meniscus of the liquid. The meniscus of most of the liquids curve downwards whiles the meniscus of mercury upwards.

Precautions

To measure correctly the volume of the liquid following precautions are kept in mind:

(i) The cylinder must be placed on horizontal surface.

(ii) The eye should be kept on a level with the bottom of the meniscus (curved surface). When the eye is above the 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.

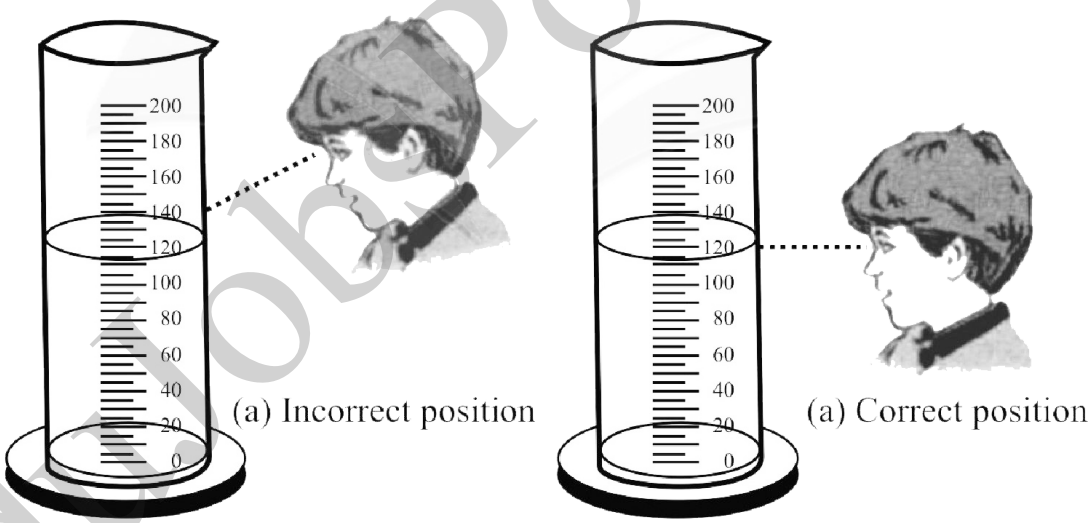

Figure 1.19 (a) Wrong way to note the liquid level keeping eye above liquid level. (b) correct position of eye to note the liquid level keeping eye at liquid level.

Measuring Volume of an irregular shaped solid:

Volume of irregular shaped solids is found by displacement method.

Displacement method

The solid is lowered into measuring cylinder containing water/liquid. The level of water/liquid rises. The increase in the volume of water/liquid is the volume of the given solid object.

Method

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

Q.17 Define and explain Significant figures. What are the main points to be kept in mind while determining the significant figures of a measurement?

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 a physical quantity.

The accuracy in measuring a physical quantity depends upon various factors.

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

Example

A student measures the length of a book as 18 cm using a measuring tape. The numbers of significant figures in this measured value 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 for determining Significant Figures

The following rules are helpful in identifying significant figures:

(i) Non-zero digits are always significant. For example 27 has 2 significant digits.

(ii) Zeros in between two significant figures are also significant. For example in 1.406, the number of significant figures is 4.

(iii) In any observation, the zeros on the left side of the decimal point for the purpose of spacing the decimal point are not significant. For example in 0.0036, the number of significant figures is 2.

(iv) Final or ending zeros on the right side in the decimal fractions are considered significant. For example the number of significant figures in 2.450 is four.

(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 serves 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.

(vi) If numbers are recorded in scientific notation then all the digits before the power of 10 are significant. For example in 1.40×10^5, the number of significant figure is three.

Q.18 Write down the rules to round off the numbers?

The following rules are used to round off the numbers:

(i) If the last digit is less than 5 then it is simply dropped. This decreases the number of significant digits in the figure.

Example

1.943 is rounder to 1.94 (3 significant figures)

(ii) If the last digit is greater than 5, then the digit on its left is increased by one. This also decreases the number of significant digits in the figure.

Example

1.47 is rounded to two significant digits 1.5

(iii) If the last digit is 5, then it is rounded to get nearest even number.

Example

1.35 is rounded to 1.4

1.45 is rounded to 1.4

Unit 1: Physical Quantities and Measurement

Multiple Choice Questions

1. **The branch of science which deals with the study of properties of matter, energy and their mutual relationship is called:**
   (a) Astronomy **(b)** Physics
   (c) Geology **(d)** Chemistry
2. **The study of properties of the ionic state of matter is called**
   (a) Plasma Physics **(b)** Astrophysics
   (c) Sound **(d)** Electromagnetism
3. **The study of internal structure of earth and its activities like seismography is called:** **(GRW 2013, 2015)**
   (a) Solid state physics **(b)** Heat
   (c) Mechanics **(d)** Geophysics
4. **The study of the isolated nuclei of an atom is called:**
   (a) Plasma Physics **(b)** Astrophysics
   (c) Nuclear Physics **(d)** Biophysics
5. **Much of the universe is made up of:**
   (a) Solid **(b)** Liquid
   (c) Plasma **(d)** All of above
6. **The international system of units is abbreviated as:**
   (a) IS **(b)** SI
   (c) Both a & b **(d)** none
7. **The terms used internationally for multiples and submultiples of various units are known as:**
   (a) Standard **(b)** Scientific notation
   (c) Prefixes **(d)** All of above
8. **Meter rule can measure the length accurately up to:**
   (a) 1 mm **(b)** 1 cm
   (c) 1 m **(d)** 1 km
9. **---------- can accurately measure up to one tenth of a millimeter.**
   (a) Meter rule **(b)** Vernier callipers
   (c) Screw Gauge **(d)** All
10. **The SI unit of intensity of light is:**
    (a) Newton **(b)** Kelvin
    (c) Kilogram **(d)** Candela
11. **One meter is equal to:**
    (a) 10^3 mm **(b)** 10^{-3} km
    (c) 10^2 cm **(d)** All

12. **Volume measuring scale has a vertical scale in:**
(a) Milliliter **(b)** cm^3
(c) Both a & b **(d)** none

13. **One Femto is equal to:**
(a) 10^{15} **(b)** 10^{-15}
(c) 10^{-9} **(d)** 10^{-12}

14. **The least count of vernier calipers is:** **(LHR 2015)**
(a) 0.1cm **(b)** 0.1mm
(c) 0.01cm **(d)** Both b & c

15. **Total length of the vernier scale is:**
(a) 1mm **(b)** 9 mm
(c) 10 mm **(d)** 1 cm

16. **Number of divisions on the vernier scale are:**
(a) 1 **(b)** 9
(c) 10 **(d)** 100

17. **Length of the smallest division on main scale of the vernier calipers is:**
(a) 1 cm **(b)** 1 mm
(c) 0.9 mm **(d)** All

18. **Separation between division on the vernier scale of the vernier calipers is:**
(a) 1 cm **(b)** 1 mm
(c) 0.9 mm **(d)** All

19. **If zero of the vernier scale is on the right side of the zero of the main scale then it is known as** ---------- zero error:
(a) Positive **(b)** Negative
(c) No error **(d)** none of these

20. **If zero of the vernier scale is on the left side of the zero of the main scale then it is known as** ---------- zero error:
(a) Positive **(b)** Negative
(c) None of these **(d)** No error

21. **If zero of the vernier scale is on the right side of the zero of the main scale then zero error is to be:**
(a) Added **(b)** Subtracted
(c) Multiplied **(d)** Divided

22. **If zero of the vernier scale is on the left side of the zero of the main scale then zero error is** to be:
(a) Added **(b)** Subtracted
(c) Multiplied **(d)** Divided

23. **The least count of Screw Gauge is:**
(a) 0.1 mm **(b)** 0.01 mm
(c) 0.1 cm **(d)** 0.01 cm

24. **Total number of divisions on the circular scale of Screw Gauge are:**
(a) 10 **(b)** 20
(c) 100 **(d)** 200

25. **Pitch of the screw gauge is:**
(a) 1m **(b)** 1 mm

(c) 1 cm **(d)** 0.1 mm

26. If the zero of the circular scale is above the horizontal line then the zero error will be:

(a) Positive **(b)** Negative

(c) None of these **(d)** No error

27. If the zero of the circular scale is below the horizontal line then the zero error will be:

(a) Positive **(b)** Negative

(c) None of these **(d)** No error

28. If the zero of the circular scale is above the horizontal line then the zero error is to be:

(a) Added **(b)** Subtracted

(c) Multiplied **(d)** Divided

29. If the zero of the circular scale is below the horizontal line then the zero error is to be:

(a) Added **(b)** Subtracted

(c) Multiplied **(d)** Divided

30. For scientific notation internationally accepted practice is that there should be ------- digit(s) before the decimal point.

(a) One **(b)** Two

(c) Three **(d)** No

31. In screw gauge, the distance moved forward or backward in one complete rotation of the circular scale is known as:

(a) Least count **(b)** Pitch

(c) Constant **(d)** None of above

32. A physical balance is used to measure:

(a) Weight **(b)** Volume

(c) Length **(d)** mass

33. Least count of mechanical stop watch is:

(a) 1 second **(b)** 1 minute

(c) 0.1 second **(d)** 0.01 second

34. Least count of digital stop watch is:

(a) 1 second **(b)** 1 minute

(c) 0.1 second **(d)** 0.01 second

35. In any measurement, the accurately known digits and first doubtful digit are known as:

(a) Prefixes **(b)** Significant figures

(c) Real numbers **(d)** All

36. The radius of wire is 0.022 cm. The number of significant figures in the measurements are:

(a) 1 **(b)** 2

(c) 3 **(d)** 4

37. The number of significant figures in 1.406 are:

(a) 4 **(b)** 3

(c) 2 **(d)** 1

38. The number of significant figures in 1.40×10^5 are:

(a) 1 **(b)** 2

(c) 3 **(d)** 4

39. Vernier constant is also known as ---------- of vernier calipers:

(a) Pitch **(b)** Proportionality constant

(c) Vernier value **(d)** least count

40. The zeros in between the digits are considered:

(a) Significant **(b)** Insignificant

(c) Constant **(d)** None of above

41. 10^6 Stands for:

(a) Micro **(b)** Pico

(c) Nino **(d)** Mega

42. 1μs is equal to:

(a) 10^{-9} s **(b)** 10^{-3} s

(c) 10^{-6} s **(d)** 10^{-12} s

43. To measure correctly the volume of the liquid, the eye must be kept on the ---------- surface of meniscus:

(a) Lower **(b)** Upper

(c) Middle **(d)** All of above

44. SI unit of electric charge is

(a) Ampere **(b)** Kelvin

(c) Pascal **(d)** Coulomb

45. The word science is derived from the Latin word

(a) Scientia **(b)** Santia

(c) Scient **(d)** None of these

46. Least count of digital vernier callipers is

(a) 0.1mm **(b)** 0.01 mm

(c) 0.001 mm **(d)** 1 mm

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	b	11	d	21	b	31	b	41	d
2	a	12	c	22	a	32	d	42	c
3	d	13	b	23	b	33	c	43	a
4	c	14	d	24	c	34	d	44	d
5	c	15	b	25	b	35	b	45	a
6	b	16	c	26	b	36	b	46	b
7	c	17	b	27	a	37	a		
8	a	18	c	28	a	38	c		
9	b	19	a	29	b	39	d		
10	d	20	b	30	a	40	a		

Unit 1: Physical Quantities and Measurement

Problems

1.1: Express the following quantities using prefixes.

(a) 5000 g

(b) 2000 000 W

(c) 52 x 10^{-10} kg

(d) 225 x 10^{-8} s

Ans:

(a) 5000 g = 5 x 10^{3} g = 5kg

(b) 2000 000 W = 2 x 10^{6} W = 2 MW

(c) 52 x 10^{-10} kg = 5.2 x 10^{1} x 10^{-10} x 10^{3} g = 5.2 x 10^{-6} g = 5.2 μ g

(d) 225 x 10^{-8} s = 2.25 x 10^{2} x 10^{-8} s = 2.25 x 10^{-6} s = 2.25 μ s

1.2: How do the prefixes micro, nano and pico relate to each other?

Ans: **Relation between micro and nano:**

$$1 \text{ nano} = 10^{-9}$$
$$= 10^{-3} \times 10^{-6}$$
$$\boxed{1\text{nano} = 10^{-3} \text{ micro}}$$

Relation between micro and pico

$$1 \text{ pico} = 10^{-12}$$
$$= 10^{-6} \times 10^{-6}$$
$$\boxed{1\text{pico} = 10^{-6} \text{ micro}}$$

Relation between nano and pico

$$1 \text{ pico} = 10^{-12}$$
$$= 10^{-3} \times 10^{-9}$$
$$\boxed{1\text{pico} = 10^{-3} \text{ nano}}$$

1.3: Your hairs grow at the rate of 1mm per day. Find their growth rate in mms^{-1}.
(LHR 2013, GUJ 2015)

Ans: Growth rate = 1 mm per day

$$= \frac{1\,\text{mm}}{1\,\text{day}}$$
$$= \frac{1 \times 10^{-3}\,\text{m}}{8.64 \times 10^{4}\,\text{s}}$$

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

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

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

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

1.4: Rewrite the following in standard form.

(a) 1168×10^{-27}

(b) 32×10^{5}

(c) 725×10^{-5} kg

(d) 0.02×10^{-8}

Ans:

(a) $1168 \times 10^{-27} = 1.168 \times 10^{3} \times 10^{-27} = 1.168 \times 10^{-24}$

(b) $32 \times 10^{5} = 3.2 \times 10^{1} \times 10^{5} = 3.2 \times 10^{6}$

(c) 725×10^{-5} kg $= 7.25 \times 10^{2} \times 10^{-5} \times 10^{3}$ g $= 7.25$ g

(d) $0.02 \times 10^{-8} = 2.0 \times 10^{-2} \times 10^{-8} = 2.0 \times 10^{-10}$

1.5: Write the following quantities in standard form.

(a) 6400 km

(b) 380 000 km

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

(d) seconds in a day

Ans:

(a) 6400 km $= 6.4 \times 10^{3}$ km

(b) 38000 km $= 3.8 \times 10^{5}$ km

(c) 300 000 000 $ms^{-1} = 3.0 \times 10^{8}\ ms^{-1}$

(d) 1 day = 24 hours = 24 x 3600 s = 86400 s $= 8.64 \times 10^{4}$ s

1.6: On closing the jaws of a vernier callipers, zero of the Vernier scale is on the right of it 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.

Ans: Number of division of Vernier scale = 4

Least count of Vernier calipers = 0.01 cm

Zero error = 4 x 0.01 cm = 0.04 cm

As zero of the Vernier scale is at the right side of the zero of the main scale so zero error will be positive.

So Zero correction = - 0.04 cm

1.7: A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5 mm. What is its least count? (LHR 2013)

Ans: No. of divisions on circular scale = 50

Pitch = 0.5 mm

$$\text{As least count} = \frac{\text{pitch of screwguage}}{\text{Number of circular scale divisions}}$$

$$\text{Least Count} = \frac{0.5\text{mm}}{50} = 0.01 \text{ mm} = 0.001 \text{ cm}$$

1.8: Which of the following quantities have three significant figures? (LHR 2015, GRW 2015)

(a) 3.0066 m
(b) 0.00309 kg
(c) 5.05 x 10^{-27} kg
(d) 2001 s

Ans: b and c

1.9: What are the significant figures in the following measurements? (LHR 2015, GRW 2015)

(a) 1.009 m	**(b) 0.00450 kg**	**(c) 1.66 x 10^{-27} kg**	**(d) 2001 s**
Ans: (a) 4	(b) 3	(c) 3	(d) 4

1.10: A chocolate wrapper is 6.7 cm long and 5.4 cm wide. Calculate its area up to reasonable number of significant figures. (GRW 2013, LHR 2014)

Ans: **Given data:**

Length of chocolate wrapper = l = 6.7 cm

Width of chocolate wrapper = w = 5.4 cm

Required:

Area of chocolate wrapper = A =?

Solution:

As we know that

Area =length x width

By putting the values we have

Area = 6.7 cm x 5.4 cm

= 36.18 cm^2

Result:

As the least number of significant figures in observed measurements are 2

So Area = 36 cm^2