UNIT 1

PHYSICAL QUANTITIES AND MEASUREMENT

1.1 INTRODUCTION TO PHYSICS

LONG QUESTIONS

1.1 Q.1. Define Science? Describe its brief history. (K.B)

Ans: **SCIENCE**

Definition:

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

Explanation:

The word science is derived from the Latin word Scientia, which means knowledge. Not until eighteenth century, 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:

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

ii) **Biological Sciences:**
It deals with the study of living things.

Branches of Physical Sciences:

In the nineteenth century, physical sciences were divided into five distinct disciplines; physics, chemistry, astronomy, geology and meteorology. The most fundamental of these is the Physics.

Technology:

The technologies are the applications of scientific principles. Most of the technologies of our modern society throughout the world are related to Physics. For example, a car is made on the principles of mechanics and a refrigerator is based on the principles of thermodynamics.

1.1 Q.2. Define Physics? Write a note on its different Branches. (K.B)

Ans: **PHYSICS**

Definition:

"The branch of physical science that deals with the study of matter, energy and their mutual relationship is called Physics".

BRANCHES OF PHYSICS

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:** **(LHR 2011)**
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. It is also called "Optics".

5) **Electricity and Magnetism:** **(GRW 2015)**
It is the study of the charges at rest and in motion, their effects and their relationship with magnetism.

6) **Atomic Physics:** **(GRW 2016, LHR 2017)**
It is study of the structure and properties of atoms.

7) **Nuclear Physics:** **(GRW 2016,LHR 2016,17)**
It deals with the properties and behavior of nuclei (The central part of an atom) and the particles within the nuclei.

8) **Plasma Physics:** **(LHR 2012, GRW 2012, LHR 2013, GRW 2015,LHR 2016)**
It is the study of production, properties of the ionic state of matter – the fourth state of matter

9) **Geo-Physics:** **(LHR 2013)**
It is the study of the internal structure of the Earth.

Q.3. Describe the importance of Physics in our daily life. **(K.B+A.B)**

IMPORTANCE OF PHYSICS

The rapid progress in science during the recent years has become possible due to the discoveries and inventions in the field of Physics. The laws and principles of Physics help us to understand nature. In our daily life, we hardly find a device where Physics is not involved.

- **Lifting Heavy Loads:**

With the help of physics Man has made many devices to lift heavy loads, Consider pulleys that make it easy to lift heavy loads.

- **Electricity:**

Electricity is a blessing of physics that 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.

- **Means of Transportation:**

The means of transportation such as car and aero-planes have increased our speed and shortened our distances.

- **Comforts in Life:**

Domestic appliances such as air conditioners, refrigerators, washing machines and microwave ovens etc. are the gifts of knowledge of physics that have brought comforts on our lives.

- **Means of Communication:**

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

- **Mobile Technology:**

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 use it as a calculator as well. All this is possible due to knowledge of physics.

Conclusion:

Physics is serving humanity as "Super Natural Mother". It has increased our speed, accuracy and vision.

1.1 SHORT QUESTIONS

Q.1. What is Science? (K.B)

Ans: *Given on Page # 02*

Q.2. Define Physics? ***(K.B)*** **(GRW 2016)**

Ans: *Given on Page # 02*

Q.3. Write Negative Aspects of Scientific inventions. ***(K.B)***

Ans:

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 Why do we study Physics? ***(K.B)*** **(Quick quiz PTB Pg. # 4)**

Ans:

STUDY OF PHYSICS

We study physics:

- To understand matter, energy and their mutual relationship.
- To know about laws and principles of Physics that help us to understand nature.
- To get knowledge about modern technologies and scientific principles for new discoveries and inventions.

Q.5. Name any five branches of physics. ***(K.B)*** **(Quick quiz PTB Pg. # 4)**

Ans: *Given on Page # 02*

Q.6. What is Andromeda? ***(K.B)***

ANDROMEDA

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

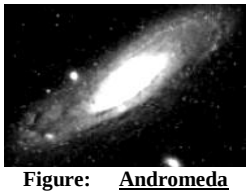


Figure: Andromeda

Q.7. What is Wind Turbine? ***(K.B)*** **(For your information PTB Pg. # 2)**

WIND TURBINES

Wind turbines are devices to produce pollution free electricity.

Figure: Wind Turbine

1.1 MULTIPLE CHOICE QUESTIONS

1. The word science is derived from the Latin word: ***(K.B)***

(A) Scientia (B) Santia

(C) Scient (D) None of these

2. The branch of science which deals with the study of properties of matter, energy and their mutual relationship is called: ***(K.B)***

(A) Astronomy (B) Physics

(C) Geology (D) Chemistry

3. The study of properties of the ionic state of matter is called: ***(K.B)***

(A) Plasma Physics (B) Astrophysics

(C) Sound (D) Electromagnetism

4. The study of internal structure of earth and its activities like seismography is called: ***(K.B)*** **(GRW 2013, 2015, 2016)**
(A) Solid state physics (B) Heat
(C) Mechanics (D) Geophysics

5. The study of the isolated nuclei of an atom is called: *(K.B)* **(GRW 2012)**
(A) Plasma Physics (B) Astrophysics
(C) Nuclear Physics (D) Biophysics

6. Much of the universe is made up of: *(K.B)*
(A) Solid (B) Liquid
(C) Plasma (D) All of above

7. Andromeda is a: *(K.B)*
(A) Series of Mountain (B) Planet
(C) Galaxy (D) Old civilization

8. Which one is used to produce pollution free electricity? *(A.B)* **(GRW 2016)**
(A) Nuclear Fuel (B) Thermal plant
(C) Bio Gas plant (D) Wind turbines

1.2 PHYSICAL QUANTITIES
1.3 INTERNATIONAL SYSTEM OF UNITS

LONG QUESTIONS

1.2 Q.1. What are Physical quantities? Write a note on their types. *(K.B)* **(LHR 2012, GRW 2013)**

Ans:

PHYSICAL QUANTITIES

Definition:

"All measurable quantities are called physical quantities".

Examples:

Length, time, mass, force, speed, volume, density etc.

Characteristics of Physical Quantities:

A physical quantity possesses at least two characteristics in common.

- Numerical magnitude
- Unit in which it is measured.

Example:

If the length of the student is 104 cm then 104 is its numeric magnitude and centimeter is the unit of measurement.

TYPES OF PHYSICAL QUANTITIES

There are two types of physical quantities:

(i) Base Quantities **(ii)** Derived Quantities

BASE QUANTITIES

Definition:

"Seven physical quantities which form the foundation for other physical quantities are called base quantities".

Base Quantities, Their SI Units with Symbols:

Base quantities and their units have been given below:

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 QUANTITIES

Definition:

"Those physical quantities which are expressed in terms of base quantities**"**.

Derived Quantities, Their SI Units with Symbols:

Derived quantities and their units have been given below:

Quantities		Units	
Name	**Symbol**	**Name**	**Symbol**
Speed	v	metre per second	ms^{-1}
Acceleration	a	metre per second per second	ms^{-2}
Volume	V	cubic metre	m^3
Force	F	newton	N or ($kg\ ms^{-2}$)
Pressure	P	Pascal	Pa or ($N\ m^{-2}$)
Density	ρ	kilogramme per cubic metre	Kgm^{-3}
Charge	Q	Coulomb	C or (As)

1.2 Q.2. What is international system of units? Write its role in the development of science. ***(K.B+A.B)***

INTERNATIONAL SYSTEM OF UNITS

Introduction:

The world-wide commonly accepted system of units adopted in the eleventh General Conference of Weight and Measures held in the Paris in 1960 is called international systems of units commonly referred as SI.

Role of S.I:

The role of SI in the development of science is as under:

- This system produces uniformity in measurement all over the world.
- It makes easy to exchange scientific and technical information.
- It provides us system of prefixes that makes our calculations easy.

1.2 Q.3. Differentiate between base and derived units. ***(K.B)***

Ans: **DIFFERENTIATION**

Differences between Base and Derived units are as follows:

Base Units	Derived Units
Definition	
• The units that describe base quantities are called base units.	• The units used to measure derived quantities are called derived units.
Formation	
• Each base quantity has its SI unit, as defined by international system of 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.
Numbers	
Base units are seven in numbers.	Derived Units are multiples in number.
Examples	
• meter • kilogram • second • ampere • Candela • Kelvin • Mole	• unit of area $(meter)^2$ • unit of volume $(meter)^3$

1.2, 1.3 SHORT QUESTIONS

Q.1. What are Physical quantities? ***(K.B)***

Ans: *Given on Page # 05*

Q.2. What are the basic characteristics of physical quantities? ***(K.B)***

Ans: *Given on Page # 05*

Q.3. Define Unit. ***(K.B)***

Ans: *Given on Page #* 06

Q.4. What are Base quantities? Enlist them. ***(K.B)*** **(LHR 2012, GRW 2013, LHR 2016)**

Ans: *Given on Page # 06, 07*

Q.5. What are Derived quantities? ***(K.B)*** **(LHR 2012, 2013, 2015)**

Ans: *Given on Page # 06, 07*

Q.6. What are Base units? Write their names and symbols. ***(K.B)*** **(GRW 2013)**

Ans: *Given on Page # 06, 07*

Q.7. What are derived units? ***(K.B)***

Ans: *Given on Page # 06,07*

Q.8. How can you differentiate between base and derived quantities? ***(K.B)*** **(QUICK QUIZ PG#7LHR 2012)**

Ans: *Given on Page # 06, 07*

Q.9. Identify the base Quantities in the following: ***(K.B)*** **(QUICK QUIZ Pg. # 7)**

(i) Speed (ii) Area (iii) Force (iv) Distance

(i) **SPEED**

Formula:

Speed = distance / time

Unit: ms^{-1}

Base Quantities Involved:

- Length
- Time

(ii) AREA

Formula:

Area = Length x width

Unit: m^2

Base Quantities Involved:

- Length

(iii) FORCE

Formula:

$F = ma$ .....(i)

$$a = \frac{change\ in\ velocity}{time} .....(ii)$$

$$Velocity = \frac{displacement}{time}$$

Putting in eq. (ii)

$$a = \frac{displacement}{(time)^2}$$

Putting in eq. (i)

$$F = \frac{mass \times displacement}{(time)^2}$$

Unit: $F = (kg\ ms^{-2})$

Base quantities involved:

- Mass
- Length
- Time

(iv) DISTANCE

Distance is a length of a path that is a base quantity.

Q.10. Identify the following as base or derived quantity: Density, force, mass, speed, time, length, temperature and volume. *(K.B)* **(QUICK QUIZ Pg. # 7)**

Ans: BASE AND DERIVED QUANTITIES

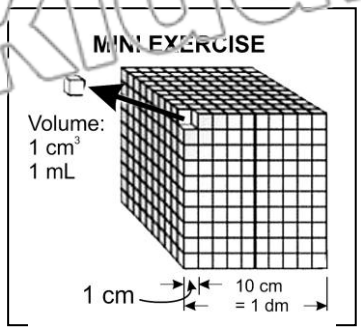
Base Quantities:

mass, time, length, temperature

Derived Quantities:

density, force, speed, volume

Q.11. Express $1m^3$ = _____ L. *(K.B)* **(Mini Exercise PTB Pg. # 5)**



Solution:

1 m = 10 dm

Taking cube on both sides

$$(1m^3) = (10dm)^3$$

$$1m^3 = 1000dm^3$$

As

$$1L = 1dm^3$$

Hence,

$$1m^3 = 1000L$$

Q.12. Right and wrong way to write unit equation. ***(Conceptual Base+A.B)***

Ans. This equation is correct:

$$\text{speed} = \frac{10m}{2s} = 5\,m/s$$

This equation is incorrect :

$$\text{speed} = \frac{10}{2} = 5\,m/s$$

It is incorrect because the m and s have been left out. 10 divided by 2 equals 5, and not 5 m/s

1.2, 1.3 MULTIPLE CHOICE QUESTIONS

1. The international system of units is abbreviated as: ***(K.B)***

(A) IS (B) SI

(C) Both a & b (D) none

2. The SI unit of intensity of light is: ***(K.B)***

(A) Newton (B) Kelvin

(C) Kilogram (D) Candela

3. SI unit of electric charge is*(K.B)*

(A) Ampere (B) Kelvin

(C) Pascal (D) Coulomb

4. Amount of a substance in terms of numbers is measured in: ***(K.B)***

(Exercise iii, LHR 2011)

(A) Gram (B) kilogram

(C) Newton (D) mole

5. 1L =? ***(K.B+A.B)***

(A) 10 dm^3 (B) 100 dm^3

(C) 1 dm^3 (D) 1000 dm^3

6. 1mL =?*(K.B+A.B)*

(A) 10 cm^3 (B) 100 cm^3

(C) 1 cm^3 (D) 1000 cm^3

7. Identify the base quantity in the following. ***(K.B)***

(A) Speed (B) Area

(C) Force (D) Distance

8. S.I unit of pressure is: ***(K.B)***

(A) Pa (B) Nm^2

(C) Nm^{-2} (D) Both (A) and (C)

1.4 PREFIXES
1.5 SCIENTIFIC NOTATION

LONG QUESTIONS

1.4 Q.1. Define Prefixes with examples and write their advantages. *(K.B+U.B+A.B)*

Ans: **PREFIXES**

Definition:

"The words or letters added before SI units are called Prefixes. These are multiples and submultiples of SI units".

Or

"You can make a unit bigger or smaller by putting an extra symbol, called a prefix."

Examples:

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

Advantages:

- Prefixes can be used to express very large quantities in shorter way as:

  200 000 ms^{-1} = 200 x 10^{3} ms^{-1} = 200 k ms^{-1}

  4 800 000 W = 4 800 x 10^{3} W = 4 800 k W

  = 4.8 x 10^{6} W = 4.8 M Hz

  3 300 000 000 Hz = 3 300 x 10^{6} Hz = 3 300 M Hz = 3.3 x 109 Hz

  = 3.3 GHz

- Prefixes can be used to express very small quantities in appropriate way as:

  0.00002 g = 0.02x10^{-3} g = 2 x10^{-6} g = 20μg

  0.0000000081m = 0.0081x10^{-6}m = 8.1x10^{-9}m = 8.1nm

- Prefixes make our calculations and unit conversions easy as divide 20,000 g by 1000 to express it into kilogram, since kilo represents 10^{3} or 1000.

  Thus, $20,000\text{g} = \frac{20,000}{1000}\text{kg} = 20\text{kg}$

  Or $20,000\text{g} = 20\times10^{3}\text{g} = 20\text{kg}$

1.5 Q.1. Define and Explain Scientific Notation. *(K.B+U.B+A.B)*

Ans: **SCIENTIFIC NOTATION**

Introduction:

A simple but scientific way to write large or small numbers is to express them in some power of ten. The Moon is 384000000 metres away from the Earth. Distance of the moon from the Earth can also be expressed as 3.84 x10^{8} m. This form of expressing a number is called the standard form or scientific notation.

Definition:

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

Advantages:

- Scientific notation saves writing down or interpreting large numbers of zeroes.
- Scientific notation helps us in computing very large and very small values. It makes our calculations fast and easy.

Example:

A number 62750 can be expressed as 62.75×10^3 or 6.275×10^4 or 0.6275×10^5. All these are correct. But the number that has one non-zero digit before the decimal i.e. 6.275×10^4 preferably be taken as the standard form. Similarly the standard form of 0.00045 s is 4.5×10^{-4} s.

1.4, 1.5 SHORT QUESTIONS

Q.1. What do you know about prefixes? *(K.B)*

Ans: *Given on Page # 10*

Q.2. Why no prefix is used with kilogramme? *(K.B)*

Ans:

NO PREFIX WITH KILOGRAMME

No prefix is used with kilogramme since it already contains the prefix kilo. We cannot use two prefixes together.

Example:

The width of a wire cannot be written as $3\text{m}\mu\text{m}$ $(3\left(3\times10^{-3}\times10^{-6}\text{m}\right)$ instead it should be written as $3\text{nm}\left(3\times10^{-9}\text{m}\right)$.

Q.3. Define Scientific Notation. *(K.B)*

Ans: *Given on Page # 10*

Q.4. Define Standard Notation. *(K.B)*

Ans: *"The scientific notation in which there is only on e non-zero digit before the decimal is called standard Notation."*

Q.5. Write Multiples and Submultiples of Length. *(K.B)*

Ans:

MULTIPLES AND SUBMULTIPLES

Some multiples and submultiples of length are as follows:

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

Q.6. Name five prefixes most commonly used. ***(K.B)*** **(Quick Quiz PTB Pg. # 8)**

Ans: **PREFIXES**

Following are the prefixes most commonly used:

(i) kilo (k) = 10^3 **(iv)** milli (m) = 10^{-3}

(ii) mega (M) = 10^6 **(v)** nano (n) = 10^{-9}

(iii) micro (μ) = 10^{-6}

Q.7. The Sun is one hundred and fifty million kilometers away from the Earth. Write this as an ordinary whole number. ***(K.B)*** **(Quick Quiz PTB Pg. # 8)**

Ans: **DISTANCE OF THE SUN**

(a) In ordinary notation 150, 000, 000 km

(b) In scientific notation 1.5×10^8 km

Q.8. Write the numbers given below in scientific notation. ***(K.B)*** **(Quick Quiz PTB Pg. # 8)**

Ans: **SCIENTIFIC NOTATION**

(a) 3000000000 ms^{-1}

$= 3.0 \times 10^9\ ms^{-1}$

(b) 6400000 m

$= 6.4 \times 10^6$ m

(c) 0.0000000016 g

$= 1.6 \times 10^{-9}$ g

(d) 0.0000548 s

$= 5.48 \times 10^{-5}$ s

1.4, 1.5 MULTIPLE CHOICE QUESTIONS

1. The terms used internationally for multiples and submultiples of various units are known as: ***(K.B)***

(A) Standard (B) Scientific notation

(C) Prefixes (D) All of above

2. One meter is equal to: ***(K.B)***

(A) 10^3 mm (B) 10^{-3} km

(C) 10^2 cm (D) All

3. One Femto is equal to: ***(K.B)***

(A) 10^{15} (B) 10^{-15}

(C) 10^{-9} (D) 10^{-12}

4. 10^6 Stands for: ***(K.B)***

(A) micro (B) pico

(C) nano (D) mega

5. 1μs is equal to: ***(K.B)***

(A) 10^{-9} s (B) 10^{-3} s

(C) 10^{-6} s (D) 10^{-12} s

6. For scientific notation internationally accepted practice is that there should be how many digit(s) before the decimal point. ***(K.B)***

(A) One (B) Two

(C) Three (D) No

7. Distance of moon from the earth is: *(K.B)*

(A) 384000000 km (B) 3.84×10^5 km

(C) 3.84×10^8 m (D) 1.5×10^8 km

8. Distance of the sun from the earth is: *(K.B)*

(A) 384000000km (B) 3.84×10^5 km

(C) 3.84×10^3 km (D) 1.5×10^8 km

9. Mass of the earth atmosphere to 2500 km is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{22} g (B) Above 10^9g

(C) Above 10^6g (D) Above 10^3g

10. Mass of ocean is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{22} g (B) Above 10^9g

(C) Above 10^6g (D) Above 10^3g

11. Mass of elephant is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{22} g (B) Above 10^9g

(C) Above 10^6g (D) Above 10^3g

12. Mass average human is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{22} g (B) Above 10^9g

(C) Above 10^6g (D) Above 10^3g

13. Mass of 1.0 litre of water is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above10^{22} g (B) Above 10^9g

(C) Above 10^6g (D) Approximately 10^3g

14. Mass of grain of table salt is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{-9} g (B) Approximately 10^{-18}g

(C) Below 10^{-22}g (D) Above 10^{-24}g

15. Mass of typical protein molecule is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{-9} g (B) Approximately 10^{-18}g

(C) Below 10^{-22}g (D) Above 10^{-24}g

16. Mass of uranium atom is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{-9} g (B) Approximately 10^{-18}g

(C) Below 10^{-22}g (D) Above 10^{-24}g

17. Mass water molecules is: *(K.B)* **(TIDBITS Pg. # 8)**

(A) Above 10^{-9} g (B) Approximately 10^{-18}g

(C) Below 10^{-22}g (D) Above 10^{-24}g

1.6 MEASURING INSTRUMENTS METRE RULE, MEASURING TAPE VERNIER CALLIPERS, SCREW GUAGE

LONG QUESTIONS

1.6 Q.1. What do you know about Metre Rule? *(K.B+A.B+U.B)* **(LHR 2016)**

Ans: **METRE RULE**

Introduction:

It is an instrument which is used in laboratories to measure the length of an object or distance between two points. At one time, the standard metre was the distance between two marks on a metal bar kept at the office of weights and Measures in Paris.A metre rule has been shown in the figure.

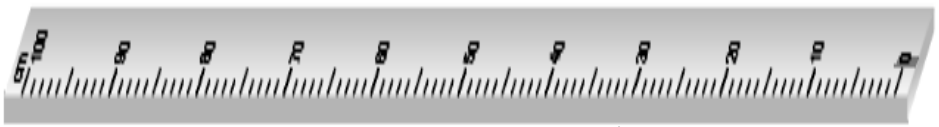


Figure: A Metre Rule

Construction:

It is one meter long which is equal to 100 centimeters. Each centimeter is divided into 10 small divisions called millimeter (mm).

Least Count:

"The minimum measurement that can be taken by an instrument accurately is called its least count**"**.

The least count of meter rule is 1mm. This is the minimum length that can be accurately measured by the metre rule.

Position of eye:

While measuring the length, or distance with the help of metre rule, we should keep the eye vertically above the reading point. The reading becomes doubtful if the eye is positioned either left or right to the reading point.

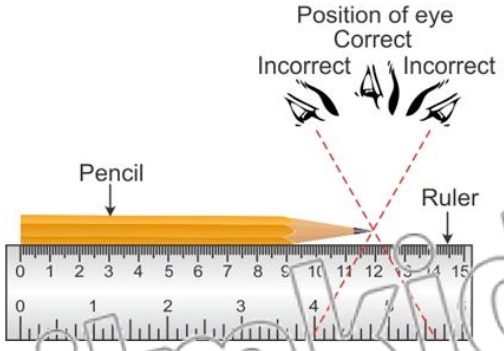


Figure: Wrong Position of the Eye to Note the Reading

Figure: Correct Position of the Eye to Note the Reading From a Metre Rule

Parallax Error:

"The error in measurement due to wrong position of eye is called parallax error**"**.

To avoid parallax error while taking measurement from metre rule we should keep the eye vertically above the reading point.

Note: The standard metre was the distance between two marks on a metal bar kept at the office of Weights and Measures in Paris.

1.6 Q.2.What do you know about measuring tape? ***(K.B+A.B)***

Ans: **MEASURING TAPE**

Introduction:

It is an instrument which is used in daily life to measure the length in metres and centimetres.

Figure: A Measuring Tape

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.

Use:

The tape is usually self- supporting, with an end-of-tape tab. usually it is used by blacksmith and carpenters.

VERNIER CALLIPERS

1.6 Q.3.Write a detail note on Vernier Callipers? ***(K.B+A.B+U.B)***

Ans: **VERNIER CALLIPERS**

Introduction:

The accuracy obtained in measurements using a metre rule is upto **1 mm**. However accuracy greater than **1 mm** can be obtained by using some other instruments such as a Vernier Callipers. Vernier Callipers is a device which is generally used to measure length as small as **$1/10^{th}$** of a milimetre **(0.1 mm 0r 0.01cm).**

Construction:

- A Vernier Callipers consists of two jaws, one is the fixed jaw with main scale attached to it. Main scale has centimeter and millimeter marks on it. The other jaw is a moveable jaw as shown in the figure:

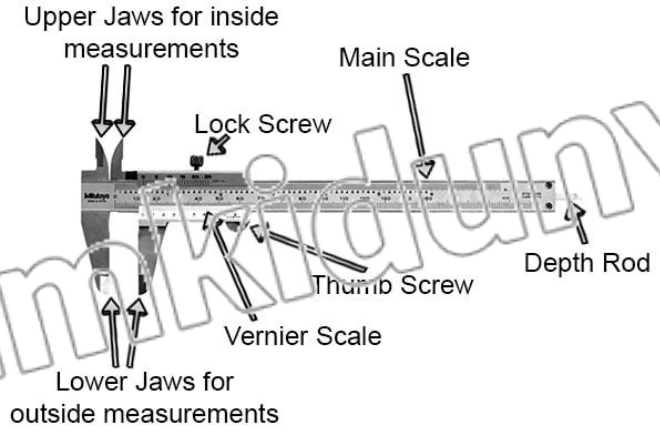


Figure: A Cylinder Placed Between Outer Jaws of Vernier Callipers

- It has Vernier scale having 10 divisions over it such that each of its division is 0.9 mm. So the total length of Vernier scale is 9mm (0.9mm x 10 = 9mm)

- Lower jaws are to find external diameter of an object while upper jaws are used to find Internal diameter of the object

Vernier Constant:

"The difference between one small division on main scale and one Vernier scale division is called Vernier constant".

One small division on main scale = 1 mm

One small division on Vernier scale = 0.9 mm

Least count = 1 mm – 0.9 mm

= 0.1 mm

Vernier Constant of Vernier Callipers is also called least count of Vernier Callipers.

Least count of Vernier Callipers can also be found as follows:

$$\text{Least Count of Vernier Callipers} = \frac{\text{smallest reading on main scale}}{\text{no. of divisions on vernier scale}}$$

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

$$= 0.1\text{mm} = 0.01\text{cm}$$

Working of Vernier Callipers:

First of all find the error, if any, in the measuring instrument known as zero error of the instrument. To find the zero error, close the jaws of Vernier callipers gently. If the zero line of the Vernier scale coincides with the zero of the main scale then the zero error is zero as shown in the figure below:

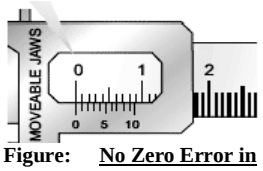


Figure: No Zero Error in Vernier Callipers

Zero error will exist if zero line of the Vernier scale is not coinciding with the zero of the mains scale.

Types of Zero Errors:

There are two types of zero 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 as shown in the figure below.

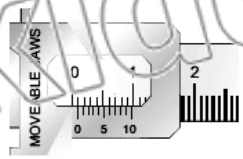


Figure: Positive Zero Error in Vernier Callipers

- **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.

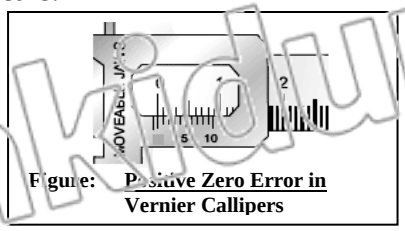


Figure: Positive Zero Error in Vernier Callipers

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:

- Before using Vernier Callipers find its zero error if any.
- Now place the solid cylinder between jaws of the Vernier callipers whose diameter is to be found.
- 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. This will be main scale reading.
- Next find the Vernier scale division that is coinciding with any division on the main scale. Multiply it by least count of Vernier callipers it will be Vernier scale reading.
- Add Vernier scale reading in the main scale reading.
- This will give observed diameter of the solid cylinder.
- Add zero correction to get the correct measurement.

1.6 SHORT QUESTIONS

Q.1. Define Vernier Constant or Define Least Count of Vernier Callipers. ***(K.B)***
(Exercise 1.7, LHR 2017)

Ans *Given on Page # 15*

Q.2. What is digital Vernier Callipers? ***(K.B)***

Ans:

DIGITAL VERNIER CALLIPERS

Digital Vernier Callipers have greater precision than mechanical Vernier Callipers. Least count of Digital Vernier Callipers is 0.01 mm

Q.3. What is Hubble Space Telescope? ***(K.B)***

Ans:

HUBBLE SPACE TELESCOPE

Hubble Space Telescope orbits around the Earth. It provides information about stars.

Q.4. What is the least count of the Vernier Callipers? ***(U.B+K.B)***

Ans: *Given on Page # 15*

Q.5. What is the range of Vernier Callipers used in your laboratory? ***(K.B)***
(Quick Quiz Pg. # 12)

Ans:

RANGE OF VERNIER CALLIPERS

In our school lab The Mitutoyo 530-119 Vernier Callipers are available. These have an Inch/Metric Dual Scale and a measuring range of 0 to 12"/ 300mm with an accuracy of 0.04mm and 0.02mm.

Q.6. How many divisions are there on Vernier scale of Vernier Callipers? ***(K.B+U.B)***
(Quick Quiz Pg. # 12)

Ans:

VERNIER SCALE DIVISIONS

There are 10 divisions on Vernier scale of the Vernier Callipers. The length of each division is 0.9mm.

Q.7. Why do we use zero correction? ***(K.B)*** **(Quick Quiz Pg. # 12)**

Ans:

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. We use zero correction to take a correct measurement free of error.

EXAMPLE 1.1

Find the diameter of a cylinder placed between the outer jaws of Vernier Callipers as shown in figure below: ***(U.B+A.B)***

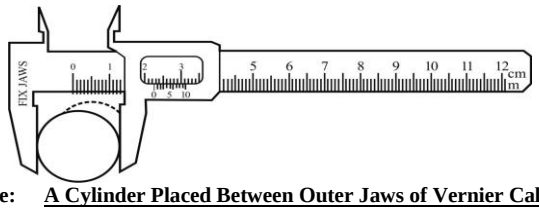


Figure: A Cylinder Placed Between Outer Jaws of Vernier Callipers

Solution:

Zero Correction:

On closing the jaws of Vernier Callipers, the position of Vernier scale as shown in figure below:

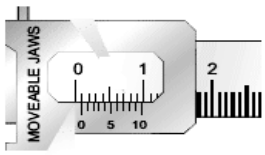


Figure: For Observing Zero Error in Vernier Callipers

Main scale reading = 0.0 cm
Vernier division coinciding with main scale = 7 div.
Vernier scale reading = 7 x 0.01 cm = 0.07 cm
Zero error = 0.0cm+0.07 cm
= +0.07 cm
Zero correction (Z.C) = - 0.07 cm
Diameter of the cylinder:
(When the given cylinder is kept between the jaws of the Vernier Callipers as shown in figure above)
Main scale reading = 2.2 cm
Vernier div. coinciding with main scale div. = 6 div.
Vernier scale reading = 6 x 0.01 cm
= 0.06 cm
Observed diameter of the cylinder =2.2cm+0.06 cm
= 2.26 cm
Correct diameter of the cylinder =2.26cm-0.07 cm
= 2.19 cm

Conclusion:

Hence, the correct diameter of the given cylinder as found by Vernier Callipers will be 2.19 cm.

1.6 MULTIPLE CHOICE QUESTIONS

1. The least count of Vernier Callipers is: *(K.B)* **(LHR 2015)**
(A) 0.1cm (B) 0.1mm
(C) 0.01cm (D) Both b & c

2. Total length of the Vernier Scale is: *(K.B)*
(A) 1mm (B) 9 mm
(C) 10 mm (D) 1 cm

3. Number of divisions on the Vernier Scale are: *(K.B)*
(A) 1 (B) 9
(C) 10 (D) 100

4. Length of the smallest division on main scale of the Vernier Callipers is: *(K.B)*
(A) 1 cm (B) 1 mm
(C) 0.9 mm (D) All

5. Separation between division on the Vernier Scale of the Vernier Callipers is: *(K.B)*
(A) 1 cm (B) 1 mm
(C) 0.9 mm (D) All

6. If zero of the Vernier scale is on the right side of the zero of the main scale then it is known as: *(K.B)*
(A) Positive (B) Negative
(C) No error (D) none of these

7. 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: *(K.B)*
(A) Positive (B) Negative
(C) None of these (D) No error

8. If zero of the Vernier scale is on the right side of the zero of the main scale then zero error is to be: *(K.B)*
(A) Added (B) Subtracted
(C) Multiplied (D) Divided

9. If zero of the Vernier scale is on the left side of the zero of the main scale then zero error is to be: *(K.B)*
(A) Added (B) Subtracted
(C) Multiplied (D) Divided

10. The least count of digital Vernier Callipers is: *(K.B)*
(A) 0.1cm (B) 0.01mm
(C) 0.001cm (D) Both B & C

11. Vernier Constant is also known as: *(K.B)*
(A) Pitch (B) Proportionality constant
(C) Vernier value (D) Least count

12. Which one is more precise? *(K.B)*
(A) Metre rule (B) Measuring tape
(C) Vernier Callipers (D) Digital Vernier Callipers

1.6 SCREW GAUGE

1.6 Q.4 Write a note on the Screw Gauge. ***(K.B+U.B+A.B)***

Ans: **SCREW GAUGE**

Introduction:

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

- A simple screw gauge 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. It is fixed at the end of U-shaped frame opposite to the stud.
- A thimble has a threaded spindle inside it.
- There is ratchet at the end of thimble it resists undue pressure.

Pitch of Screw Gauge:

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; this distance is called the pitch of screw gauge on the spindle.

Circular Scale:

The thimble has 100 divisions around its one end. It is the circular scale of the screw gauge. As the 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.

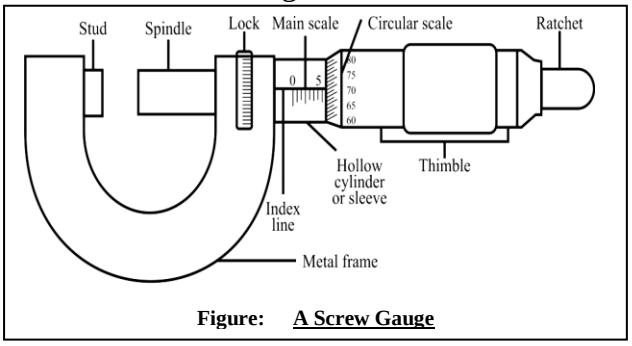


Figure: **A Screw Gauge**

Least Count:

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

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

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

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

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

WORKING OF 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.

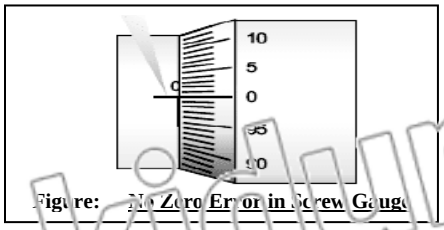


Figure: No Zero Error in Screw Gauge

If zero of circular scale does not coincide with index line, then there will be zero error in the screw gauge.

Types of Zero Errors:

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.

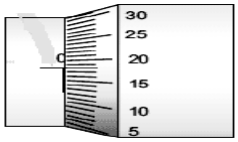


Figure: Positive Zero Error (18 × 0.01 mm = + 0.18 mm)

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.

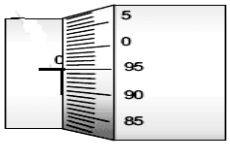


Figure: Negative Zero Error (100-95) × 0.01 mm = – 0.05 mm)

Taking Reading on a Screw Gauge:

- Before using Screw Gauge find its zero error if any
- 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 division (coinciding with index line) with least count.
- Add circular scale reading in the main scale reading. This will give observed diameter of wire.
- Add zero correction to get the correct measurement.

1.6 SHORT QUESTIONS

Q.1. Define Pitch of Screw Gauge. ***(K.B)***
Ans: *Given on Page # 20*
Q.2. What is the least count of a Screw Gauge? ***(K.B)*** **(Mini Exercise PTB Pg. # 15)**
Ans: *Given on Page # 20*
Q.3. What is the pitch of your laboratory Screw Gauge? ***(K.B)*** **(Mini Exercise PTB Pg. # 15)**
Ans: *Given on Page # 20*
Q.4. What is the range of your laboratory Screw Gauge? ***(K.B)*** **(Mini Exercise PTB Pg. # 15)**
Ans: **RANGE OF LABORATORY SCREW GAUGE**
In my school lab nickel plated brass screw gauge is present, with ratchet top, accurately machined. Stainless steel rod with Range of 0-25 x 0.01 mm.
Q.5. Which one of the two instruments is more precise and why? ***(K.B+U.B)*** **(Mini Exercise PTB Pg. # 15)**
(a) Vernier Callipers
(b) Screw Gauge
OR
Explain the statement, "A micrometer screw gauge measures more accurately than a vernier calipers". **(GRW 2014)**
Ans: **MORE ACCURATE**
We know,
Least count of Screw Gauge = L.C = 0.01mm
Least count of Vernier Callipers = L.C = 0.1mm
This shows that:
A micrometer Screw Gauge can measure more accurately than Vernier Callipers because a micrometer Screw Gauge can accurately measure up to one 100th part of a millimeter whereas Vernier Callipers can only measure accurately up to one 10th part of a millimeter.

EXAMPLE 1.2

Find the diameter of a wire using a Screw Gauge. ***(U.B+A.B)***
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 anticlockwise direction. Place the given wire in the gap as shown in figure:

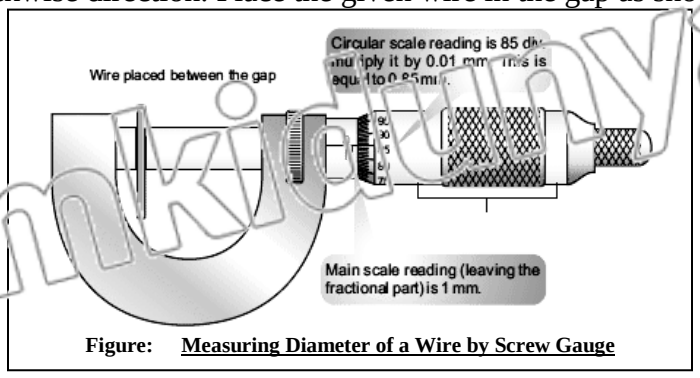


Figure: **Measuring Diameter of a Wire by Screw Gauge**

(iv) Turn the ratchet so that the object is pressed gently between the studs and the spindle.

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

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

(vii) 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 as shown in the figure:

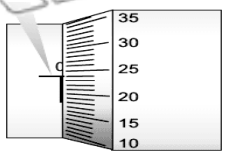


Figure: To Note Zero Error

Main Scale reading = 0 mm

Circular Scale reading mm = 24 x 0.01

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 (When the given wire is pressed by the stud and spindle of the screw gauge)

Main Scale reading = 1 mm

No. of divisions on Circular Scale = 85 div.

Circular Scale reading = 85x0.01 mm = 0.85 mm

Observed diameter of the given wire = 1mm+0.85 mm = 1.85 mm

Correct diameter of the given wire = 1.85 mm - 0.24 mm = 1.61 mm

Result:

Hence, the diameter of the given wire will be 1.61 mm.

1.6 MULTIPLE CHOICE QUESTIONS

1. The least count of Screw Gauge is: ***(K.B)***

(A) 0.1 mm (B) 0.01 mm

(C) 0.1 cm (D) 0.01 cm

2. Total number of divisions on the circular scale of Screw Gauge are: ***(K.B)***

(A) 10 (B) 20

(C) 100 (D) 200

3. Pitch of the Screw Gauge is: ***(K.B)***

(A) 1m (B) 1 mm

(C) 1 cm (D) 0.1 mm

4. If the zero of the circular scale is above the horizontal line then the zero error will be: ***(K.B)***

(A) Positive (B) Negative

(C) None of these (D) No error

5. If the zero of the circular scale is below the horizontal line then the zero error will be: ***(K.B)***

(A) Positive (B) Negative
(C) None of these (D) No error

6. If the zero of the circular scale is above the horizontal line then the zero error is to be: ***(K.B)***

(A) Added (B) Subtracted
(C) Multiplied (D) Divided

7. If the zero of the circular scale is below the horizontal line then the zero error is to be: ***(K.B)***

(A) Added (B) Subtracted
(C) Multiplied (D) Divided

8. In Screw Gauge, the distance moved forward or backward in one complete rotation of the circular scale is known as: ***(K.B)***

(A) Least count (B) Pitch
(C) Constant (D) None of above

1.6 MASS MEASURING INSTRUMENTS PHYSICAL BALANCE

LONG QUESTIONS

1.6 Q.1 What is Physical Balance? Write its construction and working. ***(K.B+U.B+A.B)***

Ans: **PHYSICAL BALANCE**

Introduction:

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

Construction:

- It consists of a beam resting at the center on a fulcrum.
- The beam carries scale pans over the hooks on either side. (as shown in the figure).

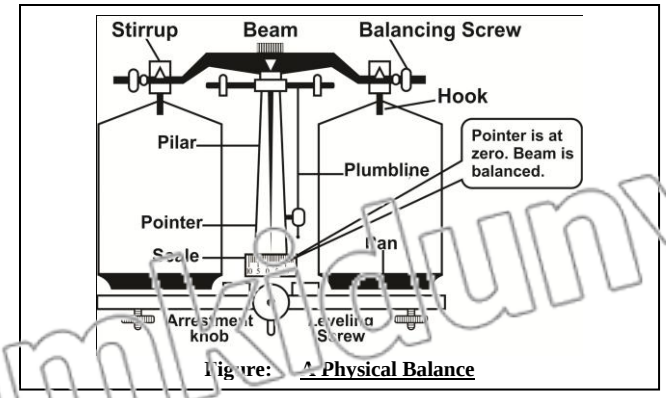


Figure: A Physical Balance

- 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.

NOTE: The standard kilogram is a block of platinum alloy kept at the office of Weights and Measure in Paris.

EXAMPLE 1.3

Working:

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.

1.6 Q.2 Briefly explain lever balance and electronic balance? ***(K.B+U.B+A.B)***

Ans:

LEVER BALANCE

Introduction:

A lever balance is a type of physical balance used to measure mass of objects.

Construction and Working:

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.

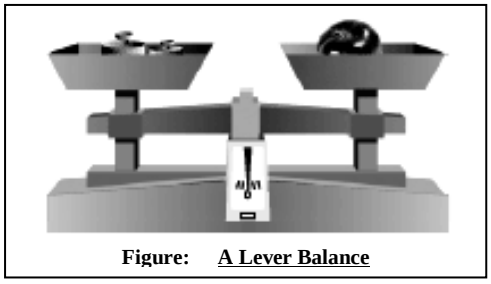


Figure: A Lever Balance

ELECTRONIC BALANCE

Introduction:

An electronic balance is a modern type of physical balance used to measure mass of objects with greater accuracy

Construction and Working:

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. Then the object to be weighed is placed on balance. The reading on the balance gives us the mass of the body placed over it.

Least Count:

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.

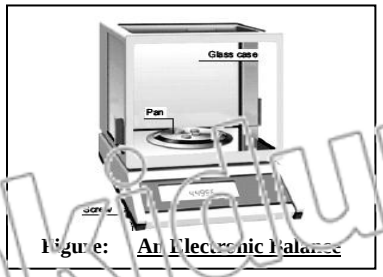


Figure: An Electronic Balance

1.6 Q.3 Which one of the following is the most accurate? *(U.B+A.B)*
Beam balance, Physical balance, and Electronic balance.

Ans: **THE MOST ACCURATE BALANCE**

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

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.

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.

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.

Conclusion:

The precision of a balance 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 even smaller difference of the order of 0.0001g or 0.1 mg. Such balances are considered the most precise balance.

1.6 STOP WATCH

1.6 Q.4 Write a note on the Stop Watch. *(K.B+A.B)*

Ans: **STOP WATCH**

Introduction:

A stop watch is used to measure the interval of an event.

Types of Stop Watch:

There are two types of stop watch.

- Mechanical stop watch
- Digital stop watch (Electronic stop watch)

Mechanical Stop Watch

A mechanical stop watch can measure a time interval up to a minimum 1/10 second or 0.1 second.

Figure: A Mechanical Stop Watch

Use:

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

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.

Figure: A Digital Stop Watch

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.

1.6 MEASURING CYLINDER

1.6 Q.5 What do you know about Measuring Cylinder? How volume of liquids is measured by using this cylinder? *(K.B+U.B+A.B)*

Ans: **MEASURING CYLINDER**

Introduction:

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 curves upwards.

Precautions:

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

- The cylinder must be placed on horizontal surface.

- The eye should be kept on a level with the bottom of the meniscus (curved surface) to avoid parallax error. 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 in this way parallax error will appear in measurement.

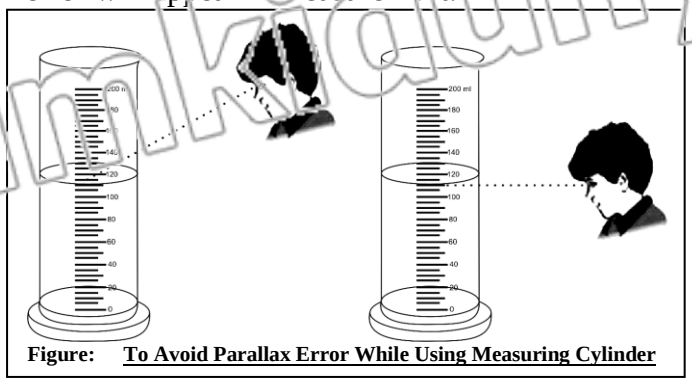


Figure: To Avoid Parallax Error While Using Measuring Cylinder

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.

Procedure:

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 $V_f - V_i$.

1.6 SHORT QUESTIONS

Q.1. What is the function of balancing screws in physical balance? ***(K.B)*** **(Mini Exercise Pg. # 16)**

Ans:

FUNCTION OF SCREWS

The function of balancing screws is to bring the pointer at zero position on raising the beam.

Q.2. On what pan we place the object and why? ***(K.B)***

Ans:

LEFT PAN

We place the object on left pan and standard masses on the right pan just for the convenience of user because we have to change standard masses again and again and it becomes easy to change standard masses by right hand as about 70% of the people are right handed.

Q.3. Why the meniscus of mercury is convex? ***(Conceptual Base)***

Ans: Mercury does not wet glass the cohesive forces within the drops are stronger than the adhesive forces between the drops and glass. When liquid mercury is confined in a tube, its surface (meniscus) has a convex shape because the cohesive forces in liquid mercury tend to draw it into a drop.

Q.4. Why is the meniscus of water different from mercury? ***(Conceptual Base)***

Ans: Mercury shows a convex meniscus (the centre is higher than the edges), because internal cohesive forces are stronger than the force between the glass wall and the metal. In contrast, water exhibits a concave meniscus (the centre is lower than the edges), because the attraction between the wall and the water is stronger than the water's internal cohesion.

1.6 MULTIPLE CHOICE QUESTIONS

1. A physical balance is used to measure: ***(K.B)*** **(GRW 2012)**

(A) Weight (B) Volume
(C) Length (D) mass

2. Least count of mechanical stop watch is: ***(K.B)***

(A) 1 second (B) 1 minute
(C) 0.1 second (D) 0.01 second

3. Least count of digital stop watch is: ***(K.B)***

(A) 1 second (B) 1 minute
(C) 0.1 second (D) 0.01 second

4. Digital stop watch can measure up to part of second: ***(K.B)*** **(LHR 2012)**

(A) 1000th (B) 100th
(C) 50th (D) 10th

5. To measure correctly the volume of the water, the eye must be kept on which surface of meniscus: ***(K.B)***

(A) Lower (B) Upper
(C) Middle (D) All of above

6. To measure correctly the volume of the mercury, the eye must be kept on which surface of the meniscus: ***(K.B)***

(A) Lower (B) Upper
(C) Middle (D) All of above

1.7 SIGNIFICANT FIGURES

LONG QUESTIONS

1.7 Q.1. Define Significant figures? Write Rules for finding significant figures in a measurement. ***(K.B+U.B+A.B)***

Ans:

SIGNIFICANT FIGURES

Definition:

"All the accurately known digits and the first doubtful (estimated) digit in a measurement are called Significant Figures**"**.

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.

Precision and Significant Figures:

Significant figures reflect the precision in a measured quantity. Greater the number of significant figures greater will be the precision in the measurement.

RULES FOR FINDING SIGNIFICANT DIGITS

The following rules are helpful in identifying significant digits in a measurement:

(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 2705, the number of significant figures is 4.

(iii) Final or ending zeros on the right side in the decimal fractions are considered significant. For example the number of significant figures in 275.00 is 5.

(iv) The zeros written on the left side of the decimal point for the purpose of spacing the decimal point are not significant. For example in 0.027, the number of significant figures is 2.

(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 part 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 x 105, the number of significant figure is 3.

1.7 Q.2. Write down the rules to round off the numbers? ***(K.B+U.B+A.B)***

(Rounding The Numbers Pg. # 22)

Ans: **RULES FOR ROUNDING 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

1.7 SHORT QUESTIONS

Q.1. Write factors effecting accuracy in a measurement. ***(K.B)***

Ans: **ACCURACY IN A MEASUREMENT**

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

Q.2. What is meant by uncertainty or error in measurement? ***(K.B)*** **(LHR 2012)**

Ans: **UNCERTAINITY**

Definition:

"Deviation of the measured value from the true value is called uncertainty in the measurement.**"**

Causes of Uncertainty:

- Instrument error (zero error)
- Inexpertness of observer
- Unpredictable environment changes

Q.3. Write names of some safety equipment used in laboratory. ***(K.B)***

Ans: **SAFETY EQUIPMENT**

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

Q.4. Write some laboratory safety Rules. ***(K.B)***

Ans:

LABORATORY SAFETY RULES

The safety rules for laboratory are:

- Here are some important laboratory rules that must be observed for your safety.
- 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 carefuly 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.

EXAMPLE 1.4

Find the number of significant figures in each of the following values. Also express them in scientific notations. a) 100.8 s b) 0.00580 km c) 210.0 g ***(U.B+A.B)***

Solution:

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

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

1.7 MULTIPLE CHOICE QUESTIONS

1. In any measurement, the accurately known digits and first doubtful digit are known as: ***(K.B)***

(A) Prefixes (B) Significant figures
(C) Real numbers (D) All

2. The radius of wire is 0.022 cm. The number of significant figures in the measurements are: ***(U.B)***

(A) 1 (B) 2
(C) 3 (D) 4

3. The number of significant figures in 1.406 are: ***(U.B)***

(A) 4 (B) 3
(C) 2 (D) 1

4. The number of significant figures in 1.40×10^5 are: ***(U.B)***

(A) 1 (B) 2
(C) 3 (D) 4

5. The zeroes in between the digits are considered: ***(K.B)***

(A) Significant (B) Insignificant
(C) Constant (D) None of above

6. 1.35 is rounded off as: ***(K.B)***

(A) 1.36 (B) 1.4
(C) 1.45 (D) 1.3

7. The number of significant figures in 0.036 are: ***(U.B)*** **(GRW 2012)**
(A) 1 (B) 2
(C) 3 (D) 4

8. 2.1203 cm is the length measured by meter rule, the number of significant figures in measurement are: ***(U.B)***
(A) 1 (B) 2
(C) 3 (D) 4

MCQ'S ANSWER KEY (TOPIC WISE)

1.1 INTRODUCTION TO PHYSICS

1	2	3	4	5	6	7	8
B	B	A	D	C	C	C	D

1.2 PHYSICAL QUANTITIES

1.3 INTERNATIONAL SYSTEM OF UNITS

1	2	3	4	5	6	7	8
B	D	D	D	C	C	D	D

1.4 PREFIXES

1.5 SCIENTIFIC NOTATION

1	2	3	4	5	6	7	8	9	10	11	12
C	C	B	D	C	A	C	D	A	B	C	D

13	14	15	16	17
D	A	B	C	D

METRE RULE, MEASURING TAPE, VERNIER CALLIPERS

1	2	3	4	5	6	7	8	9	10	11	12
D	B	C	B	C	A	B	B	A	D	D	D

SCREW GUAGE

1	2	3	4	5	6	7	8
B	C	B	B	A	A	B	B

PHYSICAL BALANCE, STOP WATCH, MEASURING CYLINDER

1	2	3	4	5	6
D	C	D	B	A	B

1.7 SIGNIFICANT FIGURES

1	2	3	4	5	6	7	8
D	C	D	B	A	B	B	C

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

1.1 Encircle the correct answer from the given choices.

i. The number of base units in SI are: *(K.B)*

(a) 3 (b) 6
(c) 7 (d) 9

ii. Which one of the following unit is not a derived unit? *(K.B)*

(a) pascal (b) kilogram
(c) newton (d) watt

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

(a) gram (b) kilogram
(c) newton (d) mole

iv. An interval of 200 μs is equivalent to: *(U.B)* **(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? *(U.B)*

(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? *(K.B)*

(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 callipers. Up to what extent do you agree with it? *(U.B)*

(a) 1 cm (b) 1.0 cm
(c) 1.03 cm (d) 1.032 cm

viii. A measuring cylinder is used to measure: *(K.B)*

(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: *(U.B+A.B)*

(a) 3.8 cm (b) 3.08 cm
(c) 3.08 mm (d) 3.08 m

x. Significant figures in an expression are: *(K.B)*

(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

ANSWER KEY

i	ii	iii	iv	v	vi	vii	viii	ix	x
c	b	d	c	d	b	c	c	b	c

1.2 What is the difference between base quantities and derived quantities? Give three examples in each case. ***(K.B)***

Ans:

DIFFERENTIATION

Differences between Base and Derived quantities are as follows:

Base Quantities	Derived Quantities
Definition	
• The quantities on the basis of which other quantities are expressed are known as base quantities.	• All the quantities, which can be described in terms of base quantities, are known as derived quantities.
Unit	
• The units used to describe base quantities are called base units	• The units used to describe derived quantities are called derived units.
Examples	
• Length • Time • Mass • Temperature	• Force • Area • Volume • Density

1.3 Pick out the base units in the following:
Joule, Newton, kilogram, hertz, mole, ampere, meter, Kelvin, coulomb and watt. ***(K.B)***

Ans:

BASE QUANTITIES

Following are the base quantities in given above:

- 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: ***(K.B+U.B)***

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

Ans:

(a) SPEED

Formula:

Speed = distance / time

Unit: ms^{-1}

Base Quantities Involved:

Following are the base quantities involved:

- Length
- Time

(b) VOLUME

Formula:

Area = Length x width x height

Unit: m^3

Base Quantities Involved:

Following is the base quantity involved:

- Length

(c) FORCE

Formula:

$F = ma$

$1N = 1kg \times 1\ ms^{-2}$

$1N = 1kgms^{-2}$

Unit: $kgms^{-2}$

Base quantities involved:

Following are the base quantities involved:

- Mass
- Length
- Time

(d) WORK

Formula:

Work done = force × displacement

$W = F.S$

$1J = 1\ N \times 1\ m$

$1J = 1\ kgms^{-2} \times 1\ m$

$1J = 1\ kgm^2\ s^{-2}$

Unit: $kgm^2s^{-2} = J = Nm$

Base Quantities Involved:

Following are the base quantities involved:

- Mass
- Length
- Time

1.5 Estimate your age in seconds. ***(K.B)*** **(LHR 2014, 2015, 2017)**

Ans:

AGE IN SECONDS

Solution:

Given Data:

Let present age = 15 years

To Find:

Age in seconds = ?

Calculations:

We know,

Days in a year = 365

$= 15 \times 365$ days

Age in hours $= 15 \times 365 \times 24$ hours

Age in minutes $= 15 \times 365 \times 24 \times 60$ mins

Age in seconds $= 15 \times 365 \times 24 \times 60 \times 60$ s

Age in seconds = 473040000s

Result:

I am 15 years old and my age in seconds is 473040000 or 4.73×10^8s.

1.6 What role SI units have played in the development of science? ***(A.B)*** **(LHR 2013)**

Ans: *Given on Page #* 06 Long Question Q.2 TOPIC 1.2

1.7 What is meant by Vernier constant? ***(K.B+U.B)*** **(LHR 2014, 2015)**

Ans: *Given on Page # 15*

1.8 What do you understand by the zero error of a measuring instrument? *(K.B)* **(LHR 2014)**

Ans:

ZERO ERROR

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? *(K.B)* **(LHR 2013)**

Ans:

USE OF ZERO ERROR

Use of zero error is very necessary in measuring instrument, if we ignore zero error in an instrument our measurement will become doubtful. Zero error leads us to zero correction that makes our measurement more accurate.

1.10 What is a stopwatch? What is the least count of a mechanical stopwatch you have used in the laboratories? *(K.B+U.B+A.B)*

Ans: *Given on Page #* 26 Long Question Q.2 TOPIC STOP WATCH

1.11 Why do we need to measure extremely small interval of times? *(K.B)*

Ans:

SMALL INTERVALS

We need to measure extremely small intervals of time to analyze and record instantly varying quantities like heart beat etc. Moreover, when we divide a long spell of time into small intervals while taking measurement it increases our accuracy.

1.12 What is meant by significant figures of a measurement? *(K.B)* **(GRW 2013)**

Ans: Given on Page # 29

1.13 How is precision related to the significant figures in a measured quantity? *(K.B)*

Ans:

PRECISION

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.

NUMERICAL PROBLEMS (U.B+A.B)

1.1 Express the following quantities using prefixes.

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

Solution:

(a) 5000 g = 5 x 103 g = 5kg
(b) 2000 000 W = 2×10^{6} W = 2 MW
(c) 52×10^{-10} kg = $5.2 \times 10 \times 10^{-10} \times 10^{3}$ g = 5.2×10^{-6} g = 5.2 μ g
(d) 225×10^{-8} s = $2.25 \times 10^{2} \times 10^{-8}$ s = 2.25×10^{-6} s = 2.25 μ s

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

Ans:

RELATION BETWEEN NANO AND MICRO

We know,
1 nano = n = 10^{-9}
1nano = $10^{-3} \times 10^{-6}$
Since 1micro = μ= 10^{-6}

So, $\boxed{1\text{nano} = 10^{-3}\text{micro}}$

RELATION BETWEEN PICO AND MICRO

We know
1 pico = 10^{-12}
1 pico = $10^{-6} \times 10^{-6}$
Since1micro = μ= 10^{-6}

So, $\boxed{1\text{pico} = 10^{-6}\text{micro}}$

RELATION BETWEEN PICO AND NANO

We know
1 pico = 10^{-12}
1 pico = $10^{-3} \times 10^{-9}$
Since 1nano = n= 10^{-9}

So, $\boxed{1\text{pico} = 10^{-3}\text{nano}}$

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

Solution:
Given Data:
Given growth rate of hair = 1mm per day
To find:
Growth rate of hair =? (nms^{-1})
Calculations:
Given Growth rate of hair = 1 mm per day

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

Since, 1mm = 10^{-3} m
1day = 8.64×10^4 s

So by putting values,

$$= \frac{1\times10^{-3}\text{m}}{8.64\times10^{4}\text{s}} = \frac{1}{8.64}\times10^{-3}\times10^{-4}\text{ms}^{-1}$$
$$= 0.1157\times10^{-7}\text{ms}^{-1}$$
$$= 11.57\times10^{-2}\times10^{-7}\text{ms}^{-1}$$
$$= 11.57\times10^{-9}\text{ms}^{-1}$$
$$= 11.57\text{nms}^{-1} \quad (\because 10^{-9} = \text{nano})$$

Result:
Hence, the growth rate of 1mm per

1.4 Rewrite the following in standard form.
(a) 1168 x 10^{-27}
(b) 32 x 10^5
(c) 725 x 10^{-5} kg
(d) 0.02 x 10^{-8}

Solution:
(a) 1168 × 10^{-27} = 1.168 x 10^3 x 10^{-27} = 1.168 x 10^{-24}
(b) 32 × 10^5 = 3.2 x 10^1 x 10^5 = 3.2 x 10^6
(c) 725 × 10^{-5} kg = 7.25 x 10^2 x 10^{-5} x 10^3 g = 7.25 g
(d) 0.02 × 10^{-8} = 2.0 x 10^{-2} x 10^{-8} = 2.0 x 10^{-10}

1.5 Write the following quantities in standard form.
(a) 6400 km
(b) 38000 km
(c) 300 000 000 ms^{-1} (Speed of light in air)
(d) seconds in a day

Solution:
(a) 6400 km = 6.4 × 10^3 km
(b) 38000 km = 3.8 × 10^5 km
(c) 300 000 000 ms^{-1} = 3.0 x 10^8 ms^{-1}
(d) 1 day = 24 hours = 24 x 3600 s = 86400 s = 8.64 x 10^4 s

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

Solution:

Given Data:

Number of division of Vernier Scale coinciding = n = 4

Least Count of Vernier Callipers = L.C = 0.01 cm

To Find:

Zero error = Z = ?

Zero correction = Z.C = ?

Calculations:

$$Z = n \times L.C$$

Putting Values

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.

Zero error = Z = + 0.04 cm

So , Zero correction = Z.C = - 0.04 cm

Result:

Hence, If 4th division of Vernier scale coincides with one of the main scale divison then zero error will be + 0.04 cm and zero correction will be –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)

Solution:

Given Data:

No. of divisions on circular scale = n = 50

Pitch = 0.5 mm

To Find:

Least Count = L.C = ?

Calculations:

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

Putting values,

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

Result:

Hence, A screw gauge having 50 divisions on its circular scale and 0.5 mm pitch will have 0.01 mm or 0.001 cm least count.

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

a. 3.0060 m

b. 0.00309 kg

c. 5.05×10^{-27} kg

d. 2001 s

Solution:

Options (b) and (c) have 3 significant figures

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

Solution:

(a) 1.009 m has 4 significant figures.
(b) 0.00450 kg has 3 significant figures.
(c) 1.66 x 10^{-27} kg has 3 significant figures.
(d) 2001 s has 4 significant figures.

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)

Solution:

Given Data:

Length of chocolate wrapper = l = 6.7 cm
Width of chocolate wrapper = w = 5.4 cm

To Find:

Area of chocolate wrapper = A =?

Calculations:

Area =length x width

By putting the values we have

Area = 6.7 cm x 5.4 cm
= 36.18 cm^2

As the least number of figures in given data are 2 so reasonable number of significant figures in answer must be 2.

Result:

Hence, the area of chocolate upto reasonable number of significant figures will be 36 cm^2.

SELF TEST

Time: 40 min. **Marks: 25**

Q.1 Four possible answers (A), (B), (C) & (D) to each question are given, mark the correct answer. (6×1=6)

1. Andromeda is:

(A) Star (B) Micro scope

(C) Planet (D) Galaxy

2. The least count of metre rule is:

(A) 1 mm (B) 0.1 mm

(C) 0.1 cm (D) 1 cm

3. 1mL = ?

(A) 10 cm^3 (B) 100 cm^3

(C) 1 cm^3 (D) 1000 cm^3

4. Approximate mass of typical protein molecule is:

(A) 6×10^{-18}g (B) 6g

(C) 3×10^{-4}g (D) 9×10^{-9}g

5. Identify the base quantity in the following:

(A) Distance (B) Area

(C) Speed (D) Force

6. Pitch of Screw Gauge is:

(A) 1m (B) 1 mm

(C) 1 cm (D) 0.1 mm

Q.2 Give short answers to following questions. (5×2=10)

i. Which safety equipment a school laboratory must have?

ii. On what factors accuracy in measuring a physical quantity depends upon?

iii. What is digital stop watch? Write its least count.

iv. Define nuclear and plasma physics.

v. Convert 15 years of age into seconds

Q.3 Answer the following questions in detail. (4+5=9)

a) What is a measuring cylinder? How volume of an irregular shaped solid is measured by displacement method?

b) Your hair grow at the rate of 1mm per day. Find their growth rate in nm s^{-1}.

Note:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.