PHYSICAL QUANTITIES AND MEASUREMENT

1

KIPS 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 matter at very high temperature is called:**
   a) Plasma Physics b) Astrophysics c) Sound d) Electromagnetism
3. **The study of internal structure of earth and its activities is called:**
   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 term used internationally for multiples and submultiples is 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 calipers 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:**
    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 know 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. **The number of derived units in SI system are:**
a) 3 b) 5 c) 7 d) Multiple

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		
6	b	16	c	26	b	36	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		

KIPS SHORT QUESTIONS

Q.1 What is Science?

Ans: The knowledge gained through observations and experimentations is called science. The word science is derived from the Latin work scientia which mean knowledge.

Q.2 What Physics?

Ans: Physics is that branch of science in which we study matter, energy and their interaction. The laws and principles of physics help us to understand nature.

Q.3 What are the physical quantities?

All measurable quantities are called physical quantities. These are characteristics of every object which are used to be measured to specify them. These characteristics of the object are known as physical quantities.

Example

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

Q.4 What are the basic characteristics of physical quantities?

A physical quantity possesses at least two characteristics in common.

(i) Numerical magnitude

(ii) Unit in which it is measured.

Q.5 What are the base quantities?

Ans: The physical quantities which form the foundation for other physical quantities are called base quantities. Base quantities are the quantities on the basis of which other quantities are expressed.

Example

These are length, time, mass, electric current, intensity of light, quantity of matter, and temperature. These are seven quantities in total.

Q.6 What are the derive quantities?

Ans: All the quantities, which can be described in terms of base quantities, are known as derived quantities. The quantities that are expressed in term of base quantities are called derived quantities.

Example

Force, area, volume, density etc.

Q.7 Why a standard unit is needed to measure a quantity correctly?

Ans: To measure a quantity, we need to compare it with some standard quantity. While measuring the physical quantity, we have to see that how many times this quantity is bigger or smaller than the standard quantity. Therefore stand unit is needed to measure a quantity correctly.

Q.8 What do you know about International System of Units (SI)?

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

Q.9 What are the base units? Write their names and symbols.

Ans: The units that describe the base quantities are called base units. Each base quantity has its SI unit. There are seven base units. The following table shows the base quantities and its units.

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

Q.10 What are derived units?

Ans: The units used to measure derived quantities, which are derived from base units, are called derived units.

Example

- Unit of speed is meter per second (ms^{-1}).
- Unit of force is Newton (N).
- Unit of volume is meter cube (m^3)
- Unit of charge is coulomb (C)

Q.11 Why multiples and submultiples are used? Describe some standard prefixes, which are internationally used.

Ans: "The terms used internationally for the multiples and submultiples for various units are known as prefixes". These prefixes are used when we have to measure very small or very large quantities in the Physics. Some of the multiples and submultiples are given as under:

Multiples	Prefix	Symbol
10^{-18}	Atto	a
10^{-15}	Femto	f
10^{-12}	Pico	p
10^{-9}	Nano	n
10^{-6}	Micro	n
10^{-3}	Milli	m
10^{-2}	Centi	c
10^{-1}	Desi	d
10^{1}	Deca	da
10^{2}	Hector	h
10^{3}	Kilo	k
10^{6}	Mega	M
10^{9}	Giga	G
10^{12}	Tera	T
10^{15}	Peta	P
10^{18}	Exa	E

Q.12 What do you know about prefixes?

Ans: Multiples and sub-multiples of units can be expressed in terms of prefixes. Prefixes are the words or letters added before SI units.

Examples

- Kilo (k) = 10^3
- Mega (M) = 10^6
- Giga (G) = 10^9
- Milli (m) = 10^{-3}
- Nano (n) = 10^{-9}

Examples of usage of Prefixes

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 10^9 Hz
			= 3.3 GHz

Q.13 How numbers are expressed in Scientific Notation?

Ans: Very small or very large numbers are expressed conveniently by using the scientific method based as some power of ten multiplied by a number between 1 and 10.

OR

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

Example

- Distance of moon from the Earth is 384000000 meters which is written in scientific notation as 3.84 x 10^8m
- 0.0045 is written in scientific notation as 4.5 x 10^{-2}

Q.14 What do you know about Meter Rule?

Ans: It is an instrument which is used in laboratories to measure the length of an object or distance between two points.

Scale

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

Precautions

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

Q.15 Explain the statement, "A micrometer screw gauge measures more accurately than a vernier calipers".

Ans: A micrometer screw gauge can measure more accurately than a vernier calliper because a micrometer screw gauge can accurately measure up to one hundredth part of a millimeter whereas vernier calipers can only measure accurately up to one tenth part of a millimeter.

Q.16 What do you know about Lever balance?

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

Q.17 What is electronic balance? What is its range? And how mass is measured by using electronic balance?

It is an instrument used to measure the mass of the body electronically.

Range

Electronic balance comes in various ranges; milligram ranges, gram ranges and kilogram ranges.

Procedure to measure mass

- Before measuring the mass of the body, it is switched on, and its reading is set to zero.
- Next place the object to be weighted.
- The reading on the balance gives you the mass of the body placed over it.

Q.18 What do you know about Measuring Tape?

Ans: Measuring tapes are used to measure length in meters and centimeters. Measuring tapes are used by blacksmith and carpenters.

Formation

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

LONG QUESTIONS

1.1 INTRODUCTION TO PHYSICS

Q.No.1 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 audible 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.No.2 Explain the importance of Physics in daily life.

Ans: Physics plays an important role in our daily. Importance of physics in some fields of life is given as under.

Rapid Progress in Science

The rapid progress in science during the recent years has become possible due to the discoveries and inventions in the field of Physics. The technologies are the applications of scientific principles. Most of the technologies of our modern society throughout the world are related to Physics.

Example

- A car is made on the principles of mechanics
- Refrigerator is based on the principle of thermodynamics.

Daily Life Usage

In our daily life, we hardly find a device where physics in not involved.

- Consider pulley that make it easy to lift heavy loads.
- Electricity is used not only to get light but also mechanical energy drives fans and electric motors etc.
- The cars, aeroplane and other means of transport have shortened the distances and now men do not live in isolation.
- Domestic appliances such as air – conditioned, refrigerators, vacuum – cleaners, washing machines and microwave ovens are used in houses.

Communication

The means of communication such as radio, T.V., telephone and computer are the result of applications of physics. These devices are made our lives much easier, faster and more comfortable than the past.

Mobile phone

It allows us to contact people anywhere in the world and to get latest worldwide information. We can take and save pictures, send and receive messages of our friends. We can also receive radio transmission and can use it as calculator as well.

Destruction in the World

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

Conclusion

Physics has also registered its glory on Commerce and industry, Trade, Agriculture, Education, and in nutshell, on all the pages of human life and because of research in Physics, standard of human living is improving day by day.

1.6 MEASURING INSTRUMENTS

Q.No.3 Write a note on Vernier Calipers.

Ans: Vernier Calipers are an instrument used to measure the very small lengths accurately up to one tenth of a millimeter.

Construction

Vernier Calipers consist of two jaws and two scales connected with these jaws.

(i) Main Scale

(ii) Vernier Scale

Main Scale

The longer line on the main scale represents centimeters and smaller lines, millimeters.

Pitch

The separation between two smaller lines on the main scale is called the **pitch** of the vernier calipers. It is one milli meter(1mm).

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)
- Meter (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

Volume

As Volume = Length x Breadth x Height

Unit of Volume = unit of Length x unit of Breadth x unit of height

Unit of Volume = m x m x m = m^3

Speed

As Speed = Distance/Time

Unit of Speed = Unit of Distance/Unit of Time

Unit of Speed = m/s = ms^{-1}

Force

As Force = m a

Unit of force = unit of mass x unit of acceleration

Unit of force = kg x ms^{-2} = kg ms^{-2}

Work

As Work = F S

Unit of work = unit of force x unit of distance

Unit of work = kg ms^{-2} x m

Unit of work = kg m^2 s^{-2}

Also kg ms^{-2} = N

So unit of work = N s

1.5: Estimate your age in seconds.

Ans: My age is 15 years

Age in days = 15 x 365.25 = 5478.75 days

Age in hours = 5478.75 x 24 = 131490 hours

Age in minutes = 131490 x 60 = 7889400 minutes

Age in seconds = 7889400 x 60 = 473364000 seconds = 4.73 x 10^8 seconds

1.6: What role SI units have played in the development of science?

Ans: With the developments 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.

Q.No.4 Write a note on the Screw Gauge.

Ans: A screw gauge is the 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 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 circular scale 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.

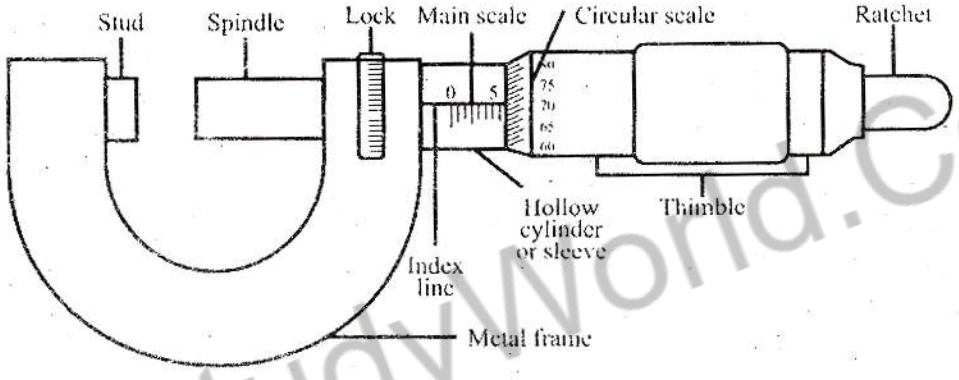

Figure 1.9: A micrometer screw gauge

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 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.

Zero Error of Screw Gauge

If we close the gap between the spindle and the stud of the screw gauge rotating the ratchet in clockwise direction. If zero of circular scale coincides with the index line, then zero error will be zero and zero of circular scale does not coincides with index line, then there zero error in the screw gauge.

There are two types of zero errors:

(i) Positive Zero Error

(ii) Negative Zero Error

Positive Zero Error

If zero of the circular scale is behind (below) the index line then it will measure slightly more than the actual thickness and called positive zero error.

Zero correction

In this case, multiply the number of divisions of the circular scale that has not crossed the index line with least count of screw gauge to find zero error. It will be subtracted from the observed measurement.

Negative Zero Error

If the zero of the circular scale has crossed (above) the index line, then it will show slightly less than the actual thickness and called negative zero error.

Zero correction

In this case, multiply the number of divisions of the circular scale that has crossed the index line with least count of screw gauge to find zero error. It will be added from the observed measurement.

Mass Measuring Instruments

Q.No.5 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 pan over the hooks on either side. Unknown mass is place on the left pan. Find some suitable standard masses that cause the pointer to remain at zero on raising the beam.

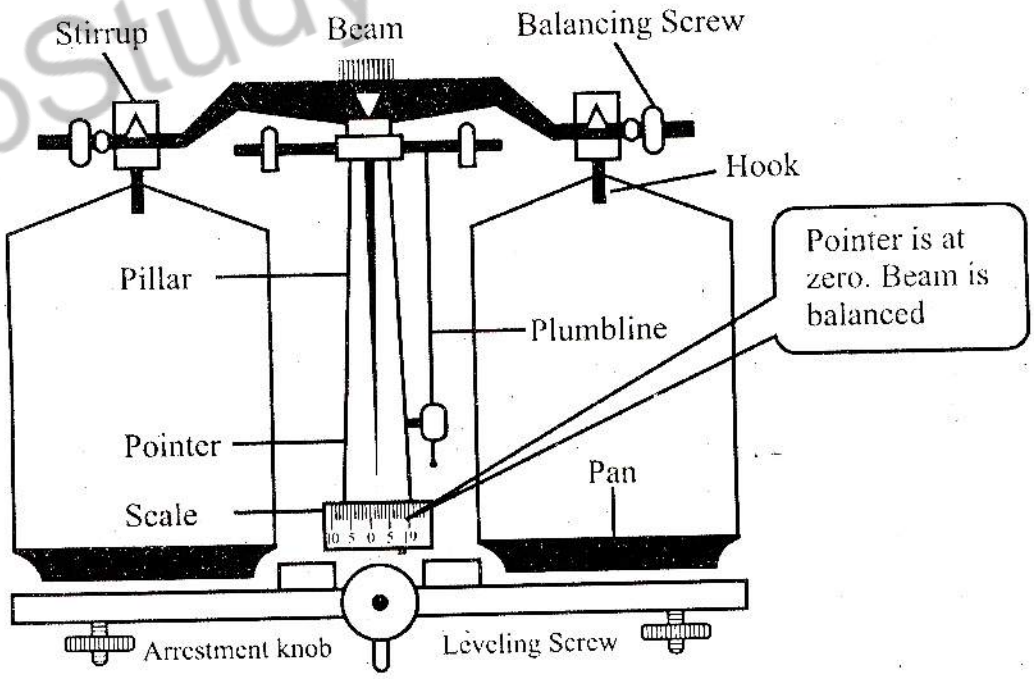

Figure 1.14: A physical balance

Example:

Find the mass of a small stone by a physical balance

Solution

(i) Follow the steps to measure the mass of a given object.

(ii) Adjusting leveling screws with the help of plumb line to level the platform of physical balance.

(iii) Raise the beam gently by turning the arresting knob clockwise. Using balancing screws at the ends of its beam, being the pointer at zero position.

(iv) Turn the arresting knob to bring the beam back on its support. Place the given object the right pane. Raise the beam. Lower the beam if its point is not zero.

(v) Repeat adding or removing suitable standard masses in the right pane till the rests at zero on raising the beam.

Electronic Balance

Q.No.6Which 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 balance may be able to measure mass accurately as small as 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 electronic balance is 0.001 g or 1 mg. Therefore, measurement would be more precise than a sensitive physical balance. The electronic balance is most sensitive balance than all the balances given above.

Q.No.7Write 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) Electronic stop watch (digital 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 wing 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.

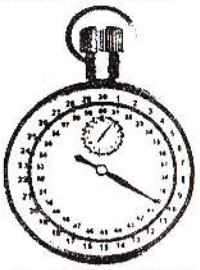

Figure 1.17: A mechanical stopwatch

(i) **Electronic/Digital Stop Watch**

Digital stop watch is 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 settings.

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.

Measuring Cylinder

Q.No.8 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 putt in it, 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.

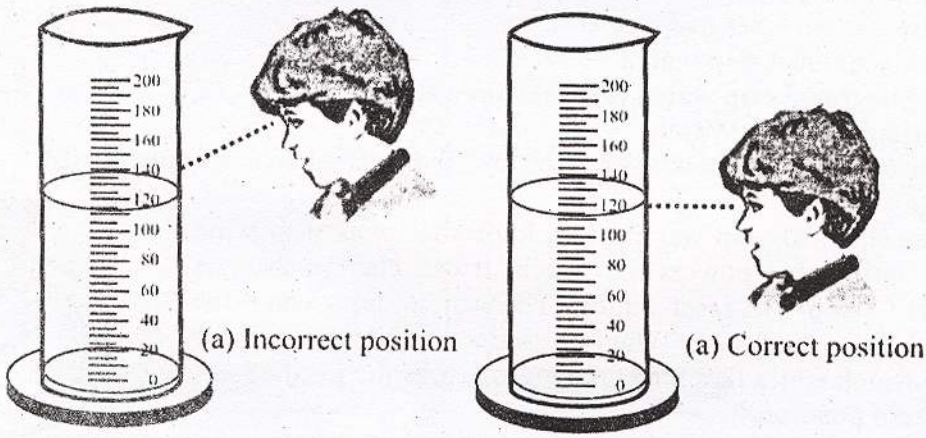

Figure 1.19 (a) Wrong way to note the liquid level keeping eye above liquid level. (b) correct position of eye to note the liquid level keeping eye at liquid level.

Q.No.9 How volume of irregular shapes is measured by using volume cylinder?

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 Vi 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 Vf of water and the solid. Volume of the solid will be Vf – Vi.

1.7 SIGNIFICANT FIGURES

Q.No.10 Define and explain Significant figures. What are the main points to be kept in mind while determining the significant figures of a measurement?

Ans: In any measurement, the accurately known digits and the first doubtful digit in an expression are called significant figures. It reflects the precision of a measured value of a physical quantity.

Accuracy of measurement

The value of a physical quantity is expressed by a number followed by some suitable unit. Every measurement is an attempt to find the true value. 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 his/her measured value are two. The left digit is the accurately known digit. While the digit 8 is the doubtful digit for which the student may not be sure. Another student measure the same book using a ruler and claims its length to be 18.4 cm. in this case all the three figures are significant. The two left digits 1 and 8 are accurately known digits. Next digit 4 is the doubtful digit for which the student many not be sure.

A third student records the length of the book as 18.425 cm. Interestingly, the measurement is made using the same ruler. The number of significant figure is again three; consisting of two accurately known digits 1 and 8 and the first doubtful digit is 4. The digits 2 and 5 are not significant. It is because the reading of these last digits cannot be justified using a ruler. Measurement up to third or even second decimal place is beyond the limit of the measuring instrument.

An improvement in the quality of measurement by using better instrument increases the significant figures in the measured result. The significant figures are all the digits that are known accurately and the one estimated digit. More significant figures mean greater precision.

Rules for determining Significant Figures

The following rules are helpful in identifying significant figures:

(i) Non-zero digits are always significant.

(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 sides 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 of 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.

(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.No.11 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

MINI EXERCISE

(1) Why do we study physics?

Ans. The rapid progress in science during the recent years has become possible due to the discoveries and inventions in the field of Physics. The technologies are the applications of scientific principles. Most of the technologies of our modern society throughout the world are related to Physics.

(2) Name any five branches of Physics.

Ans. **(i)** Mechanics **(ii)** Heat **(iii)** Sound **(iv)** Light (Optics) **(v)** Atomic Physics

How can you differentiate between base and derived quantities?

Base Quantities	Derived Quantities
The physical quantities which form the foundation for other physical quantities are called base quantities. **Example** length, time, mass	All the quantities, which can be described in terms of base quantities, are known as derived quantities. **Example** Force, area, volume, density etc

(3) **Identify the following as base or derived quantity:**
Density, force, mass, speed, time, length, temperature and volume.

Base units	Derived Units
Mass, time, length, temperature	Density, force, speed, volume

(4) **Name five prefixes most commonly used.**
(i) Kilo (k) = 10^3
(ii) Mega (M) = 10^6
(iii) Giga (G) = 10^9
(iv) Milli (m) = 10^{-3}
(v) Nano (n) = 10^{-9}

(5) **The Sun is one hundred and fifty million kilometers away from the Earth. Write this**
(a) As an ordinary whole number.
150, 000, 000 km = 150, 000, 000, 000 m
(b) In scientific notation
1.5×10^{11} m

(6) **Write the numbers given below in scientific notation**
(a) 3000000000 ms^{-1}
3.0×10^9 ms^{-1}
(b) 6400000 m
6.4×10^6 m
(c) 0.0000000016 g
1.6×10^{-9} g
(d) 0.0000548 s
5.48×10^{-5}

(7) **What is the least count of the Vernier Callipers?**
Ans. Least count of Verneir Callipers is 0.1 mm or 0.01 cm.

(8) **How many divisions are there on its Vernier scale?**
Ans. There are 10 division on Vernier scale.

(9) **Why do we use zero correction?**
Ans. Zero correction is used to take correct measurement.

(10) **What is the least count of a screw gauge?**
Ans. The least count of screw gauge is 0.01 mm or 0.001 cm.

(11) **What is the pitch of your laboratory screw gauge?**
The pitch of laboratory 1mm.

(12) **What is the range of the two instruments is more precise and why?**
(a) Vernier calipers
(b) Screw Gauge
Screw gauge is more precise because it can measure accurately up to one hundredth part of a millimeter while vernier calipers can only measure accurately up to one tenth part of a millimeter.

(13) **What is the function of balancing screws in physical balance?**
Function of the physical balance is to balance the panes of the physical balance.

(14) **On what pan we place the object and why?**
We place the object in left pane because standard masses are placed on the right pan.

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:

a) Gram b) kilogram c) Newton **d) mole**

iv. An interval of 200 μs is equivalent to:

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 calipers** 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 an 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 know 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 physical quantities which form the foundation for other physical quantities are called 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)
- Meter (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

Volume

As Volume = Length x Breadth x Height

Unit of Volume = unit of Length x unit of Breadth x unit of height

Unit of Volume = m x m x m = m^3

Speed

As Speed Distance/Time

Unit of Speed = Unit of Distance/Unit of Time

Unit of Speed = m/s = ms^{-1}

Force

As Force = m a

Unit of force = unit of mass x unit of acceleration

Unit of force = kg x ms^{-2} = kg ms^{-2}

Work

As Work = F S

Unit of work = unit of force x unit of distance

Unit of work = kg ms^{-2} x m

Unit of work = kg m^2 s^{-2}

Also kg ms^{-2} = N

So unit of work = N s

1.5: Estimate your age in seconds.

Ans: My age is 15 years

Age in days = 15 x 365.25 = 5478.75 days

Age in hours = 5478.75 x 24 = 131490 hours

Age in minutes = 131490 x 60 = 7889400 minutes

Age in seconds = 7889400 x 60 = 473364000 seconds = 4.73 x 10^8 seconds

1.6: What role SI units have played in the development of science?

Ans: With the developments 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.

1.7: What is meant by vernier constant?

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

1.8: What do you understand by the zero error of a measuring instrument?

Ans: In Vernier Calipers, if the zero of the main scale does not coincide with the zero of the vernier scale then the error is called zero error.

1.9: Why is the use of zero error necessary in a measuring instrument?

Ans: The use of Zero error is necessary in measuring instrument to take correct measurements

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

Ans: "It is an instrument use to measure the time interval or specific period of an event is known as stop watch". A mechanical stop watch used in laboratories can measure a time interval up to a minimum 0.1 second.

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

Ans: Instantaneous time rate of change of variable is calculated with the help of small interval of time.

1.12: What is meant by significant figures of a measurement?

Ans: In any measurement, 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 figure in the measured result. The significant figures are all the digits that are known accurately and the one estimated one. More significant figure means greater precision.

PROBLEMS

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

Ans:

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

(b) $2000\ 000\ W = 2 \times 10^6\ W = 2\ MW$

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

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

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

Ans: 1 pico = 1 p $= 10^{-12}$

1 nano = 1 n $= 10^{-9}$

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

1 n = 1000 p

1 μ = 1000 n

1.3: Your hairs grow at the rate of 1mm per day. Find their growth rate in mms^{-1}.

Ans: Rate of growth = 1mm/day

As 1 mm = 1000000 nm

And 1 day = 24 x 60 x 60 s

$$= \frac{1000000}{24x60x60}$$

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

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

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

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

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

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) $6.4 \times 10^{3} \times 10^{3} = 6.4 \times 10^{6}$ m

(b) $3.8 \times 10^{5} \times 10^{3}$ m = 3.8×10^{8} m

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

(d) 1 day = 24 x 60 x 60 s = 86400 s = 8.64×10^{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 divisions 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?

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

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

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

(a) 3.0066 m

(b) 0.00309 kg

(c) 5.05×10^{-27} kg

(d) 2001 s

Ans: b and c

1.9: What are the significant figures in the following measurements?

(a) 1.009 m (b) 0.00450 kg (c) 1.66×10^{-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.

Ans: Given data:

Length of chocolate wrapper = l = 6.67 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 $= 6.67 \times 5.4$

$= 36.018\ cm^2$

Result:

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

So Area $= 36\ cm^2$