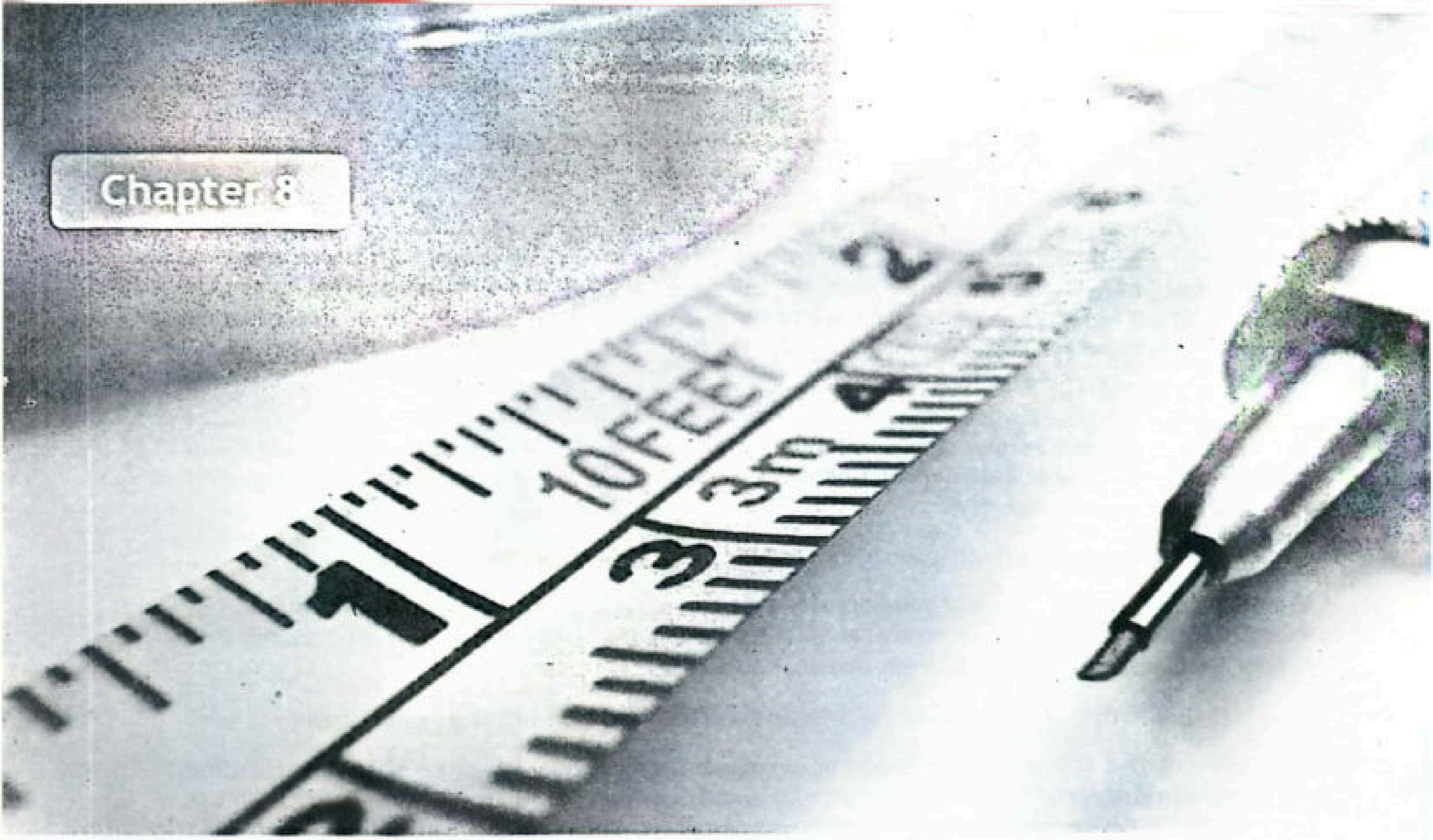
## Chapter 8




# MEASUREMENT

**SLOs: After completing this lesson, the student will be able to:**

1. **Differentiate between physical quantities and non-physical quantities and also describe measurement of physical quantities in table form.**
2. **Explain with example that physics is based on physical quantities.**
3. **Justify and illustrate how to measure length using common instrument like measuring tape and meter rod etc.**
4. **Justify and illustrate how to measure time interval using stop watch both digital and analog**
5. **Round off and justify calculational estimates.**

Measurement of substances in the physical world is being done from prehistoric times, as it plays an important role to describe and understand the physical world. They are parts of our lives. How far the sun and other stars are from us? How long we have been here on Earth? How heavy is the block of wood we have to put it on walls to make it a beam? These questions and many more questions like them were coming in our minds since long. To find answers to these questions we need measurement. In this unit, we will study some physical and non-physical quantities and some useful measuring instruments. We will also study the rounding off technique used in measurement.

## 8.1 PHYSICAL QUANTITIES

We have five senses hearing, smell, touch, sight and taste. We can assess the things around us by using these senses but we cannot find the extent of these quantities. To find the extent we have to measure the quantity.

**"Physical quantities are those quantities which can be measured".**

Quantities like length, mass, time, density and temperature can be defined and measured, therefore they are termed as physical quantities. On the other hand, feeling and thinking cannot be measured so they are non-physical quantities.

**"Quantities which cannot be measured are called non-physical quantities".**

Measurement is a comparison between an unknown physical quantity (like mass, length, time etc.) and some standard to see how large or small it is compared to that standard. A unit is standard with which physical quantities are compared. Some of the instruments measuring physical quantities around you are shown in the given figure below.

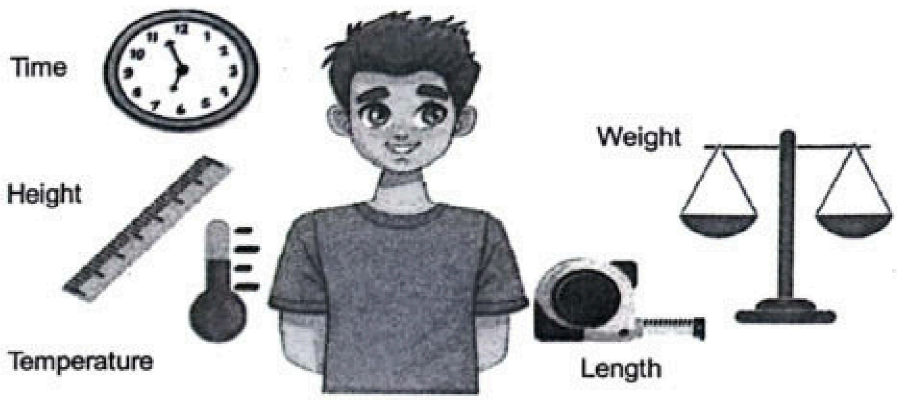



Fig. 8.1: Some instrument measuring physical quantities around you

Measurement of physical quantity consists of numerical magnitude, which is a number, representing the size of that quantity and a unit in which it is measured. For example, the height of a person and a tree are measured with the help of some length measuring instrument. The height of the person comes out to be 1.6 meter, here '1.6' is the numerical magnitude, which represents the height of the person and 'meters' is the unit in which the height of the person is measured. Similarly, the height of the tree is 4 meters. In this measurement '4' is the magnitude or height of the tree and 'meter' is the unit in which the measurement is taken.

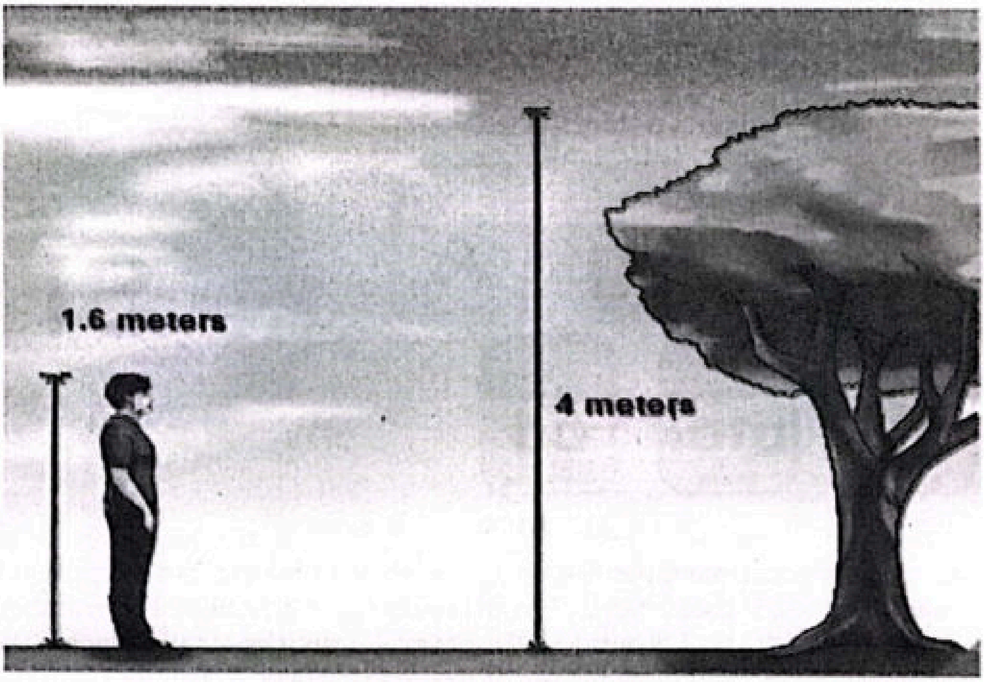



Fig. 8.2: Measuring length

In above case to record measurement, an appropriate unit is chosen and the size of quantity is then found with an instrument having a proper scale like a measuring tape. While non-physical quantities cannot be measured. Non-physical quantities include feelings like love, hate, happiness, sadness etc.

## Relation between Physics and Physical Quantities

Physics is closely related to the physical quantities, as we know that Physics is the study of matter, energy and their relationship while physical quantities are the properties of matter and energy which can be measured. Some of the daily life examples of the relation of Physics with the physical quantities may include: When you are driving a car you monitor your speed with the help of speedometer, which measures how fast you are moving here the speed is a physical quantity. Similarly in cooking food, when you cook food you rely on the temperature measurements to ensure food is cooked properly in this case understanding the heat transfer which means how heat moves from the stove to the pot and then to the food is all about Physics. There are many more examples in our daily life where we study Physics and it relates to some physical quantities.

**STEAM ACTIVITY 8.1**

Make some groups of students with four to five students in each group. Each group can be given to find some daily life application and relate Physics and some physical quantity involved in that daily life task.

## Measurement of Physical Quantities

To measure a physical quantity the nature of that quantity is to be cleared first. Different parameters of a physical quantity can be measured. Each parameter has its own magnitude and a set of units. A complete set of units for all physical quantities is called the system of units. The international system of units is termed as system international (abbreviated as SI). The physical quantities are divided mainly into two groups i.e. the base physical quantities and the derived physical quantities.

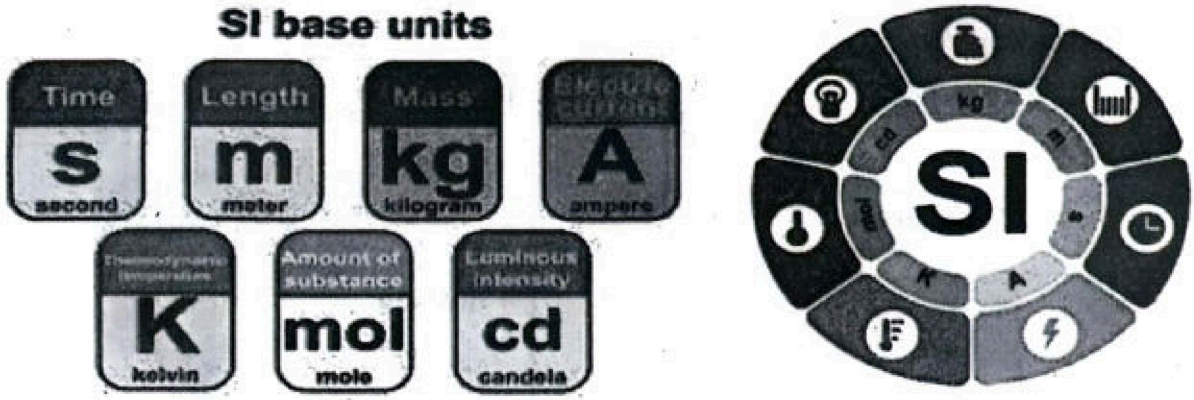



Fig. 8.3: SI base units

Base or fundamental physical quantities like, mass, length and time etc. are selected as the simplest form of physical quantities. SI base units are shown here in figure 8.3. All other physical quantities can be derived from the base physical quantities. The physical quantities obtained by multiplying or and dividing the base physical quantities are termed as the derived physical quantities.

## Base Quantities

The quantities which are fundamental quantities are called base quantities. In system international (SI) seven physical quantities are chosen as base and their units are defined and standardized. The seven basic physical quantities are length, mass, time, temperature, electric current, amount of substance and intensity of light.

**Table 8.1 Base quantities and their symbols**

| | Name | Symbol |
|---|---|---|
| 1 | Length | $l$ |
| 2 | Mass | m |
| 3 | Time | t |
| 4 | Temperature | T |
| 5 | Electric current | I |
| 6 | Amount of substance | n |
| 7 | Intensity of light | J |

The units in which these seven base quantities are measured are called the base units. Each SI unit is defined carefully so that accurate and reproducible measurement can be made. The units of base quantities are as, meter (m) for length, kilogram (kg) for mass, second (s) for time, kelvin (K) for temperature, ampere (A) for electric current, mole (mol) for amount of substance and candela (cd) for the intensity of light.

| Table 8.2 Base units | | | |
|---|---|---|---|
| | Name of unit | Symbol | Corresponding quantities |
| 1 | meter | 1m | Length |
| 2 | kilogram | 1kg | Mass |
| 3 | second | 1s | Time |
| 4 | kelvin | K | Temperature |
| 5 | ampere | A | Electric current |
| 6 | mole | mol | Amount of substance |
| 7 | candela | cd | Intensity of light |

## Derived Quantities

The quantities which are obtained by multiplying and/or dividing base quantities are known as derived physical quantities. All these quantities can be derived from the seven base quantities. For example, area which is a derived quantity and can be found by the product of length and breadth as:

$$Area = length \times breadth$$

In above example we find a derived quantity (area) by multiplying a base quantity (length) twice. The measurement of area is shown in figure given below.

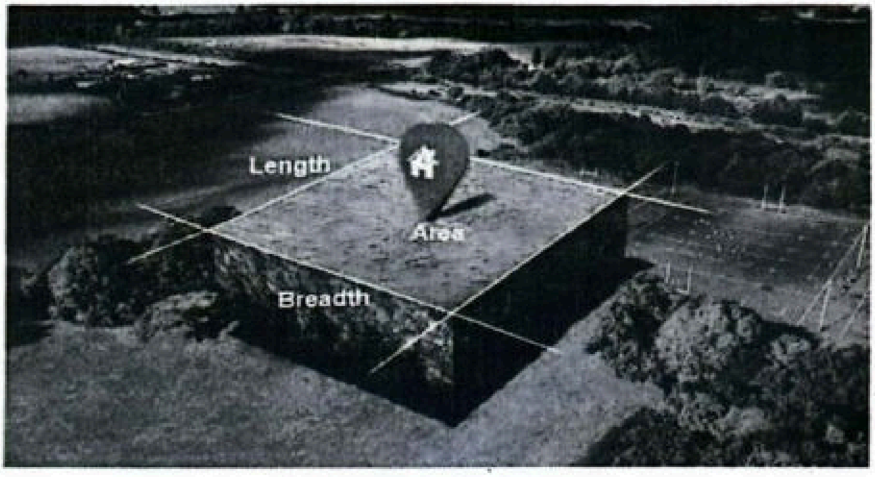



Fig. 8.4: Area measurement

Similarly in case of velocity of a body we divide the length (distance) covered by the body in unit time. In this case velocity or speed is a derived quantity and it can be obtained by dividing distance or length (base quantity) by time (base quantity) as:

$$Speed\ (v) = \frac{Distance\ (S)}{Time\ (T)}$$

The speed measurement for a moving car is shown in figure 8.5.

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

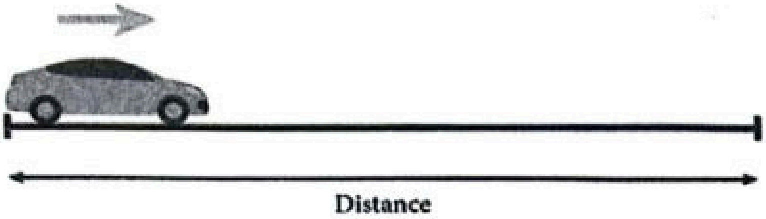



Fig. 8.5: Speed measurement

In above two cases we find derived quantities by simply multiplying and dividing two base quantities respectively. We can find many derived quantities by the same method. The units of derived quantities are called derived units. Like their respective quantities, derived units are also derived from the units of respective base units. Derived units can be obtained by multiplying and/or dividing the base units. For example, area is the derived quantity which was obtained by twice multiplication of base quantity length. Its unit can also be found by multiplication of base units of length twice as:

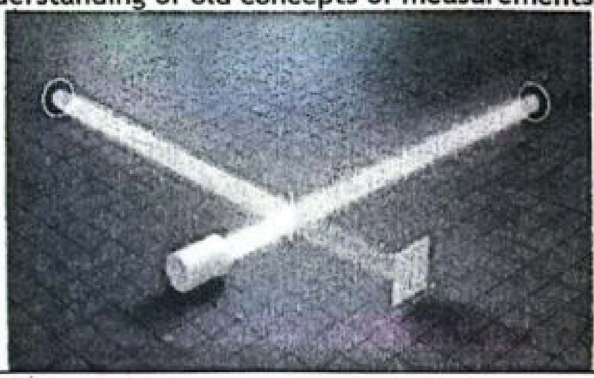
$$m^2 = m \times m$$

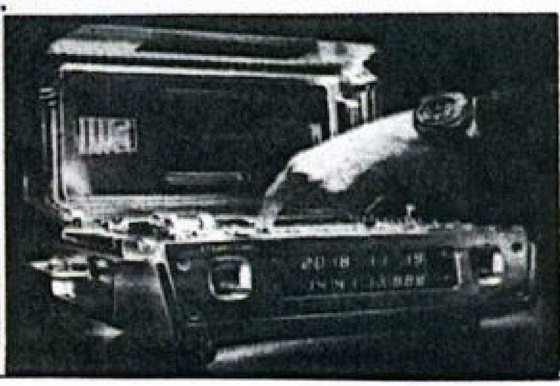
Hence the unit of area is the squared meter ($m^2$). In the same way as speed is the distance which is a length divided by the time, its unit can be obtained by dividing the unit of length to the unit of time, as:

$$unit\ of\ speed = \frac{m}{s} = ms^{-1}$$

**SCIENCE TIDBITS**

Advancement in technology has greatly changed the way we measure and understand the physical quantities. For example with an instrument called interferometer we can measure extremely small lengths with great accuracy, with the help of atomic clocks (which use the vibration of atoms to measure the time) can measure extremely small time intervals with incredible accuracy and many more such devices have been developed which changed our understanding of old concepts of measurements.





Some of the commonly used derived quantities along with their units are given in table 8.3.

**Table 8.3 some derived quantities and their units**

| Quantity | In terms of base quantity | SI Unit |
|---|---|---|
| Area (A) | $length \times length$ | $m^2$ |
| Volume (V) | $length \times length \times length$ | $m^3$ |
| Speed / Velocity (v) | $\frac{length}{time}$ | m/s |
| Acceleration (a) | $\frac{length}{time^2}$ | $m/s^2$ |
| Force (F) | $mass \times acceleration = mass \times \frac{length}{time^2}$ | (newton) N |
| Pressure (P) | $\frac{force}{area} = \frac{mass \times length}{time^2} \cdot \frac{1}{length^2}$ | Pascal (Pa) $N / m^2$ |
| Density (ρ) | $\frac{mass}{volume} = \frac{mass}{length^3}$ | $Kg/m^3$ |
| Work (w) / Energy (U) | $force \times displacement = \frac{mass \times length}{time^2} \cdot length$ | (joule) J |
| Power (P) | $\frac{work}{time} = \frac{mass \times length^2}{time^2} \cdot \frac{1}{time}$ | (watt) W |

**Example 8.1 (Finding Units)** According to Newton's law of gravitation every object of mass say '$m_1$' attracts every other object of mass say '$m_2$' with a force 'F' if placed near each other at distance 'r', given by:

$$F = G\frac{m_1\ m_2}{r^2}$$

Here 'G' is the universal gravitational constant. Find

a) the SI units of 'G'

b) the unit of 'G' in terms of base units

**GIVEN**

$$F = G\frac{m_1\ m_2}{r^2}$$

**REQUIRED**

SI units of 'G' = ?

Base units of 'G' = ?

**SOLUTION:** To find the units of 'G' we have to rewrite above relation, as:

$$G = F\frac{r^2}{m_1\ m_2}$$

As we know that units of:

$$Force\ (F):\ N = kg\ m\ s^{-2}$$

$$mass:\ m_1 = m_2 = kg$$

$$Distance:\ r = m$$

**a)** now to find SI units of 'G' we use SI values of 'F', '$m_1$', '$m_2$' and 'r' in above relation:

$$G = N\frac{m^2}{kg\ kg} = N\frac{m^2}{kg^2}$$

$$G = N\ m^2\ kg^{-2}$$

**b)** In terms of base units:

As

$$N = \frac{kg\ m}{s^2}$$

Using this value in above we get:

$$G = \frac{kg\ m}{s^2}\ \frac{m^2}{kg^2}$$

We get:

$$G = kg^{-1}m^3s^{-2}$$

**Table 8.4 the Differences between fundamental and derived units**

| Base Units | Derived Units |
|---|---|
| Base units are all those units which are independent of any other unit (including themselves) | Derived units are all those units which are obtained by multiplying and/or dividing one or more fundamental units with or without introducing any other numerical factor. |
| Base units cannot be further reduced to elementary level, infect these are elementary units. | Derived units can be reduced to its elementary level, which are composed of fundamental units. |
| Base units cannot be expressed in terms of derived units. | Derived units can be expressed in terms of fundamental units. |
| Only seven fundamental units exist in all measuring systems including SI system. | There exist a large number of derived units in all measuring systems including SI system. |
| Seven fundamental units are: meter, kilogram, second, kelvin, ampere, mole and candela | Derived units are in large number, some of which are: newton, joule, watt, volt, pascal, etc. |

The need of physical quantities is essential for the study of physics. We can divide the physical quantities mainly into two types the vectors and scalars. Does the direction of wind matter when you fly a kite? Some physical quantities require direction to be specified completely, while other can be understood without information of direction.

Scalars are those quantities which can be completely described only by their numerical magnitude with proper unit for example, distance, speed, time, mass, energy, temperature etc. are scalar quantities. Scalar quantities can be added, subtracted, multiplied and divided by using ordinary rules of algebra. For example, if we took 5s to reach the door of classroom and another 15s to reach the main hall of the school, the total time for these events can simply be calculated by adding the both values i.e. (5s+15s) 20 s.

Physical quantity which requires not only numerical magnitude with proper unit, but also the direction is termed as vector or vector quantity. For example, displacement, velocity, acceleration, weight, force etc. all these quantities require direction as well for their complete understanding. When we refer to a vector quantity, we not only mention its numerical magnitude and unit, but also its direction. To fully describe a vector, its direction must be specified. Since vector quantities are associated with direction, they cannot be added, subtracted, multiplied or divided by using the usual rules of algebra. They follow their own set of rules known as vector algebra.

## 8.2 MEASUREMENT

For every type of measurement, we use different types of instruments. Even for measuring the same physical quantity, we have many different measuring instruments. These instruments range from simple objects such as rulers and stop watches to digital atomic microscopes etc. All measuring instruments have some measuring limitations. **Least count of any instrument is the minimum value that can be measured with the help of this instrument.** Here we will discuss some measuring instruments for measuring some basic physical quantities.

### Length Measuring Instruments

For measurement of length, we have a lot of measuring instruments, but in science laboratories commonly used measuring instruments are measuring tape and meter rod.

- **Meter Rule:** We use ruler to draw margin lines on our notebooks. Have you ever used the scale on it to draw the lines with exact length? A meter rule is the science laboratory tool, used to measure the length of objects. Meter rules are generally one meter long which is made by comparison with a standard meter. Meter rulers usually have 1000 small divisions on them called millimetres (mm). Such meter rule has a least count of 1 mm. meter rule also marked with 100 bigger lines which come at every $10^{th}$ small line and these marking of large lines are called centimetres (cm), as shown in figure 8.6.

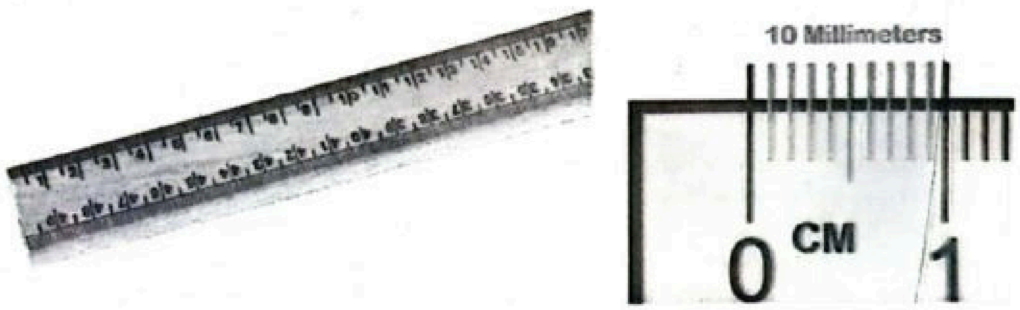



Fig. 8.6: Meter rule and its divisions

Each centimetre has 10 millimetres. These instruments have similar scale on it as drawn on our rulers. Principally, rulers are shorter version of meter rule. The reading can be taken by meter rule by putting starting point of body at zero point of meter ruler and note the ending of the object or length at meter rule. This point will give you the length of the object.

- **Measuring Tape**: A measuring tape is a flexible ruler use to measure larger distances or lengths up to 30, 50, 60 or even 100 meters. It consists of a ribbon of cloth, plastic, metal or fiberglass with linear measurement markings on it, as shown in figure 8.7.


Fig. 8.7: Measuring tapes of different materials

The tape is usually housed in a compact case, and it can be pulled out and locked in place to measure distances, as shown in figure 8.8. The most common units of measurement on a measuring tape are inches and centimetres. Note that 1 inch is equal to 2.5 centimetres. Measuring tapes come in various lengths, typically ranging from a few feet to several meters.

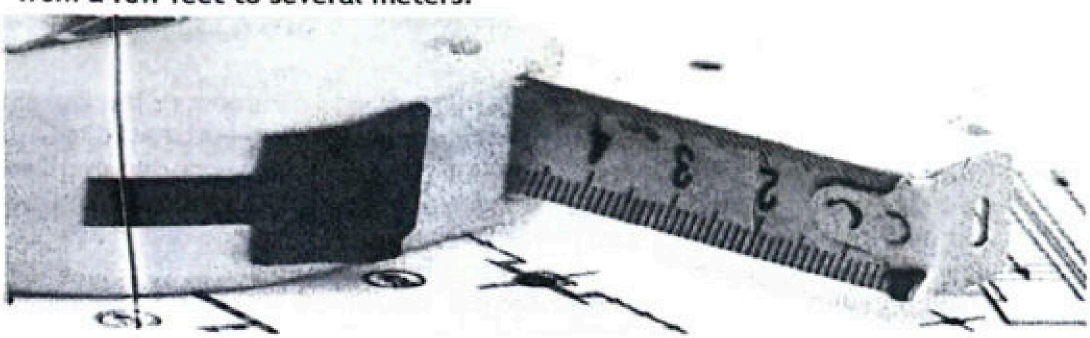


Fig. 8.8: Measuring tape with casing and lock

Reading of measuring tape is simple and easy it usually has a clamp at one end. The clamp fixes itself at starting point of object whose length is to be measured, the clamp end of measuring tape starts from zero reading. Now note the point on measuring tape where the object's length ends, this is the reading of the length of that object.

## Time Measuring Instruments

Time measuring instruments have a long history. These instruments have evolved significantly throughout the history, from the ancient sundials to modern day atomic clocks. But the measurement of time has two aspects, one is to check the running time for example morning, noon, afternoon and night etc. and the other is to note the time between two events or of specific interval. The duration of specific interval of time is measured by stopwatch. Stopwatches are of two types, i.e. mechanical (analog) stopwatch and digital stopwatch.

- **Mechanical (analog) Stopwatch:** The commonly used mechanical stopwatch has two circular dials, a large circular dial in which a second hand of watch rotates and a small minute hand in which a minute hand of watch rotates, as shown in figure 8.9. For taking measurement with the help of analog stopwatch we have to press the knob given on the upside of the stopwatch. First when we press the knob all needles reset themselves to zero. Now stopwatch is ready to use. For taking reading, with the start of event whose time interval is to be measured press the knob. The needle starts to rotate and stopwatch starts taking measurement. When the event is going to be ended and our interval ends then press the knob of stopwatch again. This time pressing the knob stops the rotation of needles.

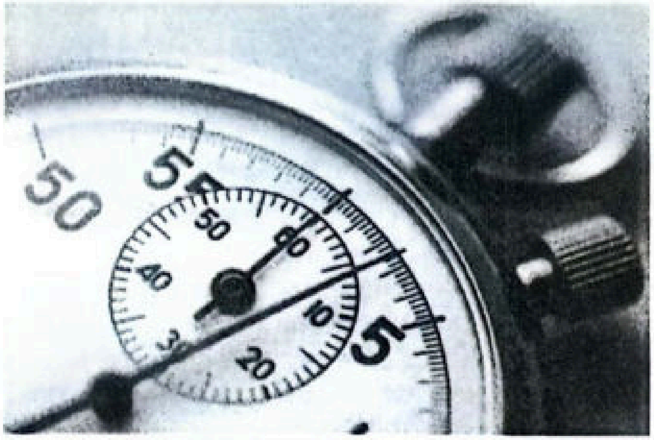


Fig. 8.9: Analog stopwatch

Note the time by taking reading of small dial as minutes and the readings of large hand as seconds, this will give you the time interval of your event, as shown in figure 8.10. After taking readings press the knob again to bring all the needles to zero so that stopwatch is ready to take more readings. Generally, the least count of analog stopwatch is 1s.

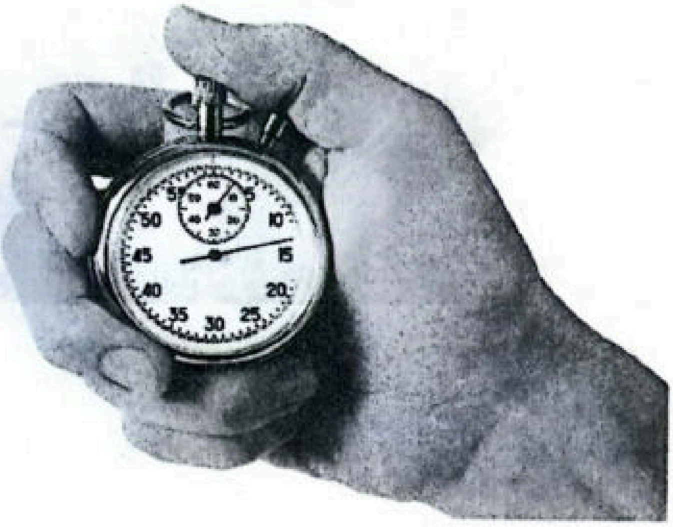


Fig. 8.10: Taking readings with analog stopwatch

- **Digital stopwatch**: Digital stopwatches are usually controlled by two buttons on the case, as shown in figure 8.11.


Fig. 8.11: Digital stopwatch

When we have to take the reading of time interval for an event, first we note that the time shown on stopwatch is zero. By starting the event we have to press the left button, which starts the time on stopwatch. At the end of event, we have to press the left button again, which stops the time on stopwatch. Note this reading, which is the time interval for the given event, as shown in figure 8.12. Pressing the right button resets the stopwatch to zero. The right button is also used to record, split times or lap times.

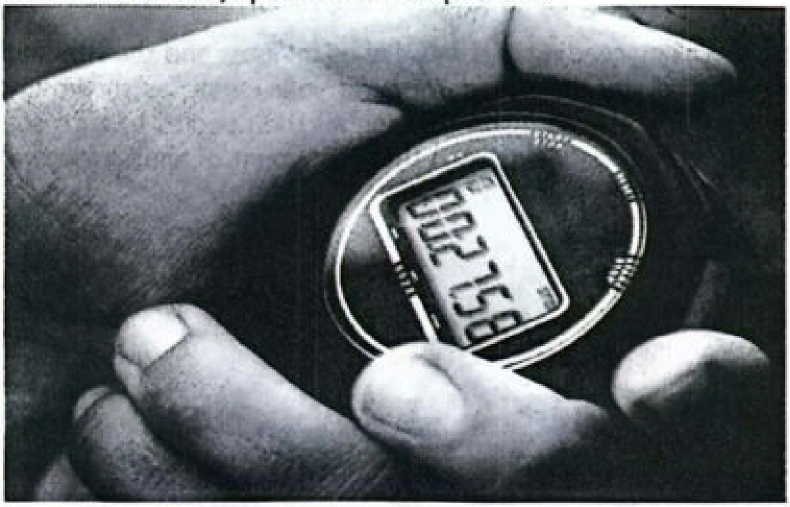


Fig. 8.12: Taking readings with digital stopwatch

## Calculational Estimates

During calculations and measurements many a times we need to round off the results, if they are in large numbers. To round off the final results, there are two terms which are important to take into account, which are precision and the number of significant figures. By ignoring these two terms rounding off, may results into an error. Now we will study these two terms before the rules of rounding off.

**Significant figure:** There are two types of values, exact and measured. Exact values are those that are counted clearly. For example, while reporting 3 pencils and 2 books, we can indicate the exact number of these items. Measured value will always contain some uncertainty, for example if we measure the length of a pencil as shown in figure 8.13.

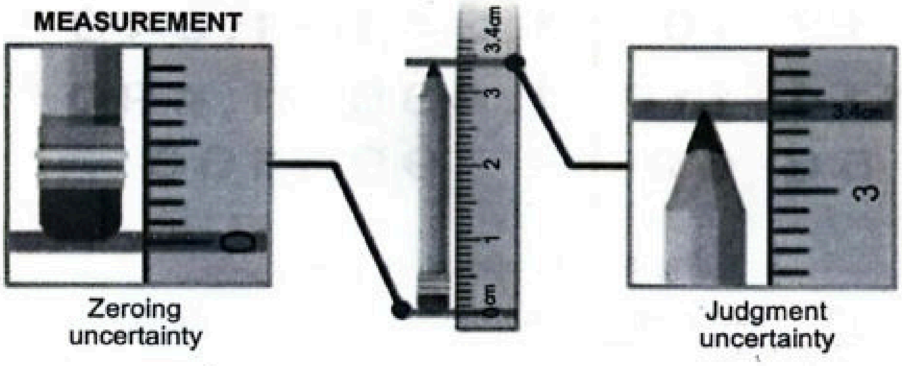



Fig. 8.13: Uncertainty in measurement

It seems clear that the length of pencil is greater than 3cm but shorter than 4cm. But how much longer or shorter? You cannot be certain about the length. As your best estimate you might say that the pencil is 3.4cm long. Everyone would be agreed that you can be certain about the first number 3cm, and the next digit i.e. 0.4cm has been estimated and is not certain. The certain number with one uncertain number, represent the greatest accuracy possible with the ruler being used. Hence the pencil is said to be 3.4cm long.

**In any calculation the accurately known digits and the first doubtful digit are called significant figure.** A significant figure is a number that is believed to be correct with some uncertainty only in the last digit.

a. All non-zero digits are always significant i.e. 1, 2, 3, 4, 5, 6, 7, 8 and 9.
b. Zeros between non-zero digits are significant, i.e. 308, 5402 etc.
c. All zeros on the left side of non-zero digits are not significant, 0.023, 0.0045 etc.
d. Zeros on right side of non-zero digits with decimal point are significant, i.e. 2.50, 3.00 etc.
e. Zeros on right side of non-zero digits without decimal point depend upon the range of instrument with which the measurement is being taken.
f. In scientific notation, all the digits in mantissa (the coefficient of power of 10) are significant, i.e. $2.30 \times 10^7$ has 3 significant and $4.050 \times 10^3$ has 4 significant digits.

**Precision:** it describes the degree of exactness with which a measurement is made and stated. Precision depends upon the instrument and technique used to make the measurement. Generally, the device that has the finest division on its scale produces the most precise measurement. The precision of a measurement is one-half the smallest division of the instrument.

**Do You Know?**

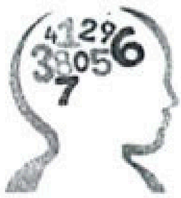
Books in a library were counted one by one. There was a total of 7,770 books in the library. How many significant figures are there in the result?
Will the result change if the books are measured in packets, such that each packet contains exactly 10 books?

**Round off:** is a process of dropping some digits from our measurement. For rounding off the number according to the given significant figure we have some rules. Some of the rounding off examples are shown in figure 8.14.

| | |
|---|---|
| $\boxed{1}\underline{2} \rightarrow 10$ | $1,3\boxed{4}\underline{4} \rightarrow 1,340$ |
| $1\boxed{1}\underline{4} \rightarrow 110$ | $1,4\boxed{8}\underline{8} \rightarrow 1,490$ |
| $\boxed{5}\underline{8} \rightarrow 60$ | $\boxed{9}\underline{9} \rightarrow 100$ |

Fig. 8.14: Examples of rounding off

1. First check the number of significant figures.
2. Drop the number after the significant figure.
3. If the dropped number is greater than 5 simply add unit in the last digit of remaining value, i.e. 4.327 rounded to 4.33, as 7 is dropped which is greater than 5 hence 2 is increased to 3.
4. If the dropped number is less than 5 simply drop it without changing the remaining values, i.e. 7.372 rounded to 7.37, as 2 is dropped which is less than 5.
5. If dropped number is equal to 5 then make the last remaining digit to nearest even number, i.e. 2.45 round to 2.4 and 7.75 round to 7.8, if 5 is dropped from both values.
6. In any measurement numbers are added, subtracted, multiplied or divided the number of significant figures in result will be equal to the number of significant figures of that quantity which has the smallest number of significant figures.
7. When we round the number to nearest 10 or 100 then all the remaining digits are reduced to zero, as shown in figure 8.15.



*Find your place*
*Look next door*
*5 or greater, add one more*

| Round to the nearest ten | Round to the nearest hundred |
|---|---|
| 54 → 50 | 415 → 400 |
| 55 → 60 | 950 → 1000 |
| 313 → 310 | 7261 → 7300 |
| 549 → 550 | 7221 → 7200 |
| 1221 → 1220 | 36430 → 36400 |

Fig. 8.15: Round off the numbers

**Example 8.2 (Round off)** Make the following calculations and round off the final results upto significant figures.

a) 2.35 + 57.46

b) 3.2 x 10.5
c) 10.20 / 2.3
d) 6.2 x 10.514
**SOLUTION:**

a)
$$\begin{array}{r} 2.35 \\ +\underline{57.46} \\ 59.81 \end{array}$$

As in this result total numbers are four, while the numbers added have significant figures 3 and 4 respectively, so result should have only 3 significant figures. So round off value of result will be:

$$Sum = 59.8$$

b)
$$\begin{array}{r} 3.2 \\ \times\underline{10.5} \\ 33.6 \end{array}$$

As in this result total numbers are three, while the numbers multiplied have significant figures 2 and 3 respectively, so result should have only 2 significant figures. So round off value of result will be:

$$\mathrm{Pr}oduct = 34$$

c)
$$\frac{10.20}{2.3} = 4.4347826087$$

As in this result total numbers are eleven, while the numbers divided have significant figures 4 and 2 respectively, so result should have only 2 significant figures. So round off value of result will be:

$$\mathrm{Re}\,sult = 4.4$$

d)
$$\begin{array}{r} 6.2 \\ \times\ \underline{10.514} \\ 65.1868 \end{array}$$

As in this result total numbers are six, while the numbers divided have significant figures 2 and 5 respectively, so result should have only 2 significant figures. So round off value of result will be:

$$\mathrm{Pr}oduct = 65$$

## SUMMARY

1. Physical quantities are those quantities which can be measured.
2. Quantities which cannot be measured are called non-physical quantities.
3. System international is the system of units which is internationally recognized.
4. Seven quantities which are chosen randomly are known as base quantities, all other quantities are derived from these base quantities.
5. Quantities which are derived from the base quantities by adding, multiplying or dividing them are called derived quantities.

6. Seven units which are the units of seven base quantities are known as base units, all other units are derived from these base units.
7. Units which are derived from the base units by adding, multiplying or dividing them are called derived units.
8. To assess the magnitude of a physical quantity by means of some instrument and by comparing it with some reference is called measurement.
9. Meter rule is a length measuring instrument which can measure up to 1 meter and minimum value of 1 mm.
10. Measuring tape is a length measuring instrument which can measure as small value as 1mm. it can measure up to several meters.
11. Time is the duration between two events.
12. Stopwatch is a time measuring device.
13. Analog stopwatch is a device which can measure the time between any two events with the help of rotating needles in fix duration.
14. Digital stopwatch is a device which can measure the time between any two events digitally with perfect accuracy.
15. In any measurement the accurately known digits and the first doubtful digit are called the significant figures.
16. The closeness of the estimated value to the actual value is called precision.
17. If the result of any measurement is quite large, we round off the result up to the significant figure this process is called rounding off.

## EXERCISE

Section I: Multiple Choice Questions

**Select the correct answer:**

1. Which of the following is not a derived unit?
   A) pascal B) newton
   C) kelvin D) joule
2. The unit of weight in terms of base units is:
   A) $kg\ m\ s^{-2}$ B) $kg\ m^{-1}\ s^{-2}$
   C) $kg\ m\ s^{-1}$ D) $kg\ m^{-1}\ s^{-1}$
3. Which of the following unit is derived from the base unit length only?
   A) J B) $m^2$
   C) Pa D) A
4. The least count of meter rule is:
   A) 0.01 mm B) 0.1 mm
   C) 1 mm D) 10 mm
5. The unit of momentum (which is product of mass and velocity) in terms of base units is:
   A) $kg\ m^{-1}\ s^{-1}$ B) $kg\ m^{-1}\ s^{-2}$
   C) $kg\ m\ s^{-1}$ D) $kg\ m\ s^{-1}$

6. The least count of analog stopwatch is:

A) 0.01 s B) 0.1 s
C) 1 s D) 10 s

7. Precision of the measurement is ________ of the smallest division of measuring instrument.

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

8. Number of significant figures in 0.00302 are:

A) 2 B) 3
C) 5 D) 6

9. Number of significant figures in $4.50 \times 10^{-8}$ are:

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

10. The product of 4.513 and 7.21, up to correct number of significant figures is:

A) 32.53 B) 32.54
C) 32.6 D) 32.5

11. The number 4.53567 is rounded off to three significant figures as:

A) 4.50 B) 4.53
C) 4.54 D) 4.60

## Section II: Short Response Questions

1. Find out the units of a physical quantity named torque, which is the product of force and displacement, in terms of base units.
2. What will be the units of gravitational potential energy in terms of base units, where potential energy can be given as, $P.E = m\ g\ h$, here 'm' is the mass, 'g' is the gravitational acceleration and 'h' is the height.
3. What are the advantages of using system international (SI) of units?
4. Why we use the least count of an instrument? Explain.
5. State any two limitations of meter rule and measuring tape.
6. Precautions should be taken for taking length measurement using meter rule? Elaborate those precautions.
7. Which one is more reliable, mechanical or digital stopwatch? Justify.
8. Find the sum of the following numbers up to correct number of significant figures.
   a) 4.5 and 8.32 b) 12.36 and 89.7 c) 3.201 and 4.76
9. Find the results of given operations of numbers up to correct number of significant figures.
   a) 4.52 x 8.6 b) 12.38 x 6.70 c) 93.21 / 12.403
10. Explain the rules of rounding off the numbers.
11. Round of the following numbers up to three significant digits.
    a) 4.527 b) 12.832 c) 93.251 d) 7.675

## Section III: Extensive Response Questions

1. What is the importance of physical quantities in the study of Physics?
2. Discuss the difference between base and derived physical quantities.

3. Explain the difference between base and derived units.
4. Justify that the physical quantities can be categorized into two types, scalar and vector.
5. Elaborate the measurement of length with the help of meter rule and measuring tape.
6. Describe the measurement of time with the help of digital and analog stopwatch.
7. Significant figures are important in measurement. Why?
8. What role precision plays in a measurement?
9. Why we round off the numbers? What rules are to be followed for it?
10. How results of basic algebraic operation can be round off up to correct number of significant figures.

Section IV: Numerical Response Questions

1. What are the units of kinetic energy in terms of base units, if the formula for kinetic energy is $K.E = \frac{1}{2}mv^2$: **(Answer: kg $m^2$ $s^{-2}$)**
2. Find the results of the given operations up to correct significant figures and proper rounding off the result.
   a) 2.31 + 3.457 b) 5.312 - 2.13
   c) 57.3 x 2.310 d) 60.3875 / 4.58
   **(Answer: 5.77, 3.18, 132, 13.2)**
3. Find the SI units of viscosity 'η' (the frictional effect between the layers of a fluid) of a fluid if the force 'F' is acting on a ball of radius 'r' moving with speed 'v' in the fluid given by: $F = 6\pi\ \eta\ r\ v$

   Here '' is a mathematical constant and has no units. Also convert the units in terms of base units. **(Answer: $\eta = Pa\ s = kg\ m^{-1}s^{-1}$)**