UNIT 1

# Matter

### *Learning Outcomes*

*Children will be able to:*

- *define matter;*
- *describe what matter is made of;*
- *list the distinguishing properties of solid, liquid and gas;*
- *classify different objects in terms of solid, liquid and gas.*

### *Chapter Outlines*

- Matter
- Composition of Matter
- States of Matter : Solids, Liquids and Gases
- Properties of Solids, Liquids and Gases

### *Activities*

- To study that solids and liquids have mass.
- To study that air has mass.
- To study that solids and liquids occupy space.
- To study that gases occupy space.
- To study that liquids have no definite shape.
- To study that liquids have definite volume.
- To study that gases have no definite shape.
- To show that gases do not have definite volume.
- To show that gases can be compressed.

# MATTER

We see around us a chair, a bullock cart, a cycle, cooking utensils, books, clothes, toys, water, stones and many other objects. All these objects have different shapes, colours, uses and are made from the "stuff" called matter. In fact 'matter is every thing in the universe that takes up space and has mass.'

Matter takes up space, meaning it has volume. Matter contains a certain amount of material, therefore it has mass. Because all matter has mass and volume, it can be detected, though some more easily than others.

## ACTIVITY 1

### TO STUDY THAT SOLIDS AND LIQUIDS HAVE MASS.

- Take an empty plastic beaker and tie it to strong cotton thread, so as to make a suspension loop. Suspend the beaker from the hook of a spring balance. Read and record the weight from the spring balance.
- Now pour water in the beaker so that it is completely filled. What do you notice? The spring balance shows more weight.
- **Conclusion :** Water (a liquid) has weight and hence has mass.
- Repeat the activity by using sand or pebbles. What do you notice? The spring balance records weight, which is more, as compared to water.
- **Conclusion :** We can say that solids and liquids have weight and hence have mass.

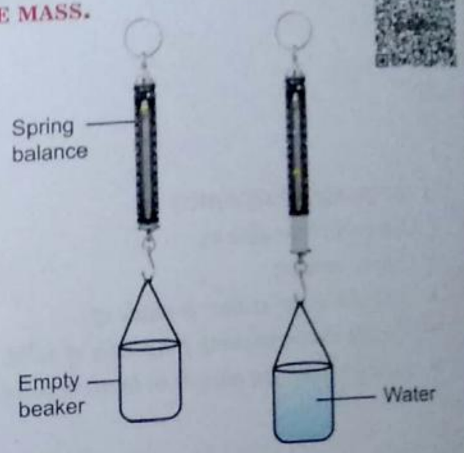



**Fig. 1.** Solids and liquids have weight.

## ACTIVITY 2

### TO STUDY THAT AIR HAS MASS.

- Take two similar balloons and inflate them equally. Suspend one balloon on the left hand side of the half meter scale and the second one on the right hand side of the half meter scale. Balance the scale in the middle as shown in Fig. 2.
- Take a long iron needle and heat its tip on a spirit lamp. When tip of needle is red hot, touch it to the balloon on the left hand side as shown in Fig. 3.
- You will observe : (i) The balloon bursts and air goes out.
  (ii) The half meter scale tilts towards right.

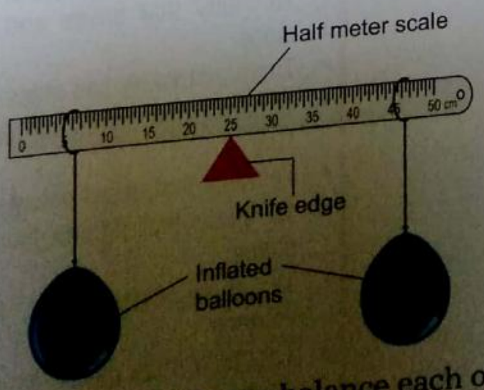



**Fig. 2.** Inflated balloons balance each other.

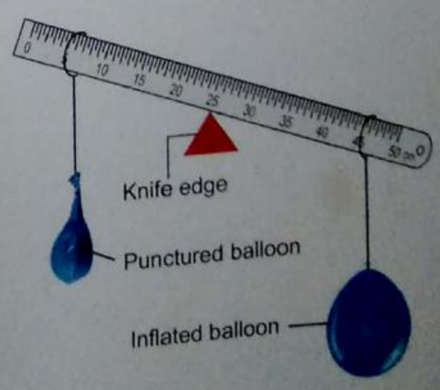



**Fig. 3.** Gases have weight and hence mass.

- **Conclusion :** Air has weight and hence has mass. It is on account of the mass of the air in the balloon on right hand side that the half meter scale tilts.

# ACTIVITY 3

**TO STUDY THAT SOLIDS AND LIQUIDS OCCUPY SPACE.**

- Take a glass tumbler and place it in a glass bowl. Pour water gently in the tumbler so that it is completely filled.
- Now take a small stone. Tie it with a thread. Lower the stone gently into water. What do you observe?
- Some water overflows from the glass tumbler and collects in the bowl.
- Remove the stone from the glass tumbler.
- The level of water in the glass tumbler is less. Now pour the water collected in the bowl into the tumbler. What do you observe? The glass tumbler is completely filled.

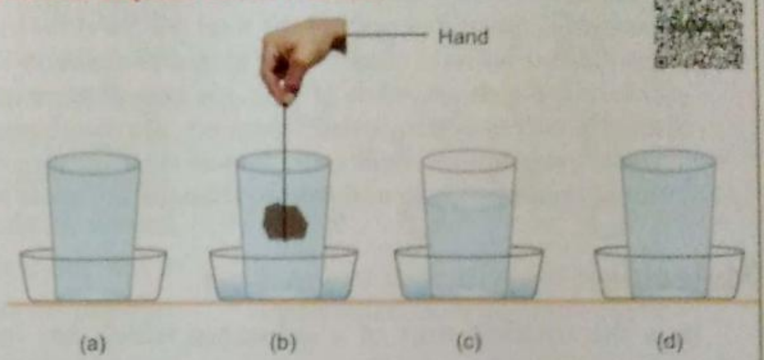



Fig. 4. Solids and liquids occupy space.

- **Conclusion :** Solids and liquids occupy space. The stone occupies space and hence, pushes water out of tumbler. The water occupies space, as the water collected in bowl on pouring into tumbler completely fills it.

# ACTIVITY 4

**TO STUDY THAT GASES OCCUPY SPACE.**

- Take an empty glass tumbler and lower it vertically downward in a trough of water. What do you observe? It is seen that the level of water inside the tumbler is less than outside. It is because the air within the glass is trapped and does not allow the water to rise up. In other words, air occupies space.
- Now, tilt the glass tumbler gently towards right. It is seen that bubbles of air rush out and to take its place water flows into tumbler.
- **Conclusion :** Gases (air) occupy space.

From the above activities, we reach at the conclusion that :

(i) All material bodies have weight and hence have mass.
(ii) All material bodies occupy space.

Thus, the matter, of which the material bodies are made, can be defined as :

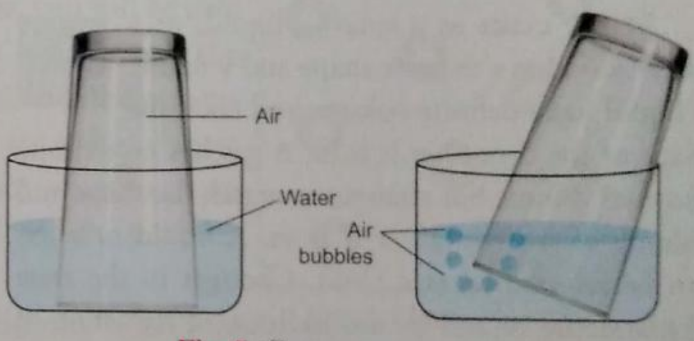



Fig. 5. Gases occupy space.

Any material which has mass and occupies space is called matter.

## COMPOSITION OF MATTER

Matter is made up of extremely small particles called molecules which in turn are made up of atoms.

Everything around us—air, water, trees, mountains, books, pencil etc., are all made up of different types of atoms and molecules.

### Atom

An atom is the smallest unit of matter. It cannot be split apart by normal chemical or physical processes and take part in a chemical reaction.

### THINKING BIG

- Human hair is about 1 million atoms width. You have around 100,000 hairs on your head. Can you estimate the number of atoms in hair?
- Atoms make about 4 percent of the total matter of the universe. What about the rest 96%?
- Some substances have same type of atoms. For example, all the atoms of hydrogen gas are the same. These substances which are made of only one type of atom are called elements. Thus hydrogen is an element. Similarly, nitrogen gas, copper, water etc. are the elements. There are 7 types of elements in human body.
- There are substances which contain more than one type of atoms. For example, sand grains are made of two kinds of atoms—oxygen and silicon. Humans are made of 28 different kinds of atoms.

## Molecule

It is the smallest unit of a substance which has independent existence and which has the same properties as that of matter.

### THINKING BIG

- Molecule is the smallest particle which can remain stable in free state.
- A molecule may be made up of one, two or more atoms of the same kind or different kinds.
- If the molecule contain a single atom then it is called mono-atomic. Similarly we have di-atomic and poly-atomic.

## STATES OF MATTER : SOLIDS, LIQUIDS AND GASES

Matter exists as a solid, a liquid, or a gas. A solid has a definite shape and volume. A liquid has a definite volume and takes the shape of the container it is in. A gas has no definite shape or volume but changes to match the shape and volume of the container it is in. A liquid or a gas can be referred to as a fluid. Changes in the state of matter are caused by the addition or reduction of energy.

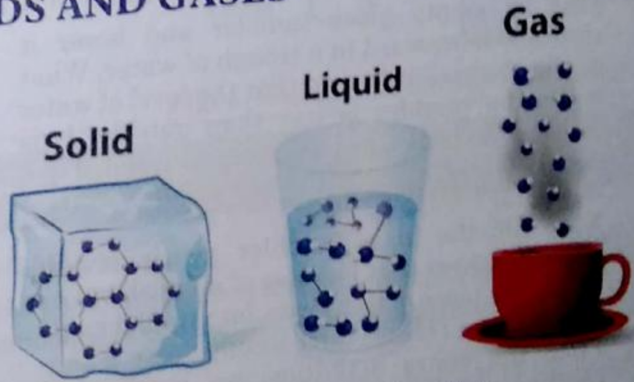



Fig. 6. States of matter.

## Solid

Look at a block of wood. Try to push on it. What you see? Now, have an elephant stand on it. Do you see any change? You can say that this solid block of wood has a definite volume and a definite shape. It doesn't change shape even with the elephant standing on it unless of course he disintegrates it, but let's pretend this is a baby elephant. These are characteristics of a solid. It has a definite volume and shape. A solid has molecules too, they are just so tightly packed that they have limited movement and are incompressible and hold their volume and shape. In general, substances are most dense in the solid state.

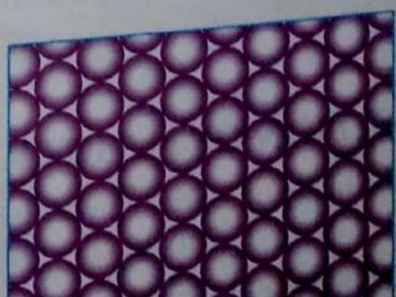


Fig. 7. Higher density solids have a definite shape and volume.

## Liquid

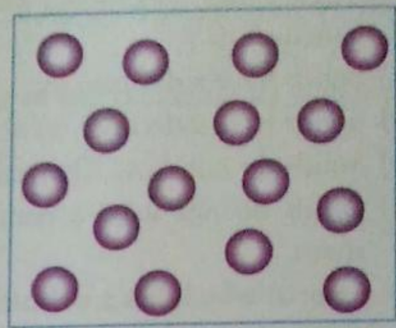


Fig. 8. Liquid molecules are more tightly compacted than gas molecules.

Look at a bottle of water. What properties do you know about that liquid? You can tell that the liquid takes the shape of the bottle and you probably know that if you pour the liquid (water) into a different container, it will take the shape of the new container. You also probably know that no matter how hard you push on the water, you can never change its volume. Whether it is in a tall, narrow bottle or spread out over a table top, liquid has a definite volume but not a definite shape. Contrast this with gas which has no definite fixed shape or volume.

In a liquid, the molecules are more tightly packed but can still move and flow past each other. Liquids are able to diffuse and mix with other liquids but it is a slower mixing than in gases. Another property common to all liquids is surface tension. Surface tension is a force of attraction that keeps molecules on the surface of a liquid together causing tension. This is why bugs can walk on water.

## Gas

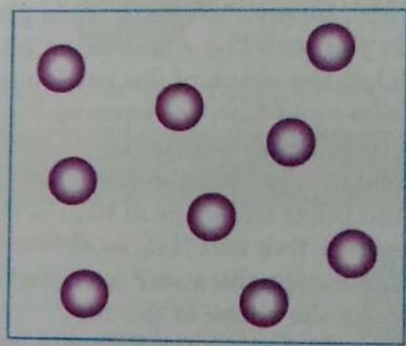


Fig. 9. Gas molecules.

Open a bottle of perfume in one corner of a room then move to the opposite corner and wait. In only a few minutes, you will be able to smell that perfume. Why is that? Because air is a gas and the perfume molecules evaporate into a gas and disperse into the gaseous air. Gases consist of tiny particles or molecules that are really far apart relative to their size. These molecules have so much room to move around that pretty soon the two gases have mixed, and the perfume has spread throughout the room.

Gas is a form of matter that does not have a definite volume or shape. Gases have low density compared to the same substance in other states. Gases are also able to diffuse easily as indicated in the above example on perfume.

## Characteristics of Solids

Fig. 10

A. We have seen that tables, chairs, fans, pen, cups, glass, spoons and saucers etc., have a definite shape.
   Do they change their shape at room temperature? Obviously, the answer would be No!
B. For example, a wooden chair that occupies space *i.e.*, it has some volume. Now, your mother to sit on that chair. Does the volume of the chair change?
   No, it does not. Thus, solids have a definite volume.
C. Now, take a bowl filled with salt. Empty the bowl on a plate.
   What do you notice? The salt does not flow, but instead it gets heaped.

From the above examples, we reached at following conclusions :

(i) Solids have a definite shape.
(ii) Solids have a definite volume.
(iii) Solids do not flow. They can be heaped.
(iv) Solids do not need a container to hold them.

**Fig. 11.** (a) Bowl with salt, (b) Plate with salt.

Any material which has a definite shape and definite volume is called solid.

## Characteristics of Liquids

To understand this, let us perform the following activities :

### Activity 5

**To study that liquids have no definite shape.**

- Take a small cup and fill half of it with water.
- Notice, the shape of water. It will resemble the shape of cup, but will have one free and flat surface on the top, as shown in Fig. 12 (a).
- Now, invert the cup in a big glass bowl. What do you see? The water flows into the bowl and takes the shape of the bowl, but its top surface is free and flat, as shown in Fig. 12 (b).
- Pour the water from the bowl into a tea flask. What do you notice? The water flows into flask and takes the shape of the tea flask with its top surface free and flat, as shown in Fig. 12 (c).
- Again pour the water from tea flask into the cup. You observe, that cup again gets half filled and the water takes the shape of the cup.
- **Conclusion :** Liquids do not have definite shape.

**Fig. 12**

### Activity 6

**To study that liquids have definite volume.**

- Take a disposable plastic syringe and remove the plunger from the syringe.
- Now, seal its nozzle with fevicol. Allow the fevicol to dry.
- Half fill it with water.
- Now, insert the plunger. Push the plunger with the force inward.
- What do you observe? The volume of water does not change.
- **Conclusion : The liquids do not change their volume when compressive forces are applied.**

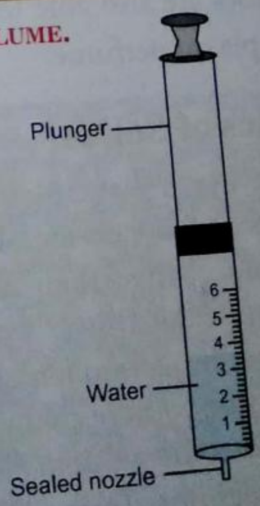


**Fig. 13.** Liquids do not get compressed.

On the basis of above activities and otherwise, following properties about liquids have been established :

(i) Liquids have **definite volume,** no matter in what shaped container they are put. However the volume is dependent upon temperature.

(ii) Liquids do not have definite shape. They take up the shape of the container in which they are poured.

(iii) Liquid are not compressible.

(iv) Liquids flow from higher elevation to lower elevation.

(v) Liquids have perfect horizontal free surface.

(vi) Liquids show the property of surface tension.

Note : Any material which has a definite volume, but no definite shape and has one free space, is called liquid.

## Characteristics of Gases

### ACTIVITY 7

**TO STUDY THAT GASES HAVE NO DEFINITE SHAPE.**

- Take balloons of different shapes and inflate them with air.
- What do you observe? The air inside the balloons takes the shape of balloons.
- It has no shape of its own.

Fig. 14. Gases take the shape of container.

### ACTIVITY 8

**TO SHOW THAT GASES DO NOT HAVE DEFINITE VOLUME.**

- Take an empty glass bottle and pour into it a few drops of scent. Smell the bottle. You will be able to smell the scent.
- Now, place this bottle in your drawing room and leave it undisturbed for a few minutes. You will observe that the whole room is filled with the smell of scent.
- **Conclusion :** Gases have no definite volume. They have a property to fill the entire space available to them.

### ACTIVITY 9

**TO SHOW THAT GASES CAN BE COMPRESSED.**

- Take a disposable syringe (see Fig. 13) and remove the plunger from the syringe.
- Now seal its nozzle with fevicol. Allow the fevicol to dry. At this moment syringe is filled with air.
- Replace the plunger in the syringe and push it inward with your force.
- You will notice that plunger moves somewhat inward on the application of force.
- However, as soon as force is removed, the plunger moves outward.
- **Conclusion :** Gases can be compressed.

From the above activities 7, 8 and 9, we can say that gases have following characteristics :

(i) Gases have no definite shape. They take the shape of the containing vessel.

(ii) Gases have no definite volume. They have a property to fill the entire space available to them.

(iii) Gases can be compressed.

(iv) Gases have no free surface.

**Note :** Any material which has neither definite shape nor definite volume, is easily compressible and has no free surface, is called gas.

Why matter exists in three different states?

- There is a force of attraction between molecules of matter. If the force is between similar molecules it is called force of cohesion and if it is between dissimilar molecules, it is called force of adhesion. These forces are together called as intermolecular forces of attraction.
- The space between molecules of a substance is called intermolecular space.
- The intermolecular force of attraction is less when the intermolecular space is more and *vice-versa*.

Depending upon the intermolecular forces between molecules and their intermolecular space, matter is divided into three states—solids, liquids and gases.

## Arrangement of Molecules in Solids

(i) The intermolecular distance between molecules in solids is very less, *i.e.*, in a solid the molecules are very tightly packed.

(ii) The intermolecular forces of attraction is very strong.

(iii) Due to the forces being very strong the molecules do not slide over each other, *i.e.*, the solids don't flow like liquids.

(iv) Solids have a definite shape as molecules are unable to move out of their mean positions.

(v) For the above reason solids expand very negligibly on heating.

(vi) Due to intermolecular distance being very less, solids cannot be compressed easily.

(vii) Solids are rigid, hard and have a definite volume.

## Arrangement of Molecules in Liquids

(i) In a liquid, the intermolecular distance is more than that in solids, *i.e.*, the molecules are not as tightly packed as in solids. The intermolecular force of attraction is also not as strong as in solids.

(ii) As the intermolecular distance is considerable, liquids can be compressed.

(iii) Due to the lesser intermolecular forces acting, liquid molecules slide over each other and liquids can flow.

(iv) Liquids also expand more on heating as the intermolecular forces are lesser.

(v) The molecules of a liquid are in random motion, hence liquids don't have a definite shape but take the shape of the container in which they are poured. However liquids have a fixed volume at a given temperature.

## Arrangement of Molecules in Gases

(i) The intermolecular distance between gas molecules is very large and the intermolecular forces of attraction are negligibly small.

(ii) As the intermolecular distance is very large in gases, they can be compressed very easily and to a greater extent than liquids. Since gases can be compressed easily, petroleum gas which is compressed is available as cooking gas in cylinders.

(iii) Due to the negligible intermolecular forces of attraction, gas molecules move randomly and fill the complete space inside a container. This is how an *agarbatti* or incense stick spreads its perfume in the whole room.

(iv) Gases don't have a definite shape and volume.

(v) The gases expand very easily on heating.

Note : The molecules of a gas move with speeds of about 1600 km/hour at room temperature that is faster than the speed of sound.

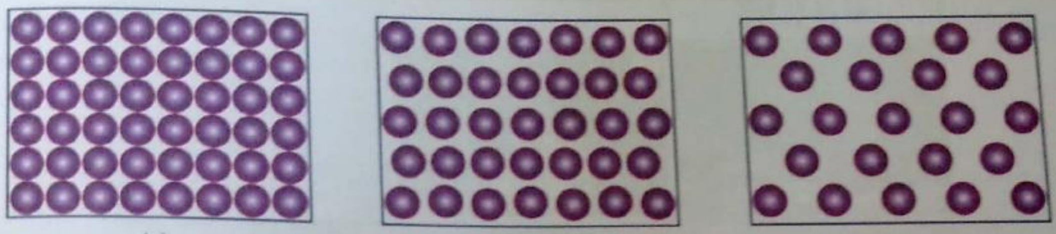


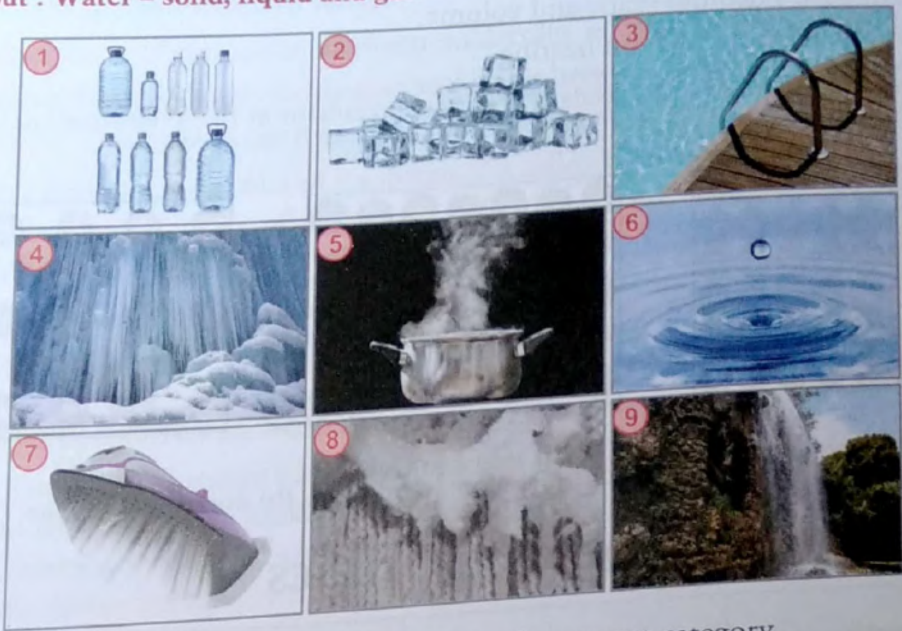

Fig. 15. Arrangement of molecules in (a) solid, (b) liquid and (c) gas.

## PROPERTIES OF SOLIDS, LIQUIDS AND GASES

| S. No. | Properties | Solids | Liquids | Gases |
|---|---|---|---|---|
| 1. | Intermolecular force of attraction | Very strong. | Lesser than in solids, more than in gases. | Negligibly small. |
| 2. | Intermolecular distance | Very small. | More than in solids, lesser than in gases. | Very large. |
| 3. | Shape | Have a definite shape. | Take the shape of the container. | No definite shape. |
| 4. | Volume | Have a fixed volume. | Have a fixed volume. | Have no fixed volume, occupy the entire volume of the container. |
| 5. | Compressibility | Cannot be compressed. | Can be slightly compressed. | Can be compressed to a large extent. |
| 6. | Motion | Molecules are fixed in their mean positions. They only vibrate. | Molecules translate and vibrate. | Molecules easily translate and vibrate. |
| 7. | Effect of heat | Expand a little on heating. | Expand more than solids on heating. | Expand very easily on heating. |

# WORKSHEET

## A. Student handout : Water – solid, liquid and gas?




Look at the pictures given above and place them in the correct category.

| Solid (Ice) | Liquid (Water) | Gas (Water vapour) |
|---|---|---|
| | | |

## B. Brain wave.

1. Since you can pour sand into a cup, why isn't it a liquid?

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2. You can't usually see gases in the air. How can you observe gases without seeing them?

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3. Does air have mass? Explain.

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## C. Choose a word from the list to complete each sentence.

**List :** solids, gases, liquids, volume, shape, container, atoms, space, matter, chair, milk, ice, oxygen, helium, juice, melting.

1. The three basic properties of matter are ......................., ....................... and ....................... .
2. All matter is made up of tiny particles called .......................
3. Volume is the amount of ....................... that matter takes up.
4. Mass is the amount of ....................... an object has.
5. Liquids take the shape of their .......................
6. ....................... do not have a definite shape or volume.
7. ....................... do not have a definite shape but they do have a definite volume.
8. ....................... have a definite shape and volume.
9. A ....................... and ....................... are examples of solids.
10. ....................... and ....................... are examples of liquids.
11. ....................... and ....................... are examples of gas.
12. Solid ice is ....................... when it is changing into a liquid.

## D. Choose the correct option.

1. What is matter?
   (a) Matter is anything that flies.
   (b) Matter is anything that occupies space.
   (c) Matter is anything that has definite shape.
2. What are the basic building blocks of matter?
   (a) Particles (b) Atoms (c) Compounds
3. What is the state of matter that has no fixed shape and no fixed volume?
   (a) Solid (b) Liquid (c) Gas
4. What is the common property of a given matter in all the three states solid, liquid and gas?
   (a) They are all living things. (b) They have definite shape.
   (c) They have the same mass.

## E. Categorize the following items as solid, liquid or gas.

1. Pencil
2. Water
3. Soda
4. Nitrogen
5. Ice cream
6. Shampoo
7. Steam
8. Table
9. Wallet
10. Car

## F. Match the statements in Column I, with those in Column II.

| S. No. | Column I | | Column II |
|---|---|---|---|
| 1. | Space in between the molecules of matter. | (a) | Matter |
| 2. | Force of attraction between molecules of matter. | (b) | Gases |
| 3. | Any material which occupy space and has mass. | (c) | Intermolecular force |
| 4. | A state of matter which is highly compressible. | (d) | Intermolecular spaces |
| 5. | A state of matter which can have any number of free surfaces. | (e) | Solids |

## G. Answer briefly.

1. (a) Define solid.
   (b) State four characteristics of a solid.
   (c) On the basis of molecular theory, explain why a solid has definite shape and a definite volume.
2. (a) Define matter. Name its four states with one examples each.
   (b) What is matter comprised of?
3. (a) Define gas.
   (b) State four characteristics of a gas.
   (c) On the basis of molecular theory, explain why a gas has neither definite shape nor definite volume.
4. Why do liquids flow and not the solids?
5. Find odd one out. Give one reason for your answer.
   Solid, Vacuum, Liquid and Gas.
6. Distinguishing the properties of a solid, a liquid and a gas with respect to :
   (a) intermolecular spaces
   (b) intermolecular forces
   (c) fluidity
   (d) number of free spaces
   (e) compressibility.

UNIT 2

# Physical Quantities and Measurement

## Learning Outcomes

*Children will be able to:*

- *define length, mass and time;*
- *express length, mass, time, temperature and area in proper units with proper symbols;*
- *measure length of objects using a ruler and a measuring tape;*
- *measure mass of an object using a beam balance and an electronic balance;*
- *measure time using a clock, a watch and a stop-watch;*
- *relate temperature of an object with its hotness or coldness;*
- *measure temperature of a person using a clinical thermometer;*
- *measure temperature of an object using a laboratory thermometer;*
- *measure area of a regular object using a graph paper;*
- *convert a physical quantity from one unit into other related units.*

## Chapter Outlines

- Measurement
- How do We Measure?
- Need for a Standard Unit System
- System of Units
- Standard Units of Measurements
- Mass
- Time Measurement
- Temperature
- Area Measurement

### Activities

- Measuring length and breadth of classroom.
- Measuring width of a table.
- Measurement of height.
- Measurement of mass using beam balance and electronic balance.
- How to use a 24 hour clock?
- To construct an oscillating pendulum by using a small stone and a string.
- How to read a laboratory thermometer?
- How to read a clinical thermometer?

# MEASUREMENT

Measurement is the comparison of a quantity of unknown magnitude with a standard for that quantity. Every measurement involves two things : a number and a unit. For example, in the statement that the length of a wall is 2 metres, 2 is the number and metre is the unit used to measure the length of the wall.

Without actual measurement one cannot make a correct judgement of a given object. It is not easy to judge the length, area, temperature or mass of different objects by just looking at them. Your judgement may go wrong. One cannot always do guess work.

## HOW DO WE MEASURE?

We measure all physical quantities by comparison. The comparison of an unknown physical quantity is done with a standard value of some kind. For example, if mass of potatoes purchased in the market is the unknown physical quantity, we have to choose a standard value of mass measurement for comparison to make the measurement.

### ACTIVITY 1

**MEASURING LENGTH AND BREADTH OF CLASSROOM.**

- Work in groups and each of you do this activity one by one. Using your foot as a unit of length measure the length and breadth of the classroom. It is possible that while measuring these you may find some part remains to be measured as it is smaller than your foot. Use a string to measure the length of a part of your foot as you did before.
- Record your observations in the following table :

| Name of student | Length of the classroom | Width of the classroom |
|---|---|---|
| | | |

### ACTIVITY 2

**MEASURING WIDTH OF A TABLE.**

- Work in a group and each of you use your handspan as a unit of measure the width of a table or a desk in the classroom (Fig. 1).
- Here too, you may find that you need string lengths equal to your handspan and then fractions of this string length to make the measurement. Record all observations in the following table.

**Fig. 1.** Measuring the width of a table with a handspan.

| Who measured the width of the table? | Number of handspans |
|---|---|
| | |

We see that measurement means the comparison of an unknown quantity with some known quantity. This known fixed quantity is called a unit. The result of a measurement is expressed in two parts. One part is a number. The other part is the unit of the measurement. For example, if in activity 1, the length of the room is found to be 12 lengths of your foot, then 12 is the number and 'foot length' is the unit selected for the measurement.

Now, study all the measurement recorded in Activity 1 and Activity 2. Are all the measurements for the room using everybody's foot equal? Are everybody's measurements, by handspan of the width of the table equal? Perhaps the result could be different as the length of your handspan and that of your friends may not be the same. Similarly, the length of the foot may be slightly different for all the students. Therefore, when you tell your measurement using your handspan or length of foot as a unit to others, they will not be able to understand how big the actual length is unless they known the length of your handspan or foot.

We see therefore, that some standard units of measurement are needed, that do not change from person to person.

The basic accepted reference standard is called a unit.

A 'unit' is the standard reference of the same physical quantity. All measurement are written in the form *nu*. '*n*' refers to the magnitude of measurement. It tells us how big or small the measurement is. It is always a number. '*u*' refers to the unit of the physical quantity.

For example, 10 metre means 10 times the length of 1 metre. 1 metre here is the standard unit of length measurement.

As the activity of measuring the length of the table shows us. Unless we choose a proper unit, our measurement will not be a proper measurement.

## NEED FOR A STANDARD UNIT SYSTEM

As we have seen in activity 2 the length of table measured by three boys is not same then which one is correct is the basic question. To avoid the discrepancy in measurement, a standard unit is required.

A standard unit has the following features :

1. It is well defined and accepted internationally.
2. Its value does not change due to physical factors like temperature, wind speed, etc.
3. It should be of convenient size, neither too long nor too small.
4. It should be easily reproducible.
5. It should be easily available for comparison.

## SYSTEMS OF UNITS

There are many systems of units like MKS system, CGS system, FPS system, etc.

- MKS stands for metre, kilogram, second.
- CGS stands for centimetre, gram, second.
- FPS stands for foot, pound, second.

These systems considered length, mass and time as the fundamental physical quantities and hence their names. The MKS system is also called the metric system.

A fundamental physical quantity is a basic unit which canot be simplifed further.

The metric system was first adopted in 1971 in France. In the CGS system the standard units are smaller than in the MKS system.

## SI Units

The system of units which is at present internationally accepted for measurement is the system international d'unites (French for International System of Units) abbreviated as SI. The SI with standard scheme of symbols and units was recommended for usage internationally in scientific, technical and commercial work.

The SI has the three units of length, mass and time of the MKS unit system and four more units for temperature, current, luminous intensity and amount of substance.

The SI has seven physical quantities which are considered as base quantities or fundamental quantities. These seven quantities are : length, mass, time, temperature, current, luminous intensity and amount of substance.

**Table 1 : Table of fundamental units**

| Quantity | Unit | Symbol |
|---|---|---|
| Length | metre | m |
| Mass | kilogram | kg |
| Time | second | s |
| Temperature | kelvin | K |
| Current | ampere | A |
| Luminous Intensity | candela | cd |
| Amount of Substance | mole | mol |

A fundamental physical quantity is one whose definition does not depend on any of the other physical quantities.

There are thousands of physical quantities but they can all be derived by using these seven fundamental physical quantities. These seven fundamental quantities have been defined very precisely and their prototypes are preserved at the National Physical Laboratory in Delhi, India.

## Derived Units

The other physical quantities which can be derived from these seven fundamental quantities are called derived units and hence can be expressed in SI.

For example,

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time taken}} = \frac{m}{s}$$

$$\text{Volume} = \text{length} \times \text{breadth} \times \text{height} = m^3$$

Some derived units in the SI are given in table 2.

**Table 2 : Table of derived units**

| Physical quantity | Relationship with other quantities | SI unit |
|---|---|---|
| Area | length × breadth | $m^2$ |
| Volume | length × breadth × height | $m^3$ |
| Density | mass/volume | $kg\ m^{-3}$ |
| Speed or Velocity | distance/time | $m\ s^{-1}$ |
| Acceleration | (change in velocity)/time | $m\ s^{-2}$ |
| Force | mass × acceleration | N |
| Work | force × distance | J |
| Energy | amount of work | J |
| Pressure | force/area | Pa (Pascal) |

### Multiples and Submultiples of Units

Prefixes are used with units to indicate multiples and submultiples. Multiples are factors used to create larger values of the unit. 1 km or 1 kilometre is 1000 times 1 m. Example, the radius of the Earth is 6,400,000 m. It is convenient to write it as 6,400 km.

Submultiples are factors used to create smaller values of the unit. Submultiple can also be used with units. 1 mm or 1 millimetre is $\frac{1}{1000}$ th of 1 m.

Some of multiples and submultiples are as follows :

**Table 3 : Table of multiples/submultiples**

| | Factor | Prefix | Symbol | Example |
|---|---|---|---|---|
| Multiples | $10^6$ | Mega | M | $1\ MW = 10^6\ W$ |
| | $10^3$ | Kilo | k | $1\ kg = 10^3\ g$ |
| | $10^2$ | Hecto | h | 1 hm = 100 m |
| Submultiples | $10^{-2}$ | Centi | c | $1\ cm = 10^{-2}\ m$ |
| | $10^{-3}$ | Milli | m | $1\ mm = 10^{-3}\ m$ |
| | $10^{-6}$ | Micro | μ | $1\ \mu = 10^{-6}\ m$ |

$10^{-6}$ m is 1 micron.

To understand multiples and submultiples, let us consider some examples :

(a) 1 kg refers to 1000 g or $10^3$ g.
1 km refers to 1000 m.
Kilogram is used to measure larger masses than gram.
Kilometre measure very large distances.

(b) Small time intervals could be measured in millisecond.
1 ms refers to $\frac{1}{1000}$ th of a second.
1 ms is a submultiple of a second.

## STANDARD UNITS OF MEASUREMENTS

In ancient times, the length of a foot, the width of a finger and the distance of a step were commonly used as different units of measurements.

The people of the Indus valley civilisation must have used very good measurements of length because we see evidence in excavations of perfectly geometrical constructions.

A cubit as the length from the elbow to the finger tips was used in ancient Egypt and was also accepted as a unit of length in other parts of the world.

People also used the "foot" as a unit of length in different parts of the world. The length of the foot used varied slightly from region to region.

People measured a yard of cloth by the distance between the end of the outstretched arm and thier chin. The Roman measured with their pace or steps.

In ancient India, small length measurement used were an angul (finger) or a mutthi (first). Even today, we can see flower sellers using their forearm as a unit of length for garlands in many town of India. Many such body parts continue to be in use as unit of length, when convenient.

However, everyone's body parts could be of slightly different sizes. This must have caused confusion in measurement. In 1790, the French created a standard unit of measurement called the metric system.

For the sake of uniformity, scientists all over the world have accepted a set of standard unit of measurement. The system of unit now used is known as the International System of units (SI units). The SI unit of length is a metre. A metre scale is shown in Fig. 2. Also shown is the 15 cm scale in your geometry box.

Each metre (m) is divided into 100 equal divisions, called centimetre (cm). Each centimetre (cm) has ten equal divisions, called millimetre (mm). Thus,

$$1 \text{ m} = 100 \text{ cm}$$
$$1 \text{ cm} = 10 \text{ mm}$$

For measuring large distances, metre is not a convenient unit. We define a larger unit of length. It is called kilometre (km).

$$1 \text{ km} = 1000 \text{ m}$$

Now, we can repeat all our measurement activities using a standard scale and measure in SI units. Before, we do that, we do need to know the correct way of measuring lengths and distances.

## Measurement of Length

Length is defined as the distance of separation between two points in space.

**Table 4 : Length measurement in different units**

| | |
|---|---|
| 10 mm = 1 cm | 10 decametre = 1 hectometre |
| 10 cm = 1 dm | 10 hectometre = 1 kilometre |
| 10 dm = 1m | 1 light year = $9.5 \times 10^{15}$ m |
| 10 m = 1 decametre | |

The SI unit of length measurement is metre (m). One metre is defined as the length of the path travelled by light in vacuum in specific time interval.

Earlier, one metre was defined as the length between 2 marks on a platinum iridium bar kept at 0°C at the International Bureau of Weights and Measures at Sevres near Paris.

1 light year is the distance travelled by light in vacuum in 1 year.

$$1 \text{ light year} = 9.5 \times 10^{15} \text{ m}$$

## Correct Measurement of Length

In our daily life we use various types of measuring devices. We use a meter scale for measuring length.

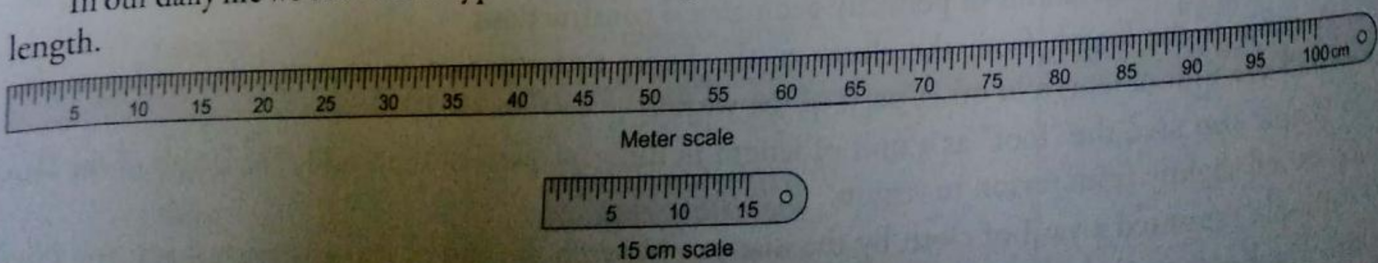
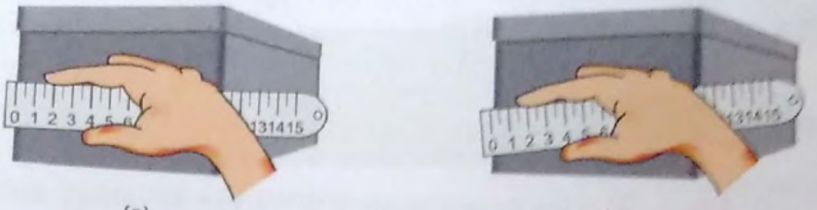



**Fig. 2.** A meter scale and a 15 cm scale.

A tailor uses a tape whereas a cloth merchant uses a metre rod. For measuring a length of an object, you must choose a suitable device. You cannot measure the girth of a tree or the size of your chest using a metre scale. For instance, measuring tape is more suitable for this. For small measurements, such as the length of your pencil, you can use a 15 cm scale from your geometry box.

In taking measurement of a length, we need to take care of the following :

1. Place the scale in contact with the object along its length as shown in fig. 3.

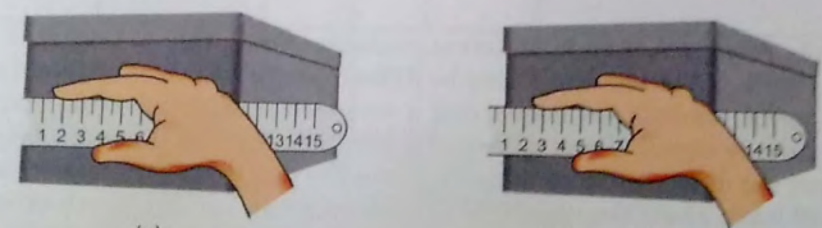



(a) (b)

**Fig. 3.** Method of placing the scale along the length to be measured
(a) correct and (b) incorrect.

2. In some scales, the ends may be broken. You may not be able to see the zero mark clearly (Fig. 4a).

   In such cases, you should avoid taking measurements from the zero mark of the scale. You can use any other full mark of the scale say, 1.0 cm [Fig. 4(b)]. Then you must subtract the reading of this mark from the reading at the other end. For example, in Fig. 4(b) the reading at one end is 1.0 cm and at the other end it is 14.3 cm. Therefore, the length of the object is (14.3 – 1.0) cm = 13.3 cm




(a) (b)

**Fig. 4.** (a) Incorrect and (b) correct method of placing the scale with broken edge.

3. Correct position of the eye is also important for taking measurement. Your eye must be exactly in front of the point where the measure is to be taken as shown in Fig. 5. Position '*B*' is the correct position of the eye.

   Note : That from position '*B*' the reading is 10 cm from positions '*A*' and '*C*', the readings may be different.

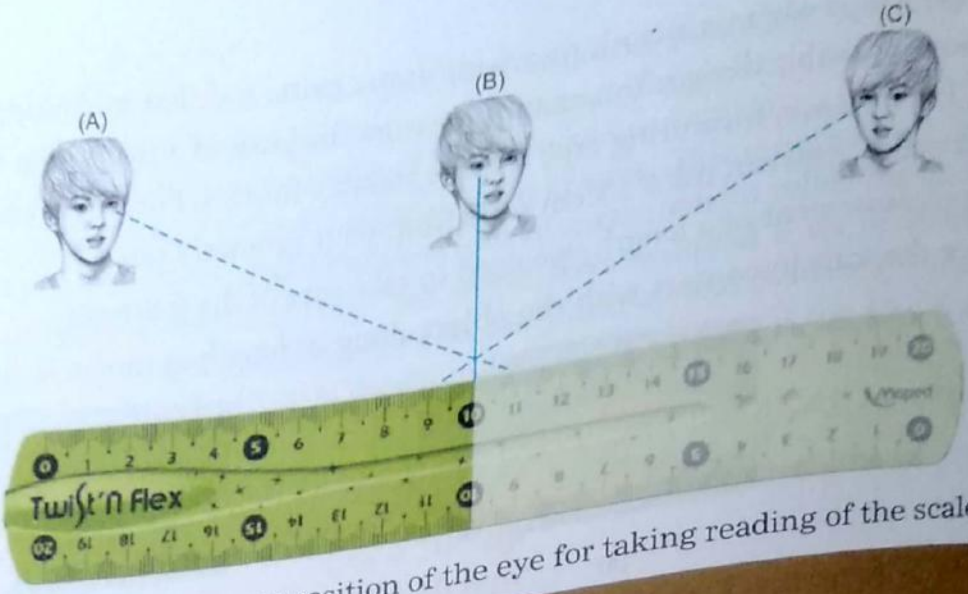



Fig. 5. 'B' is the proper position of the eye for taking reading of the scale.

## ACTIVITY 3

**MEASUREMENT OF HEIGHT.**

- Measure the height of your classmate using handspan and then by using a metre scale. For this, ask your classmate to stand with his back against a wall. Make a mark on the wall exactly above his head. Now, measure the distance from the floor to this mark on the wall with your handspan and then with a metre scale. Let all other students measure this length in a similar way. Record all observations in the following table.

| Who measured the height? | Height in handspans | Height in cm |
|---|---|---|
| | | |

- Study carefully result obtained by different students. The result in column 2 may be different from each other as the length of the handspan may be different for different students. Look at the results in column 3 where the measurements are done using a standard scale. The result may be close to each other now but are they exactly equal? If not, why do you think there is a difference? After all, everybody is using the same scale and not different handspans. This could be due to small errors in taking observations. In higher classes we will learn about the importance of knowing and handling such errors in measurement.

## MASS

Mass is the quantity of matter contained in a body. The mass of a body remains unchanged wherever the body may be on Earth, on Neptune or in space. The SI unit of mass is kilogram (kg) and its CGS unit is gram (g).

### Measurement of Mass

Mass of body is determined by comparison with standard masses. A beam balance, grocer's balance or physical balance can be used for this.

### Construction of a Beam Balance

A beam balance consists of a horizontal iron beam supported at its centre by an iron loop. A vertical pointer is fixed at the centre of the beam inside the iron loop. From the two ends of the beam two identical pans are suspended by means of strings of equal mass and length.

The principle of the beam balance is that for the beam to remain horizontal the masses on the two sides should be equal. In a correct balance :

(a) Both pans should be of equal mass.

(b) Pans should be suspended with strings of same lengths and mass.

(c) When no object is placed on either pan, the beam should be horizontal and the pointer vertical.

(d) String should be inextensible.

The object (with unknown mass) is placed on the right pan and standard weights are placed on left pan. When the beam becomes horizontal and pointer vertical or the mass on both pans are equal we say that the beam is balanced. The sum of masses of weights on left pan is the mass of the object.

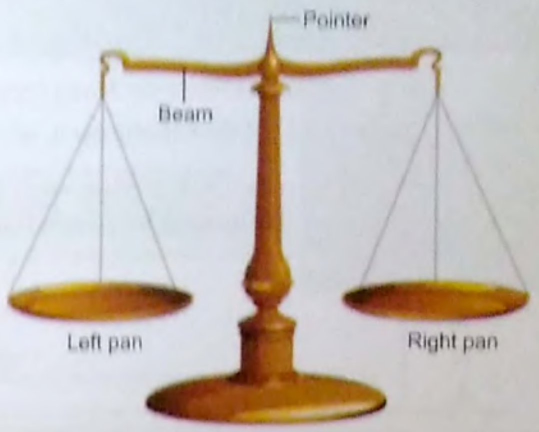


Fig. 6. Beam balance (or tarazu).

## Physical Balance

A physical balance is one that is used in a laboratory. It is more accurate and sensitive. It is used to measure smaller masses.

Fig. 7. Use a physical balance for accurate measurement of mass.

## Electronic Balance

Eletronic balance are used to make accurate measurement. It shows a digital display of the mass. No standard masses are required for comparison.

Fig. 8. Electronic balance.

## Activity 4

### Measurement of mass using beam balance and electronic balance.

- Go to a market and list four items each, which are sold by using beam balance and using electronic balance.

| S. No. | Item sold by beam balance | Item sold by electronic balance |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |

## Units of Mass

The SI unit of mass is kilogram abbreviated as kg. The mass of light bodies is measured in grams (g) and that of very small bodies in milligrams (mg). Similarly, the mass of heavy bodies is measured using bigger units like quintal and metric tonne.

$$1 \text{ kg} = 1000 \text{ g}$$

$$1 \text{ g} = \frac{1}{1000} \text{ kg} = 10^{-3} \text{ kg}$$

$$1 \text{ g} = 1000 \text{ mg}$$

$$1 \text{ mg} = \frac{1}{1000} \text{ g} = 10^{-3} \text{ g} = 10^{-6} \text{ kg}$$

$$1 \text{ quintal} = 100 \text{ kg}$$

$$1 \text{ metric tonne} = 10 \text{ quintals} = 1000 \text{ kg}$$

## Submultiple and Multiple Units of Mass

The gramme and milligram are submultiple units of mass.

Quintal and metric tonne are multiple units of mass.

### Do You Know?

- 1 kg is the mass of a piece of platinum-iridium alloy bar kept in the Bureau of Weights and Measures in Paris.
- For measuring the mass of atomic particles such as protons, electrons and neutrons a unit called atomic mass unit (amu) of the unified mass (u) is used.

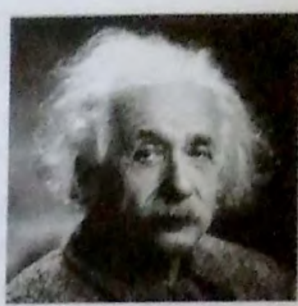
$$1 \text{ amu} = 1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$$

## TIME MEASUREMENT

Can you define time?

According to Albert Einstein, "Time is simply what a clock reads. Any phenomena that repeats itself in equal time intervals can be used as a time standard".

Time interval is defined as the duration between two events. The SI unit of time measurement is second (s). The CGS unit is also second (s). Other convenient units are minute, hour, etc.



| Name of the unit | Symbol |
|---|---|
| second | s |
| minute | min |
| hour | hr |

| How different units of time are related ? |
|---|
| 1 minute = 60 seconds |
| 1 hour = 60 minutes |
| 24 hours = 86,400 s = 1 mean solar day. |

Note : Christian Huygens invented the pendulum clock.

## Clocks and Watches are Used to Measure Time

A stop clock is used to measure time interval. A stop clock can be started and stopped as we require. When an event starts the stop clock is started and when it ends, the stop clock is stopped.

(a) (b) (c)

**Fig. 9.** (a) Clock, (b) Wrist watch, (c) Stop clock.

Clock and wrist watch are used to measured time, *e.g.*, we can use the stop clock to measure the time ken for running a 100 m race or the time taken for a pendulum to swing from one side to another.

Clock can work on the 12 hour system or the 24 hour system.

In a common clock, the type that is used in our homes, we use the 12 hour format. The time between idnight to noon is indicated by writing a.m. after the time *e.g.*, 5 a.m. The time from noon to midnight indicated by writing p.m. after the time, *e.g.*, 8 p.m.

In a 24 hour clock system, midnight is 00.00 hr, noon is 12.00 hr and 8.30 p.m. at night would be 20.30 hr. Such a system is used in train and airway schedules.

Fig. 10. Two types of 24 hour clock.

A 24 hour clock system avoids confusion. There is no need to write a.m. or p.m. after the time. Four digits are used to display the time in an XX.YY format.

The first two digits XX indicate the hour on a 24 hour format and the next two digits YY indicate the minutes, *e.g.*, 7.30 p.m. is written as 19.30.

The duration of 1 day and night constitutes the 24 hours. So the clock reads 00.00 at midnight and time is read continuously thereafter.

**Table 5 : Airways Schedule**

| Origin | Destination | Flight number | Departure | Arrival |
|---|---|---|---|---|
| Abu Dhabi | Delhi | A1 0940 | 00 : 05 | 05 : 20 |
| Abu Dhabi | Mumbai | A1 0944 | 02 : 40 | 06 : 55 |
| Ahmedabad | Delhi | A1 0011 | 20 : 15 | 21 : 40 |
| Ahmedabad | Delhi | A1 0030 | 22 : 05 | 23 : 30 |
| Agartala | Kolkata | A1 0744 | 11 : 20 | 12 : 15 |
| Agatti | Bengaluru | A1 9502 | 12 : 00 | 15 : 10 |
| Agatti | Kochi | A1 9502 | 12 : 00 | 13 : 20 |
| Agra | Khajuraho | A1 0406 | 13 : 50 | 14 : 10 |
| Agra | Mumbai | A1 9624 | 14 : 40 | 16 : 35 |

**Table 6 : Train Schedule**

| S.No. | Stn. code | Stn. name | Route No. | Arrival time | Dep. time | Halt (time in minutes) | Distance | Day |
|---|---|---|---|---|---|---|---|---|
| 1. | FZR | FIROZPUR CANT | 1 | Source | 21 : 40 | | 0 | 1 |
| 2. | FDK | FARIDKOT | 1 | 22 : 05 | 22 : 07 | 02 : 00 | 33 | 1 |
| 3. | KKP | KOT KAPURA | 1 | 22 : 21 | 22 : 23 | 02 : 00 | 45 | 1 |
| 4. | GJUT | GANGSAR JAITU | 1 | 22 : 38 | 22 : 40 | 02 : 00 | 61 | 1 |
| 5. | GNA | GONEANAB JAGTA | 1 | 22 : 54 | 22 : 56 | 02 : 00 | 76 | 1 |
| 6. | BTI | BHATINDA JN | 1 | 23 : 25 | 23 : 35 | 10 : 00 | 88 | 1 |
| 7. | MAUR | MAUR | 1 | 00 : 02 | 00 : 04 | 02 : 00 | 122 | 2 |
| 8. | MSZ | MANSA | 1 | 00 : 19 | 00 : 21 | 02 : 00 | 141 | 2 |

Airways and Train schedules are based on 24-hour clock system.

## ACTIVITY 5

**HOW TO USE A 24 HOUR CLOCK ?**

- Learn to read a 24 hour clock. The clock shows 00:00 hr at midnight. 23.59 hr is 1 minute before midnight.
- A time of 22.45 hr would be 10.45 p.m. (22.45 – 12.00 = 10.45)

Beating of a human heart, oscillation of a pendulum, rotation of the earth about its axis and revolution of the earth around the sun are all phenomena which repeat themselves at regular time intervals.

A pendulum with 1 m string length and a small metal bob will move from one end to the other in 1 s. A to and fro motion takes 2s.

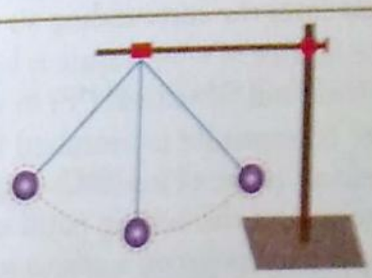


Fig. 11. Simple pendulum.

## ACTIVITY 6

**TO CONSTRUCT AN OSCILLATING PENDULUM BY USING A SMALL STONE AND A STRING.**

- Tie the stone to one end of a string and suspend it from a clamp or a ruler.
- The length of string should be 1 m.
- Pull the stone to one side and let go.
- The stone should move in an arc and not in a horizontal circle.
- The time it takes to move from one end to the other is 1 s.

The smallest time interval that we can measure with commonly available clocks and watches is 1 second. Special clocks are available that can measure very small time intervals like one thousand of a second (1 milli second) or one millionth of a second (1 micro second) or one billionth of a second (1 nano second). Clocks like this are used for scientific research due to their precision. On the other hand, times of historical events are stated in terms of centuries or millenniums. The ages of stars and planets are often expressed in billions of years. Can you imagine the range of time intervals that we deal with?

### CHECK YOUR PROGRESS!

Some common daily activities are listed. Estimate the time it would take to perform them. Then find the actual time taken to perform the activites.

| S. No. | Activity | Estimated time | Actual time |
|---|---|---|---|
| 1. | Taking a bath | | |
| 2. | Walking to the shop | | |
| 3. | Boiling an egg | | |
| 4. | Having lunch | | |
| 5. | Wearing clothes and shoes | | |
| 6. | Sharpening a pencil | | |

## TEMPERATURE

Temperature is the measure of the degree of hotness of a body. Hot and cold are relative terms like tall and short. A hot utensil has a higher temperature than, say, an ice cube, therefore we say it is hotter. We can perceive temperature by touch, though this would be non-reliable for scientific purposes.

| Name of the unit | Symbol |
|---|---|
| Celsius | °C |

Temperature also indicates the direction in which heat flow will take place. A hot body (a cup of hot tea) loses heat to the surrounding air and its temperature decreases. Whereas a colder object (an ice cube) gain heat from the surrounding air and its temperature increases.

The SI unit of temperature is kelvin (K). Commonly used units of temperature are celsius (°C) in the celsius scale and fahrenheit (°F) in the fahrenheit scale.

The temperature is measured by a thermometer. The melting point of ice (0°C) is considered as lower fixed point and the boiling point of water (100°C) is the upper fixed point on a celsius scale. The lower and upper fixed point on a fahrenheit scale are 32° F and 212°F respectively. For a kelvin scale they are 273 K and 373 K.

The temperatures measured on a kelvin scale are also called absolute temperatures. In the kelvin scale, no negative temperatures are there. The lowest reading possible on a kelvin scale is zero kelvin. In the other two temperature scales, negative temperatures are there.

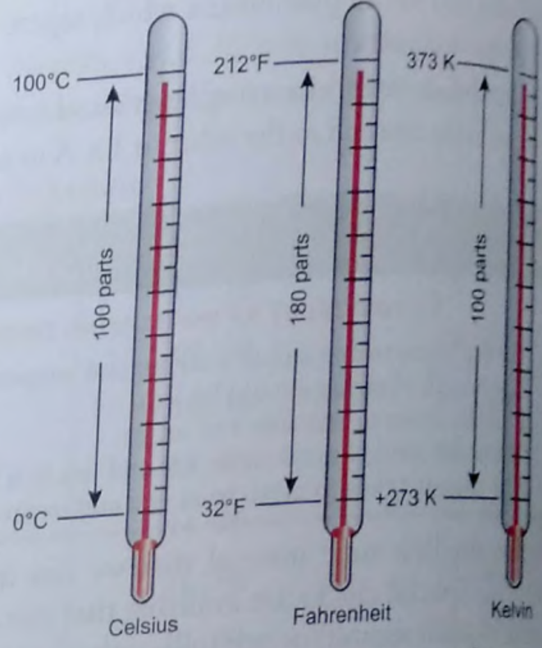



**Fig. 12.** Different temperature scales.

The relationship for converting between the three scales is as follows :

$$\frac{t_F - 32}{180} = \frac{t_c}{100}$$

$$t_c + 273 = t_K$$

where the subscript indicates the temperature scale.

**Example :** Convert 167°F into celsius and kelvin scales of temperature.

$$t_F = 167°F$$

where $t_c$ is unknown

$$\frac{t_F - 32}{180} = \frac{t_c}{100}$$

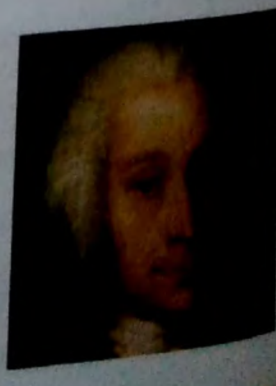
$$10t_F - 320 = 18t_c$$

$$10 \times 167 - 320 = 18\, t_c$$

$$t_c = 75°C$$

$$t_K = t_c + 273 = 75 + 273 = 348 \text{ K}.$$

Note : Anders Celsius proposed the celsius scale.



## Thermometers

A laboratory thermometer is used to record temperature during an experiment in the laboratory. A clinical thermometer on the other hand is used to measure a human body temperature. Hence, the temperature markings are different on both.

### A Laboratory Thermometer

A laboratory thermometer uses mercury as a thermometric fluid. It consists of two glass tubes, one inside the other. The inner tube is a capillary tube or bore, the outer tube is a stem. The lower end of the bore widens out into a bulb which contains mercury. The other end of the bore is sealed. The stem has °C or °F markings. When the mercury heats up, it expands and rises in the capillary. The reading at which the mercury level stops rising is the temperature to be measured.

Commonly used laboratory thermometers have a range of −10°C to 110°C. This is sufficient for most experiments done in the school labs. However, in the high technology labs, mercury thermometers may have more range.

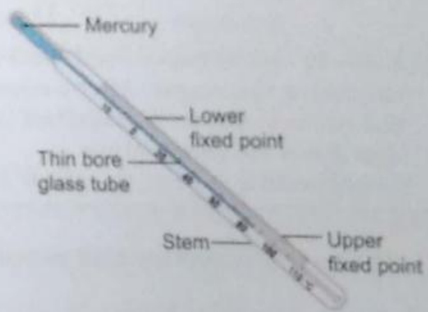



Fig. 13. A laboratory thermometer.

## Activity 7

**How to read a laboratory thermometer?**

- To note down the room temperature we directly see the level of mercury in the thermometer and note down the reading.
- To note down the temperature of the cup of hot tea or hot water in a beaker, we place the bulb in the water. The mercury level rises in the bore. When it stops rising, note down the reading that is showing in the thermometer.
- To note down such a reading, we have to ensure that the fan is not cooling down the water or tea, so switch off the fan.

### Clinical Thermometer

The normal temperature of the human body is 37°C or 98.6°F. A clinical thermometer is read in the fahrenheit scale. If temperature is more than 98.6°F, the person has fever. A clinical therometer is calibrated from about 35°C (95°F) to 42°C (108°F). The range of clinical thermometer is lesser than a laboratory thermometer. The other difference between the two thermometers is that in a clinical thermometer there is a kink in the string of mercury just above the bulb (see Fig. 14). This kink ensures that the mercury level does not fall into the bulb while noting the temperature, there by giving us time to note the reading. After noting down the reading if we give a jerk to the thermometer the mercury returns to the bulb.

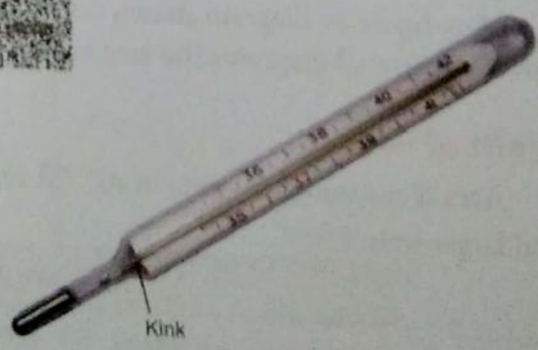



Fig. 14. A clinical thermometer.

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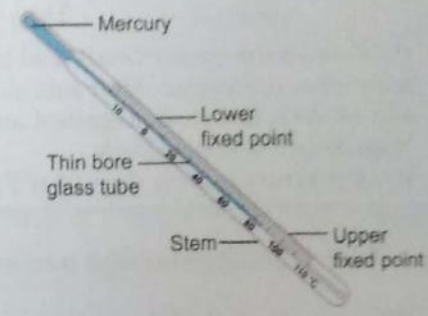



Fig. 13. A laboratory thermometer.

## ACTIVITY 7

### HOW TO READ A LABORATORY THERMOMETER?

- To note down the room temperature we directly see the level of mercury in the thermometer and note down the reading.
- To note down the temperature of the cup of hot tea or hot water in a beaker, we place the bulb in the water. The mercury level rises in the bore. When it stops rising, note down the reading that is showing in the thermometer.
- To note down such a reading, we have to ensure that the fan is not cooling down the water or tea, so switch off the fan.

### Clinical Thermometer

The normal temperature of the human body is 37°C or 98.6°F. A clinical thermometer is read in the fahrenheit scale. If temperature is more than 98.6°F, the person has fever. A clinical therometer is calibrated from about 35°C (95°F) to 42°C (108°F). The range of clinical thermometer is lesser than a laboratory thermometer. The other difference between the two thermometers is that in a clinical thermometer there is a kink in the string of mercury just above the bulb (see Fig. 14). This kink ensures that the mercury level does not fall into the bulb while noting the temperature, there by giving us time to note the reading. After noting down the reading if we give a jerk to the thermometer the mercury returns to the bulb.

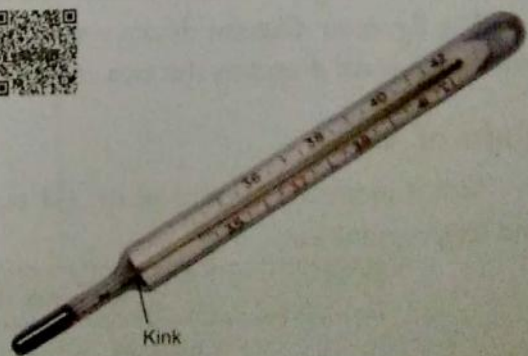



Fig. 14. A clinical thermometer.

Note : The average body temperature for most people is 98.6°F (or 37°C).

The temperature of every person need not be 37°C. It could be slightly higher or lower. What we call as normal temperature of the human body is the average body temperature of a large number of healthy persons.

The thermometer has an arrow mark to indicate normal body temperature.

## ACTIVITY 8

### HOW TO READ A CLINICAL THERMOMETER?

- Hold the thermometer firmly and give it a jerk so that the mercury level falls to 35°C. Place the bulb below the tongue. After a minute take the thermometer out of the mouth. Hold it horizontally and rotate it slowly. A magnified image of the mercury will be seen.
- Note down the temperature.
- If temperature is more than 98.6°F you have fever.

Note : Clinical thermometer with mercury have now been banned due to mercury poisoning.

We now use digital thermometers which directly display the temperature.

### CHECK YOUR PROGRESS!

*Measure the maximum and minimum temperature of the following.

| S. No. | Activity | Maximum | Minimum |
|---|---|---|---|
| 1. | A hot summer day | | |
| 2. | A cold winter day | | |
| 3. | Water being heated | | |
| 4. | When you have fever | | |
| 5. | Normal body temperature | | |

## AREA MEASUREMENT

Area is the region within a closed boundary in a two dimensional space, e.g., circle, triangle.

Any figure or diagram drawn on a sheet of paper would be two dimensional. For all such two dimensional diagrams the area can be determined.

### Units of Area

Area is measured in units of $m^2$ (SI unit). In CGS unit it is measured in $cm^2$. Smaller unit is $mm^2$ and larger unit is $km^2$.

**How are different area unit related ?**

1 hectare = $100\ m \times 100\ m = 10000\ m^2$

$1\ km^2$ = $1\ km \times 1\ km = 1000\ m \times 1000\ m = 1000000\ m^2$

$1\ m^2$ = $1\ m \times 1\ m = 100\ cm \times 100\ cm = 10000\ cm^2$

$1\ cm^2$ = $1\ cm \times 1\ cm = 10mm \times 10\ mm = 100\ mm^2$

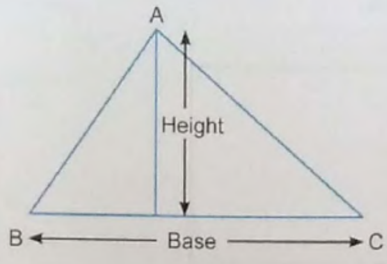
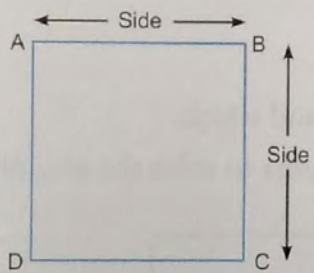
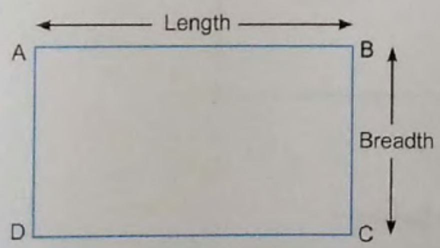
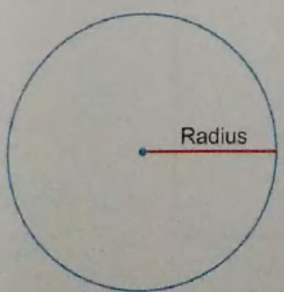
* Some common activities are listed.

## Area of Geometrical Figures

Regular figures are geometrical figures. Their areas are easy to calculate. Combination of two such figures is also easy to determine.

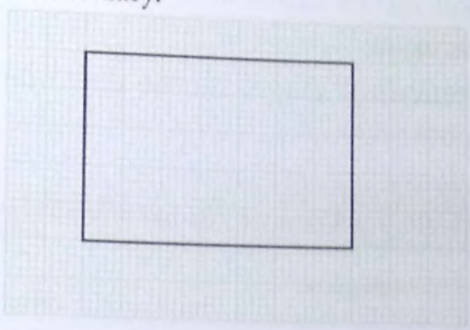
Regular area, *i.e.*, area of geometrical shapes can be determined by using Standard mathematical formulas.

**Table 7 : Area of geometrical figures**

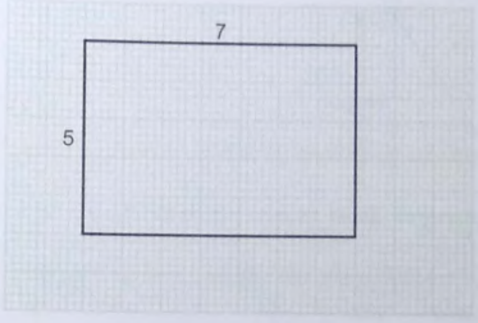
| Shape | Figure | Formula |
|---|---|---|
| Triangle |  | Area of triangle $= \frac{1}{2} \times$ base $\times$ height |
| Square |  | Area of square = side × side |
| Rectangle |  | Area of rectangle = length × breadth |
| Circle |  | Area of circle $= \pi \times (\text{radius})^2$ |

## Area of Regular Shapes

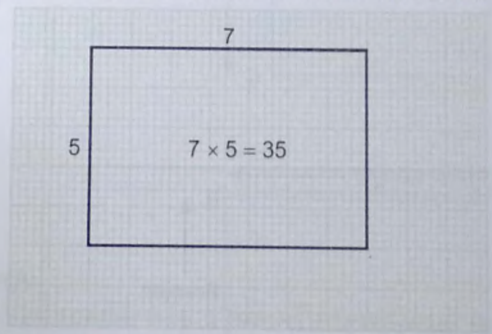
Area is the space inside the closed boundary.



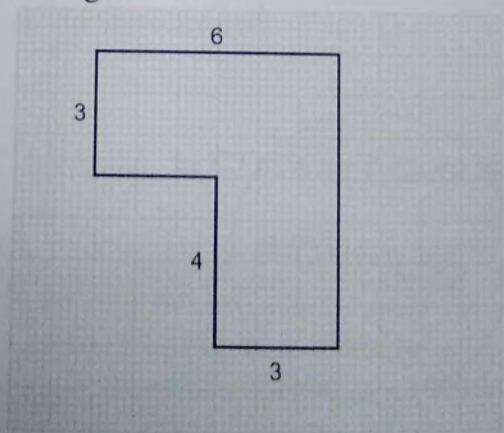
Instead of counting we find length and width.




- Remember, the area is the space inside.
- Instead of counting, we will find length and width.
- Then we will use the length × width formula to solve the area of a rectangle.

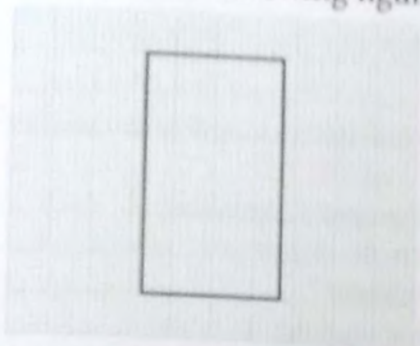



Let us now, calculate the area of the figure below :

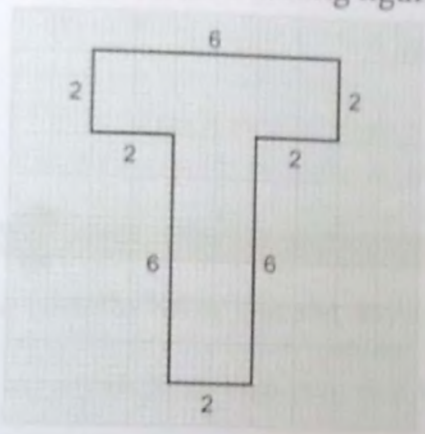


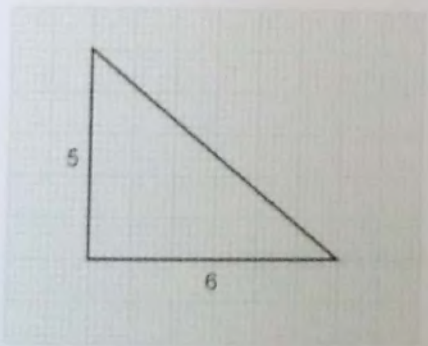

The trick is to find the rectangles and solve like before $(3 \times 6) + (4 \times 3) = 18 + 12 = 30$ sq. units

Find the area of the following figure (assume that each grid is 1 unit) :

1. 

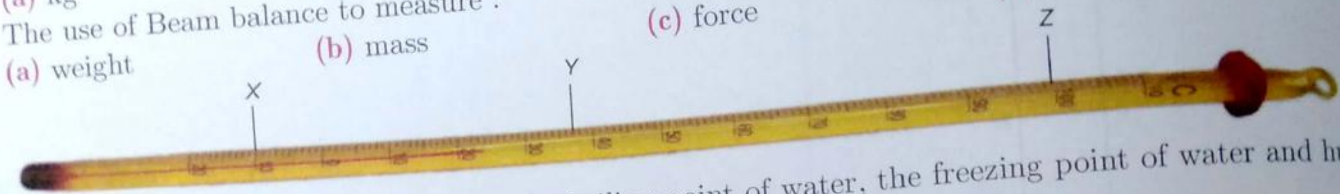
Find the area of the following figures :

2. 


3. 

# WORKSHEET

**A. Choose the correct option.**

1. At the national level, the name of the laboratory which ensures that the measurement standard conforms to international standards is :
   (a) Indian Meteorological Laboratory (b) National Physical Laboratory
   (c) Indian Standards Institution (d) Indian Institute of Science
2. Which of the following activities do not require an exact measurement?
   (a) Olympic race of 400 m (b) Your mother cooking at home
   (c) Firing of a rocket in a space centre (d) Performing an experiment in a chemistry lab
3. The SI unit of mass is :
   (a) kg (b) gram (c) newton-metre (d) km
4. The use of Beam balance to measure :
   (a) weight (b) mass (c) force (d) length
5. 


   On a laboratory thermometer shown, the boiling point of water, the freezing point of water and human body temperature in order are :
   (a) *X, Y, Z* (b) *Y, X, Z* (c) *Z, X, Y* (d) *X, Z, Y*

**B. Fill in the blanks.**

1. The three basic physical quantities are ............, ............ and ............
2. The length equal to $\frac{1}{1000}$ part of a metre is ..............
3. One kilometre is ............mm.
4. ............units are got by combining ............ units by multiplication or division.
5. ............is a device that would measure time more accurately.

**C. State whether the following statements are true or false. Correct the false statements.**

1. The temperature of a body can be measured by using a thermometer.
2. The standard unit system should be based on human body parts.
3. Mass of body changes from place to place.
4. Light year is a unit for measuring time.
5. A laboratory thermometer and a clinical thermometer have the same range and can be used interchangeably.

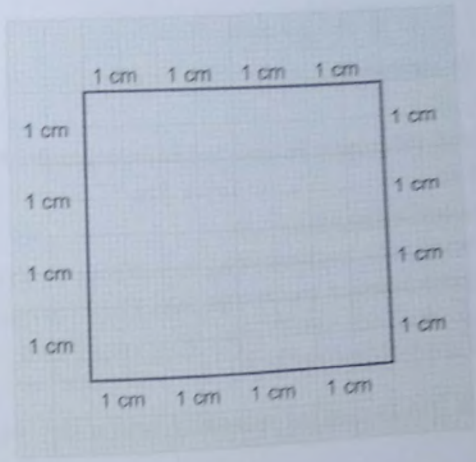
**D. Match the statements in Column I, with those in Column II.**

| S. No. | Column I | | Column II |
|---|---|---|---|
| 1. | Area | (a) | second |
| 2. | Time | (b) | hectare |
| 3. | Mass | (c) | kelvin |
| 4. | Temperature | (d) | quintal |

## E. Answer briefly.

1. Arrange the following lengths in increasing order of magnitude.
   1 m, 1 cm, 1 km, 1 mm, 1 nm
2. Which of the following is the best estimate in metres of the height for a mountain?
   (a) 1 m (b) 100 m (c) 1 km (d) 100 km.
3. Express each of the following as indicated.
   (a) 3.5 dm expressed in mm
   (b) 3 h 20 min. expressed in seconds
   (c) 0.59 km expressed in cm
   (d) 380 km expressed in cm
   (e) 0.592 mg expressed in grams
   (f) 25 g expressed in micrograms
   (g) 36 km/h expressed in m/s
4. What is the difference between a fundamental quantity and a derived quantity?
5. Give reasons for the following :
   (a) A 24 hour clock is better than a 12 hour clock.
   (b) A standard system of units is required.
   (c) A beam balance and a physical balance are used for different purposes.
   (d) The range of a clinical thermometer is lesser than that of a laboratory thermometer.
   (e) Mercury is preferred as a thermometric liquid.
6. Describe three precautions required while taking length measurements.
7. From the measurement shown, find the thickness of each coin.


8. Name three things that mass less than a gram.
9. A penny mass 3 grams. A nickel mass 5 grams. A dime mass 2 grams. How much three dimes, two nickels, and a penny mass ? Show your work.
10. Find the area of the given square.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