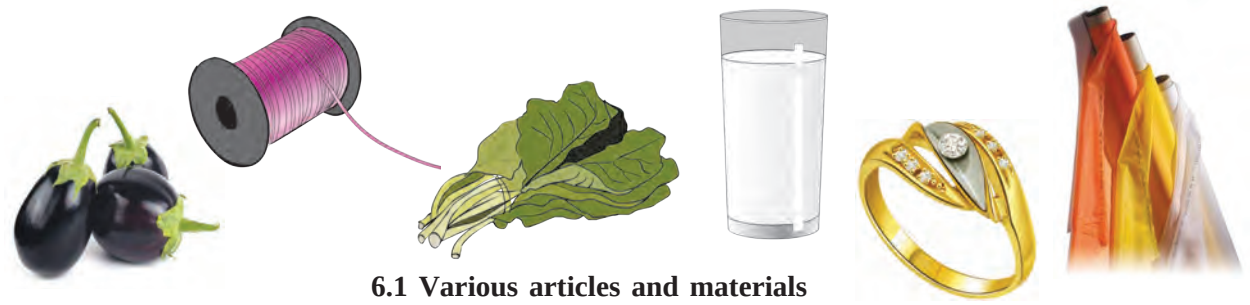
6. Measurement of Physical Quantities

Observe and discuss.

How are the various articles and materials, shown in the picture measured?



6.1 Various articles and materials

Physical quantity

In day-to-day life, we measure many things such as the weight of fruits, vegetables, food grains, temperature of the body or some liquids, volume of liquids, density of various substances, the speed of vehicles, etc. Quantities such as mass, weight, distance, speed, temperature, volume are called **physical quantities.**

A value and a unit are used to express the magnitude of a physical quantity. For example, Swarali walks two kilometres everyday. In this example, 'two' is the value and 'kilometre' is the unit used to express the magnitude of the distance which is a physical quantity.

Scalar quantity

A quantity that can be completely expressed by its magnitude alone is called a scalar quantity. For example, only magnitude, i.e. a value with a unit, is used to express quantities such as length, breadth, area, mass, temperature, density, time, work, etc. Thus, we say that the length of a tunnel is two kilometres, the fever (temperature) is 101° Farenheit, etc.

Vector quantity

The quantity that is expressed completely only when magnitude and direction are both given is called a vector quantity.

Displacement, velocity are vector quantities. For example, a displacement of 20 kilometres towards the north, the aeroplane flying at a velocity of 500 km/hr towards Mumbai.

Mass

The amount of matter present in a substance is called mass. Matter has a natural tendency to resist a change in its state, which is called inertia. **Mass** is the qualitative measure of the inertia of an object. The larger the mass, the greater is the inertia. **Mass is a scalar quantity**. It does not change from place to place anywhere in the world. The quantities mass and weight are, however, different. Gram and kilogram are the units of mass.

When we use the two-pan common balance in a shop, we compare two masses.

Weight

What we measure in grams, kilograms is mass, and not weight. The gravitational force that acts on this mass is called its **weight**. The gravitational force by which the earth attracts an object towards its centre is called the weight of the object. Therefore, **weight is a vector quantity**. It is different at different places on the earth.

Use your brain power!

1. Why would the weight of an object be maximum at the poles and minimum at the equator?
2. Why is the weight of an object at a high altitude less than its weight at the sea-level?

Will it be possible to use one and the same unit to measure physical quantities such as mass, weight, distance, velocity, temperature?

In everyday affairs, we measure many different physical quantities. As these physical quantities are different from each other a specific unit is used to measure each quantity. Therefore, different units are used while measuring different quantities.

Try this. **Standardized measurement**

1. Take a ball of string. Let one student from the class measure four hand-spans of the string and cut it there. Let each of the other students in the class cut four hand-spans of the string, too. Now hold all the pieces together by one end. Are they all of the same length?

2. Now, measure the length of a bench by means of the span of your hand. Ask your friends to do the same. Did each of you obtain the same measure for that bench? What could be the reason?

Standardized measures are required for measuring things. Such measures are called standard units.

We have to measure many physical quantities accurately. To measure any quantity, we use the unit specified for it.

For example, the metre (m) is the specified unit for measuring length. A certain distance has been accepted as the standard for 1.0 metre. Why is there a need for such a standard unit? Suppose, the span of a hand is accepted as the unit for measuring length. With this unit, we can measure lengths of cloth as two hand-spans, three hand-spans, and so on. However, the lengths of the cloth measured by each one of us will come out to be different. That is why a 'hand-span' cannot be a standard unit for measuring length.

Do you know?

Our body has weight because of the gravitational force of the earth. The gravitational force of the moon being less, our weight will turn out to be less there. Our mass, however, is the same at both the places.

Always remember –

Prevailing systems of measurement

1. MKS System : In this system distance is measured in metres, mass in kilograms and time in seconds.

2. CGS System : In this system distance is measured in centimetres, mass in grams and time in seconds.

In the MKS system of measurement, distance, mass, and time are accepted as the fundamental quantities. These three quantities are used to measure all other quantities.

Complete the following table.

Physical Quantity	M.K.S.	C.G.S.
Mass	Kilogram	Gram
Distance		
Time		
Speed		

There are many physical quantities but a majority of them are related to each other. For example, you have learnt that the quantity 'speed' is the ratio of the quantities 'distance' and 'time'.

Try this.

Work out the area of your classroom. Which quantities are taken into account to calculate the area?

Fundamental quantities : It is enough to select a few out of the many quantities and standardize their units. You can see from the above examples, that units of the quantities length and time need to be standardized. Such quantities are called fundamental quantities and their units are called standard units. Of course, a standard fundamental unit must be available to all, and it must not be variable.

International system of units : An international system of units based on seven fundamental units, called the System International (SI), is currently used all over the world. It is also called the **metric system**.

The names and symbols of the units of the fundamental quantities, length, time and mass, in this system, are given in the following table:

Quantity	Name of the unit	Symbol of the unit
Length	metre	m
Mass	kilogram	kg
Time	second	s

Standards of the fundamental quantities

As the standard of mass a solid cylinder made of a platinum-iridium alloy is kept in the International Bureau of Weights and Measures at Paris. As per the international agreement, this mass is called one kilogram. Official accurate copies of this prototype are kept in the standardizing laboratories/institutes all over the world.

Two fine lines are engraved on a platinum-iridium bar kept in the International Bureau of Weights and Measures at Paris. The distance between these two lines is accepted as the standard metre. Accurate copies of this prototype are made and distributed to standardizing laboratories/institutes all over the world.

The time required for one revolution of the earth is measured by means of an accurate device. This time is taken as 24 hours. To standardize one second, one hour is considered to have 60 minutes and one minute, 60 seconds.

Find out.

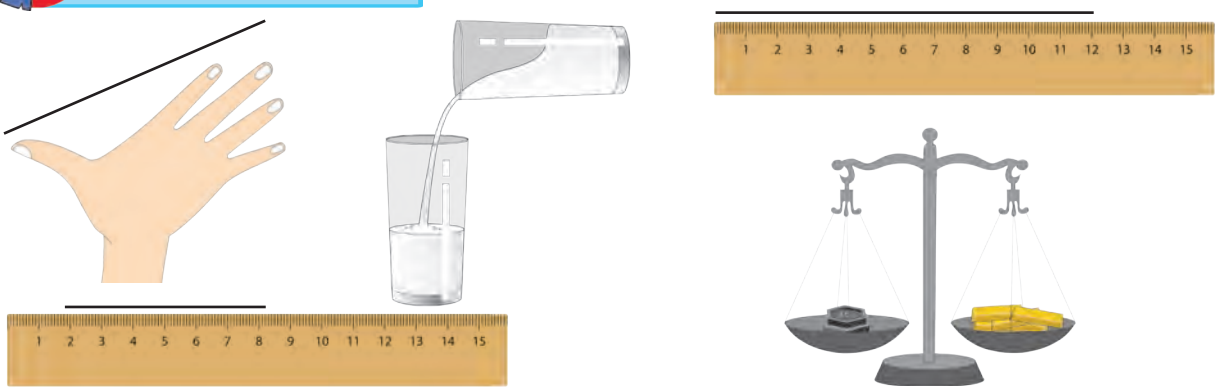
1. What is an atomic clock? Where is it kept?
2. How is the velocity of light used for determining the standard metre?

Great Scientists

When man felt the need to measure things, he started by using the parts of his own body for the purpose. In Egypt in ancient times, the distance from a man's elbow to the tip of his middle finger was called a 'cubit'. This measure would differ from person to person. Therefore, the cubit of the King was considered as the standard. In olden times, we weighed gold in a unit called *gunj*. An 'hour glass' was used for measuring time. Have you seen one?

Observe and discuss.

Identify the wrong methods of measurement shown in the picture and explain why they are wrong.



6.2 Various methods of measurement

Importance of accurate measurement

How accurate a measurement must be depends upon its purpose. Accordingly, an appropriate device has to be used for the measurement. Measurement of substances that are precious, of great importance and used in very small quantities, is done meticulously and accurately. Due to advancements in technology, devices that measure very small magnitudes of quantities like distance, mass, time and temperature, are available now, for example, distance and time in connection with very important sports competitions, mass of gold, body temperature, etc.

Major causes of errors in measurement

1. Not using the appropriate device.
2. Not using the device properly.

Make a list of possible errors other than these.

Do you really get as many litres of petrol as the petrol pump indicates? To ensure this, it is necessary to check it against a standard measure from time to time. This is called standardization. Similarly, it is necessary to standardize the weights and measures used in the market.

While buying things at grocery shops, the vegetable market, remember to look out for the following and tell your guardians to do so, too.

1. Does the balance carry the stamp of standardisation by the department of weights and measures ?
2. Is the balance stable? Is the pointer of the balance upright?
3. Is the weight made of metal? How is the balance held?
4. Has the underside of the pan of the balance been tampered with?

To prevent consumers from being cheated, a Weights and Measures sub-division functions as part of the Food, Urban Supply and Consumer Protection Division of the Government. Officers of this sub-division visit different places from time to time, and ascertain whether the weights and balances being used are proper or not. It is binding by law to use standard weights and measures. It is also a function of the Weights and Measure sub-division to grant licences for the production, sales and repairs of weights and measures.

My friend, the internet!

1. www.legalmetrology.maharashtra.gov.in
2. **The standards of the six fundamental units, namely, metre, kilogram, second, Kelvin, Ampere and Candela are kept in the National Physical Laboratory at New Delhi.** www.nplindia.org/npl-charter

Do you know?

During the rainy season, you might have heard, seen and read, news regarding how much water is collecting in the dam, how much water is being released and about the present stock of water in the dam. Do you know the following terms in this connection?

1 TMC means one thousand million cubic feet.

1 cubic foot means 28.317 litres.

1 TMC = 28316846592 litres, that is about 28.317 thousand million litres.

My friends, newspapers

What is the capacity of the various dams in Maharashtra ? Collect information about the discharge of water from various dams during the month of August, September and October and of the consequences of the discharge.

1. Write answers to the following questions in your own words.

(a) Why is the weight of the same object different on different planets?

(b) What precautions will you take to make accurate measurements in day-to-day affairs?

(c) What is the difference between mass and weight?

2. Who is my companion?

Group 'A'	Group 'B'
(1) Velocity	(a) litre
(2) Area	(b) kilogram
(3) Volume	(c) metre/second
(4) Mass	(d) kilogram/cubic metre
(5) Density	(e) square metre

3. Explain giving examples.

(a) Scalar quantity

(b) Vector quantity

4. Explain, giving examples, the errors that occur while making measurements.

5. Give reasons.

(a) It is not proper to measure quantities by using body parts as units.

(b) It is necessary to get the weights and measures standardized at regular intervals.

6. Explain the need for accurate measurement and the devices to be used for that.

Project :

Collect information about various physical quantities used in day-to--day life and the devices used for their measurement.

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