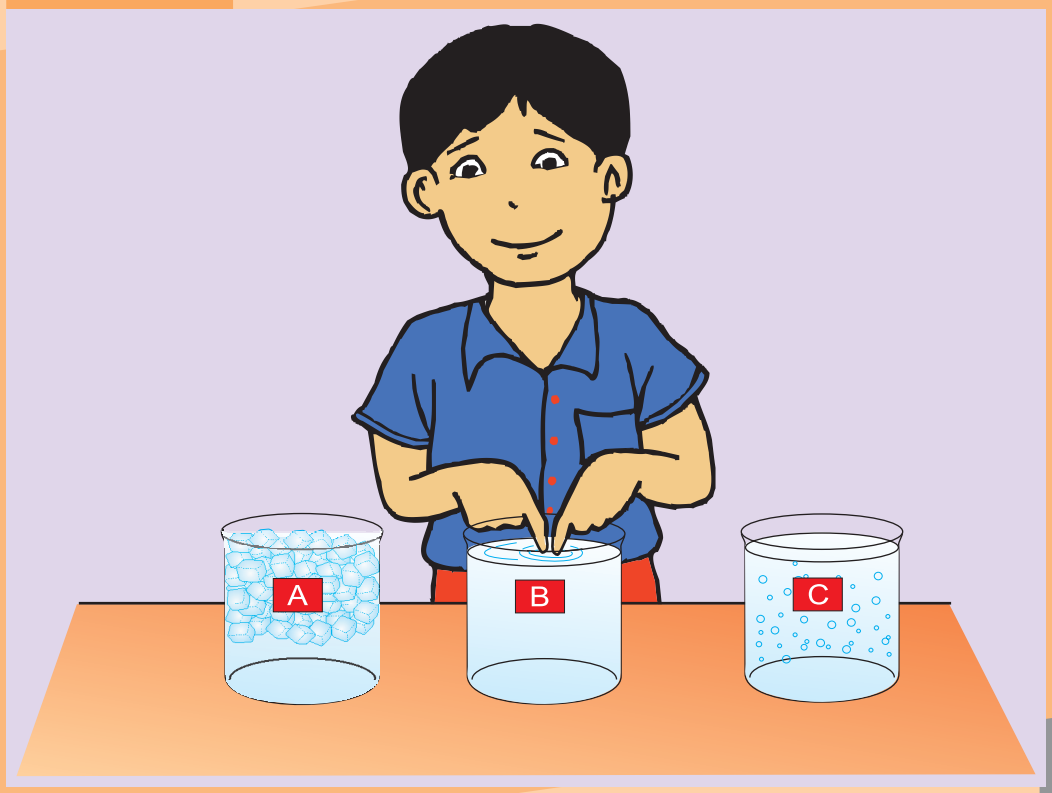
# 1 Measurement



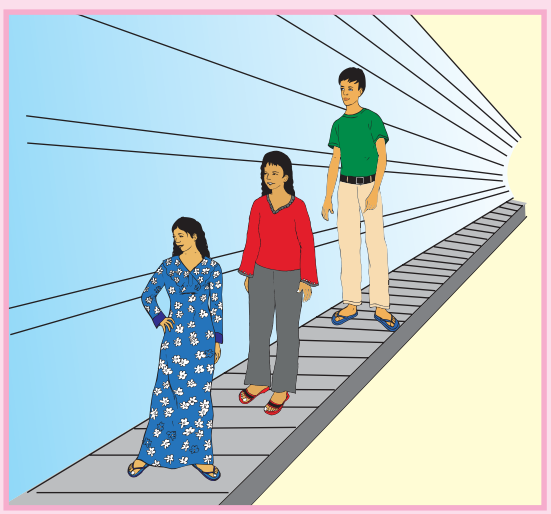

## What you will learn

- Your senses need help
- Setting our standards
- Measuring length
- Measuring Area and Volume
- What's the time?
- What is mass?
- Temperature

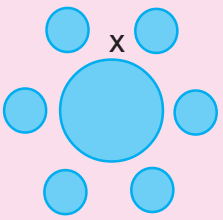
1a

# Your senses need help

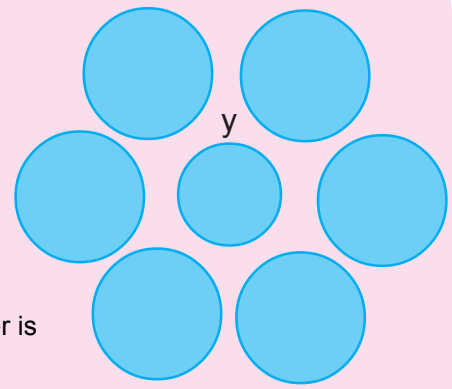
As you learn to be a scientist, you will find out more and more about the things around you. You have five senses to help do this. It has been shown that human senses are not always reliable. Check this for your self.

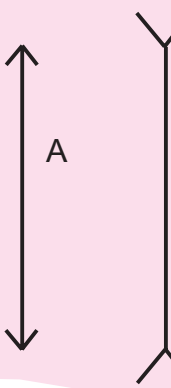


Who is the tallest?




Which circle in the center is larger, X or Y?




Which line is longer?

So we need instruments for making accurate scientific measurements.

**Trundlewheel**

Measures long distances.

**Do you Know?**

*Airline pilots cannot use their senses to guide the plane through thick clouds. They must depend on the plane's instruments.*

# Accurate measurements

Before measuring instruments were invented, people used different parts of the body for measuring lengths. That's where units like the foot and the cubit came from.

It's very easy to see how this way of measuring caused problems. The length of the cubit, for example, would vary among people.

# Physical quantities

Physical quantity is a quantity, which can be measured. Length, volume, mass, time and temperature are examples of physical quantities.

A non-physical quantity is one, which cannot be measured.
Can you give some examples of such quantities?

In the past, methods of measuring physical quantities were inaccurate and many types of units were used in different parts of the world.
What were the different measurements we used in our daily life in the past?

1. Name your five senses.
2. Why do scientists use measuring instruments whenever they can?
3. Make a list of 5 measuring instruments used in your home.
4. Try to find out something about the instruments, which help pilots to fly planes through thick cloud.

## Ideas

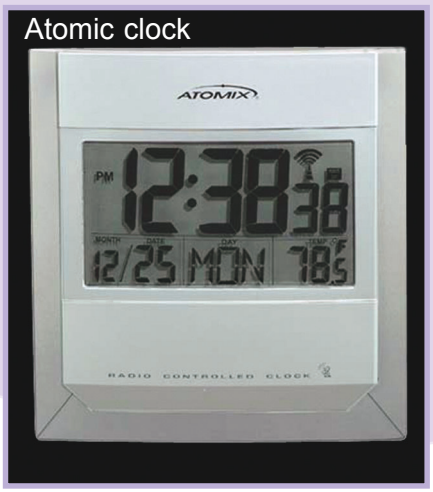
- *Physical quantity is a quantity that can be measured.*
- *We cannot depend on our senses only.*

# Setting our standards

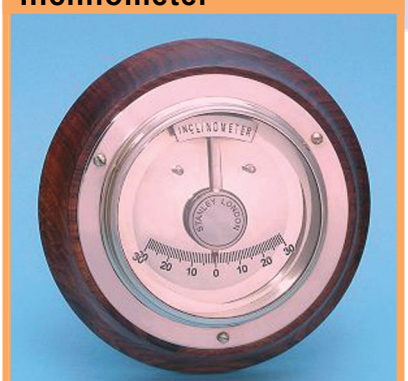
The Egyptians solved the problem of how to measure lengths exactly. They invented a standard cubit. They realized that the length of the cubit didn't really matter as long as everyone used the same length. So they marked out a cubit length on a piece of granite.

Then they made measuring sticks exactly the same length all over Egypt.

That's really how measuring is carried out to day. For each measurement, a **standard** is chosen. Every measuring instrument has to be compared with that standard.


**Inclinometer**




Measures angles in the field

**Do you Know?**

*An atomic clock only goes wrong by 1 second in 10000 years.*

# SI units

Today, accurate measurements are obtained by using better developed methods and more accurate instruments. Since 1960, scientists from different parts of the world have agreed to take on a single system of units called the **SI units.**

## ■ Common physical quantities and units

| Physical quantity | SI unit | Symbol for unit |
|---|---|---|
| Length | metre | m |
| Mass | Kilogram | kg |
| Time | Second | s |
| Temperature | Kelvin | K |
| Electric current | ampere | A |

## ■ Some commonly used SI prefixes

| Prefix | Symbol | Meaning |
|---|---|---|
| Milli | m | One thousandth (1/ 1000) |
| Centi | c | One hundredth (1/ 100) |
| Kilo | k | - |

**Hygrometer**


Measures relative humidity

**1 Fill in the blanks.** An example has been done for you.

**a.** One milli metre (mm) is equal to one thousandth of a metre (1mm = 1/1000)

**b.** One centimetre (cm) is equal to .....

**c.** One Kilometre (km) is equal to .....

**2 Convert the following readings to the units indicated.**

**a.** 0.05m = .....cm

**b.** 50g = ..... kg

**c.** 25mm = ..... km

**Ideas**

*The SI units are the standard units which people use for measurement.*

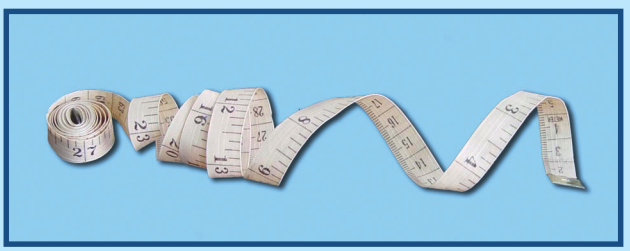
*Prefixes such as milli, centi, and kilo are added to SI unit to form smaller or larger units.*

1c

# Measuring Length

Length is the distance between two points and its SI unit is the metre (m).
Short distances are measured in centimeters (cm) or millimeters (mm).

Long distances are measured in kilometres (km).



**Speedometer**


Tells you the speed in which the vehicle is travelling.

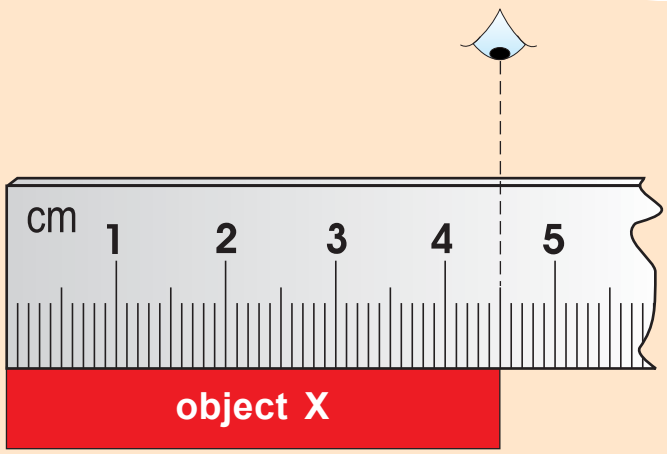
**Do you Know?**

*The standard metre is the distance traveled by light in 1/299 792 458 of a second through a vacuum.*

The photographs in the opposite page show two types of measuring tapes. Measuring tapes measure length in centimeters and metres, and sometimes in feet and inches.

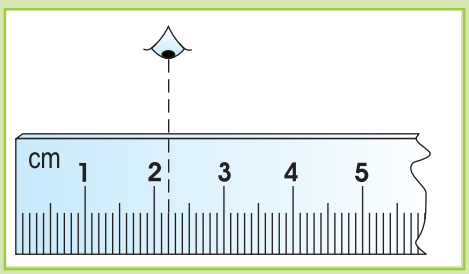
■ Name an occupation associated with each type of measuring tape?

The metre rule and half-metre rule are commonly used to measure length in the laboratory. The metre rule measures length in centimeters, with an accuracy of 0.1cm.




**1** Copy and complete the following table.

1 km = .....m = ..... cm = .....mm.
..... km = 1m =..... cm = .....mm.
..... km = .....m = 1cm = .....mm.
..... km = .....m = .....cm = 1.mm.




What is the reading shown in the picture?

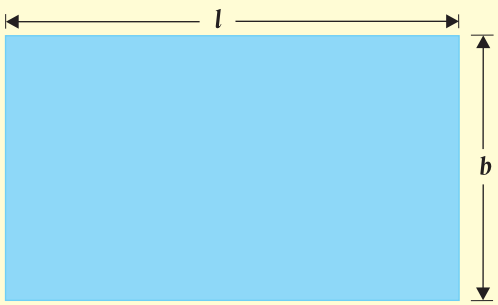
## Ideas

- *SI unit for measuring length is in metre (m)*
- *The metre rule and half - metre rule are commonly used to measure length in the laboratory.*
- *The eye must be placed vertically above the mark being read for accurate measurement.*

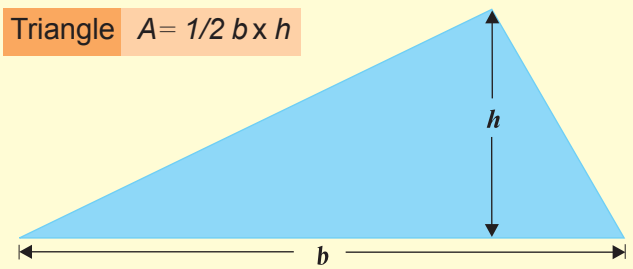
# 1d Measuring Area and volume

Area is a measure of the extent of a surface.
The SI unit for area is the square metre ($m^2$).
Other common units for area include $mm^2$, $cm^2$ and $km^2$.
One $m^2$ is the area of a square, which measures 1m on every side.

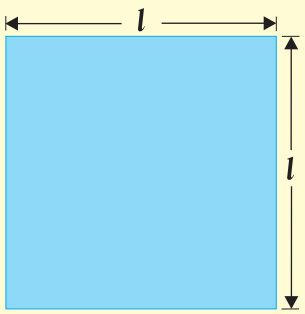
The areas of regular surfaces can be calculated by using formulae.
The formulae for some common regular surfaces are shown below.




Rectangle $A = l \times b$




Triangle $A = 1/2\ b \times h$




Square $A = l \times l$

**Calipper**


Measures width of an object.

**Do you Know?**

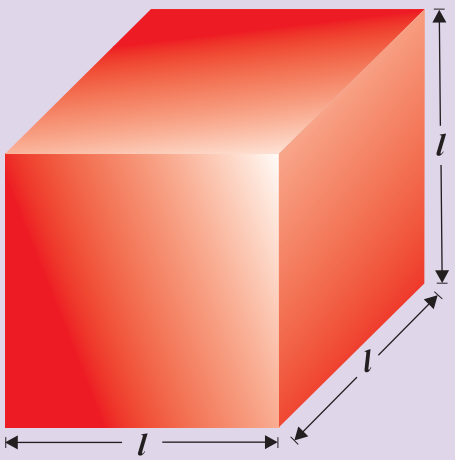
*A flu virus is only 0.000 0015cm long.*

# Measuring Volume

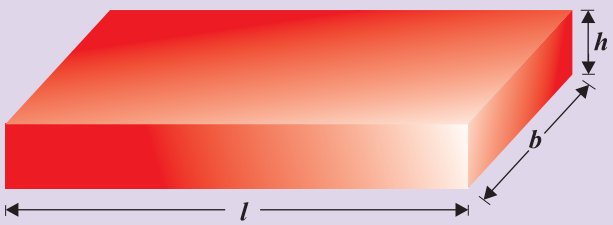
Volume is the measure of the space occupied by a substance.
The SI unit for volume is the cubic metre ($m^3$).

Volume is the measure of the space occupied by a substance.
The SI unit for volume is the cubic metre ($m^3$).
Other common units for volume include $mm^3$, $m^3$, milliliter (m*l*) and litre (*l*).

Some objects have regular shapes, for example, books.
The volume of regular shaped objects can be calculated using formulae.
The formulae for two regular shaped objects are shown below.



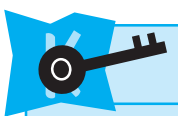

Cube $V = l^3$




Cuboid $V = l \times b \times h$

1 Which instrument would you use to measure:
   **a.** your waste?
   **b.** the height of a table?
   **c.** the width of a door?

2 Ms Shizna lives in a very large house. It has five large bedrooms and a big kitchen. The living area is very big too. Her room measures 4.8m x 3m x 3.3 m. Find out the volume of her room.



## Ideas

- *Area is a measure of the extent of a surface.*
- *The SI unit for area is the square meter ($m^2$).*
- *Volume is the measure of the space occupied by a substance.*
- *The SI unit for volume is the cubic meter ($m^3$).*

1e

# What's the time?

The photographs below show different kinds of measuring instruments.
Which one of the time measuring instruments shown wakes you up in the morning?
Which one estimates time? Which one is the most accurate?


Wrist watch


Alarm clock


Radio clock


Wall clock


Pendulum clock


Atomic clock


Hour glass


Stop watch

The SI unit for time is the **second (s).** Other units for time include minutes (min), hours (hrs), days, months, years, decades and centuries.

**Sundial**

Estimates time.

**Do you Know?**

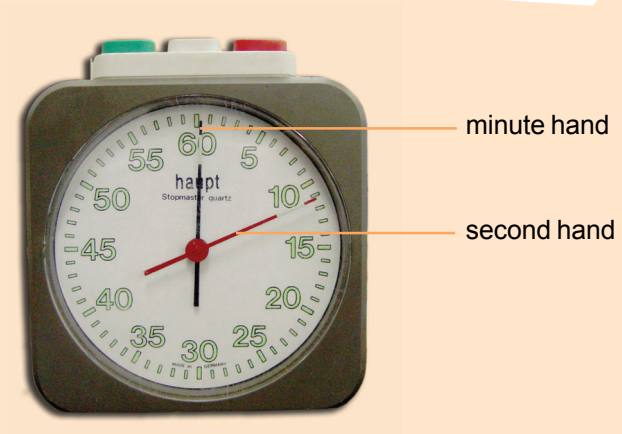
*The importance of time is mentioned in Qur'an. In Surah An-Nisa' 103 Aya'th says that all the believers of Allah should pray at fixed hours.*

# The stopclock

In science class you will be required to carry out experiments involving measuring short intervals of time. Stopwatches and stopclocks are commonly used in the laboratory for measuring time intervals accurately.

The stopclock has a clock face with sixty divisions, each representing a time interval of one second.

The long red hand shows the number of seconds while the slightly shorter black, hand shows the number of minutes. Look at the picture and study the illustration carefully. It will show you how to read the stopclock.





# The electronic stopwatch

The electronic stopwatch, gives a higher accuracy than a mechanical stopwatch. It has a digital display of the time and it can measure time intervals accurate to 0.01s.

It can also record time intervals in hours. Look at the photograph above. It will show you how to read the electronic stopwatch.

**1** What is the reading shown by this stopwatch?

_____

**2** Imagine yourself running on a sandy beach at different speeds, using a stop watch to time your self. Will your footprints be further apart, nearer, or equal in space when you run faster?

## Ideas

- *The SI unit for time is the second (s)*
- *Clocks and watches are commonly used for measuring time.*
- *Short time intervals are measured using stopclocks or stopwatches.*

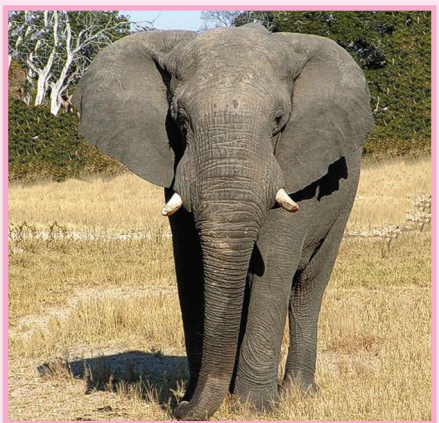
1f

# What is mass?

The mass of an object is the measure of the amount of matter in it.
The SI unit for mass is the **kilogram (kg).**

Large masses are measured in tonnes (1 tonne = 1000 kg)
while small masses are measured in grams (g) or milligrams (mg)

Each grain of rice has a mass of about 0.02mg.



An elephant may weigh about 4 tonnes.

An apple has mass of about 40g.

Mass should not be confused with weight, although in daily life, we sometimes use the two interchangeably. The mass of a substance depends on the number and size of particles, which make up that substance.

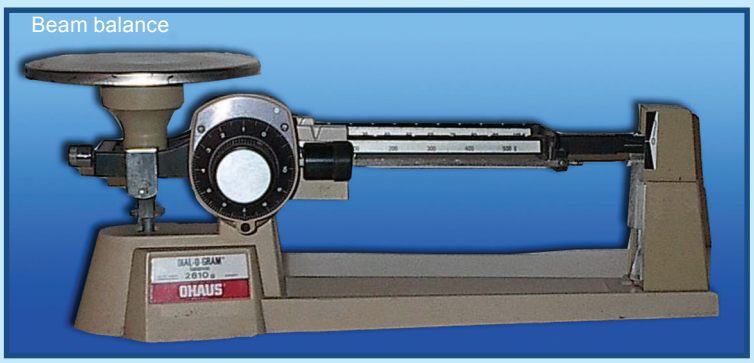
For example, a lump of plasticine having a mass of 50g will still have the same mass even if it is made into the shape of a boat.

**Do you Know?**

*The biggest earthworm ever measured was 6m 70cm long.*

# Measuring mass

We use a balance to measure mass. A beam balance is still used to give very accurate measurements. However, the electronic balance has become popular due to its easy handling, high accuracy and easy digital reading. You will learn to identify the different types of balances and use the beam balance to measure mass in your exercise book.





**1** Define mass.

**2** Can the mass of a substance change if you
**a.** bring it to the moon,
**b.** distort its shape?

**3** 10 tonnes = ——————————kg
= —————————— g
= —————————— mg

**4** Which instrument can be used to measure mass?

**A.** beam balance **B.** forcemeter
**C.** hydrometer **D.** thermometer

## Ideas

*The SI unit for mass is the kilogram (kg).*

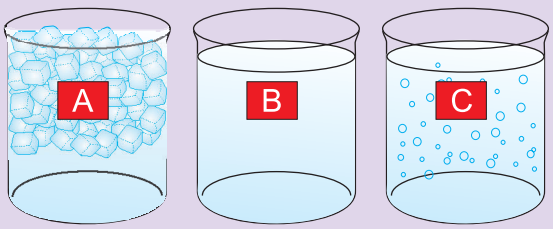
*The electronic balance and the beam balance are instruments used for measuring mass.*

# 1g Temperature

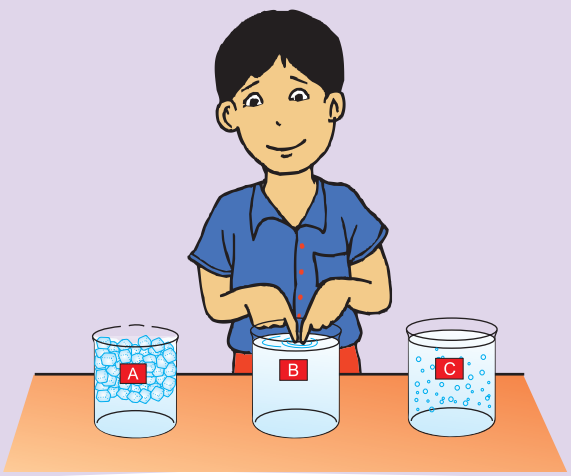
The **temperature** of a substance tells how hot or cold that substance is.
Our sense of touch can tell us if an object is hot or cold, but we cannot tell the accurate measurement, just by touching.

**To find out whether our sense of touch is reliable, you can do the following simple experiment.**

a) Fill the following beakers as follows:
Beaker A with ice water
Beaker B with tap water
Beaker C with warm water




b) Put your right index finger into the ice water in beaker A and your left index finger into the warm water in beaker C as shown below




c) After about one minute, put both index finger into the tap water in beaker B as shown below.
Does your right index finger feel warm or cold?
Does your left index finger feel warm or cold?
Can you tell if the tap water is warm or cold?


**Do you Know?**

*An airline pilot cannot use his or her senses to guide his or her plane through thick cloud. He must depend on the plane's instruments.*

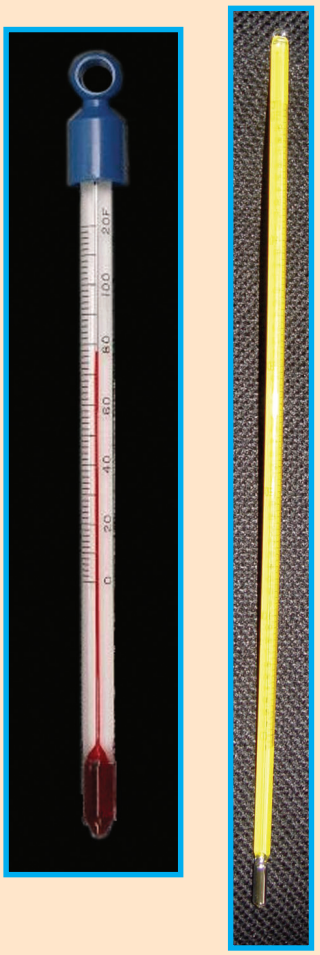
# Thermometers

A thermometer is used to measure temperature accurately. The temperature of a substance is commonly measured according to the **Celsius scale.** The unit used in this scale for temperature is **degree Celsius** (°C).

In the laboratory, liquid-in-glass thermometers are commonly used to measure temperature.

Examine the thermometer shown in the photograph on the right.

- What is the highest temperature it can measure?
- What is the lowest temperature it can measure?
- What is the reading on the thermometer?



**1** Define temperature.

**2** Why is it better to use a thermometer rather than our sense of touch to measure temperature?

**3** A cup of water and a large pot of water both have a temperature of 50 degree Celsius.
Which is hotter?
Which has more heat energy?
Can a large iceberg have more heat than a cup of boiling water?

## Ideas

*Temperature is a measure of the hotness or coldness of an object. A common unit for temperature is the degree Celsius.*

*Thermometers are used for measuring temperature.*

# Ibn Sina
## 980 - 1037 A.D.

*Doctor of doctors*

Abu Ali al-Hussain Ibn Abdallah Ibn Sina was born in 980 A.D. and died in June 1037 A.D. at Afshana near Bukhara. (Central Asia, now Uzbekistan) The young Abu Ali received his early education in Bukhara. By the age of ten he had become well versed in the study of the Qur'an and various sciences. While still young, he attained a degree of expertise in medicine that his renown spread far and wide.

At the age of 17, he was fortunate in curing Nooh Ibn Mansoor, the King of Bukhhara, of an illness in which all the well-known physicians had given up hope. On his recovery, the King wished to reward him, but the young physician only desired permission to use his uniquely stocked library.

On his father's death, Abu Ali left Bukhara and travelled to Jurjan where Khawarizm Shah welcomed him. Later he moved to Ray and then to Hamadan, where he wrote his famous book *Al-Qanun fial-Tibb*. Here he treated Shams al-Daulah, the King of Hamadan (Persia now Iran)for severe colic.

He was the most famous physician, philosopher, encyclopaedist, mathematician and astronomer of his time. His major contribution to medical science was his famous book *al-Qanun*, known as the "Canon" in the West. The *Qanun fi al-Tibb* is a huge encyclopaedia of medicine extending over a million words. It surveyed the entire medical knowledge available from ancient and Muslim sources. It remained supreme for six centuries". In addition to bringing together the then available knowledge, the book is rich with the author's original contribution.

He was also the first to describe meningitis and made rich contributions to anatomy, gynaecology and child health.

His philosophical encyclopaedia *Kitab al-Shifa* was a monumental work, embodying a vast field of knowledge from philosophy to science. He classified the entire field as follows: theoretical knowledge: physics, mathematics and metaphysics; and practical knowledge: ethics, economics and politics.
He made several astronomical observations, and devised a device similar to the vernier, to increase the precision of instrumental readings. In physics, his contribution comprised the study of different forms of energy, heat, light and mechanical, and such concepts as force, vacuum and infinity.