Try yourself

If the atomic number of carbon is Z=6, what is the number of the electrons revolving in its atom

Mass number (A) or Atomic mass :

We have seen that the mass of an atom is concentrated in its nucleus. From this, we can get the atomic mass number. mass number (A) is equal to the sum of the number of protons(p) and neutrons (n) in the nucleus.

Automic mass or mass number = Number of Protons + Number of Neutrons

$$A = p+n$$

A lithium atom contains 3 Protons and 4 neutrons . Its atomic mass number A = 3+4 = 7.

In a sodium atom, there are 11 Protons and 12 neutrons. Hence , its atomic mass number A = 11 + 12 = 23.

Try yourself

1. Why are atomic numbers and mass numbers are always whole numbers ?
2. A sulphur atom contains 16 Protons and 16 neutrons . Give its atomic number and atomic mass number.

When writing the symbol of an element, its atomic number and atomic mass number are also written. For example, the symbols of hydrogen, carbon and oxygen are written as ${}_{1}H^{1}$, ${}_{6}C^{12}$, ${}_{8}O^{16}$ respectively.

All the elements in the periodic table have the following combination of protons, electrons and neutrons:

Elements	Symbols	Number of proton, electron, neutron,
Carbon	${}_{6}C^{12}$	**6p,6e,6n**
Beryllium	${}_{4}Be^{12}$	4p,4e,5n
Nitrogen	${}_{7}Be^{14}$	7p,7e,7n
Boron	${}_{5}B^{11}$	5p,5e,6n

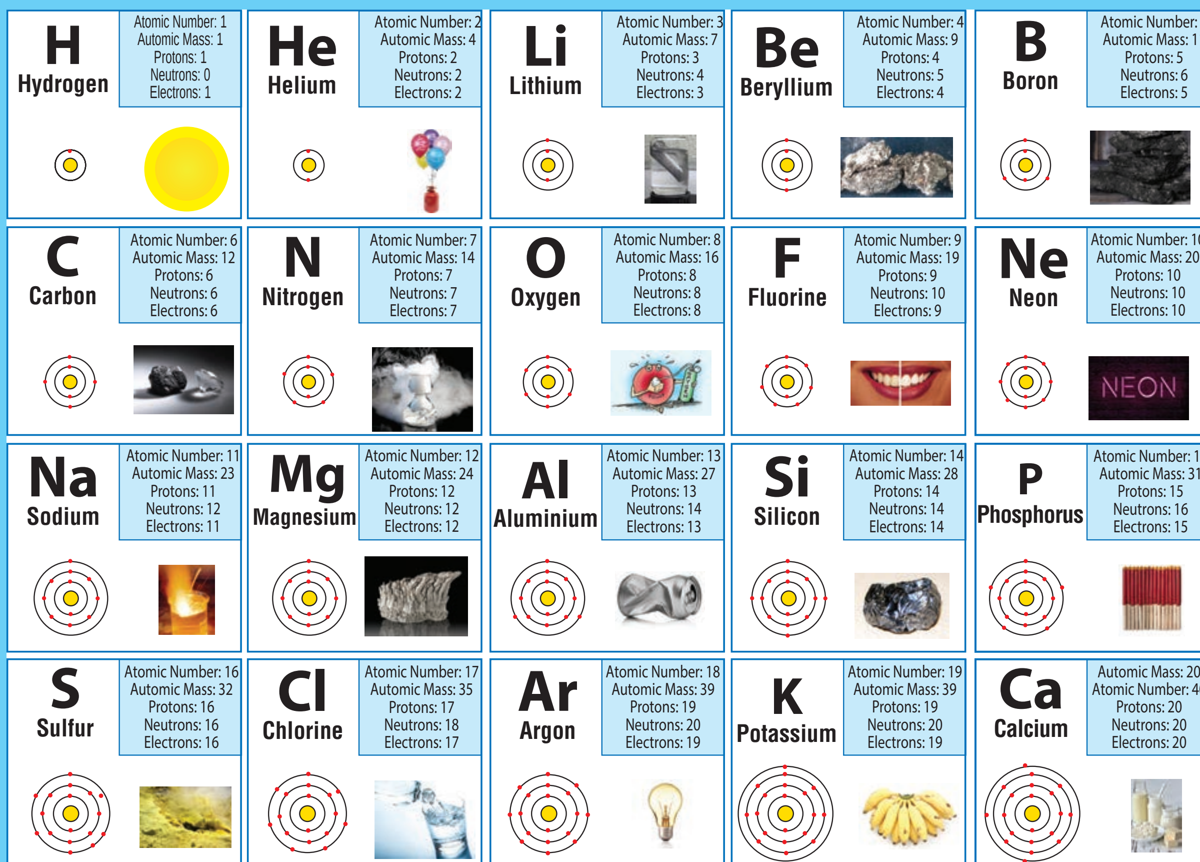
Isotopes: Atoms of the same element can have different number of neutrons. Such atoms will have same atomic number but different mass numbers. These atoms are called isotopes. For example Hydrogen has three isotopes --- Hydrogen (${}_{1}H^{1}$), Deuterium (${}_{1}H^{2}$), Tritium (${}_{1}H^{3}$).

Isobars: Atoms that have the same mass number but different atomic numbers. for example Calcium – 40 and Argon - 40

Elements and their symbols with their atomic number and mass number.

Element	symbol	Atomic number	Protons (p)	Neutrons(n)	Mass number(p+n)
Hydrogen	H	1	1	0	1
Helium	He	2	2	2	4
Aluminium	Al	13	13	14	27
Oxygen	O	8	8	8	16
Sodium	Na	11	11	12	23

ACTIVITY 3



Observe the table given above and answer the following questions.

1. I am used for breathing, without me you cannot live. Do you know me? Write my name and symbol ________________________________ .
2. It is used in filling the balloons. It is a gas, identity it. What is its mass number?
3. ________________________________.
4. Name the element present in banana. What is my atomic number?
5. ________________________________.
6. I am found in crackers. How many protons do i have?
7. ________________________________.
8. I am the most valuable element. Find who am I? Can you say my mass number?
9. ________________________________.

4.5 Valency

Imagine there are various people having different pattern of hands. Some have no hands and some have one, some two and others three. Few have four and no one has more than four. The person with four hands can hold hands of four others at a same time, while the one with no hands can never hold any hand. In this manner some atoms can hold one electron, some can hold two, some can hold three, some can hold four and some cannot hold any electron. This property is called valency.

DO YOU KNOW?

WHAT MAKES ATOMS STICK TOGETHER?

Electrons carry a negative electric charge, and protons carry a positive charge. The attraction between them holds electrons in orbits.

This combining property of an atom is called as Valency. It is a measure of how many hydrogen atoms it can combine with. For example: oxygen can combine with two hydrogen atoms and create water molecule, the valency of oxygen atom is two. In case of chlorine, it can combine with only one hydrogen to create HCl (hydrochloric acid) here the valency of chlorine is one. Methane has one carbon atom combining with four hydrogen atoms to form carbon molecule is methane (CH_4). Can you guess the valency of Carbon in methane? In ammonia molecule, Nitrogen combines with three hydrogen atoms. What is the valency of Nitrogen in ammonia?

Valency is defined as the combining capacity of an element. Atoms of different elements combine with each other to form molecules. Valency determines the number of atoms of an element that combines with atom or atoms of another type.

The element having valency one is called monovalent. For example: Hydrogen and Sodium. The elements having valency two are called divalent. For example: Oxygen and Beryllium. The elements having valency three are called trivalent. For example: Nitrogen and Aluminium. Some elements exhibits more than one valency. For example: Iron combines with oxygen to form two types ferrous oxide (exhibits valency 2) and ferric oxide (exhibits valency 3), however we will study about them later.

When atoms of different elements combine with each other then molecules of compounds are formed. In these instances, it is necessary to know the valancies of those elements. For example:

1 2Na + Cl_2 ---------- 2NaCl

Valency 1 + 1

Here, the valancies of both sodium and chlorine are 1.

Remember The valency of element Na is 1

The valency of element Cl is 1

Then, the molecular formula will be

Symbol of Elements Na Cl Molecular Formula

Radicals and ions 1 1

NaCl

2 Mg + Cl_2 ---------- Mg Cl_2

Valency 2 1

Here , the valency of magnesium is 2 and that of Cl is 1.

Elements and their symbols with their atomic number and mass number and valency.

Element	Symbol	Atomic Number	Mass Number	Valency
Hydrogen	H	1	1	1
Carbon	C	6	12	4
Oxygen	O	8	16	2
Sodium	Na	11	23	1
Calcium	Ca	20	40	2

ICT CORNER

Atomic Structure

Let's build an atom.

PROCEDURE :

Step 1: Use the URL to reach stimulation page. Click play button to launch the simulation.

Step 2: Click on the"ATOM" , a new window will be open. Drag the particles (Protons, Neutrons and Electrons) from the baskets which is at the bottom of the display.

Step 3: You can observe the changes in 'Elements, Net charge and Mass number' at the right side windows.

Step 4: Click on the 'Symbol" at the bottom. Drag the particles and get the Symbol of the element.

Step 5: Click on the"GAME" and play the games.

Step 1

Step 2

Step 3

Step 4

Atomic Structure URL:

https://phet.colorado.edu/en/simulation/build-an-atom

B351_7_SCI_EM

*Pictures are indicative only

*If browser requires, allow Flash Player or Java Script to load the page.

Points to remember

- ❖ An atom is the smallest particle of a chemical element that retains its chemical properties.
- ❖ They are very tiny compared to other particles.
- ❖ Atoms are too small to be seen by the naked eye or even through microscope.
- ❖ An atom consists mostly of empty space.
- ❖ Atoms of same element are identical, and different elements differ.
- ❖ An atom consists of a dense nucleus of positively-charged protons and electrically-neutral neutrons.
- ❖ The protons and neutrons are called nucleons.
- ❖ The protons, neutrons and electrons are denoted by p,n,e respectively.
- ❖ An atom is electrically neutral. Atoms contain equal number of protons and electrons.
- ❖ Atomic number is the number of protons in an atom.
- ❖ The total number of protons and neutrons present in the nucleus of an atom is the mass number.
- ❖ Valency is defined as the combining capacity of an element.

Evaluation

I. Choose the appropriate answer.

1. The basic unit of matter is ________
   a. Element
   b. Atom
   c. Molecule
   d. Electron

JHG1TS

2. The subatomic particle revolve around the nucleus is ________
   a. Atom b. Neutron
   c. Electron d. Proton

3. ________ is positively charged.
   a. Proton b. Electron
   c. Molecule d. Neutron

4. The atomic number of an atom is ________
   a. Number of neutrons
   b. Number of protons
   c. Total number of protons and neutrons
   d. Number of atoms

5. ________________ Nucleons comprises of
   a. Protons and electrons
   b. Neutrons and electrons
   c. Protons and neutrons
   d. Neutrons and Positron

II. Fill in the blanks.

1. The smaller particles found in the atom is called ________________.
2. The nucleus has ________________ and ________________ .
3. The ________________ revolve around the nucleus.
4. If the valency of carbon is 4 and that of hydrogen is 1 , then the molecular formula of methane is________________ .
5. There are two electrons in the outermost orbit of the magnesium atom. Hence, the valency of magnesium is________________ .

III. Match the following:

1. Valency	Fe
2. Neutral Particle	Proton
3. Iron	Electrons in the outermost Orbit
4. Hydrogen	Neutron
5. Positively charged Particle	Monovalent

IV. True or False. If False, give the correct statement (T/F).

1. The basic unit of an element is molecule.
2. The electrons are positively charged.
3. An atom is electrically neutral.
4. The nucleus is surrounded by protons.

V. Complete the analogy.

1. Sun: Nucleus, planets: ________________.
2. Atomic number: ________________, Mass number: number of protons and neutrons.
3. K: Potassium, C: ____________________.

VI. Assertion and reason.

1. **Assertion**: An atom is electrically neutral.
   Reason: Atoms have equal number of protons and electrons.
2. **Assertion:** The mass of an atom is the mass of nucleus.
   Reason: The nucleus is at the centre.
3. **Assertion:** The number of protons and neutrons is atomic number.
   Reason: The mass number is sum of protons and neutrons.

VII. Give very short answer.

1. Define an atom.
2. Name the sub-atomic particles.
3. What is atomic number?
4. What is the characteristics of proton?
5. Why neutrons called neutral particles?

VIII. Give short answer.

1. Distinguish Isotopes from Isobar.
2. What are the isotones give one example.
3. Differentiate mass number from atomic number.
4. The atomic number of an element is 9, it has 10 neutrons. Find the element from the periodic table. What will be its mass number?

IX. Answer in detail.

1. Draw the atom structure and explain the position of the sub-atomic particles.
2. The atomic number and the mass number of an element is 26 and 56 respectively. Calculate the number of electrons protons and neutrons in its atom. Draw the structure.
3. What are nucleons. Why are they so called? Write the properties of the nucleons.
4. Define valency? What is the valency of the element with atomic number 8. What is the compound by the element with hydrogen.

X. Questions based on Higher Order Thinking Skills.

1. Anatom of an element has no electron, will that atom have any mass or not? Can atom exist without electron? If so then give example.
2. Find what is common salt? Name the elements present in it? Write the formula of common salt. What are the atomic number and the mass number of the elements? Write the ions in the compound.

XI. Project.

To have an idea of what atoms are, students will construct atoms using pipe cleaners (thin metal wires-electron shells), pom-poms (balls) (different colors for protons and neutrons) and beads (electrons). Students will love and enjoy putting them together and they look great hanging from the ceiling in the classroom.

Unit 1

Heat and Temperature

Learning Objectives

- ❖ To understand the working principle of thermometer
- ❖ To measure temperature using thermometer
- ❖ To know about Thermometric Liquids
- ❖ To differentiate between Clinical and Laboratory Thermometer
- ❖ To know the various units of temperature
- ❖ To convert a temperature from a thermometer scale to others.

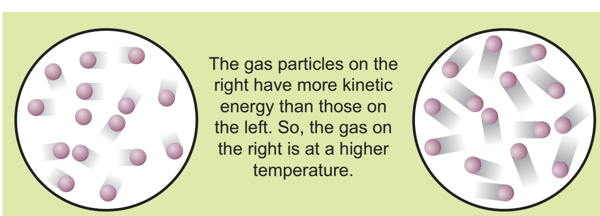
N1S2E1

Introduction

You shiver when it is cold outside and sweat when it is hot outside, but how can you measure those weather temperatures? Temperature is involved in many aspects of our daily lives, including our own bodies and health; the weather; and how hot the stove must be in order to cook food.

The measurement of warmness or coldness of a substance is known as its temperature.

It is a measure of the average kinetic energy of the particles in an object. Temperature is related to how fast the atoms within a substance are moving.



1.2 Temperature Units:

There are three units which are used to measure the temperature: Degree Celsius, Fahrenheit and Kelvin.

Degree Celsius: Celsius is written as°C and read as degree. For example 20°C; it is read as twenty degree Celsius. Celsius is called as Centigrade as well.

Fahrenheit: Fahrenheit is written as °F for example 25°F; it is read as twenty five degree Fahrenheit.

Kelvin: Kelvin is written as K. For example 100K; it is read as hundred Kelvin.

❖ The SI unit of temperature is kelvin (K).

1.3 Measuring Temperature

The temperature of the object is well approximated with the kinetic energy of the substances. The high temperature means that the molecules within the object are moving at a faster rate.

But the question arises, how to measure it? Molecules in any substance are very small to analyze and calculate its movement (Kinetic energy) in order to measure its temperature. You must use an indirect method to measure the kinetic energy of the molecules of a substance.

We studied that solids expands when heat is supplied to it. Like solid substances, liquids are also affected by heat. To know this let us do the activity 1.

In a thermometer, when liquid gets heat, it expands and when it is cooled down, it contracts. It is used to measure temperature.

Like solid and liquid objects, the effect of heat is also observed on gaseous objects.

1.4 Thermometer:

Thermometer is the most common instrument to measure temperature.

There are various kinds of thermometers. Some of them are like glass tubes which look thin and are filled with some kind of liquid.

Why Mercury or Alcohol is used in Thermometer?

Mostly Alcohol and Mercury are used in thermometers as they remain in liquid form even with a change of temperature in them. A small change in the temperature causes change in volume of a liquid. We measure this temperature by measuring expansion of a liquid in thermometer.

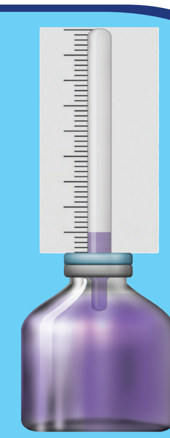
ACTIVITY 1

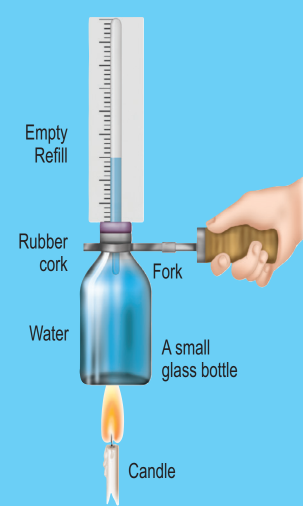
What is required?

A small glass bottle, a rubber cork, an empty refill, water, colour, a candle, a fork, a paper.

What to do?

- Take a small glass bottle. Fill it with coloured water.
- Make hole at the centre of the rubber cork.
- Pass empty refill from the hole of the rubber cork.
- Make the bottle air tight and observe the water raised in the refill.
- Make a scale on paper, place it behind the refill and note down the position of the surface of water.
- Hold bottle with fork and supply heat to it with candle. Then observe.





What is the change in the surface of water?

- Stop the supply of heat. When water is cooled, observe the surface of water in the refill, **what change takes place? Why?**

When, a liquid is heated, it expands and when it is cooled down, it contracts.

Properties of Mercury:-

- Its expansion is uniform. (For equal amounts of heat it expands by equal lengths.)
- It is opaque and shining.
- It does not stick to the sides of the glass tube.
- It is a good conductor of heat.
- It has a high boiling point (357°C) and a low freezing point (−39°C). Hence a wide range of temperatures can be measured using a mercury thermometer

Properties of Alcohol

- The freezing point of alcohol is less than −100°C. So it can be used to measure very low temperatures.
- Its expansion per degree Celsius rise in temperature is very large.
- It can be coloured brightly and hence is easily visible.

1.4 Types of Thermometers

V4A4I9

There are different types of thermometers for measuring the temperatures of different things like air, our bodies, food and many other things. Among these, the commonly used thermometers are clinical thermometers and laboratory thermometers.

1.4.1 Clinical Thermometer

These thermometers are used to measure the temperature of a human body, at home, clinics and hospitals. All clinical thermometers have a kink that prevents the mercury from

ACTIVITY 2

What is required?

A big bottle, a balloon, threads, candle, water, fork

What to do?

- Take one big bottle, and fill some water in it.
- Attach one balloon on the mouth of bottle and fix it with thread.
- Hold bottle with a fork. Heat the bottle with a candle and take observation.
- What change occurs in the state of balloon after heating the bottle? ---
- What change occurs in the state of balloon after heating the bottle?

Why? ---

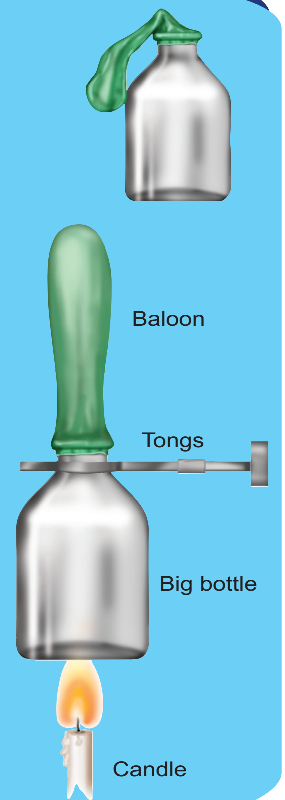
Now, let the bottle get cooled down.

What change occurs in the state of balloon after bottle gets cool down?

Why? ---------------------------------

When gases substance gets heat, it expands; when it cools it contracts.

Why does a tyre get burst in summer? ---------------------------------



flowing back into the bulb when the thermometer is taken out of the patient's mouth, so that the temperature can be noted conveniently. There are temperature scales on either side of the mercury thread, one in Celsius scale and the other in Fahrenheit scale. Since the Fahrenheit scale is more sensitive than the Celsius scale, body temperature is measured in F only. A clinical thermometer indicates temperatures from a minimum of 35°C or 94°F to a maximum of 42°C or 108°F.

Precautions to be Followed While Using a Clinical Thermometer

- The thermometer should be washed before and after use, preferably with an antiseptic solution.
- Jerk the thermometer a few times to bring the level of the mercury down.
- Before use, the mercury level should be below 35°C or 94°F.
- Do not hold the thermometer by its bulb.
- Keep the mercury level along your line of sight and then take the reading.
- Handle the thermometer with care. If it hits against some hard object, it may break.
- Do not place the thermometer in a hot flame or in the hot sun.

1.4.2 Laboratory Thermometers

Laboratory thermometers are used to measure the temperature in school and other laboratories for scientific research. They are also used in the industry as they can measure temperatures higher than what clinical thermometers can record. The stem and the bulb of a lab thermometer are longer when compared to that of a clinical thermometer and there is no kink in the lab thermometer. A laboratory thermometer has only the Celsius scale ranging from −10°C to 110°C.

Precautions to be Followed While Using a Laboratory Thermometer

- Do not tilt the thermometer while measuring the temperature. Place it upright.
- Note the reading only when the bulb has been surrounded by the substance from all sides.

DO YOU KNOW?

In humans, the average internal temperature is 37°C (98.6°F), though it varies among individuals. However, no person always has exactly the same temperature at every moment of the day. Temperatures cycle regularly up and down through the day according to activities and external factors.

ACTIVITY 3

Measure your body temperature

Wash the thermometer preferably with an antiseptic solution. Hold it firmly by the end and give it a few jerks. These jerks will bring the level of Mercury down. Ensure that it falls below 35°C (95°F). Now place the thermometer under your tongue or arm pit.

After one minute, take the thermometer out and note the reading. It tells you your body temperature. **What did you record as your body temperature?______________**

ACTIVITY 4

Use of Laboratory thermometer

- Take some water in a beaker.
- Take a laboratory thermometer and immerse its bulb end in water; holding it vertically. Ensure to dip whole portion of bulb end. The bulb end should not touch the bottom or side of the beaker.
- Observe the movement of rise of mercury. When it becomes stable, take the reading of the thermometer.
- Repeat this with hot water and take the reading.

Difference between clinical and laboratory thermometer

Clinical Thermometer	Laboratory Thermometer
Clinical thermometer is scaled from 35°C to 42°C or from 94°F to 108°F.	Laboratory thermometer is generally scaled from —10°C to 110°C.
Mercury level does not fall on its own, as there is a kink near the bulb to prevent the fall of mercury level.	Mercury level falls on its own as no kink is present.
Temperature can be read after removing the thermometer from armpit or mouth.	Temperature is read while keeping the thermometer in the source of temperature, e.g. a liquid or any other thing.
To lower the mercury level jerks are given.	No need to give jerk to lower the mercury level.
It is used for taking the body temperature.	It is used to take temperature in laboratory.

1.4.3 Digital Thermometer

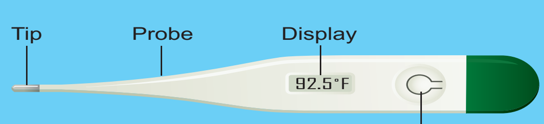
Here is a lot of concern over the use of mercury in thermometers. Mercury is a toxic substance and is very difficult to dispose of if a thermometer breaks. These days, digital thermometers are available which do not use mercury. Instead, it has a sensor which can measure the heat coming out from the body directly and from that can measure the temperature of the body.

K6A7W4

Digital thermometers are mainly used to take the body temperature.

ACTIVITY 5

Use of Digital thermometer



1. Wash the tip with warm (not hot), soapy water.
2. Press the "ON" button.
3. Insert the tip of the thermometer into the mouth, bottom, or under the armpit.
4. Hold the thermometer in place until it beeps (about 30 seconds).
5. Read the display.
6. Turn off the thermometer, rinse under water, and put it away in a safe place.

Caution

Alex wanted to measure the temperature of hot milk using a clinical thermometer. His teacher stopped him from doing so.

We are advised not to use a clinical thermometer for measuring the temperature of any object other than human body. Also we are advised to avoid keeping it in the sun or near a flame. Why?

A Clinical thermometer has small temperature range. The glass will crack/ burst due to excessive pressure created by expansion of mercury.

DO YOU KNOW?

Maximum _ minimum thermometer

The maximum and minimum temperatures of the previous day reported in weather reports are measured by a thermometer called the maximum - minimum thermometer.

1.5 Scales of thermometers

Celsius scale

Celsius is the common unit of measuring temperature, termed after Swedish astronomer, **Anders Celsius** in 1742, before that it was known as Centigrade as thermometers using this scale are calibrated from (Freezing point of water) 0°C to 100°C (boiling point of water). In Greek, '**Centium**' means 100 and '**Gradus**' means steps, both words make it **centigrade** and later **Celsius**.

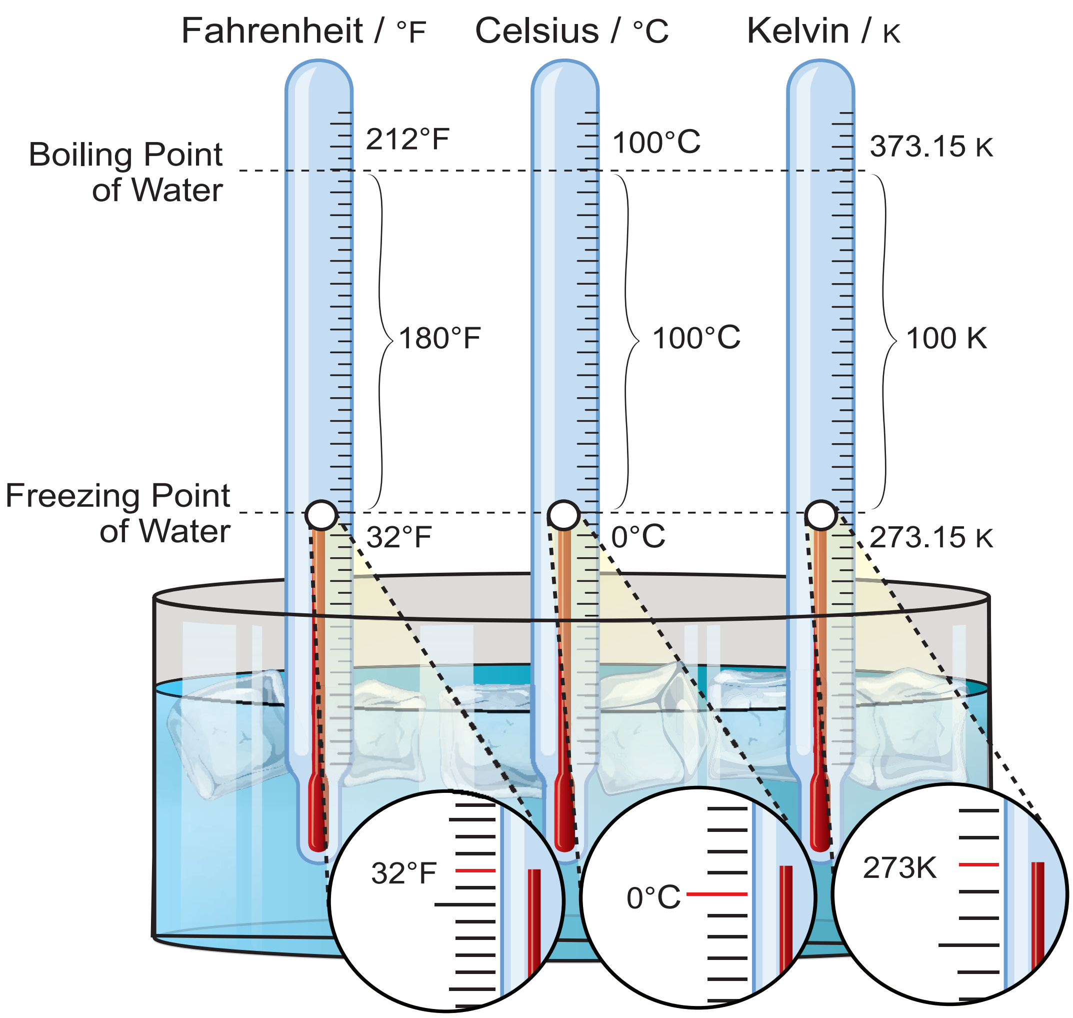
Fahrenheit Scale

Fahrenheit is a Common unit to measure human body temperature. It is termed after the name of a German Physicist **Daniel Gabriel Fahrenheit**. Freezing point of water is taken as 32°F and boiling point 212°F. Thermometers with Fahrenheit scale are calibrated from 32°F to 212°F.

Kelvin scale

Kelvin scale is termed after **Lord Kelvin**. It is the SI unit of measuring temperature and written as K also known as absolute scale as it starts from absolute zero temperature.

Temperature in Celsius scale can be easily converted to Fahrenheit and Kelvin scale as discussed ahead



Relation between Fahrenheit scale and Celsius scales is as under.

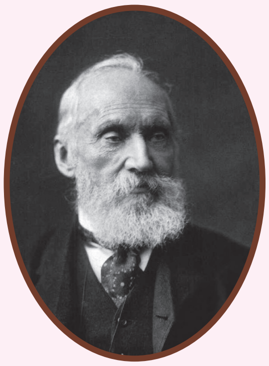
$$\frac{(F-32)}{9} = \frac{C}{5}, \quad K = 273.15 + C$$

The equivalence between principal temperature scales are given in Table for some temperatures.

Temperature	Celsius scale (°C)	Farenheit scale (°F)	Kelvin scale (K)
Boiling point of water	100	212	373.15
Freezing point of water	0	32	273.15
Mean temperature of human body	37	98.6	310.15
Room temperature (Average)	72	23	296.15

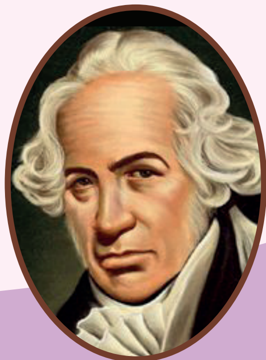
HEAT AND TEMPERATURE

KEY CONTRIBUTORS



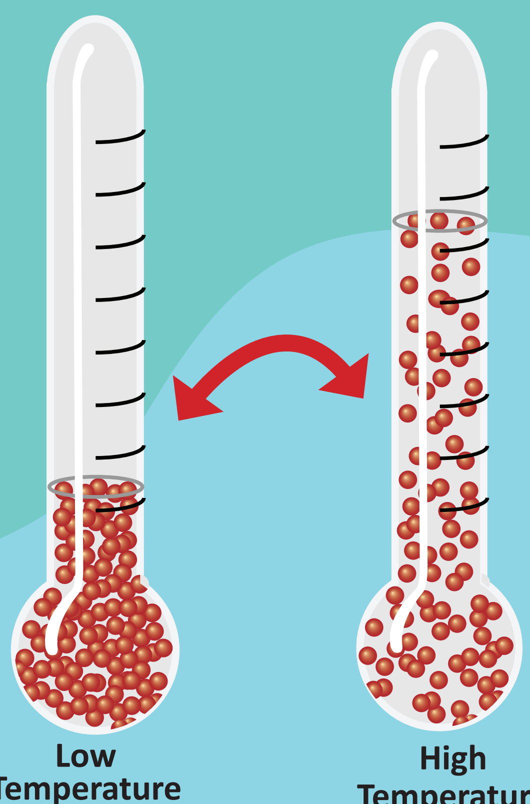
Lord Kelvin

Anders Celsius



Gabriel Fahrenheit

Rankine



Thermometer Liquid Expands when Heated

10^{32} KELVIN
Temperature of the Universe in the earliest moments after the Big Bang

373.15 KELVIN
Boiling point of water

100 °C, 212 °F

329.85 KELVIN
Hottest natural temperature ever recorded on Earth.

56.7 °C, 134.06 °F

310.15 KELVIN
Average human body temperature

37 °C, 98.6 °F

273.15 KELVIN
Freezing point of water

0 °C, 32 °F

178.45 KELVIN
Coldest natural temperature ever recorded on Earth

-94.7 °C, -138.46°F

1 KELVIN
The Boomerang Nebula maintains the coldest known natural temperature in the universe

-272.15 °C, -457.87 °F

0 KELVIN
Absolute zero Temperature

-273.15 °C, -459.67 °F

DO YOU KNOW?

Most of the people in the world use the Celsius scale to measure temperature for day to day purpose. The Kelvin scale has been designed in such a way, it is not only an absolute temperature scale, but also 1°C change is equal to a 1K change. This makes the conversion from Celsius to absolute temperature scale (Kelvin scale) easy, just the addition or subtraction of a constant 273.15

But in United States they prefer to use the Fahrenheit scale. The problem is, converting Fahrenheit to absolute scale (Kelvin) is not easy.

To sort out this problem they use The Rankine scale. It named after the Glasgow University engineer and physicist **Rankine**, who proposed it in 1859. It is an absolute temperature scale, and has the property of having a 1°R change is equal to a 1°F change. Fahrenheit users who need to work with absolute temperature can be converted to Rankine by

$$R = F + 459.67$$

1.6 Numerical Problems

Solved examples

1. How much will the temperature of 68°F be in Celsius and Kelvin?

Given :

Temperature in Fahrenheit = F = 68°F

Temperature in Celsius = C = ?

Temperature in Kelvin = K = ?

$$\frac{(F-32)}{9} = \frac{C}{5}$$

$$\frac{(68-32)}{9} = \frac{C}{5}$$

$$C = 5x\frac{36}{9} = 20°C$$

$$K = C + 273.15 = 20 + 273.15 = 293.15$$

Thus, the temperature in Celsius = 20ºC and in Kelvin = 293.15 K

2. At what temperature will its value be same in Celsius and in Fahrenheit?

Given : If the temperature in Celsius is C, then the temperature in Fahrenheit (F) will be same,

i.e. F = C. $\frac{(F-32)}{9} = \frac{C}{5}$

(or)

$$\frac{(C-32)}{9} = \frac{C}{5}$$

$$(C-32) \times 5 = C \times 9$$

$$5C - 160 = 9C$$

$$4C = -160$$

$$C = F = -40$$

The temperatures in Celsius and in Fahrenheit will be same at – 40

3. Convert the given temperature :

1) 45°C = ... °F	2) 20°C = ... °F
3) 68°F = ... °C	4) 185°F = ... °C
5) 0°C = ... K	6) -20°C = ... K
7) 100 K = ... °C	8) 272.15 K = ... °C

POINTS TO REMEMBER

1. The measurement of warmness or coldness of a substance is known as its temperature.
2. There are three units which are used to measure the temperature: Degree Celsius, Fahrenheit and Kelvin.
3. The SI unit of temperature is Kelvin (K).
4. In a thermometer, when liquid gets heat, it expands and when it is cooled down, it contracts. It is used to measure temperature.

5. Relation between Fahrenheit scale and Celsius scales is

$$\frac{(F-32)}{9} = \frac{C}{5}$$

$$K = 273.15 + C$$

EVALUATION

S6P7M6

I. Choose the correct answer

1. International unit of measuring temperature is ....

   a. Kelvin b. Fahrenheit

   c. Celsius d. Joule

2. In thermometer when bulb comes in contact with hot object, liquid inside it

   a. expands b. contracts

   c. remains same d. none of above

3. The body temperature of a healthy man is;

   a. 0°C b. 37°C c. 98°C d. 100°C

4. Mercury is often used in laboratory thermometers because it ____________________

   a. is a harmless liquid

   b. is silvery in colour and is attractive in appearance

   c. Expands uniformly

   d. is a low cost liquid

5. Which of the following temperature conversions is incorrect

   K (Kelvin) = °C (Celsius) + 273.15

	°C	K
a.	-273.15	0
b.	-123.	+150.15
c.	+ 127.	+ 400.15
d.	+ 450	+ 733.15

II. Fill in the blanks

1. Doctor uses ____________ thermometer to measure the human body temperature.

2. At room temperature Mercury is in ______________ state.

3. Heat energy transfer from ______________ to ___________

4. – 7°C temperature is ______________ than 0°C temperature.

5. The common laboratory thermometer is a _____________ thermometer

III. Match the following

i) Clinical thermometer	A form of energy
ii) Normal temperature of human body	100°C
iii) Heat	37°C
iv) Boiling point of water	0°C
v) Melting point of water	Kink

IV. Give very short answer

1. Temperature of Srinagar (J&K) is – 4°C and in Kodaikanal is 3°C which of them has greater temperature ? What is the difference between the temperatures of these two places?

2. Jyothi was prepared to measure the temperature of hot water with a clinical thermometer. Is it right or wrong? Why?

3. A clinical thermometer is not used to measure the temperature of air, why?

4. What is the use of kink in clinical thermometer?

5. Why do we jerk a clinical thermometer before we measure the body temperature?

VII Std Science Term-2 EM Unit 1.indd 10 20-07-2019 1.46.42 PM

V. Give short Answer

1. Why do we use Mercury in thermometers? Can water be used instead of mercury? What are the problems in using it?

2. Swathi kept a laboratory thermometer in hot water for some time and took it out to read the temperature. Ramani said it was a wrong way of measuring temperature. Do you agree with Ramani? Explain your answer.

3. The body temperature of Srinath is 99°F. Is he suffering from fever? If so, why?

VI. Give long answer

1. Draw the diagram of a clinical thermometer and label its parts.

2. State the similarities and differences between the laboratory thermometer and the clinical thermometer.

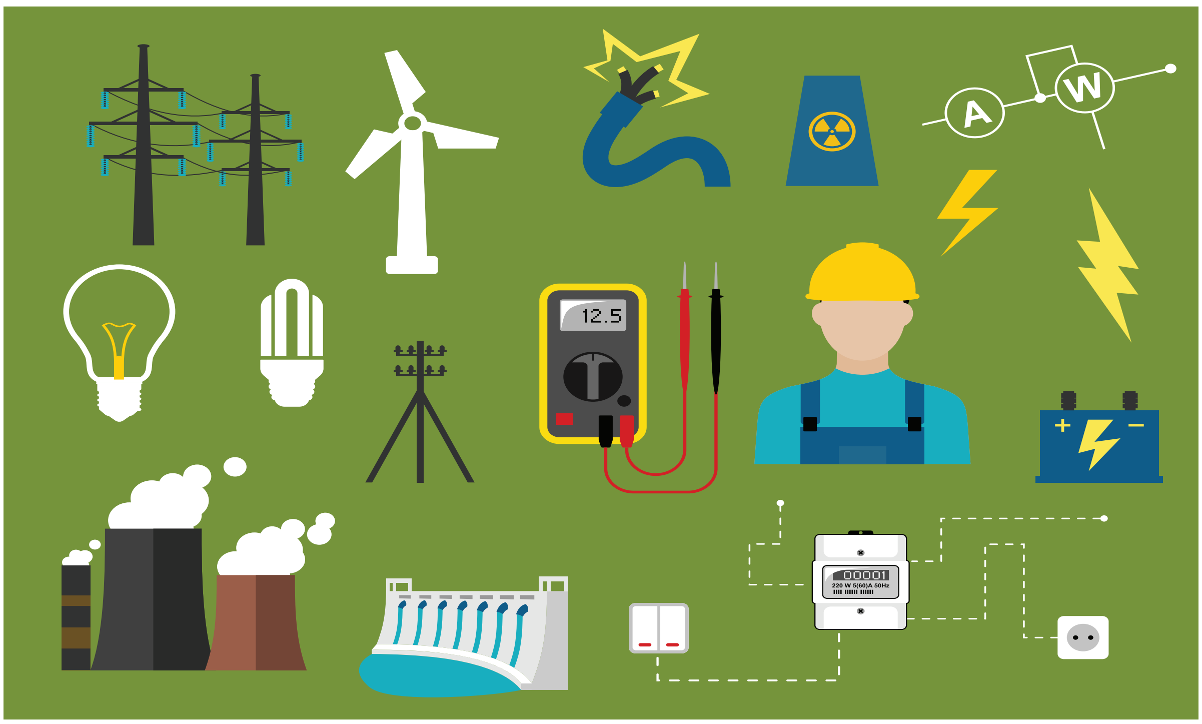
VII. Higher Order Thinking questions

1. What must be the temperature in Fahrenheit, so that it will be twice its value in Celsius?

2. Go to a veterinary doctor (a doctor who treats animals). Discuss and find out the normal temperature of domestic animals and birds.

Unit 2

ELECTRICITY



Learning Objectives

A8T3D9

- ❖ Understanding the flow of electric current and learning to draw the circuit diagram
- ❖ Understanding the difference between conventional current and electron flow.
- ❖ Understanding the different types of circuit based on flow of electricity and the connection of bulbs in a circuit
- ❖ Distinguishing a cell and a battery
- ❖ Understanding the effects of electric current and factors affecting the effect of electric current
- ❖ Applying their knowledge in identifying the components of electrical circuits.
- ❖ Understanding the discrimination between different type of circuits.
- ❖ Doing numerical problems and drawing the circuit diagram of their own.

Introduction

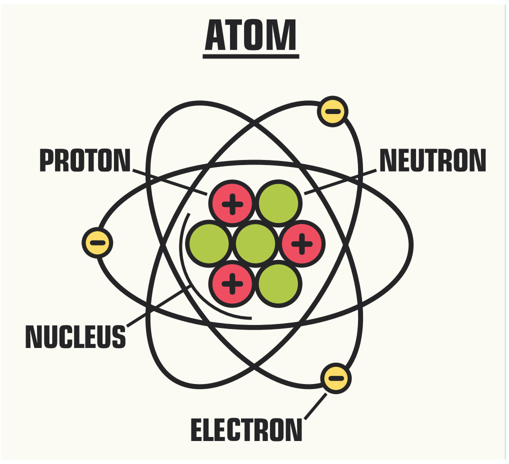
In 1882, when it was sun set in the west that miracle happened in New york city. When Thomas Alva Edison gently pushed the switch on 14,000 bulbs in 9,000 houses suddenly got lighted up. It was the greatest invention to mankind. From then the world was under the light even in the night.

Many countries began using electricity for domestic purposes. Seventeen years after the New York, in 1899 electricity first came to India. The Calcutta Electric Supply Corporation Limited commissioned the first thermal power plant in India on 17 April 1899

Around 1900s, a thermal power station was set up at Basin Bridge in Madras city and power was distributed to the government press, general hospital, electric tramways and certain residential areas in Madras. Today electricity is a common household commodity.

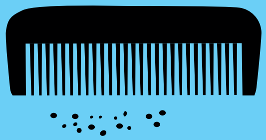
In your class 6, we learned about electricity and their sources. From operating factories, running medical equipments like ventilator, communications like mobile, radio and TV, drawing water to the agricultural field and light up homes electricity is important. What is electricity? We can see that. it is a form of energy, like heat and magnetism.

We have learnt that all materials are made up of small particles called atoms. The centre of the atom is called the nucleus. The nucleus consists of protons and neurtrons. Protons are positively charged. Neutrons have no charge. Negatively charged electrons revolve around the nucleus in circular orbits. Electricity is a form of energy that is associated with electric charges that exists inside the atom



ACTIVITY 1

Comb your dry hair. Immediately after combing the dry hair, bring the comb closer to the bits of paper . what will you observe?



When you are getting up from the plastic chair , the nylon shirt seems to be stuck to the chair and make crackling sound. What is the reason for the creation of the sound?

A balloon sticks to wall without any adhesive after rubbing on your hand.

Do you know the reason for all?

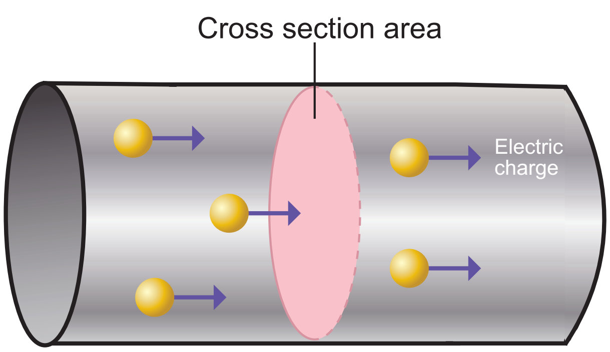
In all the above activities, when a body is rubbed against some other body become charged.

Electric charge is measured in a unit called coulomb. One unit of coulomb is charge of approximately 6.242×10^{18} protons or electrons.

Electrical charges are generally denoted by the letter `q`

2.1. Electric Current

The flow of electric charges constitute an electric current. For an electrical appliance to work, electric current must flow through it. An electric current is measured by the amount of electric charge moving per unit time at any point in the circuit. The conventional symbol for current is 'I'.



Unit of Electric Current

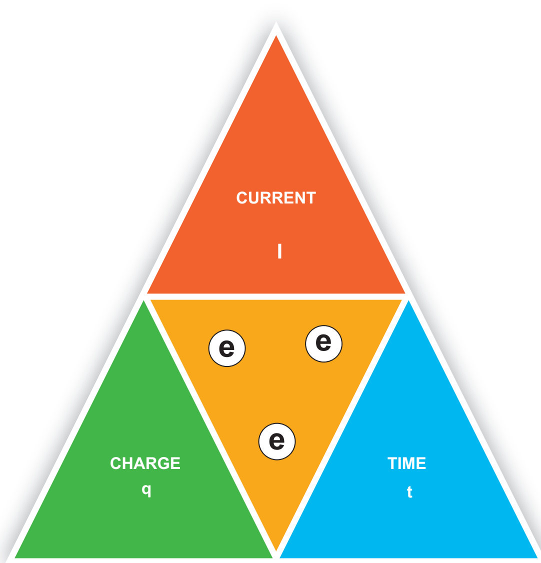
The SI unit for measuring an electric current is the ampere, which is the flow of electric charge across a surface at the rate of one coulomb per second.

$$\boxed{I = q / t}$$

Where $I \Rightarrow$ current (in Ampere - A)

$q \Rightarrow$ charge (in coulomb - c)

$t \Rightarrow$ time taken (in seconds - s)



Worked example 2.1

If 30 coulomb of electric charge flows through a wire in two minutes, calculate the current in the wire?

Solution

Given :

Charge (q) = 30 coulomb

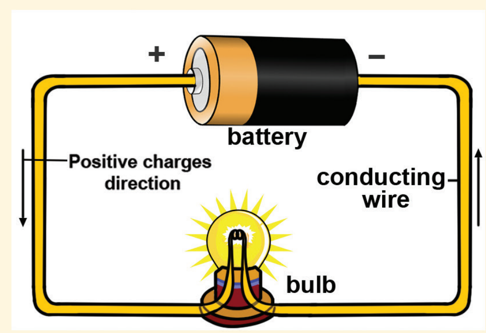
Time (t) = 2 min x 60s

= 120 s

Current I = q/t = 30C/120s = 0.25 A

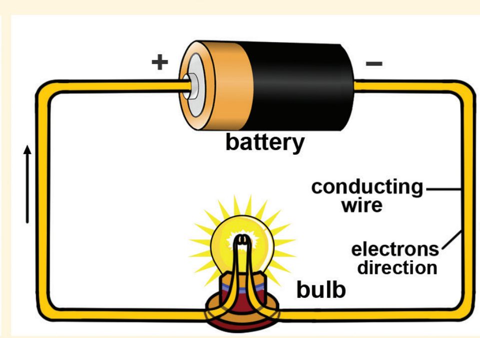
2.1.1. Conventional Current and Electron Flow

Conventional Current



Conventional current flow from the positive to the negative end

Electron Flow



Electric charges flow from the negative to the positive end

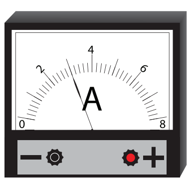
Before the discovery of electrons , scientists believed that an electric current consisted of moving positive charges.

This movement of positive charges is called conventional current.

After the electrons were discovered, it was known that electron flow actually takes place from the negative terminal to the positive terminal of the battery. This movement is known as electron flow.

Conventional current is in the direction opposite to electron flow.

2.1.2. Measurement of electric current



Electric current is measured using a device called ammeter. The terminals of an ammeter are marked with + and - sign. An ammeter must be connected in series in a circuit.

Instruments used to measure smaller currents, in the milli ampere or micro ampere range, are designated as milli ammeters or micro ammeters.

1 milliampere (mA) = 10^{-3} ampere.
= 1/1000 ampere
1 microampere (μA) = 10^{-6} ampere
= 1/1000000 ampere

Worked Examples 2.2

If 0.002A current flows through a circuit, then convert the current in terms of micro ampere?

Solution:

Given that the current flows through the circuit is 0.002A

We know that

$$1\text{ A} = 10^6\ \mu\text{A}$$

$$0.002\text{A} = 0.002 \times 10^6\ \mu\text{A}$$

$$= 2 \times 10^{-3} \times 10^6\ \mu\text{A}$$

$$= 2 \times 10^3\ \mu\text{A}$$

$$0.002\text{A} = 2000\ \mu\text{A}$$

2.2. Potential difference (v)

Electrical charges need energy to push them along a circuit.

W1B9B6

Water always flows from higher to lower ground. Similarly an electric charge always flows from a point at higher potential to a point at lower potential.

An electric current can flow only when there is a potential difference (V) or P.D.

The potential difference between any two points in the circuit is the amount of energy needed to move one unit of electric charge from one point to the other.

2.2.1. Unit of potential difference

Did you ever notice the precautionary board while crossing the railway track and the electrical transformer? What does the word high voltage denotes?

The term metioned in the board volt is the measurement for the electric potential difference.

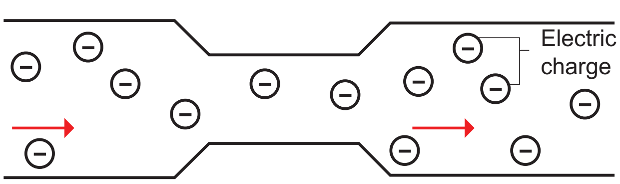
The SI unit of potential difference is volt (V). potential difference between two points is measured by using a device called voltmeter.

Water at the top of the waterfall has more potential energy

Water near the base of the waterfall has less potential energy

> The electric current flow from the higher potential level to the lower potential level is just like the water flow.

2.2.2. Electrical conductivity and Resistivity



Electrical component with resistance

Resistance (R)

An electrical component resists or hinders the flow of electric charges, when it is connected in a circuit. In a circuit component, the resistance to the flow of charge is similar to how a narrow channel resists the flow of water.

The higher the resistance in a component, the higher the potential difference needed to move electric charge through the component. We can express resistance as a ratio.

Resistance of a component is the ratio of the potential difference across it to the current flowing through it. $R = \frac{V}{I}$

The S.I unit of resistance is ohm

Greater the ratio of V to I, the greater is the resistance

Electrical conductivity (σ)

Electrical conductivity or specific conductance is the measure of a material's ability to conduct an electric current. It is commonly represented by the Greek letter σ (sigma) The S.I Unit of electrical conductivity is Siemens/meter(S/m)

Electrical resistivity (ρ)

Electrical resistivity (also known as specific electrical resistance, or volume resistivity) is a fundamental property of a material that quantifies how strongly that material opposes the flow of electric current. The SI unit of electrical resistivity is the ohm-metre (Ω.m).

Material	Resistivity (ρ) (Ω m) at 20°C	Conductivity (σ) (S/m)at 20°C
Silver	$1.59x10^{-8}$	$6.30x10^{7}$
Copper	$1.68x10^{-8}$	$5.98x10^{7}$
Annealed Copper	$1.72x10^{-8}$	$5.80\ x10^{7}$
Aluminum	$2.82x10^{-8}$	$3.5x10^{7}$

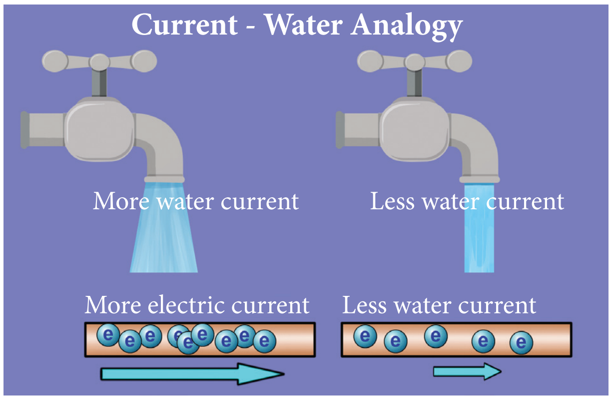
2.2.3. Analogy of Electric Current with Water Flow

An electric current is a flow of electrons through a conductor (like a copper wire). We can't see electrons, however, we can imagine the flow of electric current in a wire like the flow of water in a pipe.

Let us see the analogy of flow of electric current with the water flow.

Water flowing through pipes is pretty good mechanical system that is a lot like an electrical circuit. This mechanical system consists of a pump pushing water through a closed pipe. Imagine that the electrical current is similar to the water flowing through the pipe. The following parts of the two systems are related

- The pipe is like the wire in the electric circuit and the pump is like the battery.
- The pressure generated by the pump drives water through the pipe.
- The pressure is like the voltage generated by the battery which drives electrons through the electric circuit.
- Suppose, there are some dust and rust that plug up the pipe and slow the flow of water, creating a pressure difference from one end to the other end of the pipe. In similar way, the resistance in the electric circuit resists the flow of electrons and creates a voltage drop from one end to the other. Energy loss is shown in the form of heat across the resistor.



2.3. Sources of Electric current - Electro chemical cells or electric cells

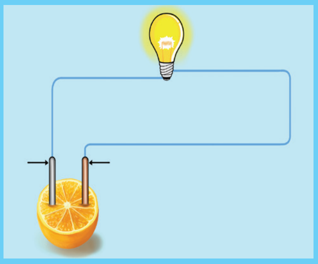
An electric cell is something that provides electricity to different devices that are not fed directly or easily by the supply of electricity.

ACTIVITY 2

Shall we produce electricity at our home?

Materials required:

Zinc and copper electrodes, a light blub, connecting wires, and fruits such as lemons, orange, apples, grapes, and bananas.



Procedure:

1. Set up a circuit as shown in figure
2. Note the brightness of the blub when the circuit is connected to a lemon.
3. Repeat the experiment using the other fruits listed above. Do you notice the differences in the brightness of the bulb when it is connected to different fruits? Which fruit gives the greatest brightness? Why? (If you do not know please get the appropriate reason from your teacher)

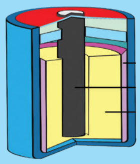
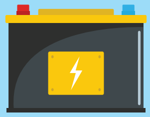
Inference:

In the above activity what makes enabled the bulb to glow. Why there is a difference in the brightness of the bulb? The reason is that the fruits which you have connected to the bulb produces the electric energy at different levels

The sources which produce the small amount of electricity for shorter periods of time is called as electric cell or electro chemical cells. Electric cell converts chemical energy into electrical energy

In addition to electro chemical, we use electro thermal source for generating electricity for large scale use.

It has two terminals. When electric cells are used, a chemical reaction takes place inside the cells which produces charge in the cell.

Primary Cell	Secondary Cell			
Dry cell	Lithium cylindrical cells	Button cells	Alkaline cells	Automobile battery
				

2.3.1. Types of cell – primary cell and secondary cell

In our daily life we are using cells and batteries for the functioning of a remote, toys cars, clock, cellphone etc. Event hough all the devices produces electrical energy, some of the cells are reusable and some of them are of single use. Do you know the reason why? Based on their type they are classified into two types namely – primary cell and secondary cell.

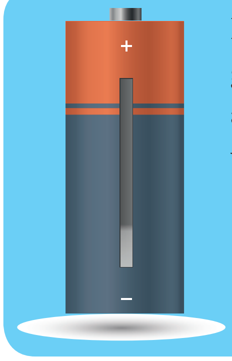
Primary cell

The dry cell commonly used in torches is an example of a primary cell. It cannot be recharged after use.

Secondary cells

Secondary cells are used in automobiles and generators. The chemical reaction in them can be reversed, hence they can be recharged. Lithium cylindrical cells, button cells and alkaline cells are the other types that are in use.

ACTIVITY 3



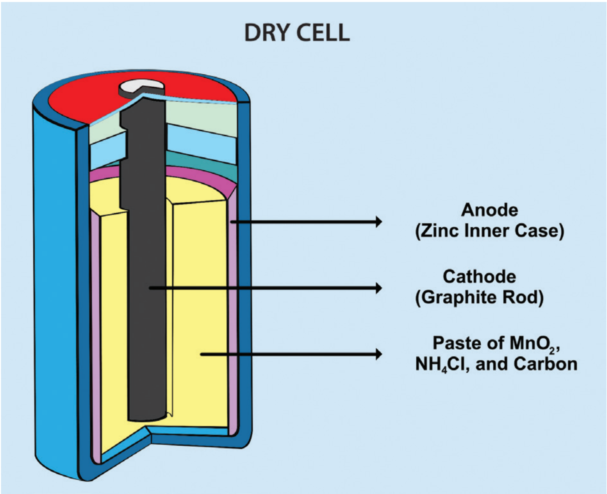
I am so exhausted. I am going to faint. What first aid will you give me to wake up?

2.3.2. Difference between primary cell and secondary cell

PRIMARY CELL	SECONDARY CELL
1. The chemical reaction inside the primary cell is irreversible	The chemical reaction inside the secondary cell is reversible
2. It cannot be recharged.	It can be recharged
3. Examples of secondary cells are lead accumulator, Edison accumulator and Nickel – Iron accumulator.	It is used to operate devices such as mobile phones, cameras, computers, and emergency lights.
4. Examples- simple voltalic cell, Daniel cell, and lechlanche cell and dry cell	Examples of secondary cells are lead accumulator, Edison accumulator and Nickel – Iron accumulator.

2.3.3. Primary cell – simply Dry cell

A dry cell is a type of chemical cell commonly used in the common form batteries for many electrical appliances. It is a convenient source of electricity available in portable and compact form. It was developed in 1887 by Yei Sakizo of Japan.



Dry cells are normaly used in small devices such as remote control for T.V., torch, camera and toys.

A dry cell is a portable form of a leclanche cell. It consists of zinc vessel which acts as a negative electrode or anode. The vessel contains a moist paste of saw dust saturated with a solution of ammonium chloride and zinc chloride.

The ammonium chloride acts as an electrolyte.

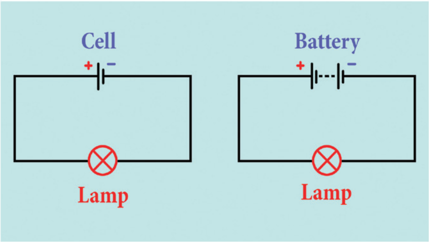
Electrolytes are substances that become ions in solution and acquire the capacity to conduct electricity.

The purpose of zinc chloride is to maintain the moistness of the paste being highly hygroscopic. The carbon rod covered with a brass cap is placed in the middle of the vessel. It acts as positive electrode or cathode.

It is surrounded by a closely packed mixture of charcoal and manganese dioxide (MnO_2) in a muslin bag. Here MnO_2 acts as depolarizer. The zinc vessel is sealed at the top with pitch or shellac. A small hole is provided in it to allow the gases formed by the chemical action to escape. The chemical action inside the cell is the same as in leclanche cell.

The dry cell is not really dry in nature but the quantity of water in it is very small, as the electrolyte is in the from of a paste. In other cells, the electrolyte is usually a solution

2.3.4. Batteries



Batteries are a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit. All batteries are made up of three basic components: an anode (the '+' side), a cathode (the '–' side), and some kind of electrolyte. Electrolyte is a substance that chemically reacts with the anode and cathode.

2.3.5. Invention of the Battery

One fateful day in 1780, Italian physicist, physician, biologist, and philosopher, Luigi Galvani, was dissecting a frog attached to a brass hook. As he touched the frog's leg with an iron scapel, the leg twitched.

Galvani theorized that the energy came from the leg itself, but his fellow scientist, Alessandro Volta, believed otherwise.

Volta hypothesized that the frog's leg impulses were actually caused by different metals soaked in a liquid.

He repeated the experiment using cloth soaked in brine instead of a frog corpse, which resulted in a similar voltage. Volta published his findings in 1791 and later created the first battery, the voltaic pile, in 1800.

The invention of the modern battery is often attributed to Alessandro Volta. It actually started with a surprising accident involving the dissection of a frog.

2.4. ELECTRIC SWITCH

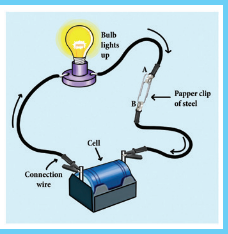
Our country faces a shortage of electricity. So wastage of electricity means you are depriving someone else of electricity. Your electricity bill goes up. So, we must use electricity very carefully and only when it is needed. We must use the electricity as long as we need it in our house hold activities.

Can you remember what you did last year to turn the current on or off?

This time, we shall use a switch to turn the current on or off. You may have used different kinds of switches to turn your household electric appliances on or off. Switches help us to start or stop the appliances safely and easily.

ACTIVITY 4

Make your own switch

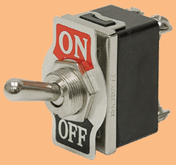
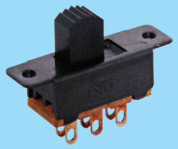


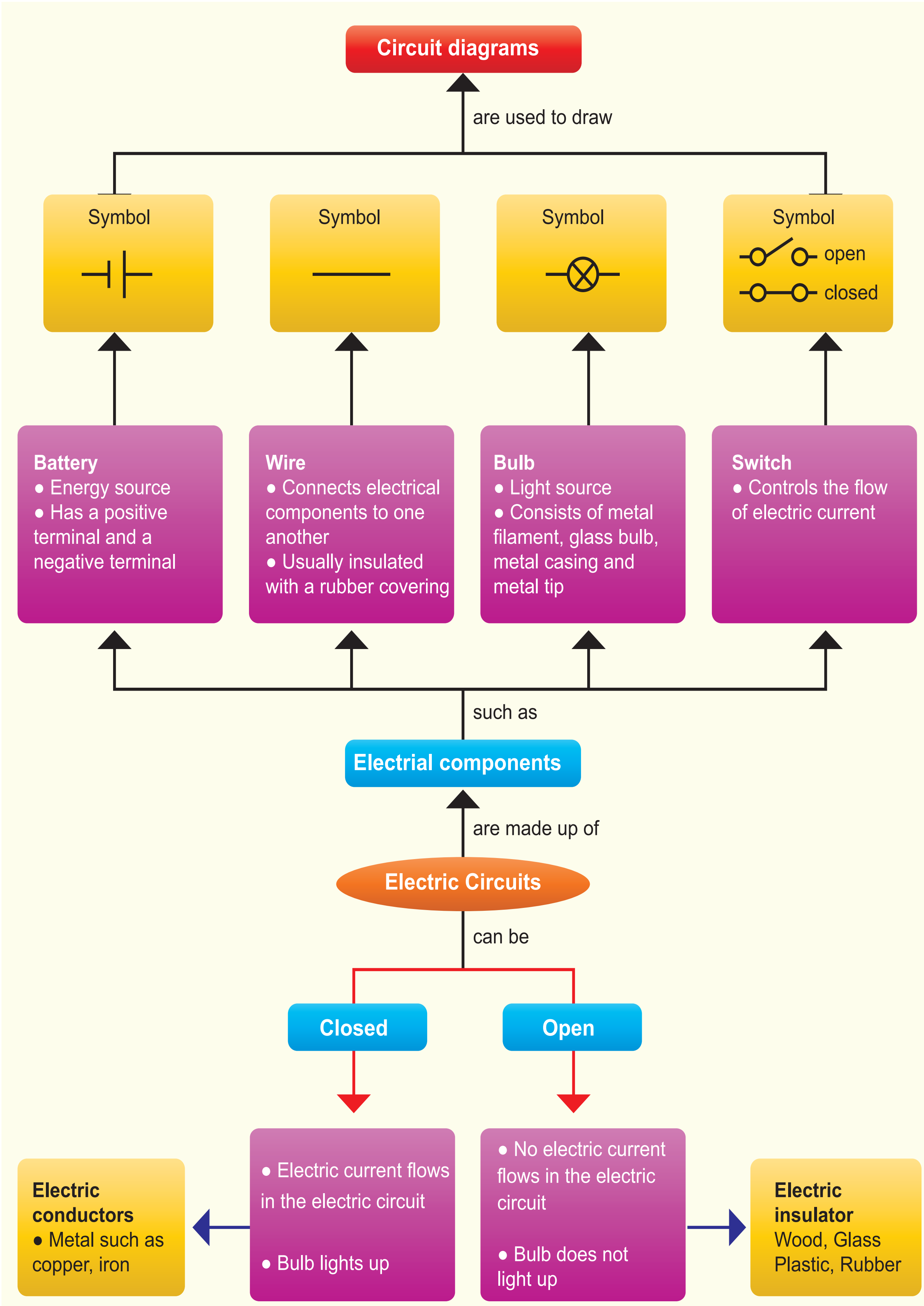
Let us make a switch of our circuits. Take 10 cm – long iron strip. Bend it twice as shown in figure. Now drive a nail into the bend of the wooden block. Nail one end of the strip to the other end of the wooden block so that its free end rests just above the first nail without touching it. Your switch is ready.

Would you like to test your switch? To do so, first set up the circuit as shown in the figure.

How would you use the switch to open or close the circuit.

If the bulb in your circuit glows when the metal strip of your switch is pressed on the nail and turns off when it is not, then your switch is working. The switch you made is a simple one. You may have seen many different types of switches on switchboards and appliances at your home and school. The switches are designed according to their usage, convenience and safety. But all of them work on the same principle. Switch is a mechanical component that consists of two or more terminals that are internally connected to a metal strip. Commonly used switches are listed below:

Tapping key		**Toggle switch**		**Illuminated switch**	
Plug key		**Rocker switch**		**Slide switch**	



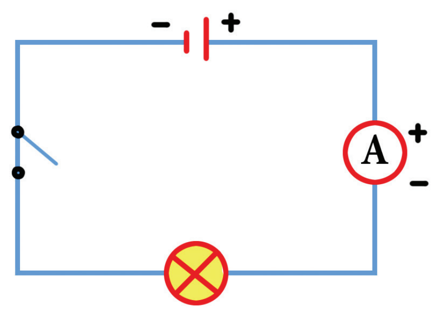
Circuit diagrams
are used to draw
Symbol
Symbol
Symbol
Symbol
open
closed
Battery
● Energy source
● Has a positive terminal and a negative terminal
Wire
● Connects electrical components to one another
● Usually insulated with a rubber covering
Bulb
● Light source
● Consists of metal filament, glass bulb, metal casing and metal tip
Switch
● Controls the flow of electric current
such as
Electrial components
are made up of
Electric Circuits
can be
Closed
Open
● Electric current flows in the electric circuit
● Bulb lights up
● No electric current flows in the electric circuit
● Bulb does not light up
Electric conductors
● Metal such as copper, iron
Electric insulator
Wood, Glass
Plastic, Rubber

2.5. Electric circuit

It is difficult to draw a realistic diagram of this circuit. The electrical appliances you use at home have even more difficult circuits. Can you draw realistic diagrams of such circuits which contain many bulbs, cells, switches and other components? Do you think it is easy? It is not easy.

Scientists have tried to make the job easier. They have adopted simple symbols for different components in a circuit. We can draw circuit diagrams using these symbols.

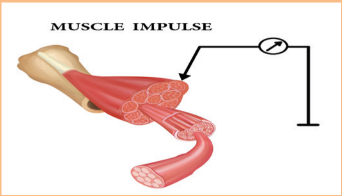
Symbols for bulbs, cells and switches are shown in figure.

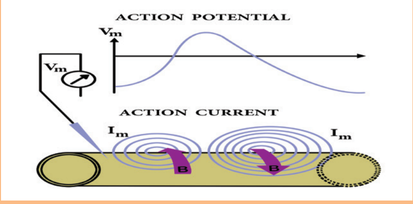


In a cell, the longer line denotes the positive (+) terminal and the short line denotes the negative (-) terminal. We shall use these symbols to show components in the circuits we draw. Such diagrams are called circuit diagrams.

DO YOU KNOW?

All muscles of our bodies move in response to electrical impulses generated naturally in our bodies





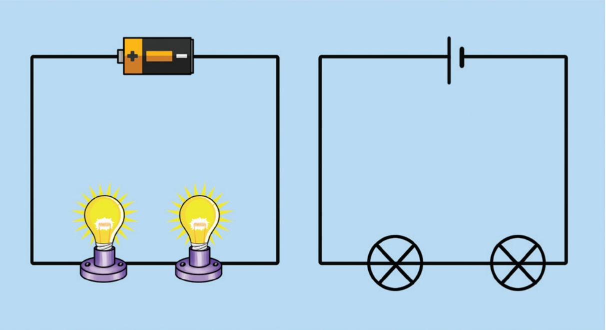
2.5.1. Types of electrical circuits

In the above experiment, we make a circuit with a bulb and a cell. We make only one kind of the circuit with a cell and a bulb. But we can make many types of circuits if we have more than one bulb or cells by connecting these components in different ways .

2.5.2. Series circuit

Two kinds of circuits can be made with two bulbs and a cell. In this experiment we shall make one of them and study it.

Look at the circuit with two bulbs, and a cell and a switch given here (Figure)



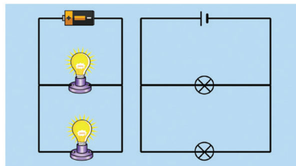
It is clear from the circuit diagram, that the two bulbs are connected one after the other. The circuit diagram shows the sequence of the bulbs and cell, not their real position. The way in which the bulbs have been connected in this circuit is called series connection.

Now make the circuit by joining the two bulbs and cell. Do both the bulbs light up? Do both glow equally bright? If one glows less bright, will it shine more brightly if we change its place in the sequence? Change the sequence of bulbs and notice.

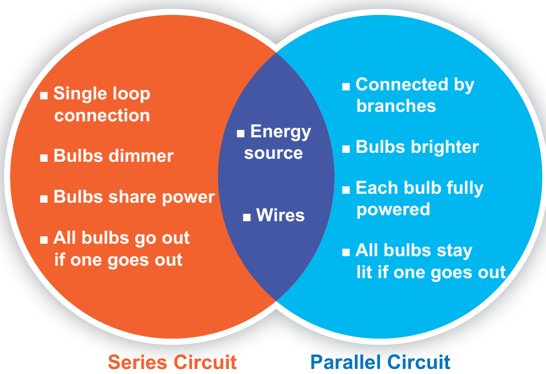
Sometimes bulbs appear to be similar can differ from each other. So, similar looking bulb do not always glow equally bright when connected in series. The circuit can be broken at several places. For example, between the cell and the bulb, between the two bulbs etc.

2.5.3 Parallel Circuit

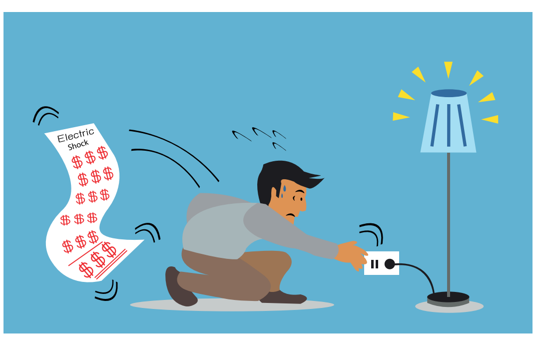
Figure - shows a circuit in which two bulbs are connected in different places. This is a second type of circuit. Two bulbs in this circuit are said to be connected in parallel and such circuits are called parallel circuits.



2.5.4. Similarity and Difference between Series and Parallel Circuit



Science to mind pricking



If an electrician attending an electrical fault at your home gets current shock, will you touch him in order to get rid off him from current risk? Will you use the wet stick to beat him to avoid further effects of electric shock?

Why do the electric line man are wear rubber gloves in their hands while doing electrical works on a electrical pole?

We know that all materials are made up of the basic building block, the 'atom'. An atom, in turn, contains electrically charged particles. Many of these particles are fixed to the atoms but in conductors (such as all metals) there are lots of particles that are not held to any particular atom but are free to wander around randomly in the metal. These are called 'free charge'.

DO YOU KNOW?

Short circuit

You might have observed the spark in the electric pole located nearby your house. Do you know the cause of this electric spark? This is due to the short circuiting of electricity along its path. A short circuit is simply a low resistance connection between the two conductors supplying electrical power to any circuit. Arc welding is a common example of the practical application of the heating due to a short circuit.

2.6. Conductors And Insulators

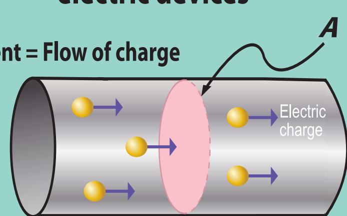
Based on the property of conductance of electricity, substances are classified into two types, namely, Conductors and Insulators (or) bad conductors of electricity

T8Y1E1

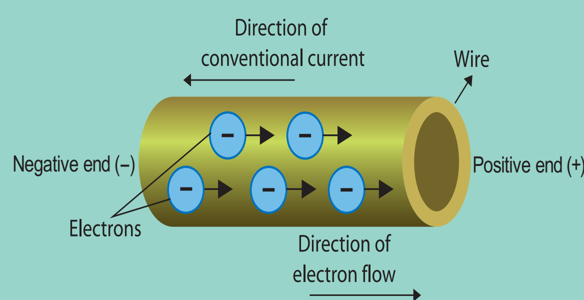
The electrons of different types of atoms have different degrees of freedom to move around. With some types of materials, such as metals, the outermost electrons in the atoms are loosely bound and they chaotically move in the space between the atoms of that material. Because these virtually unbound electrons are free to leave their respective atoms and float around in the space between adjacent atoms, they are often called as free electrons.

Electricity

Electric current is the flow of electric charges, typically through wires, conductors and electric devices



Conventional current and Electric current



Conventional current

Conventional current flow is from positive (`+`) to negative (`-`)

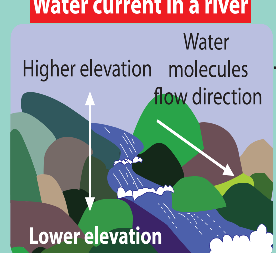
Electric current

Electric current flow is from (`-`)negative to (`+`) positive

Electric current I = Q/t

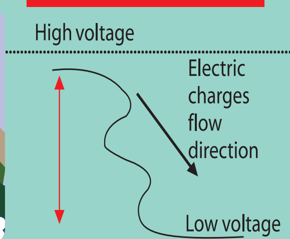
Water current vs electric current - Analogy

Water current in a river



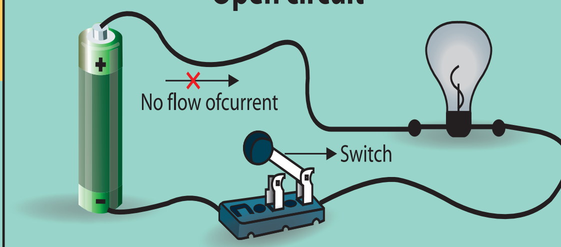
water molecules flow towards a point of lower elevation

Electric current in a wire



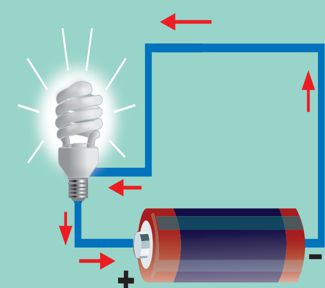
Electric charges flow towards a point of lower voltage

Open circuit



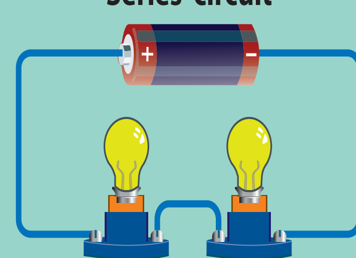
An incomplete electrical circuit in which no current flows

Closed circuit



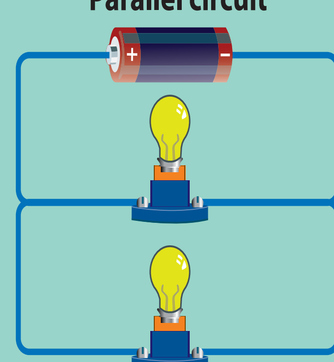
An electric circuit providing an uninterrupted endless path for the flow of current

Series circuit



Circuit that has only one closed path through which the electric current flows

Parallel circuit



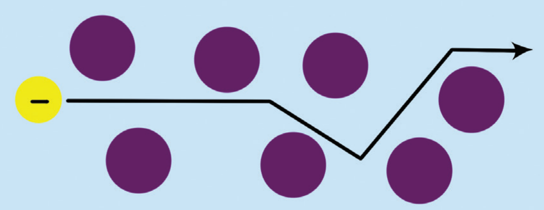
Circuit that Offers more than one path for the flow of electric current

Let's imagine that we have a metal in the form of a wire. When a voltage is connected across the ends of the metal wire, the free electrons drift in one direction.

So, a really good conductor is one that has lots of free charges while those who don't have enough 'free charges' would not be good at conducting electricity or we can say that they would be 'poor conductors' of electricity.

2.6.1. Conductors

Conductors are the materials whose atoms have electrons that are loosely bound and are free to move through the material. A material that is a good conductor gives very little resistance to the flow of charge (electron) on the application of external voltage. This flow of charge (electron) is what constitutes an electric current. A good conductor has high electrical conductivity in the above activity.

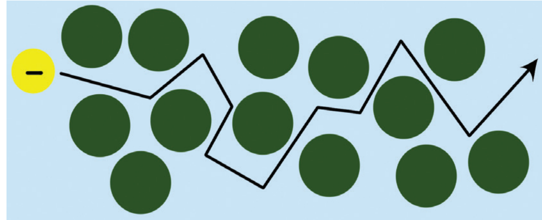


Conductors offer less resistance to electons

In general, more the free electrons, the better the material will conduct (for a certain applied voltage).

2.6.2. Insulators

Those materials which don't have enough 'free electrons' are not good at conducting electricity or we can say that they would be 'poor conductors' of electricity and they are called insulators.

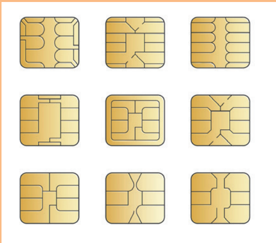


Insulators which gives very high resistance

DO YOU KNOW?

This is the material used in SIM Cards, Computers, and ATM cards. Do you know by which material I am made up off?

The chip which are used in SIM Cards, Computers, and ATM cards are made up of semiconductors namely, silicon and germanium because of their electrical conductivity lies between a conductor and an insulator.



An insulator gives a lot of resistance to the flow of charge (electron). During the drift of the electrons in an object when an external voltage is applied, collisions occur between the free electrons and the atoms of the material also affect the movement of charges. These collisions mean that they get scattered. It is a combination of the number of free electrons and how much they are scattered that affects how well the metal conducts electricity. The rubber eraser does not allow electric current to pass through it. So rubber is a non-conductor of electricity. Rubber is an insulator

Most of the metals are good conductors of electricity while most of the non-metals are poor conductors of electricity.

DO YOU KNOW?

Wires made of copper, an electrical conductor, have very low resistance. Copper wires are used to carry current in households. These wires are in turn enclosed in electrical insulators, or materials of high electrical resistance. These materials are usually made of flexible plastic.

2.7.Effects of Electric Current

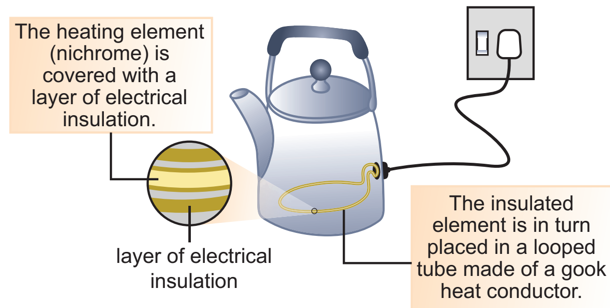
X4Z4Z6

You performed many experiments with electricity in Class 6 and learned quite a few interesting facts. For example, you saw that a bulb can be made to light up by making electricity flow through it. The light of the bulb is thus one of the effects of electricity. There are several other important effects of electricity. We shall study some of these effects in this chapter. There are 3 main effects of electricity as,

- Heating effect
- Magnetic effect (Magnetism)
- Chemical effect

2.7.1.Heating effect

When an electric current passes through a wire, the electrical energy is converted to hear. In heating appliances, the heating element is made up of materials with high melting point. An example of such a material is nichrome (an alloy of nickel, iron and chromium).



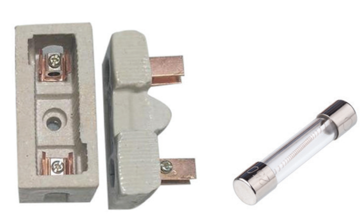
The heating effect of electric current has many practical applications. The electric bulb, geyser, iron box, immersible water heater are based on this effect. These appliances have heating coils of high resistance.

Generation of heat due to electric current is known as the heating effect of electricity.

Factors affecting Heating Effect of current

1. Electric Current
2. Resistance
3. Time for which current flows

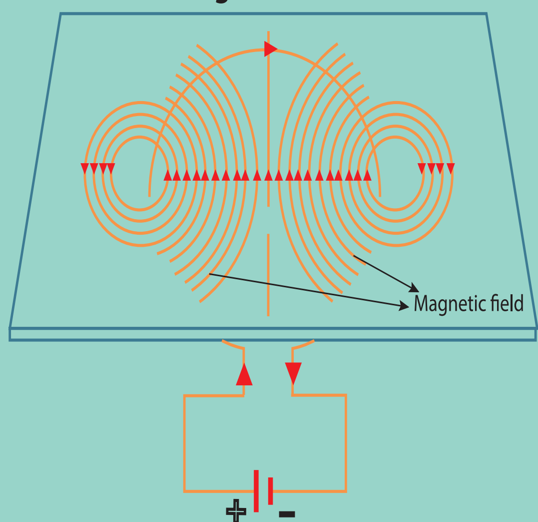
Electric Fuse



Electric fuse is a safety device which is used in household wiring and in many appliances. Electric fuse has a body made of ceramic and two points for connecting the fuse wire. The fuse wire melts whenever there is overload of the current in the wire. This breaks the circuit and helps in preventing damage to costly appliances and to the wiring. In electrical devices, a glass fuse is often used. This is a small glass tube, in which lies the fuse wire.

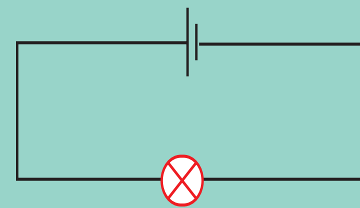
Effects of Electric current

Magnetic effect



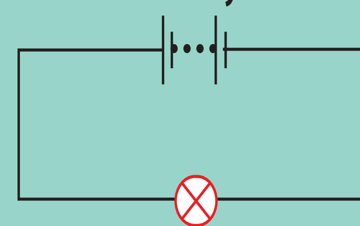
Production of magnetic field when the current flows through the coil of wire

Cell



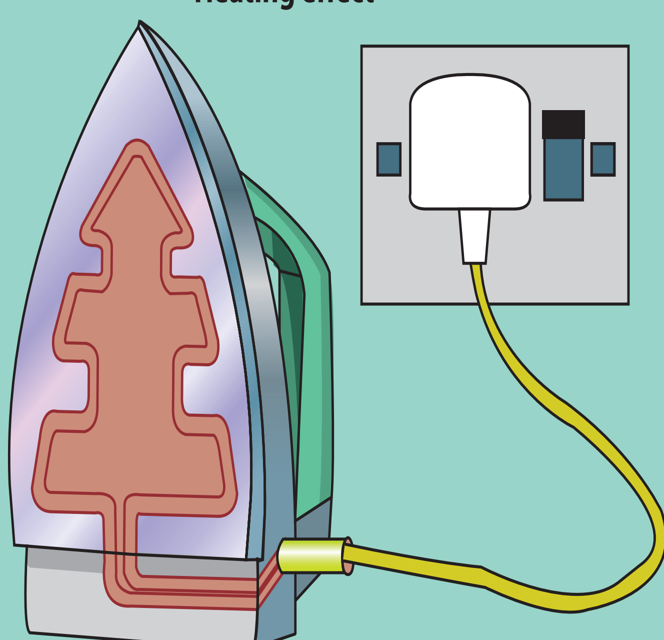
Cell is the basic electrochemical unit that converts chemical energy into electrical energy

Battery



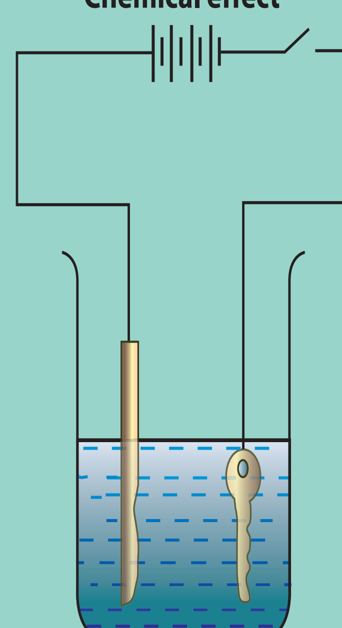
Baterry is a group of cells

Heating effect



Prodction of heat by flow of electric current in a circuit

Chemical effect



Chemical reaction happens when electricity passes through various conducting liquids

VII Std Science Term-2 EM Unit 2 Folder.indd 27

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MCBs (Miniature Circuit Breaker)

MCBs have been replacing electric fuse from wirings at most of the places. The electric fuse has a big practical problem. Whenever the wire fuses, one needs to replace the wire to resume electric supply. More often than not, this proves to be a cumbersome task. Miniature circuit breakers break the circuit automatically. One just needs to switch it on to resume the electric supply. Many models of MCBs have a built in mechanism by which the electric supply is automatically resumed.

2.8. Magnetic Effect of electricity

The next effect of electric current is Magnetism. In 1819, Hans Christian Oersted discovered the electricity that has a magnetic effect. The experiment in activity-5 will help you understand the magnetic effect of electric current.

2.8.1. Application of magnetic effect of electric current - Electromagnet

Magnetic effect of electric current has been used in making powerful electromagnets. Electromagnets are also used to remove splinters of steel or iron in hospitals dealing with eye injuries.

Electro magnets are used in many appliances that we use in our day to day life, namely, electric bell, cranes and telephone. Let us know how the magnetic effect of electric current is applied in telephones.

ACTIVITY 5

Materials required

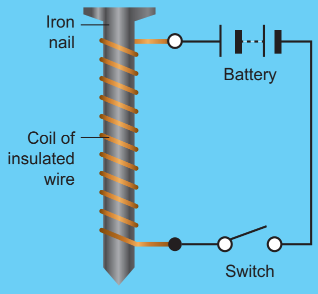
- Iron nail
- Battery & Switch
- Wire

Take around 75 cm long piece of insulated flexible wire and an iron nail say about 8 - 10 cm long. Wind the wire tightly around the nail in the form of a coil. Connect the free ends of the wire to the terminals of a cell as shown. Place some pins on or near the end of the nail. Now switch on and switch off the current, What happens?

When the switch is kept in on position the pins starts to cling to the end of the nail.

When the electric current is switched off the coil generally loses its magnetism. Such coils are called as electromagnets.

The polarities of both ends of the coil changes according to the direction of electric current passes.



2.8.2. Telephone

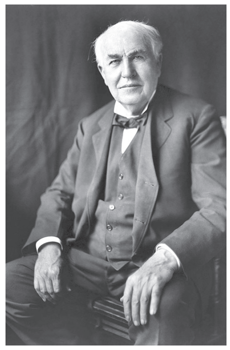
In telephones, a changing magnetic effect causes a thin sheet of metal (diaphragm) to vibrate. The diaphragm is made up a metal that can be attracted to magnets.

1. The diaphragm is attached to spring that is fixed to the earpiece.
2. When a current flows through the wires, the soft – iron bar becomes an electromagnet.

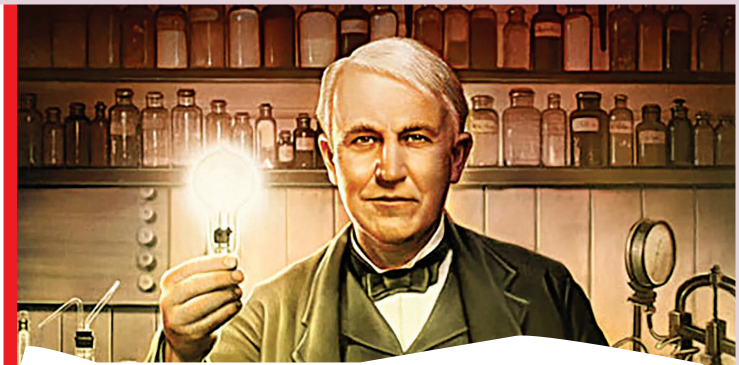
The world comes to brightness

Thomas Alva Edison (1847-1931)

Thomas Alva Edison was affected by scarlet fever and hence he joined the school at Fort Huron in America only at the age of eight.



He invented an advanced instrument Gramophone in 1877.



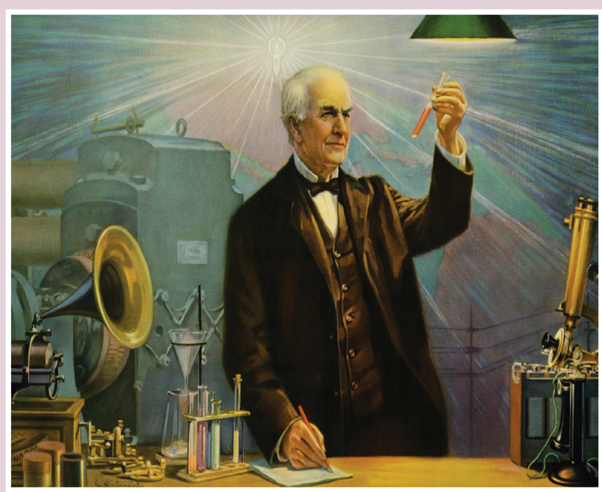
He used a platinum wire coil in a vacuum glass and discovered the first electric bulb in 1879.

Thomas Alva Edison invented a commercially viable electric bulb. This was exhibited in 1897

By using mechanical power in a battery, electric power was generated by providing the voltage. Edison proved that voltage is given in the ends of battery. The same was transferred into an electric motor which provided mechanical energy.

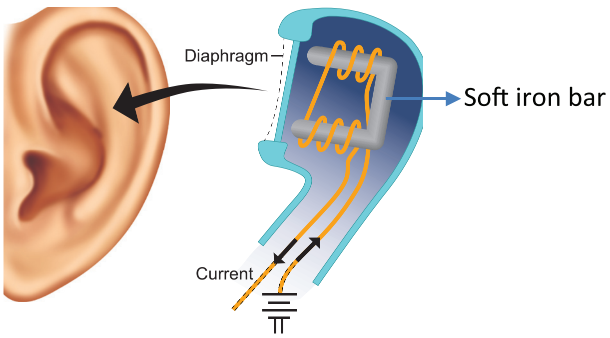
By extending Kinetoscope into 50 feet film strip, he made first talkie film by using electric motor and magnifying glass in 1891.

As a mark of respect to Edison on his death, the light of “Statue of Liberty” in New York was turned off. Except the road lights of Chicago and Broadway, all the lights in the city were turned off.



Edison was an American Scientist and Industrialist. He invented many instruments like Electric bulb, electric motor, gramophone and kinetoscope. He was known as for taking the world of darkness to brightness crossing all the obstacles in life.

3. The diaphragm becomes attracted to the electromagnet.
4. As the person on the other end of the line speaks, his voice cause the current in the circuit to change. This causes the diaphragm in the earpiece to vibrate, producing sound.



2.9. Chemical Effects of Electricity

Chemical reactions happens, when electricity passes through various conducting liquids. This is known as chemical effects of electricity. You will learn chemical effect of electricity in your higher classes.

POINTS TO REMEMBER

- ❖ An electric current is a flow of electric charge or the amount of charge flowing through a given cross section of a material in unit time.
- ❖ Conventional current is in the direction opposite to electron flow.
- ❖ One ampere is defined as the flow of electric charge across a surface at the rate of one coulomb per second.
- ❖ An electric cell is something that provides electricity to different devices that are not fed directly or easily by the supply of electricity
- ❖ A dry cell is a portable form of a leclanche cell
- ❖ Batteries are a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit
- ❖ The cell is the basic single electrochemical unit which converts chemical energy to electrical energy.
- ❖ Ammeter — An instrument for measuring the flow of electrical current in amperes. Ammeters are always connected in series with the circuit to be tested.
- ❖ Ampere (A) — A unit of measure for the intensity of an electric current flowing in a circuit. One ampere is equal to a current flow of one coulomb per second.
- ❖ Circuit — A closed path in which electrons from a voltage or current source flow. Circuits can be in series, parallel, or in any combination of the two.
- ❖ Current (I) — The flow of an electric charge through a conductor. An electric current can be compared to the flow of water in a pipe. Measured in ampere.
- ❖ Fuse — A circuit interrupting device consisting of a strip of wire that melts and breaks an electric circuit if the current exceeds a safe level.
- ❖ Conductor — Any material where electric current can flow freely. Conductive materials, such as metals, have a relatively low resistance. Copper and aluminum wire are the most common conductors
- ❖ Insulator — Any material where electric current does not flow freely. Insulation materials, such as glass, rubber, air, and many plastics have a relatively high resistance. Insulators protect equipment and life from electric shock.

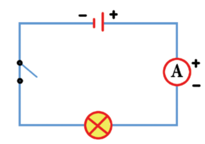
- Parallel Circuit — A circuit in which there are multiple paths for electricity to flow. Each load connected in a separate path receives the full circuit voltage, and the total circuit current is equal to the sum of the individual branch currents.
- Series Circuit — A circuit in which there is only one path for electricity to flow. All of the current in the circuit must flow through all of the loads.
- Short Circuit — When one part of an electric circuit comes in contact with another part of the same circuit, diverting the flow of current from its desired path.
- One unit of coulomb is charge of approximately 6.242×10^{18} protons or electrons.
- The potential difference between any two points is the amount of energy needed to move one unit of electric charge from one point to the other.
- Electrical conductivity or specific conductance is the measures a material's ability to conduct an electric current
- Electrical resistivity is the property of a material that quantifies how strongly that material opposes the flow of electric current.
- The sources which produce the small amount of electricity for shorter periods of time is called as electric cell or electro chemical cells.
- Electrolytes : A substance that dissociates into ions in solution and acquires the capacity to conduct electricity. Sodium, potassium, chloride, calcium, and phosphate are examples of electrolytes.

EVALUATION

I. Choose the correct answers

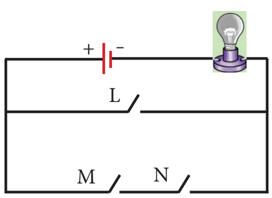
M6Z8D1

1. In the circuit diagram below, 10 units of electric charge move past point x every second What is the current in the circuit ------------------------



   a) 10 A b) 1 A
   c) 10 V d) 1 V

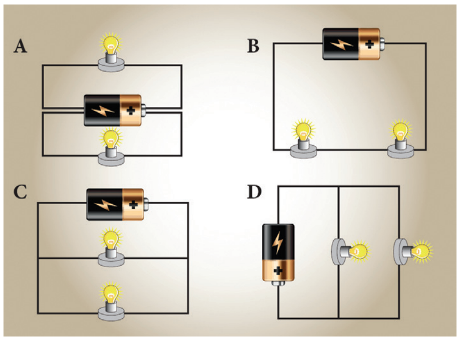
2. In the circuit shown, which switches (L,M or N) must be closed to light up the bulb?



   a) switch L only
   b) switch M only
   c) Switch M and N only
   d) either switch L or switches M and N

3. Small amounts of electrical current are measured in milliampere (mA). How many milliampere are there in 0.25 A ?
   a) 2.5 mA b) 25 mA
   c) 250 mA d) 2500 mA

4. In which of the following circuits are the bulb connected in series?



II. Fill in the blanks.

1. The direction of conventional current is ----------------- to electron flow.

2. One unit of coulomb is charge of approximately ----------------- protons or electrons.
3. ----------------- is used to measure the electric current.
4. In conducting materials electrons are ----------------- bounded with atoms.
5. S.I. unit of Electrical conductivity of a conductor is --------------------

III. True or False – If False give the correct answer

1. Electron flow is in the same direction to conventional current flow.
2. The fuse wire does not melts whenever there is overload in the wiring.
3. In a parallel circuit, the electric components are divided into branches.
4. The representation of the electric current is A.
5. The electrical conductivity of the semiconductor is in between a conductor and an insulator.

IV. Match the following

1.	Cell	-	used to open or close a circuit
2.	Switch	-	safety device used in electric circuit
3.	Circuit	-	A complete path for the flow of an electric current
4.	Miniature circuit Breaker	-	Reset by hand, circuit becomes complete once again
5.	Fuse	-	A device which converts chemical energy into electrical energy

V. Analogy

1. Water : pipe :: Electric current :-------------
2. Copper : conductor :: Wood : ---------------
3. Length : metre scale :: Current : ------------
4. milli ampere: micro ampere :: 10^{-3}A : ------

VI. Assertion and Reason

1. Assertion (A) : Copper is used to make electric wires.

   Reason (R) : Copper has very low electrical resistance.

   Option:

   A. Both A and R are true and R is the correct explanation of A.

   B. Both A and R are true but R is NOT the correct explanation of A.

   C. A is true but R is false.

   D. A is false but R is true.

   E. Both A and R are false

2. Assertion (A): Insulators do not allow the flow of current through themselves.

   Reason (R) : They have no free charge carriers.

   A. If both A and R are true and the R is correct explanation of A.

   B. If both A and R are true but R is not a correct explanation of A.

   C. If A is true and R is false.

   D. If both A and R are false.

VII. Very short answer

1. What is the speed of electric current?
2. What is the S.I unit of electrical conductivity?
3. Name the device used to generate electricity.
4. Define fuse.
5. Name some devices that run using heat effect of electric current
6. Name few insulators.
7. What is a battery?

VIII. Short Answer

1. Define an electric current.
2. Differentiate parallel and serial circuits.
3. Define electrical conductivity.

IX. Long Answer

1. Explain the construction and working of an Telephone.
2. Explain the heating effect of electric current.
3. Explain the construction and working of a dry cell.

X. Higher Order Question

A student made a circuit by using an electric cell, a switch, a torch bulb (fitted in the bulb holder) and copper connecting wires. When he turned on the switch, the torch bulb did not glow at all. The student checked the circuit and found that all the wire connections were tight.

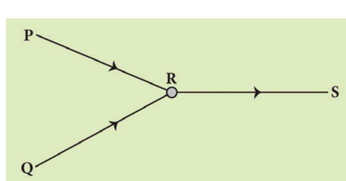
- ❖ What could be the possible reason for the torch bulb not glowing even when the circuit appears to be complete?

XI Picture based Questions

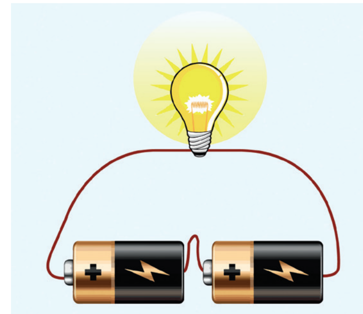
1. Three conductors are joined as shown in the diagram

The current in conductor RS is 10 A. The current in conductor QR is 6 A. What will be the current in conductor PR

a) 4 A
b) 6 A
c) 10 A
d) 16 A

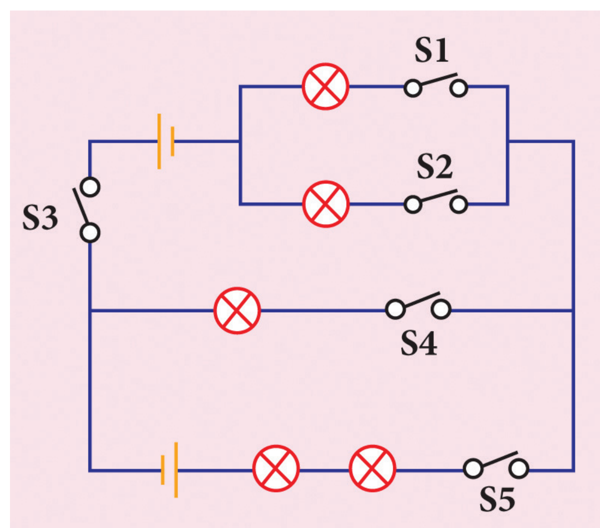


2. Draw the circuit diagram for the following series connection



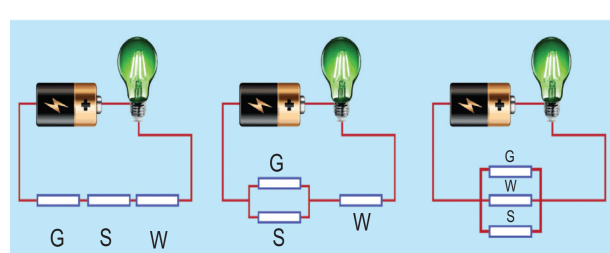
3. Study the electric circuit below. Which of the following switches should be closed so that only two bulbs will light up

a) S1,S2 and S4 only
b) S1, S3 and S5 only
c) S2, S3 and S4 ony
d) S2, S3 and S5 only



4. Study the three electric circuits below. Each of them has a glass rod (G), a steel rod (S), and a wooden rod (W).
In which of the electric circuits would the bulb not light up .

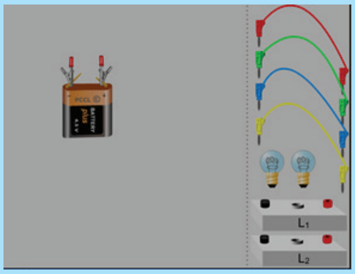
a) A only b) C only
c) A and B only d) A , B and C



ICT CORNER

ELECTRICITY

This activity helps the students to understand about the Parrellel and series circuit

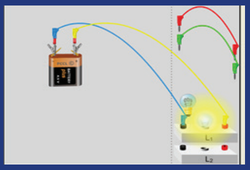


PROCEDURE :

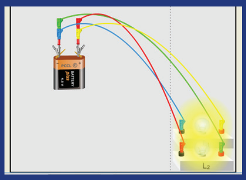
Step 1: Type the URL link given below in the browser or scan the QR code. A page opens with a battery , some cables, two sets for circuit and two bulbs.

Step 2: Ask the students to fix the wires to the battery and the circuit

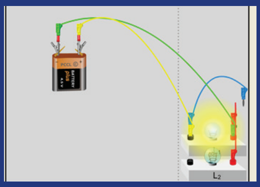
Step 3: Let the students do it and understand the concept with different combinations



Step 1



Step 2



Step 3

Electricity URL:

http://www.physics-chemistry-interactive-flash-animation.com/electricity_electromagnetism_interactive/components_circuits_association-series_parallel.htm

*Pictures are indicative only

*If browser requires, allow Flash Player or Java Script to load the page.

B351_7_SCIENCE_EM

UNIT 1

MEASUREMENT

XDED2K

Learning Objectives

At the end of this lesson, students will be able to:

- Understand SI units, base quantities and base units.
- Explain the system of units and measurements.
- Analyze the different system of units.
- Know about temperature, amount of substance, electric current and luminous intensity.
- Explore the knowledge of accuracy in measurements.
- Difference between the plane angle and solid angle, different clocks.
- Solve the numerical problems.

Introduction

Physics is the study of nature and natural phenomena. Physics is considered as the base of all science subjects. Physics is based on experimental observations. The principles and observations allow us to develop a deeper understanding of nature. Scientific theories are valid, only if they are confirmed through various experiments.

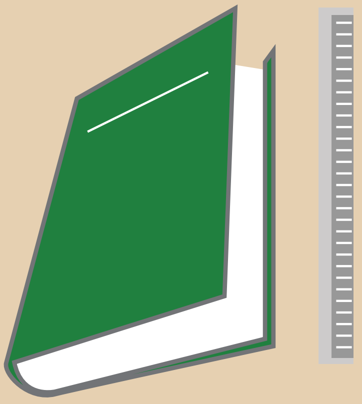
Theories in physics use many physical quantities that have to be measured.

Measurement is the base of all scientific studies and experimentations. It plays a vital role in our daily life. Measurement is the process of finding an unknown physical quantity by using a standard quantity.

We need three things for a perfect measurement. They are (i) an instrument, (ii) a standard quantity and (iii) an acceptable unit.

Activity 1

Students are asked to measure the length and breadth of their science book using a ruler (scale) and compare their measurement with those of their friends.



In this activity, let the length of the book be 15 cm, the length is the physical quantity, ruler is the 'instrument', 15 is the 'magnitude' and 'cm' is the unit. This process is called "Measurement".

Here, all the students will not get the same value. Thus, one can infer that there may be an error while taking the measurement. This lesson helps us to get a better understanding of measurements.

1.1 System of Units

People in various part of the world are using different systems of units for measurement. Some common systems of units are :

1. FPS - System (Foot for length, Pound for mass and Second for time)
2. CGS -System (Centimetre for length, Gram for mass and Second for time)
3. MKS - System (Metre for length, Kilogram for mass and Second for time)

DO YOU KNOW?

The 'CGS', 'MKS' and SI units are metric systems of units and 'FPS' is not an metric system. It is a British system of units.

1.1.1 International System of Units

In earlier days, scientists performed their experiments and recorded their results in their own system. Due to lack of communication, they couldn't organize other's experimental results. So, the scientists planned to follow a uniform system for taking the measurements.

As you studied in the lower classes, in 1960, in the 11th General Conference on Weights and Measures at Paris in France, the scientists recognized the need of using standard units for physical quantities. That was called as "International System of Units" and is popularly known as SI System (abbreviated from the French name 'Systeme International'). The scientists chose seven physical quantities as 'Base Quantities' and defined a 'Standard Unit' to measure each one. They are known as Base Units or Fundamental Units (Table 1.1)

1.1.2 SI Base Units

Table: 1.1 Base Quantities and Units

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

You have already studied about Length, Mass and Time in the lower classes. So, now you are going to study about the other base quantities such as temperature, current, amount of substance and luminous intensity.

DO YOU KNOW?

In December 1998, the National Aeronautics and Space Administration (NASA), USA launched the Mars Climate Orbiter to collect the data of the Martian climate. Nine months later, on September 23, 1999, the Orbiter disappeared while approaching Mars at an unexpectedly low altitude. An investigation revealed that the orbital calculations were incorrect due to an error in the transfer of information between the spacecraft's team in Colorado and the mission navigation team in California. One team was using the English FPS system of units for calculation, while the other group was using the MKS system of units. This misunderstanding caused a loss of approximately 125 million dollars.

1.2 Temperature

Identify, which of these objects are hot or cold? (Fig 1.1)


(a)


(b)


(c)


(d)

Fig 1.1 - Various Hot and Cold Objects

You can see that some objects are cold, and some are hot. You also know that, some objects are hotter than others while some of them are colder than others.

How do you decide, which is hotter and which is colder? So, you need a reliable quantity to decide the degree of hotness or coldness of an object. That quantity is 'temperature'.

Temperature is a physical quantity that expresses the degree of hotness or coldness of a substance. Heat given to a substance will increase its temperature. Heat removed from a substance will lower its temperature.

1.2.1 Definition

Temperature is a measure of the average kinetic energy of the particles in a system.

The SI unit of Temperature is kelvin. 'Thermometers' are used to measure temperature directly.

Usually, thermometers are calibrated with some standard scales. Celsius, Fahrenheit, Kelvin are the most commonly used scales to measure Temperature.

In these thermometers, melting point of pure ice (0°C) is taken as Lower Fixed Point (LFP) and Boiling point of water (100°C) is taken as Upper Fixed Point (UFP).

Table : 1.2 Various Scales to measure Temperature

Types of Scale	Lower Fixed Point (LFP)	Upper Fixed Point (UFP)	No. of divisions in thermometer
Celsius	0° C	100° C	100
Fahrenheit	32° F	212° F	180
Kelvin	273 K	373 K	100

Activity 2

Measure the room temperature inside the class room and outside the class room by using a thermometer and tabulate it with different time intervals for a week. Do you find any differences in these values? Discuss your observations.

Day	10:00 a.m.		12:00 p.m.		2:00 p.m.		4:00 p.m.	
	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside
Day-1								
Day-2								
Day-3								
Day-4								
Day-5								

1.2.2 Conversion of Scales of Temperatures

The general formula for the conversion of scales of temperature is:

$$\frac{C-0}{100} = \frac{F-32}{180} = \frac{K-273}{100}$$

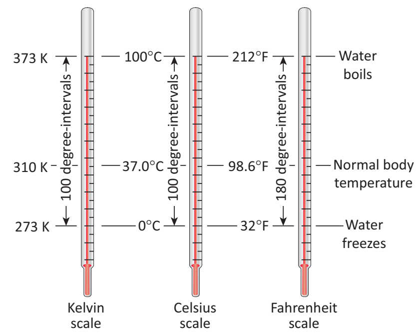


Fig: 1.2 - **Various Thermometers**

1.2.3 Application of various thermometric scales

1. Physicians use 'clinical thermometers'. It is graduated in 'Fahrenheit Scale'
2. Scientists are using thermometers with kelvin scale.
3. Common temperature measurements are made in celsius scale. (Example: Weather reports are given in celsius scale.)

Info bits

"Normal temperature of the human body is between 98.4° F and 98.6° F"

DO YOU KNOW?

Infra red thermometer, measures the temperature of an object without any physical contact.

Activity 3

Collect the highest and lowest temperature details of your nearest town or city from the news paper or television for a week and record the values in a tabular column. Does this data remain same throughout the year?

1.3 Electric Current (I)

Flow of electric charges, in a particular direction is known as 'electric current'.

The magnitude of an electric current is the amount of electric charges flowing through a conductor in one second.

$$\text{Total capitalised value of the business} = \frac{\text{Average profit}}{\text{Normal rate of return}} \text{ x } 100$$

$$I = \frac{Q}{t}$$

SI unit of Electric Current is 'ampere' and it is denoted as A. Unit of charge is coulomb.

One ampere is defined as one 'coulomb' of charge moving in a conductor in one second. Ammeter is a device used to measure 'electric current'. (Fig 1.3)

Fig 1.3 - **Ammeter**

More to Know

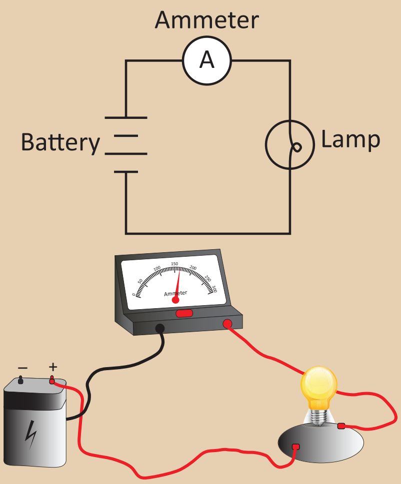
At very low temperature, around 30 K (-243.2° C), some conductors conduct electric current without any loss. These conductors are known as 'SUPER CONDUCTORS'.

The super conductors are used to levitate trains from the track.

Super conductors can be used as memory or storage element in the computers.

Activity 4

Measure the current in an electric circuit.



Components Required:

Battery, Ammeter, Lamp (Bulb)

Procedure:

1. Connect the battery, ammeter and the lamp in series as shown in the figure.
2. Note the ammeter reading
3. It is the current in the circuit

1.4 Amount of substance

Can you count the number of copper coins in the picture? (Fig 1.4)

Can you count the number of copper atoms in a coin? (Fig 1.4)

M6M2GC

It is very difficult to count the number of atoms because the atoms are not visible. There is an indirect method to count the number of atoms or molecules in a substance in multiples of mole. Let us see in detail.

Fig 1.4 - **Copper Coins**

Amount of substance is a measure of the number of entities (particles) present in a substance. The entity may be an atom, molecule, ion, electron or proton etc.

Generally, the amount of substance is directly proportional to the number of atoms or molecules.

The SI unit of amount of substance is mole and it is denoted as 'mol'.

Mole is defined as the amount of substance, which contains 6.023×10^{23} entities.

More to Know

The number 6.023×10^{23} is also known as Avogadro Number.

1.5 Luminous Intensity

Fig 1.5 (a & b) - Photometer in day to day life

Have you seen these scenes on the television? (Fig 1.5)

What is the umpire doing? Is he taking a 'selfie' ? (Fig 1.5)

No, he is checking the intensity of light, as perceived by the human eye, by using an instrument called 'Photometer'.

1.5.1 Definition

The measure of the power of the emitted light, by a light source in a particular direction, per unit solid angle is called as Luminous Intensity.

The SI unit of luminous intensity is candela and is denoted as 'cd'.

Fig 1.6 - Photometer

The light emitted from a common wax candle is approximately equal to one candela

Luminous intensity is measured by a 'photometer' (Fig 1.6) (Luminous Intensity Meter) which gives the luminous intensity in terms of candela directly.

Info bits

Luminous Flux or luminous power is the measure of the perceived power of light. Its SI unit is 'lumen'.

One lumen is defined as the luminous flux of the light produced by the light source that emits one candela of luminous intensity over a solid angle of one steradian.

1.6 Plane angle

It is the angle between the intersection of two straight lines or intersection of two planes. (Fig 1.7)

The SI unit of Plane Angle is 'radian' and is denoted as 'rad'.

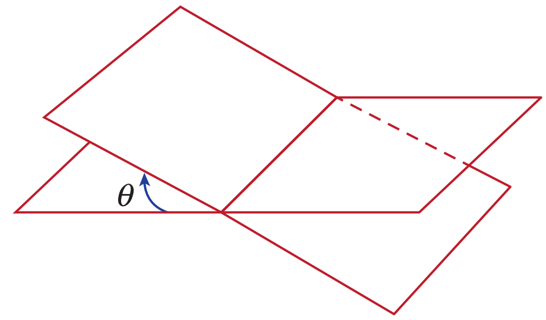


Fig 1.7 - Plane Angle

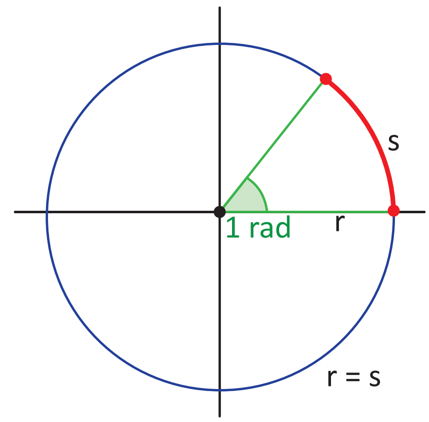


Fig 1.8 - Radian

Radian is the angle subtended at the centre of a circle by an arc whose length is equal to the radius of the circle. (Fig 1.8)

π radian = 180°

1 radian = $\frac{180°}{\pi}$

1.7 Solid Angle

It is the angle formed by three or more planes intersecting at a common point.

It can also be defined as 'angle formed at the vertex of the cone'

The SI unit of solid angle is 'steradian' and is denoted as 'sr'.

1.7.1 Definition

Steradian is the solid angle at the centre of a sphere subtended by a portion whose surface area is equal to the square of its radius of the sphere. (Fig 1.9)

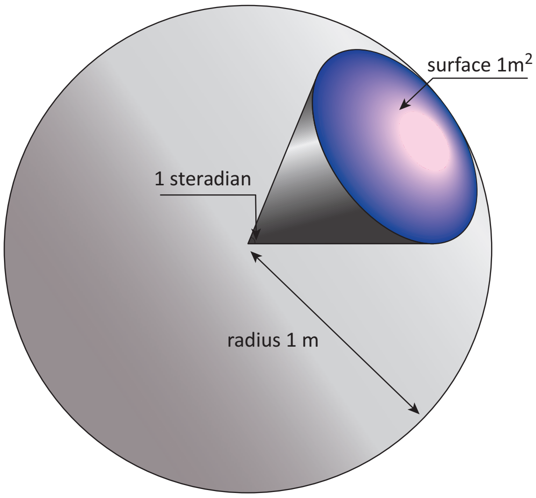


Fig 1.9 - **Steradian**

DO YOU KNOW? Until 1995, Plane Angle and Solid Angle were classified under supplementary quantities. In 1995, they were shifted to derived quantities.

Table: 1.3 Difference between Plane Angle and Solid Angle

Plane Angle	Solid Angle
Angle between the intersection of two lines or planes	Angle between the intersection of three or more planes at a common point
It is two dimensional	It is three dimensional
Unit is radian	Unit is steradian

1.8 Clocks

Clocks are used to measure time intervals. So, many clocks were used from the ancient time. Scientists modified the clock's mechanism to obtain accuracy.

Fig 1.10 - **Ancient Clock**

1.8.1 Types of clocks based on display:

1. Analog clocks; 2. Digital clocks

1. Analog clocks

Fig 1.11 - **Analog Clock**

It looks like a classic clock. It has three hands to show the time. (Fig 1.11)

Hours Hand: It is short and thick. It shows 'hour'.

Minutes Hand: It is long and thin. It shows 'minute'.

Seconds Hand: It is long and very thin. It shows 'second'. It makes one rotation in one minute and 60 rotations in one hour.

Analog clocks can be driven either mechanically or electronically.

Activity 5

Students must make a model of an Analog clock using a cardboard.

2. Digital clocks

A **digital clock** displays the time directly. It shows the time in numerals or other symbols. It may have a 12 hours or 24 hours display. (Fig 1.12)

Recent clocks are showing Date, Day, Month, Year, Temperature etc.

Digital clocks are often called as Electronic Clocks.

Fig 1.12 - **Digital Clock**

Activity 6

Students must make a model of a digital clock using match sticks on a cardboard, with date and time.

1.8.2 Types of clocks based on working mechanism

1. Quartz Clock:

These clocks are activated by 'electronic oscillations', which are controlled by a 'quartz crystal'. (Fig 1.13)

The frequency of a vibrating crystal is very precise. So, the quartz clock is more accurate than the mechanical clock.

These clocks have an accuracy of one second in every 10^9 seconds.

Fig 1.13 - **Quartz Clock**

More to Know

The principle of a quartz clock is the Piezo - electric property of a crystal. Piezo-electric property means that when a pressure is applied along a particular axis of a crystal, an electric potential difference is developed in a perpendicular axis.

In the reverse piezo-electric effect, a crystal becomes mechanically stressed when a voltage is applied across its opposite faces.

2. Atomic Clock:

These clocks are making use of periodic vibrations occurring within the atom. (Fig 1.14)

These clocks have an accuracy of one second in every 10^{13} seconds.

Atomic clocks are used in Global Positioning System (GPS), Global Navigation Satellite System (GLONASS) and International time distribution services.

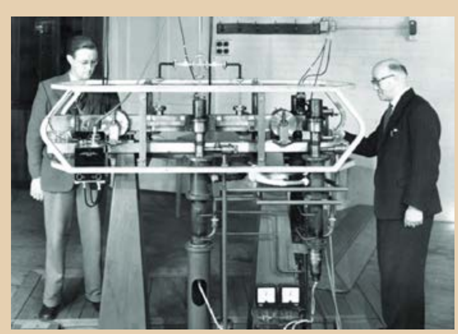
Fig 1.14 - **Atomic Clock**

BYUQV4

More to Know

The first atomic clock was developed in 1949 at the US National Bureau of Standards. But, it was less accurate than the quartz clock.

The first accurate atomic clock (based on Caesium - 133) was built by Lauis Essan and Jack Penny in 1955, at the National Physics Laboratory in the United Kingdom.



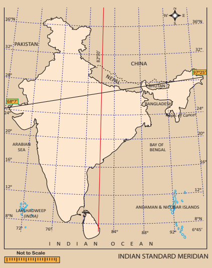
Activity 7

You may know about the 'Sun Dial'. Construct a sundial of your own and read out the values from morning to evening. Compare your values with modern clocks.

DO YOU KNOW?

Greenwich Mean Time (GMT) is the mean solar time at the Royal Observatory, located at Greenwich in London. It is measured at the longitude of zero degree.

The Earth is divided into 24 zones, each of a width of 15 degree longitude. These regions are called as 'Time Zones'. Time difference between two adjacent time zones is 1 hour.



Indian Standard Time (IST):

The location of Mirzapur in Uttar Pradesh is taken as the reference longitude of the Indian Standard Time. It is located at 82.5 degree longitude.

IST = GMT + 5:30 hours

1.9 Accuracy in Measurements

Measurement is the base of all experiments in science and technology. The value of every measurement contains some uncertainty. These uncertainties are called as 'Errors'.

The difference between the real value and the observed value is called an error.

1.9.1 Accuracy

Accuracy is the closeness of a measured value to the actual value or true value. (Fig 1.15)

NVGKJZ

1.9.2 Precision

Precision is the closeness of two or more measurements to each other. (Fig 1.15)

1.10 Approximation

Activity 8

Observe the 'Rasam making' process in your home. Ask your elders and try to answer the following questions:

The rasam is made for how many persons?

How could you increase the taste?

How much of salt has to be added?

Is there any prescribed standard for taking the ingredients?

We are not following any standard values for preparing a dish. We are following an approximation method for choosing ingredients.

While we prepare a dish, the ingredients are taken approximately.

Approximation is the process of finding a number, which is acceptably close to the exact value of the measurement of a physical quantity.

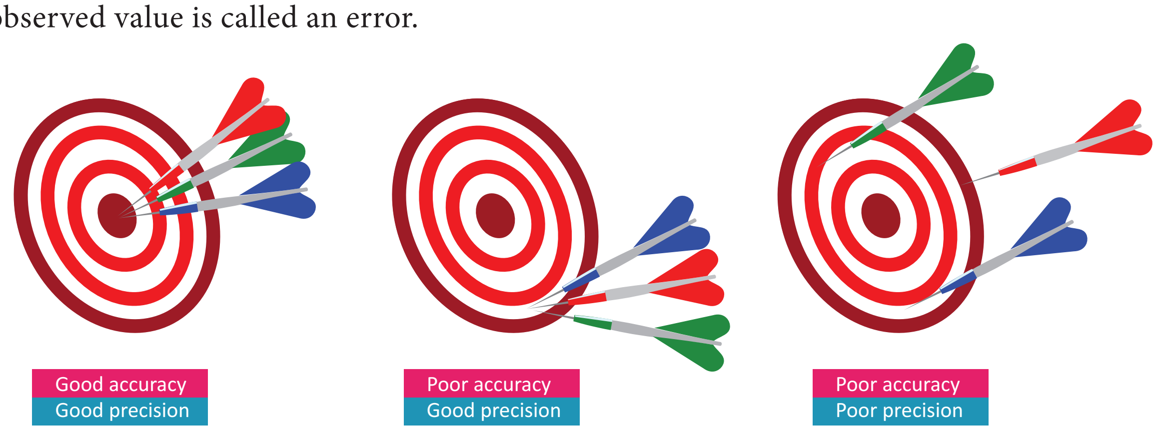


Fig 1.15 - Accuracy and Precision

It is an estimation of a number obtained by rounding off a number to its nearest place value.

When the data are inadequate, physicists are in need of an approximation to find the solution for problems. Approximations are usually based on certain assumptions having a scientific background and they can be modified whenever accuracy is needed.

Activity 8

Calculate the approximate 'heart beat' of a man in a day. (Hint: Take number of heart beats per minute as 75, approximately)

1.11 Rounding off

Calculators are widely used in day to day life to do the calculations. The result given by a calculator has too many digits. Hence, the result containing more digits should be rounded off. The technique of rounding off is used in many areas of physics.

1.12.1 Rules for rounding off

- Decide which is the last digit to keep.
- Leave it the same, if the next digit is less than 5.
- Increase it by one, if the next digit is 5 or greater than 5.

Thinking Corner:

Since, the true value is also an observed value then what is meant by true value? Think and discuss it with your friends?

1.12 Numerical Problems:

1. Convert 80° C into kelvin.

   Solution:

   K = C + 273

   K = 80 + 273

   K = 353 kelvin

2. Convert 300 K into celsius.

   Solution:

   C = K – 273

   C = 300 – 273

   C = 27 celsius.

3. When 2 coulomb of charge, flows through a circuit for 10 seconds, calculate the current?

   Solution:

   Given: Charge Q = 2 C; time t = 10 s

   $I = \frac{Q}{t}$ or $I = \frac{2}{10}$

   I = 0.2 A

4. Convert 60° into radian.

   $1° = \frac{\pi}{180}$

   $60° = \frac{\pi}{\cancel{180}_{3}} \times \cancel{60}$

   $= \frac{\pi}{3}$ radian

5. Convert $\frac{\pi}{4}$ into degrees.

   π radian = 180°

   $\frac{\pi}{4}$ radian $= \frac{180}{4} = 45°$

6. Round off the number 1.864 to two decimal places

   Step: 1 Identify the last digit to be kept. 6 is the last digit to be kept.

   Step: 2 The following digit, i.e. 4 is less than 5. So, retain it as 6. The answer is 1.86

7. Round off the number 1.868 to two decimal places

   Step: 1 Identify the last digit to be kept. 6 is the last digit to be kept.

   Step: 2. The following digit, i.e. 8 is greater than 5. So, increase 6 by one. The answer is 1.87

Points to remember

- SI units - International System of units, introduced in the 14th General Conference on Weights and Measure in 1971.
- Base quantities: Length, Mass, Time, Temperature, Electric current, Amount of substance & Luminous Intensity - 7 quantities.
- Temperature: Measure of hotness or coldness of a substance - average kinetic energy of the particles in a system - its unit is 'kelvin'.
- Electric current: Flow of electric charges (electrons) in a unit time - unit: ampere
- Amount of substance: Measure of number of entities (Particles) present in a substance - unit: mole.
- Luminous Intensity: Amount of light emitted by a light source in a particular direction per unit time - unit: candela.
- Plane angle : Angle between the intersection of two lines or planes - unit: radian.
- Solid angle: Angle between the intersection of three or more planes - unit: steradian
- Quartz clock : uses the 'electronic oscillations' controlled by a 'quartz crystal'.
- Atomic clock: uses the 'periodic vibrations occurring within the atom'.
- Accuracy: closeness of a measured value to the actual value.
- Precision: closeness of two or more measurements to each other.
- Approximation: Process of finding the solution by means of 'estimation'.

TEXT BOOK EXERCISES

DNP9YR

Choose the best answer

1. Which one the following system of units is the British System of unit?

   a) CGS　　b) MKS

   c) FPS　　d) SI

2. Electric current belongs to ______ quantities

   a) base

   b) supplementary

   c) derived

   d) professional

3. SI unit of temperature is

   a) celsius　　b) fahrenheit

   c) kelvin　　d) ampere

4. Amount of substance is

   a) directly proportional to the number of atoms

   b) inversely proportional to the number of atoms

   c) directly proportional to the square of number of atoms

   d) inversely proportional to the square of number of atoms

5. Luminous intensity is the intensity of

   a) Laser light

   b) UV light

   c) visible light

   d) IR light

6. Which one of the following devices is used to measure electric current

a) 

b) 

c) 

d) 

7. SI unit stands for
   a) International system of units
   b) Integrated System of units
   c) International symbol of units
   d) Integrated symbol of units

8. Closeness of two or more measured values is called as
   a) accuracy b) precision
   c) error d) approximation

9. Quantities other than base quantities are called as
   a) supplementary quantities
   b) derived quantities
   c) professional quantities
   d) energy quantities

10. Which of the following statements about approximation is wrong?
   a) Approximation gives accurate value.
   b) Approximation simplifies the calculation.
   c) Approximation is very useful when little information is available.
   d) Approximation gives the nearest value only.

II. Fill in the blanks.

1. The solid angle is measured in ________.
2. ________ recognized the need of 'Standard Units' for physical quantities.
3. The coldness or hotness of a substance is expressed by ________.
4. ________ is used to measure electric current.
5. ________ of substance, contains $6.023 \times 10^{+23}$ atoms or molecules.
6. Luminous Intensity is the amount of visible light, that is emitted in unit area per unit ________.
7. Quartz clock uses ________ oscillations.
8. The uncertainty in measurement is called as ________.
9. ________ is the closeness of the measured value to the original value.
10. The intersection of two straight lines gives us________.

III. True or False.

1. SI units are metric system of units.
2. Temperature is a measure of total kinetic energy of the particles in a system.
3. In thermometers, freezing point of water is taken as the Upper Fixed Point.
4. One coulomb of charge flowing per minute is called 'ampere'.
5. Amount of substance gives the number of particles present in the substance.
6. Intensity of light from a candle is approximately equal to one 'candela'.
7. Angle formed at the top of a cone is an example of 'Plane Angle'.
8. Quartz clocks are used in GPS Devices.
9. Candela is used to express electric field intensity.
10. The number 4.582 can be rounded off as 4.58 .

IV. Match the following:

	Column A		Column B
1.	Temperature	a	Closeness to the Actual Value
2.	Plane Angle	b	Measure of hotness or coldness
3.	Solid Angle	c	Closeness to two or more measurements
4.	Accuracy	d	Angle formed by the intersection of three or more planes
5.	Precision	e	Angle formed by the intersection of two planes

V. Assertion & Reason.

1. Direction: Mark the correct choice as
   a. If both assertion and reason are true and reason is the correct explanation of the assertion.
   b. If both assertion and reason are true but reason is not the correct explanation of the assertion.
   c. Assertion is true, but reason is false.
   d. Assertion is false, but reason is true.

1. Assertion: The SI system of units is the suitable system for measurements.
Reason: The SI unit of temperature is kelvin.

2. Assertion: Electric current, amount of substance, Luminous Intensity are the fundamental physical quantities.
Reason: They are independent of each other.

3. Assertion: The seconds hand of a clock is having least count of one second.
Reason: Least count is the maximum measurement that can be measured accurately by an instrument.

4. Assertion: Avogadro's number is the number of atoms in one mole of substance.
Reason: Avogadro's number is a constant

5. Assertion: Radian is the unit of solid angle.
Reason: One radian is the angle subtended at the centre of a circle by an arc of length equal to its radius.

VI Answer in a word or two (Very Short Answer):

1. What is the unit of mass in FPS system?
2. How many base quantities are included in SI system?
3. Give the name of the instrument used for the measurement of temperature.
4. What is the 'Lower Fixed Point' of the Fahrenheit scale?
5. What is the SI unit of Luminous Intensity?
6. What is the value of Avogadro's number?
7. What type of oscillations are used in atomic clocks?
8. Mention the types of clocks based on their display.
9. How many times will the 'minute hand' rotate in one hour?
10. How many hours are there in a minute?

VII Answer the questions given below (Short Answer):

1. What is measurement?
2. Name some common systems of measurement.
3. Define- Temperature.
4. Define - ampere.
5. What is electric current?
6. What is luminous Intensity?
7. Define - mole.
8. What are the differences between Plane angle and solid angle?

9. What are errors?

VIII Answer in detail:

1. List out the base quantities with their units.
2. Write a short note on different types of clocks.

IX Higher Order Thinking Question:

1. Your friend was absent yesterday. You are enquiring about his absence. He told, he was affected by a fever of 100°C and went to a hospital for treatment. Is it possible of 100°C fever? If it is wrong, try to make him to understand his mistake.

REFERENCE BOOKS

1. Units and measurements – John Richards, S. Chand publishing, Ram nagar, New Delhi.
2. Units of Measurement - Past, Present and Future. International System of Units - Gupta, S. V. eBook ISBN 978-3-642-00738-5 DOI 10.1007/978-3

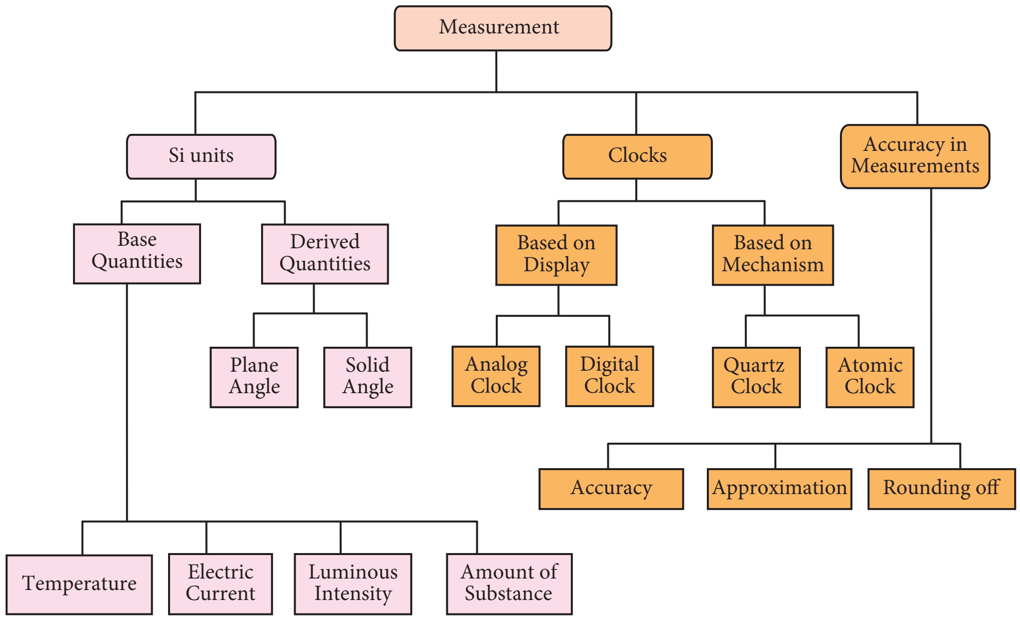
INTERNET RESOURCES

1. http://www.npl.co.uk/reference/measurement-units/
2. http://www.splung.com/content/sid/1/page/units
3. https://www.nist.gov/sites/default/files/documents/2016/12/07/sp330.pdf
4. https://study.com/academy/lesson/standard-units-of-measure.html

A-Z GLOSSARY

Kinetic energy	energy of moving objects
Calibration	process of configuring an instrument in a particular range
Electronic Oscillation	oscillations produced by an electronic circuit
Quartz Crystal	crystal formed by Silicon and Oxygen (SiO_2)
Potential Difference	the difference in potential between two points in an electric field or electric circuit.

Mind Map



ICT CORNER

Measurement

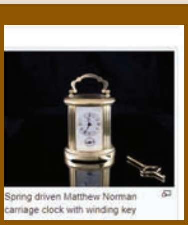
This activity enables the students to learn about the various types of Time keeping devices

Steps

- Open the Browser and type URL link given below (or) Scan the QR Code.
- Click and select the "History of time keeping devices"
- Options will be given. Select any content (Eg) Digital clock
- It gives clear understanding of the "History of time keeping devices"

Step1

Step2



Step3

Step4

Web link: https://playablo.com/Blog/5-fun-activities-to-teach-temperature-hot-and-cold-to-preschoolers/ https://en.wikipedia.org/wiki/History_of_timekeeping_devices

(or) scan the QR Code

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*Pictures are indicative only

UNIT 2

FORCES AND PRESSURE

Learning Objectives

QKB4NM

After learning this unit, students will be able to:

- Understand the concept of force and its effects.
- Differentiate thrust and pressure.
- Understand pressure and its application.
- Understand the relation between force and pressure.
- Understand the characteristics of atmospheric and liquid pressure.
- State Pascal's law and know its applications.
- Apply Pascal's law in day to day life.
- Know the instrument used to measure atmospheric and liquid pressure.
- Understand the property of surface tension and viscosity.
- Analyze friction in rest and motion.
- Know the ways to increase and decrease the friction.
- Solve numerical problems related to force and pressure.

Introduction

Every day you can observe bodies around you. When you are coming to school, you can notice that some of them are moving, some of them are at rest. What pushes or pulls them? What brings the moving bodies to rest? What is the effect of these pulls or pushes?

All the above questions can be answered by saying just one word, which is "Force".

2.1 FORCE

Observe the following actions in day to day life:

Opening up a pen, opening a door, kicking a football, striking a carrom coin, making of chapattis etc., all these actions need a force. Force is an 'action of push or pull', which makes the bodies to move or brings the moving bodies to rest. It even changes the shape and size of certain bodies.

Activity 1

Make two groups of students. Let them stand along a straight line, one behind the other, on a playground. Start the game of "tug of war" with a rope. Observe the movement of the students.

Who are the winners?

The group of students who pull the rope with a greater force will definitely win. The winners are applying a greater amount of force. Hence, the rope moves in the direction of the greater force.

2.1.1 Definition of force

Force is that which changes or tends to change: i) the state of rest or ii) the state of uniform motion of a body or iii) the direction of a moving body or iv) the shape of a body.

Pushes and pulls are forms of forces. The direction of a force is in the direction in which a push or a pull is applied. Thus, force is a vector quantity, which has magnitude and direction. It is measured with a unit called "newton (N)".

2.1.2 Factors on which a force depends

You have studied the effects of force so far. Now, you are going to study the factors on which the effect of a force actually depends.

When you play any game, the greater the force you apply on a body, greater will be its effect on it. Just observe the strokes of the bat by a batsman. If he wants to hit the cricket ball to the boundary, the striking force on the ball must be greater.

Now, the question before you is does it depend on the area of impact?

Activity 2

Fix a matrix of sharp pins on a wooden board in rows and columns. Take a big blown up balloon. Next, place it gently over the pins. Place a small book on

the top of the balloon. Will the balloon burst? Will the pins prick the balloon?

Inference: It is a wonderful sight to see that the balloon will not burst. How is this possible?

Reason: If you prick the blown up balloon with a single pin it will burst. But, this did not happen even though many more pins were pricking the balloon.

A single pin produces a large pressure over a small area. But, when a large number of pins prick a body, each pin exerts very little pressure on the balloon, as the applied force gets distributed over a larger surface of the body. So, the balloon will not burst.

We conclude that the effect of a force depends on the magnitude of the force and the area over which it acts.

2.1.3 Thrust

It is a force acting perpendicularly on any given surface area of a body. It is measured by the unit newton.

2.1.4 Pressure

The effect of force can be measured using a physical quantity called pressure. It can be defined as the amount of force or thrust acting perpendicularly on a surface of area one square meter of a body. Unit of pressure is pascal (Pa) or N m^{-2}.

Pressure = $\frac{\text{Thrust (or) Force}}{\text{Area}}$, $P = \frac{F}{A}$. The SI unit of pressure is pascal (named after the French scientist Blaise Pascal). 1 pascal = 1 N m^{-2}

Pressure exerted by a force depends on the magnitude of the force and the area of contact.

SOLVED PROBLEM: 2.1

Calculate the pressure exerted by the foot of an elephant using the following data. Average weight of an elephant is 4000 N. Surface area of the sole of its foot is 0.1m^2 .

Solution:

Average weight of the elephant = 4000 N

Weight of one leg = force exerted by one leg = 4000/4 = 1000 N

Area of the sole of one foot = 0.1 m^2.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{1000}{0.1}$$

$$= 10000 \ \frac{N}{m^2} = 10^4 \ N \ m^{-2}$$

Pressure exerted by one leg of the elephant is 10,000 newton on one square metre.

Increasing pressure:

The effect of pressure can be increased by increasing the thrust or by decreasing the area of the surface of the body experiencing the thrust.

Examples:

The axe, nail, knife, injection needle, bullet etc., all these are having sharp fine edges so as to exert a larger pressure on a smaller area of the body; in order to get the maximum effect from them.

It is very difficult to walk on sand. But, camels can walk easily on it because they have large padded feet, which increase the area of contact with the sandy ground. This reduces the pressure and enables them to walk easily on the sand.

Examples:

1. More number of wheels are provided for a heavy goods-carrier for decreasing the pressure; thereby increasing the area of contact on the road.
2. Broader straps are provided on a back-pack for giving a lower pressure on the shoulders by providing a larger area of contact with the shoulder.
3. It is difficult to drive an automobile, which has flattened tyres.

Figure 2.1 Broader straps

2.2 PRESSURE EXERTED BY AIR - ATMOSPHERIC PRESSURE

You all know very well that air fills the space all around us. This envelope of air is called as atmosphere. It extends up to many kilometres above the surface of the Earth. All objects on the surface of the Earth experience the thrust or force due to this atmosphere.

The amount of force or weight of the atmospheric air that acts downward on unit surface area of the surface of the Earth is known as **atmospheric pressure**. It can be measured using the device called **barometer**. The barometer was invented by "Torricelli".

Atmospheric pressure decreases with altitude from the surface of the Earth.

Atmospheric pressure can be measured by the height of the mercury column in a barometer. The height of the mercury column denotes the atmospheric pressure at that place at a given time in 'millimetre of mercury'. Even if you tilt the tube at various angles, you will see that the level of mercury will not vary. At sea level, the height of the mercury column is around 76 cm or 760 mm. The pressure exerted by this mercury column is considered as the pressure of magnitude 'one atmosphere' (1 atm).

More to know

Cooking in a place located at a higher altitude is difficult. Why?

At a higher altitude, due to the lack of atmospheric pressure the boiling point of a substance reduces. So, the water boils even at 80° C. At this temperature, the thermal energy that is produced is not sufficient enough for baking or cooking. So, cooking is difficult at higher altitude.

1 atmospheric pressure = 1 atm = pressure exerted by the mercury column of height 76 cm in the barometer = $1.01 \times 10^5 N\ m^{-2}$.

In the SI system 1 atm = 1,00,000 pascal (approximately).

SI unit of atmospheric pressure is Nm^{-2} or pascal.

To realise the effect of atmospheric pressure:

Activity 3

Take a conical flask. Take a well boiled egg, after removing its shell. Place the egg on the mouth of the flask. It will not enter the flask. Next, take a piece of paper. Burn it and drop it inside the flask. Wait for a few seconds; let it burnt fully. Now, keep the egg on the mouth of the flask. Wait for a few minutes. What did you observe?

Inference: The egg placed at the mouth of the flask gets compressed and it falls into the flask, due to the atmospheric pressure.

Reason: When the paper is burning in the flask, the oxygen present in the air inside the conical flask is used up for its combustion. This reduces the pressure of the air in the flask. The air in the atmosphere tends to occupy the low pressure region in the flask. So, it rushes through the mouth of the flask, thus pushing the egg into the flask. Eventually, the egg falls down to the bottom of the flask.

2.3 FORCES IN LIQUIDS

2.3.1 Buoyant force of a liquid

An upward force is exerted by water on a floating or a partly submerged body. This upward force is called **buoyant force**. The phenomenon is known as "buoyancy". This force is not only exerted by liquids, but also by gases. Liquids and gases together are called fluids.

This upward force decides whether an object will sink or float. If the weight of the object is less than the upward force, then the object will float. If not, it will sink.

A body floats if the buoyant force > its weight; A body sinks if its weight > buoyant force.

2.3.2 Pressure exerted by liquids

Liquids do not have a definite shape. The force acting on unit area of the surface, on which the liquid is placed, is called the static pressure of the liquid. Liquids exert a pressure not only on the base of their container/vessel, but also on its side walls. The pressure exerted by a liquid depends upon the depth of the point of observation considered in it.

An instrument used to measure the difference in the liquid pressure is called a "manometer". You can measure the pressure of fluids enclosed in a definite container using the manometer.

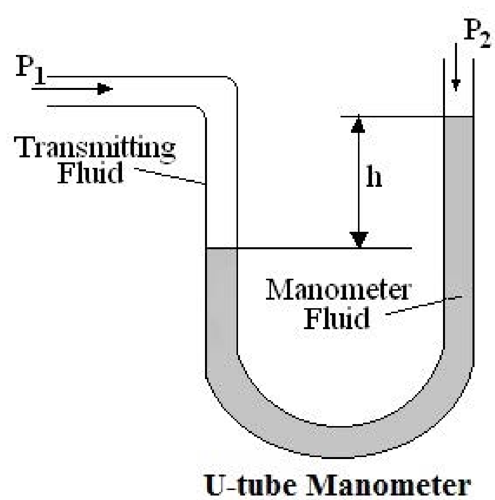


Figure 2.2 Manometer

a) Pressure exerted by a liquid on the base of a container depends upon the height of the liquid column:

Activity 4

Take a glass tube that is open at both ends. Fix a rubber balloon at the lower end of the tube. Put some water into the tube and observe the balloon. Now, pour some more water into the balloon and again observe the balloon.

Inference: The balloon starts bulging outwards. The bulge increases with an increase in the height of the water column.

Reason: The pressure exerted by a liquid at the bottom of a container depends on the height of the liquid column in it.

You have already studied that the atmospheric pressure is measured in terms of the height of the mercury column in a barometer.

b) Liquids exert the same pressure in all directions at a given depth:

c) Liquid pressure varies with the depth:

Activity 5

Take a plastic bottle. Punch three holes on its sides at the same height from its base. Now, pour some water into it and let it flow through the holes. Observe the flow of the water.

Inference: The water comes out from all the holes with the same force and falls on the ground/table, at the same distance from the bottle.

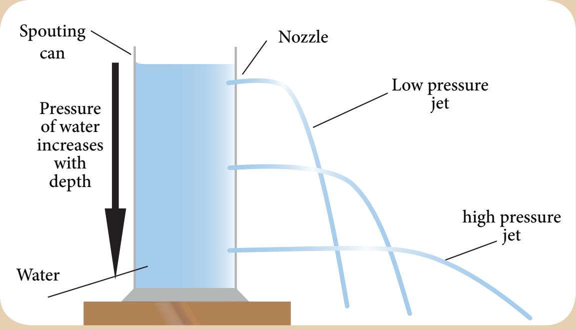
Reason: This activity confirms that liquids exert the same pressure in all directions, at a given depth in their container.

Activity 6

Take a plastic bottle. Punch three holes on its side in the same direction, but at different heights. Now pour some water into it and let it flow through the holes. Observe the flow of water.

Inference: The water comes out from all the holes with a different force and falls on the table at points that are at variable distances from the bottle. Water from the lowest hole comes out with the greatest force and falls at a point that is at the maximum distance from the bottle. Water from the topmost hole comes out with the least force and falls at the point that is at the minimum distance from the bottle.

Reason: This activity confirms that the pressure in a liquid varies with the depth of the point of observation in it.



Thinking Corner

Why dams are made stronger and thicker at the bottom than at the top?

Why do scuba divers wear a special suit while they go into deep sea levels?

Home Assignments

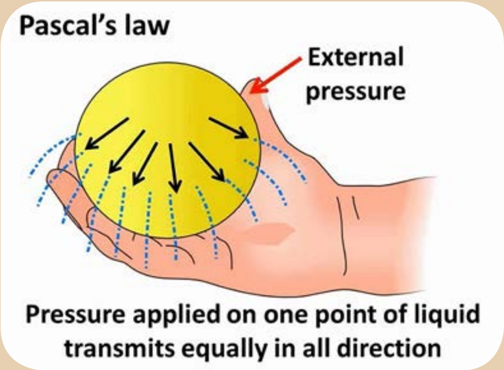
1. Ask your family doctor how blood pressure is to be measured?
2. Read the life history of Blasie Pascal.

Activity 7

Take a rubber ball. Fill it with water. Then, make tiny holes on it with a pin at different points on its surface. Press anywhere on the ball. What do you observe?

Inference: There are identical streams of water flowing in all directions from the holes.

Reason: This is due to the phenomenon that the pressure, which is applied on the liquid, is equally transmitted in all direction. This concept was first given by the French scientist Blasie Pascal.



Activity 8

Fill two identical syringes with water. Connect them with a plastic tube. Press gently on one end of a piston. What do you observe?

Inference: If one piston is pressed downward, then the other piston will move up slightly, depending on the pressure given on the first piston.

Reason: This activity confirms that the pressure exerted on a liquid at rest is transmitted equally to other portions of the liquid.

2.3.3 Pascal's law:

The pressure applied at any point of a liquid at rest, in a closed system, will be distributed equally through all regions of the liquid.

2.3.4 Application of Pascal's law:

Some of the following examples highlight their working according to Pascal's law.

- In an automobile service station, the vehicles are lifted upward using the hydraulic lift, which works as per Pascal's law.
- The automobile brake system works according to Pascal's law.
- The hydraulic press is used to make the compressed bundles of cotton or cloth so as to occupy less space.

2.4 SURFACE TENSION

Thinking Corner

- Why are rain drops spherical in nature?
- A liquid flowing out of a very small opening of a tube or tap comes out in the form of fine drops and not as a continuous stream. Why?
- Trees are greenish. They are greenish at the tip too. How does the water rise upward in a tree or plant against the force of gravity?

All the above questions have an answer, i.e., **"due to surface tension"**.

Surface tension is the property of a liquid. The molecules of a liquid experience a force, which contracts the extent of their surface area as much as possible, so as to have the minimum value. Thus, the amount of force acting per unit length, on the surface of a liquid is called surface tension. It has the unit N m^{-1} .

Activity 10

Take a paper clip. Take a beaker of water. Take a tissue paper and spread it on the surface of the water. Gently, place the paper clip on the tissue paper. Observe what happens to the paper pin after some time.

Inference: After a few moments the tissue paper will submerge and the paper clip will make a small depression on the surface of the water. It will instantly begin to float on the surface, even though it is denser than water.

Reason: This is due to the water molecules on the surface, which tend to contract themselves like the molecules of an elastic membrane. A force exists on them, which tends to minimize the surface area of water. The paper clip is balanced by the molecules on the water surface that is now behaving like a stretched elastic membrane. So, it does not submerge.

2.4.1 Application of surface tension:

- Water molecules rise up due to surface tension. Xylem tissues are very narrow vessels present in plants. Water molecules are absorbed by the roots and these vessels help the water to rise upward due to "capillarity action" (you will study this topic in the forth-coming classes), which is caused by the surface tension of water.
- For a given volume, the surface area of a sphere is the minimum. This is the reason for the liquid drops to acquire a spherical shape.
- Water strider insect slides on the water surface easily due to the surface tension of water.
- During a heavy storm, sailors pour soap powder or oil into the sea near their ship to decrease the surface tension of sea water. This process reduces the impact of the violent water current against the all of ship.

Figure 2.3 Water strider

2.7 VISCOUS FORCE OR VISCOSITY

Activity 11

Take a small quantity of different kinds of liquid like coconut oil, honey, water and ghee etc., in a cup. Place one drop of each liquid on a separate glass plate. Next, gently raise one end of the glass plate, one by one, so as to allow the liquid to slide down the smooth surface of the plate. Observe the speed of each liquid.

Inference: Each liquid moves with a different speed. Water flows faster than other liquids. Coconut oil flows with a moderate speed. Ghee flows very slowly.

Reason: Between the layers of each liquid, in motion, there is a frictional force parallel to the layers of the liquid. This frictional force opposes the motion of the liquid layers while they are in motion.

Definition:

When a liquid is flowing, there is a frictional force between the successive layers of the liquid. This force which acts in order to oppose the relative motion of the layer is known as viscous force. Such a property of a liquid is called viscosity.

Viscosity force is measured by the unit called poise in CGS and kg m^{-1} s^{-1} or N s m^{-2} in SI.

2.6 FRICTION

Thinking Corner

Ram is a good student. But, sometimes he does not care about the cleanliness of his surroundings. Once, he got bananas from his mother. After eating them he just threw the peels of banana on the path of his house. When his brother crossed the path, unknowingly he kept his leg on them. He fell down with a scream. Ram rushed out and helped him. This incident occurred because of his negligence. He realised his mistake. He took the peels of banana and put them in the dustbin.

He then asked himself how the peels of banana had made his brother slide over the path. Could you help him?

Reason: Ram's brother falls down due to the lack of friction between his feet and the banana peels.

You have studied that forces are classified into two types: contact force and non-contact force. Now, you are going to study one of the contact forces, i.e., **friction**.

It is easy to hold a tumbler due to the friction between the surfaces of your palm and the tumbler. But, when oil is applied to your palm, the contact force between your fingers and the tumbler is reduced. So, the friction is reduced. Hence, it is difficult to hold it with an oily hand.

2.6.1 Origin of friction

Frictional force or friction arises when two or more bodies in contact move or tend to move, relative to each other. It acts always in the opposite direction of the moving body. This force is produced due to the geometrical dissimilarities of the surface of the bodies, which are in relative motion.

2.6.2 Effects of friction:

Friction can produce the following effects:

a) Friction opposes motion.

b) Friction causes wear and tear of the surfaces in contact.

c) Friction produces heat.

2.6.3 Types of friction:

Friction can be classified into two basic types: static friction and kinetic friction.

Static friction: The friction experienced by the bodies, which are at rest is called static friction. (E.g.: all the objects rigidly placed to be at rest on the Earth, a knot in a thread.)

Kinetic friction: Friction existing during the motion of bodies is called kinetic friction.

Further, kinetic friction can be classified into two: sliding friction and rolling friction.

Sliding friction: When a body slides over the surface of another body, the friction acting between the surfaces in contact is called sliding friction.

Rolling friction: When a body rolls over another surface, the friction acting between the surfaces in contact is called rolling friction.

Rolling friction is less than sliding friction. That is why wheels are provided in vehicles, trolleys, suitcases etc.

Activity 12

Push or slide a book on a rough surface. It is difficult to push it. Isn't it? Now, keep some cylindrical pencils underneath the book. Again, push it. It is easy to move the book. Why?

Reason: When you push the book, the pencils roll in the direction of the applied force. They prevent the contact of the book with the rough surface. Rolling pencils offer the least amount of friction. So, it is easy to displace the book in comparison with sliding it on the table.

This method is often used in moving heavy wood from one place to another.

2.6.4 Factors affecting friction

a) Nature of a surface:

Activity 13

Arrange some notebooks one over the other to form a platform, on a table. Keep a wide scale, as a slide, such that one of its ends rests on the pile of books. Take different kinds of materials like cotton cloth, plastic paper, newspaper, writing pad etc. Place some glass marbles in a bowl placed on the table.

First, keep a rectangular piece of paper near the end of the scale, which is in contact with the table. Now, release a glass marble from the top end of the scale such that it rolls down the scale. Allow the marble to roll over the piece of paper and finally, come to rest.

Measure the distance travelled by the marble over the paper, using the meter scale. Replace the 'rolling surface' by placing the plastic sheet, wooden plank, cotton cloth, etc. In each trial measure the distance travelled by the glass marble. Tabulate the distance covered by the marble over each surface.

S. No.	Rolling surface placed on the table	Distance covered by the glass marble after sliding down (in centimetre)
1	Paper	
2	Glass	
3	Cotton cloth	
4	Wood	

Inference: The marble covers a lesser distance over the cotton cloth in comparison with the distance it covers over the glass plate.

Reason: A rough surface like the cotton cloth, offers more frictional force. So, the marble moves slowly and covers a minimum distance. The smooth surface of glass, offers lesser friction. So, the glass marble travels a greater distance over it.

The above activity reveals the 'effect of the force of friction', which increases as the roughness of the surface increases.

It is easy to walk or ride a vehicle on a road, but it is difficult to do the same on sand due to its greater friction (roughness).

b) Weight of the body:

It is easy to pedal your cycle without any load on its carrier. With a load placed on its carrier, it is difficult to move it because the weight on the carrier increases the friction between the surface of the tyre and the road.

c) Area of contact:

For a given weight, the friction is directly related to the area of contact between the two surfaces. If the area of contact is greater, then, the friction will be greater too.

A road roller has a broad base, so it offers more friction on the road. But, a cycle has the least friction, since the area of contact of the tyre with the surface of the road is less.

2.6.5 Advantages of friction

Friction is a necessity in most of our day to day activities. It is desirable in most situations of our daily life.

- We can hold any object in our hand due to friction.
- We can walk on the road because of friction. The footwear and the ground help us to walk without slipping.

- Writing easily with a pen on paper is due to friction.
- Automobiles can move safely due to friction between the tyres and the road. Brakes can be applied due to frictional resistance on brake shoes.
- We are able to light a matchstick, sew clothes, tie a knot or fix a nail in the wall because of friction.

Though it is giving a negative effect, in most of our day to day life friction helps us to make our life easy. So, it is called as "necessary evil".

2.6.6 Disadvantages of friction

- Friction wears out the surfaces rubbing with each other, like screws and gears in machines or soles of shoes.
- To overcome the friction an excess amount of effort has to be given to operate a machine. This leads to wastage of energy.
- Friction produces heat, which causes physical damage to the machines.

2.6.7 Increasing and decreasing friction

a) Area of contact:

Friction can be increased by increasing the area of the surfaces in contact. Have you seen the sole of a shoe, which has grooves? It is done to provide the shoes a better grip with the floor, so that you can walk safely. Treaded tyres (tyres with slots and projections) are used to increase the friction.

Brake shoes in a cycle have to be adjusted so that they are as close as possible to the rim of the wheel, in order to increase the friction.

E.g.: Sumo players, Kabbadi players rub their hand with mud, to get a better grip. Football shoes are having soles with many projections, for providing a stronger grip with the ground.

b) Using lubricants:

A substance, which reduces the frictional force, is called a lubricant. E.g.: grease, coconut oil, graphite, castor oil, etc.

The lubricants fill up the gaps in the irregular surfaces between the bodies in contact. This provides a smooth layer thus preventing a direct contact between their rough surfaces.

c) Using ball bearing:

Since, the rolling friction is smaller than sliding friction, sliding is replaced by rolling with the usage of ball bearings. You can see lead shots in the bearing of a cycle hub.

Points to remember

Force

- ➢ Force is defined as 'a push' or 'a pull' acting on a body, which tends to change i) its state of rest or of motion or ii) its shape. The SI unit of force is newton.
- ➢ Force acts only when two or more objects interact with one other.
- ➢ A force can start a motion, stop a motion, change the direction of motion, and can change the shape or size of a body.

Pressure

- ➢ The effect of force can be measured using the physical quantity called pressure. It can be defined as the amount of force or thrust acting perpendicularly on one square meter area of a surface. Unit of pressure is pascal (Pa) or Nm^{-2}
- ➢ Fluids (liquids, gases and air) also exert pressure.
- ➢ All objects on the surface of the Earth experience a constant thrust or force due to the atmosphere.
- ➢ The amount of force due to the atmospheric air that acts on unit surface area of the Earth is known as atmospheric pressure.
- ➢ Atmospheric pressure can be measured by a device called barometer.
- ➢ 1 atmospheric pressure = 1 atm = pressure due to 76 cm of mercury column in a barometer = 1.01×10^5 N m^{-2}

Friction

- Friction is the force that opposes the motion of an object.
- It slows down or prevents the motion of a body. Friction always opposes the motion and it produces heat.
- Friction is caused by irregularities on the surfaces, which are in contact.
- Friction depends on the nature of the surfaces and mass of the bodies in contact.
- Friction is classified into two types: static friction and kinetic friction. Kinetic friction can be further classified as rolling friction and sliding friction.

Surface Tension

- Surface tension is the property of a liquid.
- The water molecules experience a force that contracts the surface of water as much as possible, so as to occupy the minimum surface area. The amount of force acting per unit length on the liquid surface is called surface tension. It has the unit Nm^{-1}.

Viscous Force

- When the liquids are flowing there is a frictional force between the layers of the liquid, which oppose their relative motion. This force is called viscous force and the phenomenon is known as viscosity.
- Viscosity is measured by the unit called poise in CGS and kg m^{-1} s^{-1} and N s m^{-2} in SI.

A-Z GLOSSARY

Force	action of push or pull
Thrust	Force acting perpendicularly on any given surface area
Pressure	force acting on unit area
buoyant force	An upward force exerted by liquid on floating body
Surface tension	The surface molecules of a liquid experience a force which contracts the surface area
Friction	This force is produced due to the geometrical dissimilarities of the surface of the bodies which are in relative motion.

HHMB6Q

TEXT BOOK EXERCISES

I. Choose the correct answer for each of the following:

1. If we apply a force against the direction of motion of a body, then the body will
   a) stop moving
   b) move with an increased speed
   c) move with a decreased speed
   d) move in a different direction

2. Pressure exerted by a liquid is increased by
   a) the density of the liquid
   b) the height of the liquid column
   c) Both (a) & (b)
   d) None of the above

3. Unit of pressure is
   a) pascal b) N m^{-2}
   c) poise d) Both (a) & (b)

4. The value of the atmospheric pressure at sea level is
   a) 76 cm of mercury column
   b) 760 cm of mercury column
   c) 176 cm of mercury column
   d) 7.6 cm of mercury column

5. Pascal's law is used in
   a) hydraulic lift
   b) brake system
   c) pressing heavy bundles
   d) All the above

6. Which of the following liquids has more viscosity?
   a) Grease b) Water
   c) Coconut oil d) Ghee

7. The unit of viscosity is
   a) $N\ m^2$ b) poise
   c) $kg\ m\ s^{-1}$ d) no unit

II. Fill in the blanks

1. The pressure of a liquid column _____ with the depth of the column.
2. Hydraulic lift works under the principle of _____.
3. The property of _____ of a liquid surface enables the water droplets to move upward in plants.
4. A simple barometer was first constructed by _____.

III. State whether the following statements are true or false:

1. Force acting on a given area is called pressure.
2. A moving body comes to rest due to friction alone.
3. A body will sink if the weight of the body is greater than the buoyant force.
4. One atmosphere is equivalent to 1,00,000 newton force acting on one square metre.
5. Rolling friction is slightly greater than the sliding friction.
6. Friction is the only reason for the loss of energy.
7. Liquid pressure decreases with the decrease of depth.
8. Using barometers, one can measure the height of a building.
9. Surface tension causes the spherical nature of a water drop.
10. Viscosity depends on the pressure of a liquid.

IV. Arrange the following in the increasing order:

1. Rolling friction, static friction, sliding friction
2. Let a marble roll on the following surfaces. Arrange the choice of the material such that a marble moving over it covers a greater distance.
   Cotton cloth, glass plate, paper, card board, silver plate

V. Match the following

Match: I		
	Column I	**Column II**
a)	Static friction	viscosity
b)	Kinetic friction	least friction
c)	Rolling friction	objects are in motion
d)	Friction between the liquid layers	objects are sliding
e)	Sliding friction	objects are at rest

Match: II		
	Column I	**Column II**
a)	Barometer	reduce friction
b)	Increase friction	atmospheric pressure
c)	Decrease friction	cause of friction
d)	Lubricants	increasing area of contact
e)	Irregular surface	decreasing area of contact

VI. ANALOGY

1. Knot in a thread : _____ friction; ball bearing : _____ friction
2. Downward force : weight ; Upward force offered by liquid : _____

VII. Problems:

1. A stone weighs 500 N. Calculate the pressure exerted by it if it makes a contact with a surface of area 25 cm^2.
2. In a hydraulic lift, the surface area of the input piston is 10 cm^2. The surface area of the output piston is 3000 cm^2. A 100 N force applied to the input piston raises the output piston. Calculate the force required to raise the output piston.

VIII. ASSERTION & REASON

1. Mark the correct choice as:
   a. If both assertion and reason are true and the reason is the correct explanation of the assertion.
   b. If both assertion and reason are true, but the reason is not the correct explanation of the assertion.
   c. If the assertion is true, but the reason is false.
   d. If the assertion is false, but the reason is true.

1. Assertion: Sharp knives are used to cut the vegetables.
   Reason: Sharp edges exert more pressure.
2. Assertion: Broad straps are used in bags.
   Reason: Broad straps last for long life.
3. Assertion: Water strider slides easily on the surface of water.
   Reason: Water strider experiences less buoyant force.

IX (A). Answer the following in one or two sentences (LOT):

1. Give two examples to verify that a force changes the shape of a body.
2. Give two examples to verify that a force tends to change the static condition of a body.
3. Taking out paste from a tooth paste tube is an example to highlight which physical property?
4. What do you feel when you touch a nail immediately after it is hammered into a wooden plank? Why?
5. How does the friction arise between the surfaces of two bodies in relative motion?
6. Name two instruments, which help to measure the pressure of a fluid.
7. Define one atmosphere.
8. Why are heavy bags provided with broad straps?
9. How does surface tension help a plant?
10. Which has greater viscosity, oil or honey? Why?

X. Answer the following questions with a few sentences (MOT):

1. Define friction. Give two examples of the utility of friction in day to day life.
2. Write down three ways of minimising friction.
3. How do sailors protect their ship during a heavy storm?
4. Write down three applications of Pascal's law.
5. Why is a ball bearing used in a cycle hub?

XI. Answer the following questions in detail:

1. "Friction is a necessary evil"- explain.
2. Give the different types of friction and explain each with an example.
3. Describe an experiment to prove that friction depends on the nature of a surface.
4. Explain how friction can be minimised.
5. Describe an experiment to prove that the pressure in a liquid increases with depth.

XII. HOT CORNER

1. Why is it not advisable to take a fountain pen while travelling in an aeroplane?
2. Is there any possibility of making a special device to measure the magnitude of friction directly?
3. Vidhya posts a question: Mercury is costly. So, instead of mercury can we use water as a barometric liquid? Answer to Vidhya and explain, the difficulty of constructing a water barometer.

4. A bubble rises from the bottom of a pond to its surface by increasing its radius by 3 times its value when it was at the bottom. Calculate the depth of the pond. (Hint: Pressure depends on the depth of the pond. Volume is inversely related to pressure.) [Science Olympiad]

PROJECT WORK:

Observe the devices, gadgets or things around you. List out the types of friction involved in each device? How would you minimise the friction? Record your observations and discuss your results with your classmates.

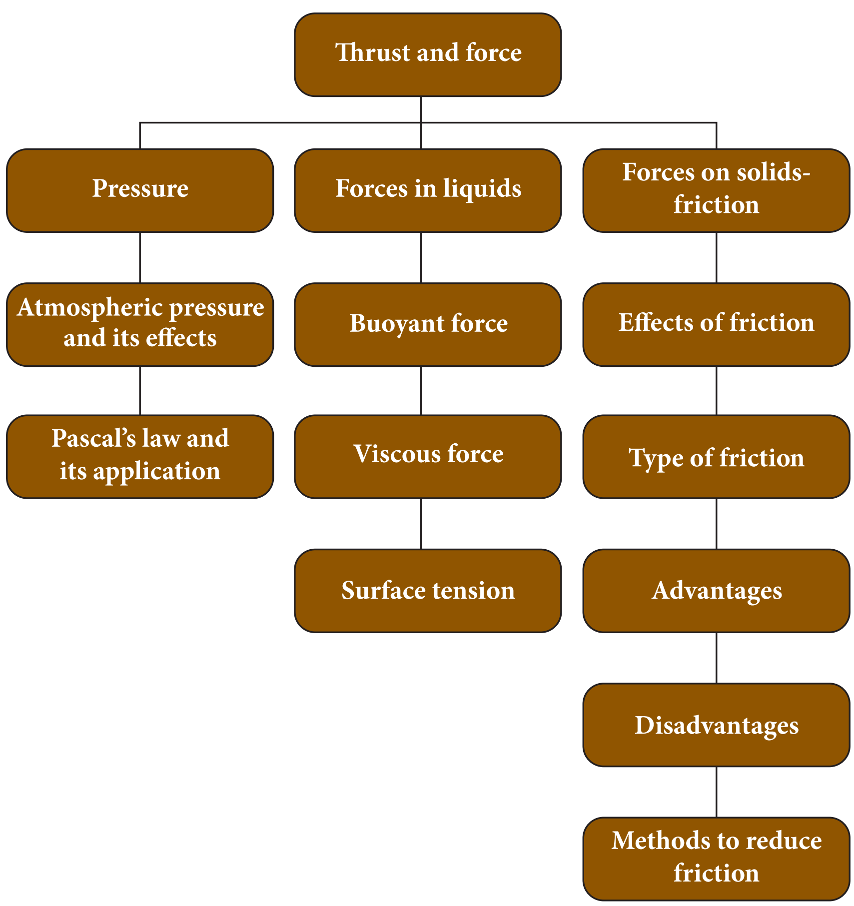
REFERENCE BOOKS

1. Fundamentals of Physics (English, Hardcover) David Halliday & Jearl Walker.
2. Principles of Physics, International Student Version (English, Paperback) Jearl Walker, David Halliday, Robert Resnick.
3. Concepts of Physics (Volume-1) 1st Edition (English, Paperback) H. C. Verma.
4. Fundamentals of Physics (English, Hardcover) David Halliday

INTERNET RESOURCES

1. https://www.youtube.com/watch?v=Oe6bDTL3YQg
2. https://www.youtube.com/watch?v=KndNN28OcEI
3. https://www.youtube.com/watch?v=-B5IBoZ08-I
4. https://www.stufftoblowyourmind.com/videos/51302-stuff-to-blow-your-kids-mind-atmospheric-pressure-video.htm
5. http://www.cyberphysics.co.uk/graphics/diagrams/forces/spouting_can.gif

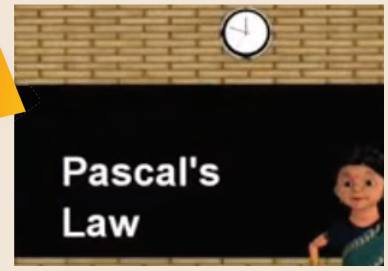
Mind Map



ICT CORNER

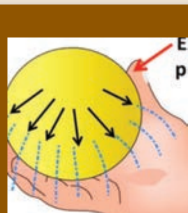
Force & Pressure

This activity helps to learn about the Fluid pressure & Pascal's Law

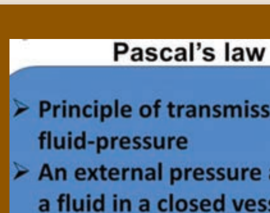


Steps

- Open the Browser and type the URL link given below (or) Scan the QR Code.
- Select the "Fluid Pressure and Pascal's Law" .You can view this page
- You can view this page .Touch the play button
- To get more idea about the Pascal's Law for fluid pressure through Experiment

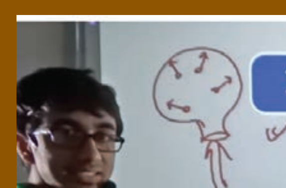


Step1



Step2

Step3



Step4

Web link: https://www.youtube.com/watch?v=dx2P7i1GPaw

(or) scan the QR Code

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*Pictures are indicative only

UNIT 3

LIGHT

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Learning Objectives

At the end of this lesson, students will be able to:

- Acquire knowledge about various types of mirrors.
- Understand image formation in spherical mirrors.
- Know the applications of spherical mirrors.
- Acquire knowledge about laws of reflection.
- Compare regular and irregular reflections.
- Know the working principle of kaleidoscope and periscope.
- Understand refraction and dispersion of light.

Introduction

Lofty mountains covered with greenish vegetation, magnificent trees reaching up to the clouds, beautiful streams drifting down the valleys, bluish sea water roaring towards the coast and the radiant sky in the morning being filled with golden red color, all give delight to our eyes and peace to our mind. But, can we see them all without light? No, because, we can see things around us only when the light reflected by them reaches our eyes.

Light is a form of energy and it travels in a straight line. You have studied in your lower classes, how it is reflected by the polished surfaces such as plane mirrors. In this lesson, you will study about other types of mirrors like the spherical mirrors and parabolic mirrors and their applications in our daily life. You will also study about the laws of reflection and the laws of refraction and some of the optical instruments, such as periscope and kaleidoscope, which work on these principles.

3.1 Types of Mirrors

We use mirrors in our daily life for various purposes. We use them for decoration. In vehicles, they are used as rear view mirrors. They are also used in scientific apparatus, like telescope. The mirror is an optical device with a polished surface that reflects the light falling on it. A typical mirror is a glass sheet coated with aluminium or silver on one of its sides to produce an image. Mirrors have a plane or curved surface. Curved mirrors have surfaces that are spherical, cylindrical, parabolic and ellipsoid. The shape of a mirror determines the type of image it forms. Plane mirrors form the perfect image of an object. Whereas, curved mirrors produce images that are either enlarged or diminished. You would have studied about plane mirrors in your lower classes. In this section, you will study about spherical and parabolic mirrors.

Mirrors
- Plane mirrors
- Curved mirrors
  - Spherical mirror
  - Cylindrical mirror
  - Parabolic mirror
  - Ellipsoid mirror

DO YOU KNOW?

Method of coating a glass plate with a thin layer of reflecting metals was in practice during the 16th century in Venice, Italy. They used an amalgam of tin and mercury for this purpose. Nowadays, a thin layer of molten aluminium or silver is used for coating glass plates that will then become mirrors.

3.1.1 Spherical mirrors

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Spherical mirrors are one form of curved mirrors. If the curved mirror is a part of a sphere, then it is called a 'spherical mirror'. It resembles the shape of a piece cut out from a spherical surface. One side of this mirror is silvered and the reflection of light occurs at the other side.

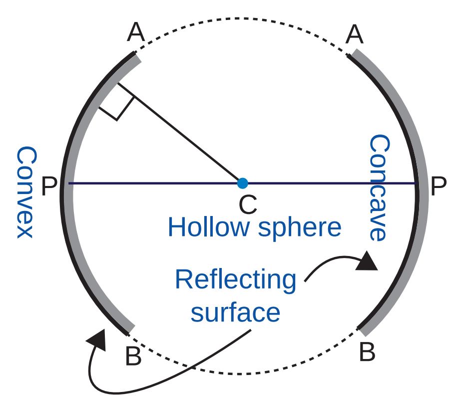


Figure 3.1 Spherical mirror

Concave mirrors

A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror. *These mirrors magnify the object placed close to them.* The most common example of a concave mirror is the make-up mirror.

Convex mirror

A spherical mirror, in which the reflection of light occurs at its convex surface, is called a convex mirror. *The image formed by these mirrors is smaller than the object.* Most common convex mirrors are rear viewing mirrors used in vehicles.

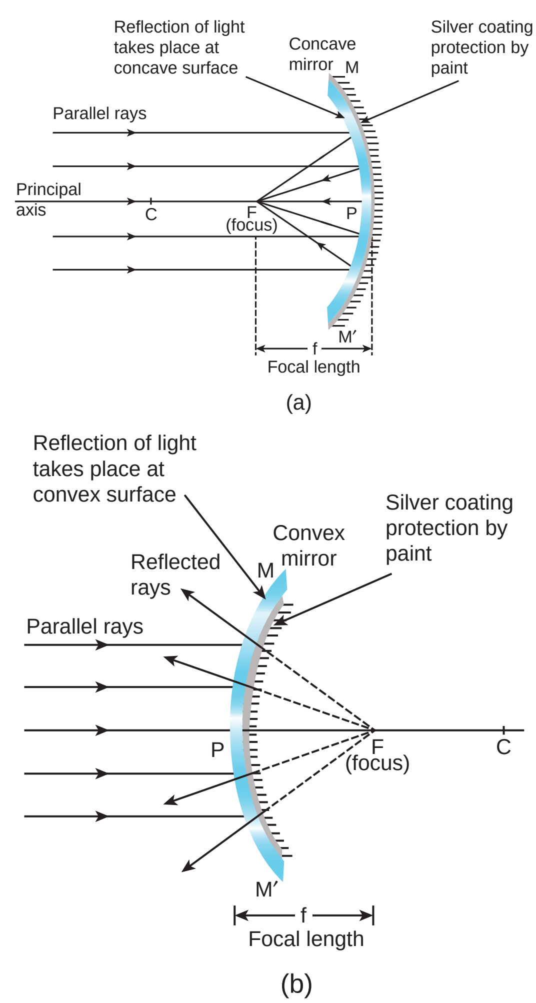


Figure 3.2 Concave and Convex mirrors

DO YOU KNOW?

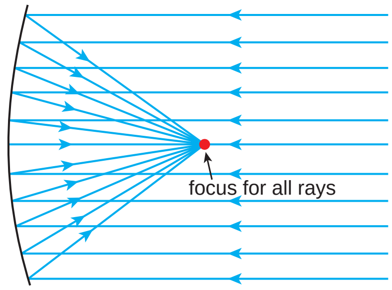
Convex mirrors used in vehicles as rear-view mirrors are labeled with the safety warning: 'Objects in the mirror are closer than they appear' to warn the drivers. This is because inside the mirrors, vehicles will appear to be coming at a long distance.

3.1.2 Parabolic mirrors

A parabolic mirror is one type of curved mirror, which is in the shape of a parabola. It has a concave reflecting surface and this surface directs the entire incident beam of light to converge at its focal point.

In the same way, light rays generated by the source placed at this focal point will fall on this surface and they will be diverged in a direction, which is parallel to the principal axis of the parabolic mirror. Hence, the light rays will be reflected to travel a long distance, without getting diminished.

Parabolic mirrors, also known as parabolic reflectors, are used to collect or project energy such as light, heat, sound and radio waves. They are used in reflecting telescopes, radio telescopes and parabolic microphones. They are also used in solar cookers and solar water heaters.



A Parabolic Mirror

Figure 3.3 Parabolic mirror

DO YOU KNOW?

The principle behind the working of a parabolic mirror has been known since the Greco-Roman times. The first mention of these structures was found in the book, 'On Burning Mirrors', written by the mathematician Diocles. They were also studied in the 10^{th} century, by a physicist called Ibn Sahl. The first parabolic mirrors were constructed by Heinrich Hertz, a German physicist, in the form of reflector antennae in the year 1888.

3.2 TERMS RELATED TO SPHERICAL MIRRORS

In order to understand the image formation in spherical mirrors, you need to know about some of the terms related to them.

Center of Curvature: It is the center of the sphere from which the mirror is made. It is denoted by the letter **C** in the ray diagrams. (A ray diagram represents the formation of an image by the spherical mirror. You will study about them in your next class).

Pole: It is the geometric centre of the spherical mirror. It is denoted by the letter **P**.

Radius of Curvature: It is the distance between the center of the sphere and the vertex. It is shown by the letter **R** in ray diagrams. (*The **vertex** is the point on the mirror's surface where the principal axis meets the mirror.* It is also called as '**pole**'.)

Principal Axis: The line joining the pole of the mirror and its center of curvature is called principal axis.

Focus: When a beam of light is incident on a spherical mirror, the reflected rays converge (concave mirror) at or appear to diverge from (convex mirror) a point on the principal axis. This point is called the 'focus' or 'principal focus'. It is also known as the focal point. It is denoted by the letter **F** in ray diagrams.

Focal length: The distance between the pole and the principal focus is called focal length (f) of a spherical mirror.

There is a relation between the focal length of a spherical mirror and its radius of curvature. The focal length is half of the radius of curvature.

That is, focal length = $\frac{\text{Radius of curvature}}{2}$.

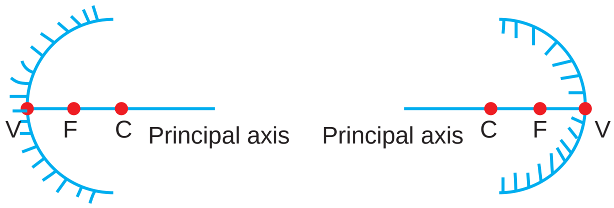


Figure 3.4 Terms related to a spherical mirror

PROBLEM 1

The radius of curvature of a spherical mirror is 20 cm. Find its focal length.

Solution:

Radius of curvature = 20 cm

Focal length (f) = $\frac{\text{Radius of curvature}}{2}$

$= \frac{R}{2} = \frac{20}{2} = 10 \text{ cm}$

PROBLEM 2

Focal length of a spherical mirror is 7 cm. What is its radius of curvature?

Solution:

Focal length = 7 cm

Radius of curvature (R) = 2 × focal length = 2 × 7 = 14 cm

3.3 IMAGES FORMED BY SPHERICAL MIRRORS

Images formed by spherical mirrors are of two types: i) real image and ii) virtual image. Real images can be formed on a screen, while virtual images cannot be formed on a screen.

Image formed by a convex mirror is always erect, virtual and diminished in size. As a result, images formed by these mirrors cannot be projected on a screen.

The characteristics of an image are determined by the location of the object. As the object gets closer to a concave mirror, the image gets larger, until attaining approximately the size of the object, when it reaches the centre of curvature of the mirror. As the object moves away, the image diminishes in size and gets gradually closer to the focus, until it is reduced to a point at the focus when the object is at an infinite distance from the mirror.

The size and nature of the image formed by a convex mirror is given in Table 3.1.

Concave mirrors form a real image and it can be caught on a screen. Unlike convex mirrors, concave mirrors show different image types. Depending on the position of the object in front of the mirror, the position, size and nature of the image will vary. Table 3.2 provides a summary of images formed by a concave mirror.

Table 3.1 Image formed by a convex mirror

POSITION OF THE OBJECT	POSITION OF THE IMAGE	IMAGE SIZE	NATURE OF THE IMAGE
At infinity	At F	Highly diminished, point sized	Virtual and erect
Between infinity and the pole (P)	Between P and F	Diminished	Virtual and erect

Table 3.2 Image formed by a concave mirror

POSITION OF THE OBJECT	POSITION OF THE IMAGE	IMAGE SIZE	NATURE OF THE IMAGE
At infinity	At F	Highly diminished	Real and inverted
Beyond C	Between C and F	Diminished	Real and inverted
At C	At C	Same size as the object	Real and inverted
Between C and F	Beyond C	Magnified	Real and inverted
At F	At infinity	Highly magnified	Real and inverted
Between F and P	Behind the mirror	Magnified	Virtual and erect

You can observe from the table that a concave mirror always forms a real and inverted image except when the object is placed between the focus and the pole of the mirror. In this position, it forms a virtual and erect image.

Activity 1

Take a curved silver spoon and see the image formed by it. Now, turn it and find the image formed. Do you find any difference? Find out the reason.

3.4 APPLICATIONS OF CURVED MIRRORS

Concave mirrors

1. Concave mirrors are used while applying make-up or shaving, as they provide a magnified image.
2. They are used in torches, search lights and head lights as they direct the light to a long distance.
3. They can collect the light from a larger area and focus it into a small spot. Hence, they are used in solar cookers.
4. They are used as head mirrors by doctors to examine the eye, ear and throat as they provide a shadow-free illumination of the organ.
5. They are also used in reflecting telescopes.

Figure 3.3 Concave mirrors

Convex mirrors

1. Convex mirrors are used in vehicles as rear view mirrors because they give an upright image and provide a

wider field of view as they are curved outwards.

2. They are found in the hallways of various buildings including hospitals, hotels, schools and stores. They are usually mounted on a wall or ceiling where hallways make sharp turns.
3. They are also used on roads where there are sharp curves and turns.

Figure 3.3 Convex mirrors

Activity 2

List out various convex and concave mirrors used in your daily life.

3.5 LAWS OF REFLECTION

Activity 3

Take a plane mirror and try to focus the light coming from the Sun on a wall. Can you see a bright spot on the wall? How does it occur? It is because the light rays falling on the mirror are bounced onto the wall by it. Can you produce the same bright spot with the help of any other object having a rough surface?

Not all the objects can produce the same effect as produced by the plane mirror. A ray of light, falling on a body having a shiny, polished and smooth surface alone is bounced back. This bouncing back of the light rays as they fall on the smooth, shiny and polished surface is called reflection.

Reflection involves two rays: i) incident ray and ii) reflected ray. The incident ray is the light ray in a medium falling on the shiny surface of a reflecting body. After falling on the surface, this ray returns into the same medium. This ray is called the reflected ray. An imaginary line perpendicular to the reflecting surface, at the point of incidence of the light ray, is called the normal.

The relation between the incident ray, the reflected ray and the normal is given as the law of reflection. The laws of reflection are as follows:

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- The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.
- The angle of incidence and the angle of reflection are always equal.

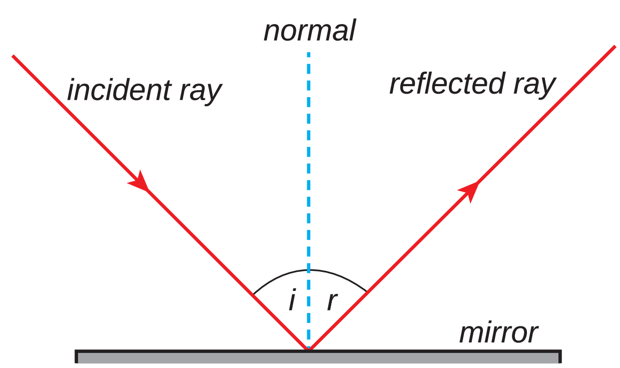


Figure 3.7 Reflection of light

DO YOU KNOW?

Silver metal is the best reflector of light. That's why a thin layer of silver is deposited on the side of materials like plane glass sheets, to make mirrors.

3.6 TYPES OF REFLECTION

You have learnt that not all bodies can reflect light rays. The amount of reflection depends on the nature of the reflecting surface of a body. Based on the nature of the surface, reflection can be classified into two types namely, i) regular reflection and ii) irregular reflection.

3.6.1 Regular reflection

When a beam of light (collection of parallel rays) falls on a smooth surface, it gets reflected. After reflection, the reflected rays will be parallel to each other. Here, the angle of incidence and the angle of reflection of each ray will be equal. Hence, the law of reflection is obeyed in this case and thus a clear image is formed. This reflection is called 'regular reflection' or 'specular reflection'. Example: Reflection of light by a plane mirror and reflection of light from the surface of still water.

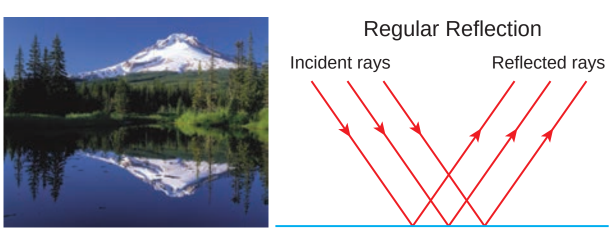


Figure 3.8 Regular reflection

3.6.2 Irregular reflection

In the case of a body having a rough or irregular surface, each region of the surface is inclined at different angles. When light falls on such a surface, the light rays are reflected at different angles. In this case, the angle of incidence and the angle of reflection of each ray are not equal. Hence, the law of reflection is not obeyed in this case and thus the image is not clear. Such a reflection is called 'irregular reflection' or 'diffused reflection'. Example: Reflection of light from a wall.

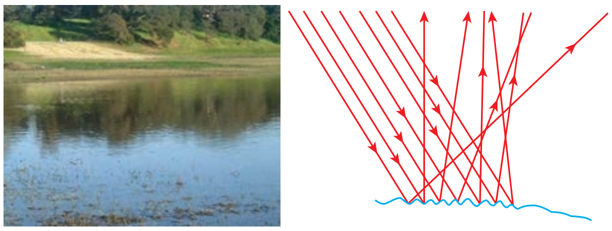
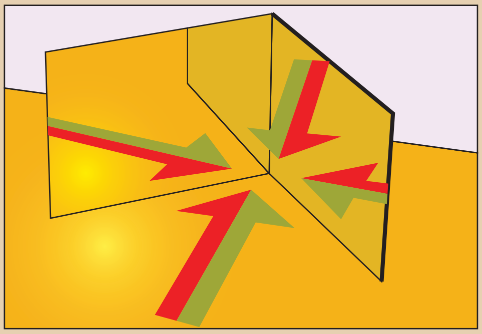


Figure 3.8 Irregular reflection

3.7 MULTIPLE REFLECTIONS

Activity 4

Take two plane mirrors and keep them perpendicular to each other. Place an object between them. You can see the images of the object. How many images do you see in the mirrors? You can see three images. How is it possible to have three images with two mirrors?



In the activity given above, you observed that for a body kept in between two plane mirrors, which were inclined to each other, you could see many images. This is because, the 'image' formed by one mirror acts as an 'object' for the other mirror. The image formed by the first mirror acts as an object for the second mirror and the image formed by the second mirror acts as an object for the first mirror. Thus, we have three images of a single body. This is known as multiple reflection. This type of reflections can be seen in show rooms and saloons.

The number of images formed, depends on the angle of inclination of the mirrors. If the angle between the two mirrors is a factor of 360°, then the total number of reflections is finite. If θ (Theta) is the angle of inclination of the plane mirrors, the number of images formed = $\frac{360°}{\theta} - 1$. As you decrease this angle, the number of images formed increases. When they are parallel to each other, the number of images formed becomes infinite.

PROBLEM 3

If two plane mirrors are inclined to each other at an angle of 90°, find the number of images formed.

Solution:

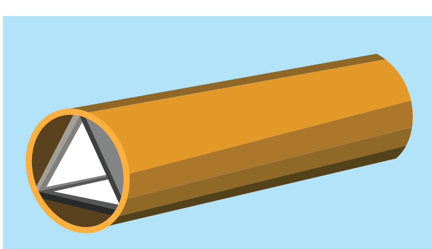
Angle of inclination = 90°

Number of images formed =

$$\frac{360°}{\theta} - 1 = \frac{360°}{90°} - 1 = 4 - 1 = 3$$

3.7.1 Kaleidoscope

It is a device, which functions on the principle of multiple reflection of light, to produce numerous patterns of images. It has two or more mirrors inclined with each other. It can be designed from inexpensive materials and the colourful image patterns formed by this will be pleasing to you. This instrument is used as a toy for children.



Kaleidoscope

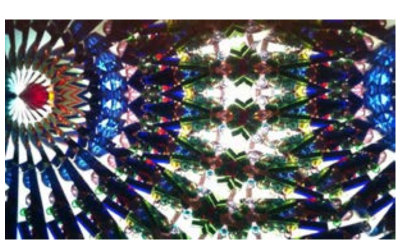


Figure 3.10 Image formed in a Kaleidoscope

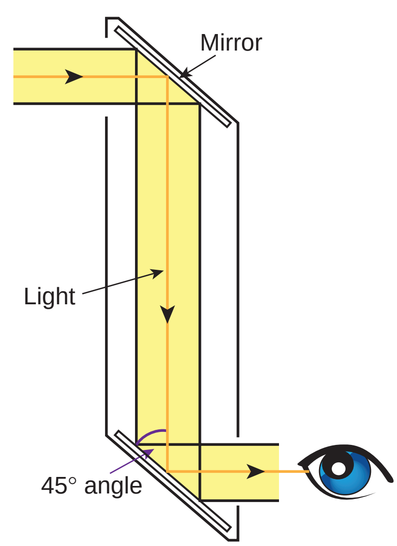
Activity 5

Take three equal sized plane mirror strips and arrange them in such a way that they form an equilateral triangle. Cover the sides of the mirrors with a chart paper. With the help of a chart paper cover the bottom of the mirrors also. Put some coloured things such as pieces of bangles and beads inside it. Now, cover the top portion with the chart paper and make a hole in it to see. You can wrap the entire piece with coloured papers to make it attractive. Now, rotate it and see through its opening. You can see the beautiful patterns.

CAUTION: Be careful while handling the glass pieces. Do this under the supervision of your teacher.

3.7.2 Periscope

It is an instrument used for viewing bodies or ships, which are over and around another body or a submarine. It is based on the principle of the law of reflection of light. It consists of a long outer case and inside this case mirrors or prisms are kept at each end, inclined at an angle of 45°. Light coming from the distant body, falls on the mirror at the top end of the periscope and gets reflected vertically downward. This light is reflected again by the second mirror kept at the bottom, so as to travel horizontally and reach the eye of the observer. In some complex periscopes, optic



fibre is used instead of mirrors for obtaining a higher resolution. The distance between the mirrors also varies depending on the purpose of using the periscope.

Uses

- It is used in warfare and navigation of the submarine.
- In military it is used for pointing and firing guns from a 'bunker'.
- Photographs of important places can be taken through periscopes without trespassing restricted military regions.
- Fibre optic periscopes are used by doctors as endoscopes to view internal organs of the body.

Figure 3.11 Periscope used in Submarine

3.8 REFRACTION OF LIGHT

We know that when a light ray falls on a polished surface placed in air, it is reflected into the air itself. When it falls on a transparent material, it is not reflected completely, but a part of it is reflected and a part of it is absorbed and most of the light passes through it. Through air, light travels with a speed of 3×10^8 m s^{-1}, but it cannot travel with the same speed in water or glass, because, optically denser medium such as water and glass offer some resistance to the light rays.

So, light rays travelling from a rarer medium like air into a denser medium like glass or water are deviated from their straight line path. This bending of light about the normal, at the point of incidence; as it passes from one transparent medium to another is called refraction of light.

When a light ray travels from the rarer medium into the denser medium, it bends towards the normal and when it travels from the denser medium into the rarer medium, it bends away from the normal. You can observe this phenomenon with the help of the activity given below.

Activity 6

Take a glass beaker, fill it with water and place a pencil in it. Now, look at the pencil through the beaker. Does it appear straight? No. It will appear to be bent at the surface of the water. Why?

In this activity, the light rays actually travel from the water (a denser medium) into the air (a rarer medium). As you saw earlier, when a light ray travels from a denser medium to a rarer medium, it is deviated from its straight line path. So, the pencil appears to be bent when you see it through the glass of water.

3.8.1 Refractive Index

Refraction of light in a medium depends on the speed of light in that medium. When the speed of light in a medium is more, the bending is less and when the speed of light is less, the bending is more.

8ZPIP5

The amount of refraction of light in a medium is denoted by a term known as refractive index of the medium, which is the ratio of the speed of light in the air to the speed of light in that particular medium. It is also known as the absolute refractive index and it is denoted by the Greek letter 'μ' (pronounced as 'mew').

$$\mu = \frac{\text{Speed of light in air (c)}}{\text{Speed of light in the medium (v)}}$$

Refractive index is a ratio of two similar quantities (speed) and so, it has no unit. Since, the speed of light in any medium is less than its speed in air, refractive index of any transparent medium is always greater than 1.

Refractive indices of some common substances are given in Table 3.3.

Table 3.3 Refractive Index of substances

SUBSTANCES	REFRACTIVE INDEX
Air	1.0
Water	1.33
Ether	1.36
Kerosene	1.41
Ordinary Glass	1.5
Quartz	1.56
Diamond	2.41

In general, the refractive index of one medium with respect to another medium is given by the ratio of their absolute refractive indices.

$${}_1\mu_2 = \frac{\text{Absolute refractive index of the second medium}}{\text{Absolute refractive index of the first medium}}$$

$${}_1\mu_2 = \frac{\frac{c}{V_2}}{\frac{c}{V_1}} \quad \text{or} \quad {}_1\mu_2 = \frac{V_1}{V_2}$$

Thus, the refractive index of one medium with respect to another medium is also given by the ratio of the speed of light in first medium to its speed in the second medium.

PROBLEM 4

Speed of light in air is 3×10^8 m s^{-1} and the speed of light in a medium is 2×10^8 ms^{-1}. Find the refractive index of the medium with respect to air.

Solution:

$$\text{Refractive index } (\mu) = \frac{\text{Speed of light in air (c)}}{\text{Speed of light in the medium (v)}}$$

$$\mu = \frac{3 \times 10^8}{2 \times 10^8} = 1.5$$

PROBLEM 5

Refractive index of water is 4/3 and the refractive index of glass is 3/2. Find the refractive index of glass with respect to the refractive index of water.

Solution:

$${}_w\mu_g = \frac{\text{Refractive index of glass}}{\text{Refractive index of water}} = \frac{\frac{3}{2}}{\frac{4}{3}} = \frac{9}{8} = 1.125$$

3.8.2 Snell's Law of Refraction

Refraction of light rays, as they travel from one medium to another medium, obeys two laws, which are known as Snell's laws of refraction. They are:

I) The incident ray, the refracted ray and the normal at the point of intersection, all lie in the same plane.

II) The ratio of the sine of the angle of incidence (i) to the sine of the angle of refraction (r) is equal to the refractive index of the medium, which is a constant.

$$\frac{\sin i}{\sin r} = \mu$$

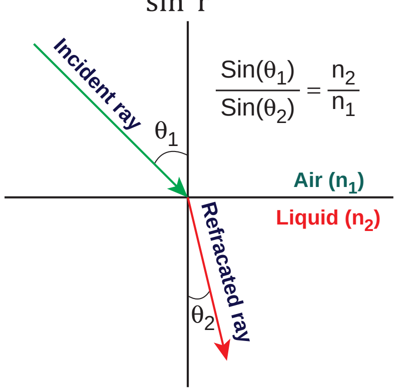


Figure 3.12 Snell's Law

3.9 DISPERSION

Activity 7

Place a prism on a table and keep a white screen near it. Now, with the help of a torch, allow white light to pass through the prism. What do you see? You can observe that white light splits into seven colored light rays namely, violet, indigo, blue, green, yellow, orange and red (VIBGYOR) on the screen. Now, place another prism in its inverted position, between the first prism and the screen. Now, what do you observe on the screen? You can observe that white light is coming out of the second prism.

In the above activity, you can see that the first prism splits the white light into seven coloured light rays and the second prism recombines them into white light, again. Thus, ***it is clear that white light consists of seven colours.*** You can also recall the Newton's disc experiment, which you studied in VII standard.

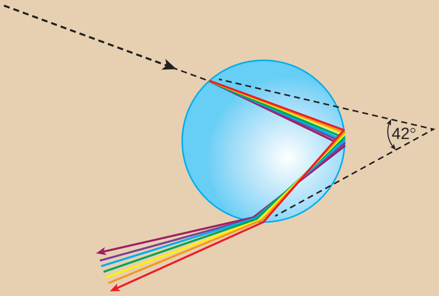
Splitting of white light into its seven constituent colours (wavelength), on passing through a transparent medium is known as dispersion of light.

Why does dispersion occur? It is because, light of different colours present in white light have different wavelength and they travel at different speeds in a medium. You know that refraction of a light ray in a medium depends on its speed. As each coloured light has a different speed, the constituent coloured lights are refracted at different extents, inside the prism. ***Moreover, refraction of a light ray is inversely proportional to its wavelength.***

Thus, the red coloured light, which has a large wavelength, is deviated less while the violet coloured light, which has a short wavelength, is deviated more.

DO YOU KNOW?

The formation of rainbow is an example of dispersion of white light. This can be seen on the opposite side of the Sun. After a rainfall, large number of droplets still remain suspended in the air. When white light passes through them, it is split into seven colours. Dispersion of white light from a large number of droplets eventually forms a rainbow.



Points to remember

- Mirror is an optical device with a polished surface that reflects the light falling on it.
- Curved mirrors have surfaces that are spherical, cylindrical, parabolic and ellipsoid.
- If the curved mirror is a part of a sphere, then it is called a 'spherical mirror'.
- A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror.
- A spherical mirror, in which the reflection of light occurs at its convex surface, is called a convex mirror.
- Parabolic mirrors, also known as parabolic reflectors, are used to collect or project energy such as light, heat, sound and radio waves.

- The focal length of a spherical mirror is half of its radius of curvature.
- Real images can be formed on a screen, while virtual images cannot be formed on a screen.
- Concave mirrors form a real image and it can be caught on a screen.
- Concave mirrors are used as make-up mirrors.
- Convex mirrors are used in vehicles as rear view mirrors.
- The laws of reflection are: The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.The angle of incidence and the angle of reflection are always equal.
- Based on the nature of the surface, reflection can be classified in to two types namely, i) regular reflection and ii) irregular reflection.
- The number of images formed by a mirror depends on the angle of inclination of the mirrors.
- Snell's laws of refraction are: The incident ray, the refracted ray and the normal at the point of intersection, all lie in the same plane; The ratio of the sine of the angle of incidence (i) to the sine of the angle of refraction (r) is equal to the refractive index of the medium, which is a constant.

A-Z GLOSSARY

Mirror	Glass sheet coated with aluminium or silver on one of its sides to produce an image.
Center of Curvature	The center of the sphere from which the mirror is made.
Radius of Curvature	Distance between the center of the sphere and the vertex.
Pole	Point on the mirror's surface where the principal axis meets the mirror.
Principal Axis	Line joining the pole of the mirror and its center of curvature.
Focus	Point where the reflected rays converge at or appear to diverge from a point on the principal axis.
Focal length	Distance between the pole and the principal focus.
Reflection	Bouncing back of the light rays as they fall on the smooth, shiny and polished surface.
Specular reflection	Reflection that obeys the laws of reflection and produces a clear image.
Diffused reflection	Reflection that does not obey the laws of reflection and does not produce a clear image.
Kaleidoscope	Device, which produces numerous and wonderful image patterns.
Periscope	Instrument used for viewing objects, which are over and around another body.
Refraction of light	Bending of light about the normal, at the point of incidence; as it passes from one transparent medium to another.
Refractive index	Ratio of the speed of light in the air to the speed of light in that particular medium.
Dispersion of light	Splitting of white light into its seven constituent colours (wavelength).

TEXT BOOK EXERCISES

ML5WHN

I. Choose the best answer.

1. Mirrors having a curved reflecting surface are called as
   a) plane mirrors b) spherical mirrors
   c) simple mirrors d) None of the above
2. The spherical mirror with a reflecting surface curved inward is called
   a) convex mirror b) concave mirror
   c) curved mirror d) None of the above
3. The centre of a sphere of which the reflecting surface of a spherical mirror is a part is called
   a) pole
   b) centre of curvature
   c) cradius of curvature
   d) aperture
4. The spherical mirror used as a rear view mirror in the vehicle is
   a) concave mirror b) convex mirror
   c) plane mirror d) None of the above
5. The imaginary line passing through the centre of curvature and pole of a spherical mirror is called
   a) centre of curvature b) pole
   c) principal axis d) radius curvature
6. The distance from the pole to the focus is called
   a) Pole length b) focal length
   c) principal axis d) None of the above
7. Focal length is equal to half of the
   a) centre of curvature b) axis
   c) radius of curvature d) None of the above
8. If the focal length of a spherical mirror is 10 cm, what is the value of its radius of curvature?
   a) 10 cm b) 5 cm
   c) 20 cm d) 15 cm
9. If the image and object distance is same, then the object is placed at
   a) infinity b) at F
   c) between f and P d) at C
10. The refractive index of water is
   a) 1.0 b) 1.33
   c) 1.44 d) 1.52

II. Fill in the blanks.

1. The spherical mirror used in a beauty parlour as make-up mirror is ____________.
2. Geometric centre of the spherical mirror is ____________.
3. Nature of the images formed by a convex mirror is ____________.
4. The mirror used by the ophthalmologist to examine the eye is ____________.
5. It the angle of incidence is 45°, then the angle of reflection is _________.
6. Two mirrors are parallel to each other, then the number of images formed is ___________.

III. Match the following.

A)

1. Convex mirror	-	a. Radio telescopes
2. Parobolic mirror	-	b. wall
3. Regular reflection	-	c. rear – view mirror
4. Irregular reflection	-	d. Plane mirror

B)

1. Snell's law	-	a. Kaleidoscopce
2. Dispersion of light	-	b. sin i/sin r =μ
3. Refractive index	-	c. Rainbow
4. Multiple reflection	-	d. c/v = μ

IV. Answer in brief.

1. What is called a spherical mirror?
2. Define focal length?
3. The radius of curvature of a spherical mirror is 25 cm. Find its focal length.
4. Give two applications of a concave and convex mirror.
5. State the laws of reflection.
6. If two plane mirrors are inclined to each other at an angle of 45°, find the number of images formed.
7. Define the refractive index of a medium.
8. State the Snell's law of refraction

V. Answer in detail.

1. Explain the images formed by a concave mirror?
2. What is reflection? Write short notes on regular and irregular reflection?
3. Explain the working of a periscope.
4. What is dispersion? Explain in detail.
5. Speed of light in air is 3×10^8 m s^{-1} and the refractive index of a medium is 1.5. Find the speed of light in the medium.

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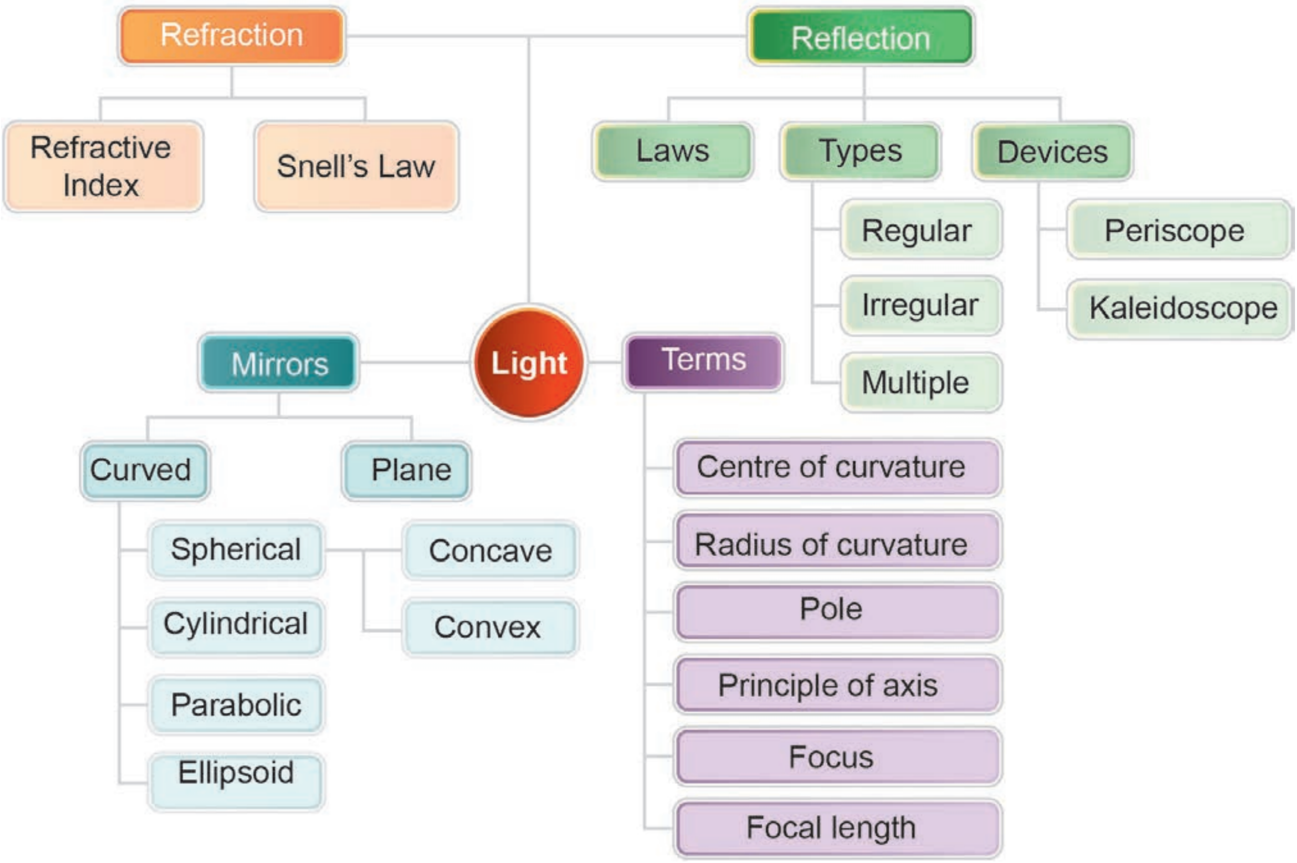
INTERNET RESOURCES

1. https://farside.ph.utexas.edu
2. https://britannica.com
3. https://studyread.com
4. https://sciencelearn.org

MIND MAP


Refraction
Refractive Index
Snell's Law
Reflection
Laws
Types
Devices
Regular
Irregular
Multiple
Periscope
Kaleidoscope
Mirrors
Light
Terms
Curved
Plane
Spherical
Cylindrical
Parabolic
Ellipsoid
Concave
Convex
Centre of curvature
Radius of curvature
Pole
Principle of axis
Focus
Focal length

UNIT 9

INTRODUCTION TO THE INFORMATION AGE

Learning Objectives

At the end of this lesson students will be able to:

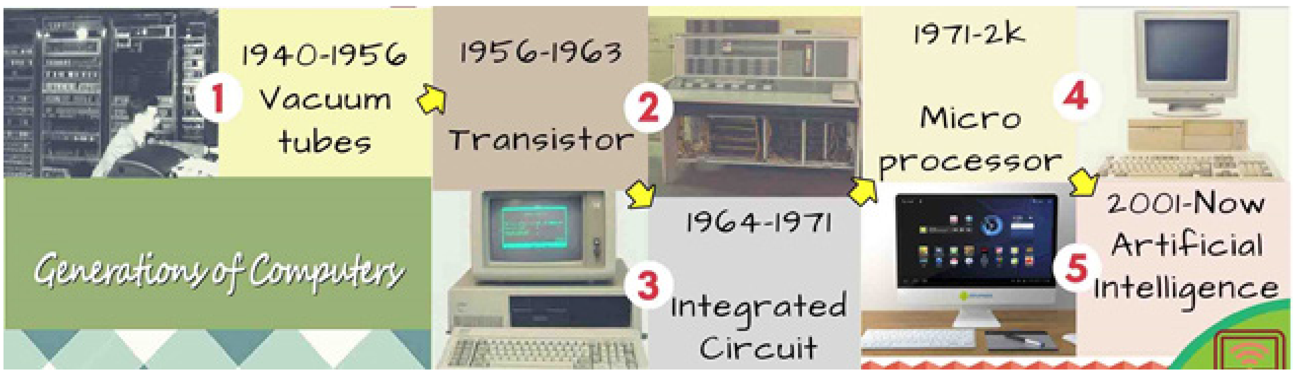
- To know about the computer.
- To know the history of computer.
- To identify Software and Hardware of a computer
- To know the Input unit, CPU and the Output unit.
- To distinguish the features of Hardware and software

Generation of Computers

A Computer is an electronic machine that accepts data, stores and processes data into information. Computer follow instructions, called programs which determine the tasks the computer will perform, the computer is able to work because there are instructions in its memory directing it. In the beginning of 19th century, Charles Babbage, a professor in Mathematics has designed an analogue computer. He is known as the father of computer

Generation of Computers

SN	GENERATION	PERIOD	MAIN COMPONENT USED
1.	First generation	1942-1955	Vacuum tubes
2.	Second generation	1955-1964	Transistors
3.	Third generation	1964-1975	Integrated Circuits(IC)
4.	Fourth generation	1975-1980	Microprocessor
5.	Fifth generation	1980 – till date	Artificial Intelligence



Parts of a Computer

Input Unit

Central Processing Unit (CPU)

Output Unit

Input Unit

The input unit helps to send the data and commands for the processing.

The hardware devices that are used to input data are called input devices.Keyboard, Mouse, Scanner, Barcode reader, Microphone-Mic, Web camera, Light Pen, Joy stick is some of the input devices.

Mouse

Mouse is an essential part of the computer. The standard Mouse has two buttons and a scroll ball in the middle. The mouse is used to move the pointer on a computer screen. Right button is used to select files and to open the folder. Left button is used to carry out corrections in the file. The page on the monitor can be moved up and down using the scroll ball.

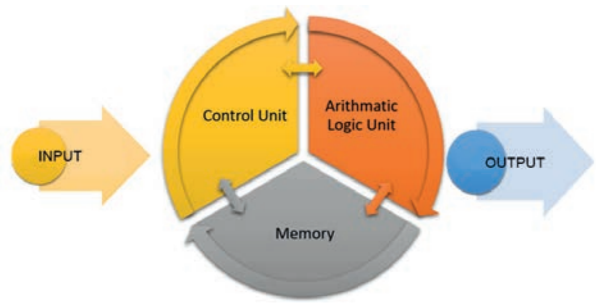
Keyboard

A keyboard is an input device, as is a mouse. A keyboard delivers data in the form of letters, numbers and symbols to the computer .The keys used to type the keys with numbers are called number keys and key with letters are called alphabet keys. Numbers 0,1,2,3,4,5,6,7,8,9 are called number keys and keys with letters A to Z are called Alphabet Keys.

Central Processing Unit (CPU)

CPU is the brain of the Computer. The data is processed in the CPU. The CPU has namely three parts.

1. Memory Unit; 2. Arithmetic Logic -Unit (ALU); 3. Control Unit



Control Unit

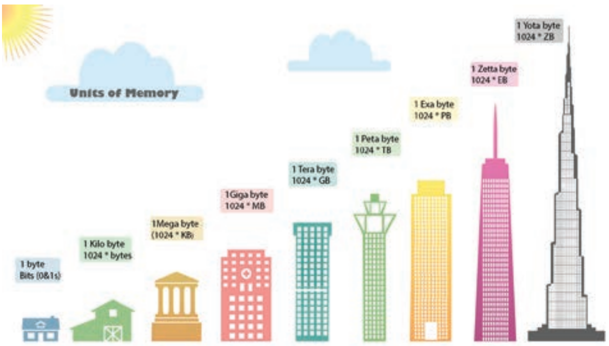
The control unit controls the functions of all the parts of the computer.

Arithmetic Logic Unit

Arithmetic and Logic unit performs all the arithmetic computations like addition, subtraction, multiplication and division.

Memory Unit :

The memory unit in the computer saves all data and information temporarily. We can classify memory unit into two types namely primary and secondary memory. Memory can be expanded externally with the help of Compact Disk (CD), Pendrive, etc.



Output Unit

The output unit converts, the command received by the computer in the form of binary signals into easily understandable characters. Monitor, Printer, Speaker, scanner are some of the output devices.

Classification of Computer

The computers can be classified based on their design, shape, speed, efficiency, working of the memory unit and their applications.

Mainframe Computer
Mini Computer
Micro or Personal Computer
Super Computer


Mainframe


Mini computer


Micro personal computer


Super computer

Personal computer and its types

Personal computer comes under the microcomputer category. Based on the memory and efficiency they can be classified as

1. Desktop; 2. Laptop; 3. Tablet


Desktop


Laptop


Tablet

Hardware

Hardware is the parts of a computer which we can touch and feel. Hardware includes Input and Output devices, Cabinet, Hard Disk, Mother Board, SMPS, CPU, RAM, CD Drive and Graphics Card.

Software

Hardware is lifeless without software in a computer. Softwares are programmed and coded applications to process the input information. The software processes the data by converting the input information into coding or programmed language. Touching and feeling the software is not possible but we can see the functions of the software in the form of output.

Types of Software

The software is divided into two types based on the process. They are

1. System Software (Operating System)
2. Application software

System Software

System Software (Operating system) is software that makes the hardware devices to process the inputted data and to display the result on the output devices like Monitor. Without the operating systems, computer cannot function on its own. Some of the popular operating system are Linux, Windows, Mac, Android etc.

Application Software

Application software is a program or a group of programs designed for the benefit of end user to work on computer. The application programs can be installed in the hard disk for the usage on a particular computer. This type of application program completes one or more than two works of the end user. The following are the examples of application program: Video player, Audio player, Word processing software, Drawing tools, Editing software, etc.

Software
Set of programs that governs the functioning of computer

System Software
Controls the internal computer operation

System Management Program
1. Operating System
2. Device Drivers
3. System utilities

Developing Software
1. Programming Language
2. Language Translator
3. Linker
4. Loder. etc

Application Software
Carries ut necessary operation for a specified application to function

General Purpose Software
1. Word Processor
2. Presentation
3. Spread Sheet
4. Image Editor. etc.

Specific Purposel Software
1. Reservation System
2. Attendance System
3. Billing System
4. Report card Generator. etc.

TEXT BOOK EXERCISES

RULSQY

I. Choose the correct answer

1. Who is the father of computer?
   a) Martin Luther King
   b) Graham Bell
   c) Charlie Chaplin
   d) Charles Babbage

2. Which one of the following is an output device?
   a) Mouse b) Keyboard
   c) Speaker d) Pendrive

3. Which one of the following is an input device?
   a) Speaker b) Keyboard
   c) Monitor d) Printer

4. Pen drive is ____________device.
   a) Output b) Input
   c) Storage d) Connecting cable

5. Fifth generation computer has ___________ Intelligence.
   a) Transistors b) Integrated Circuits
   c) Microprocessor d) Artificial Intelligence

II. Match the following :

Column A	Column B
Keyboard	RAM
Fourth generation Computer	Input device
Hardware	Integrated Circuits
Third generation Computer	Drawing tools
Application Software	Microprocessor

III. Give short answer :

1. What is a Computer?
2. Name the parts of a computer
3. What is Hardware and Software?

UNIT 1

HEAT

I8X5R1

Learning Objectives

After completing this lesson students will be able to:

- understand the effects of heat.
- explain the transfer of heat.
- know about calorimetry.
- calculate heat capacity and specific heat capacity of substances.
- list out the functions of thermostat.
- know about the working of thermos flask.

Introduction

All the substances in our surrounding are made up of atoms and molecules. These atoms and molecules are always at vibratory motion. Due to this motion substances have an energy known as heat energy. This energy flows from hot substances to cold substances or from hot region to cold region of a substance. When heat energy is supplied to any substance it increases the energy of the atoms and molecules in it and so they start to vibrate. These atoms and molecules which vibrate make other atoms and molecules to vibrate. Thus, heat energy is transferred from one part of the substance to other part. We can see this heat energy transfer in our daily life also. Heat energy brings about lot of changes. You will learn about this in this lesson. You will also study about transfer of heat and measurement of heat change.

1.1 Effects of Heat

When heat energy is supplied to any substance, it brings about many changes. There are three important changes that we can see in our daily life. They are:

- Expansion
- Increase in temperature
- Change in state

1.1.1 Expansion

Activity 1

Take a metal ball and a metal ring of suitable diameter. Pass the metal ball through the ring. You can observe that the metal ball can easily go through it. Now heat the metal ball and then try to pass it through the ring. It will not pass through the ring. Keep the metal ball on the ring for some time. In few minutes, it will fall through the ring.

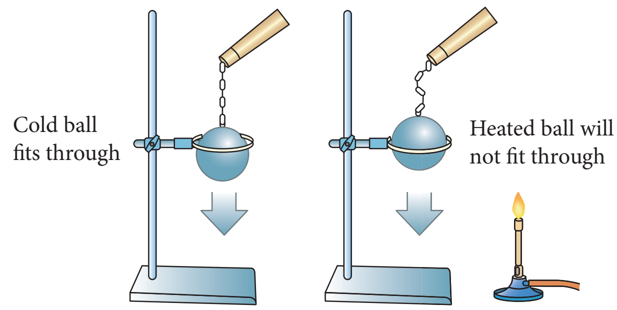


Figure 1.1 Expansion in Solids.

Why didn't the ball go through the ring initially but went through it after some time? When the ball is heated the atoms in the ball gain heat energy. They start vibrating and force each other apart. As a result an expansion takes place. That's why the ball did not go through the ring. After some time, as the ball lost the heat energy to the surrounding it came back to its original size and it went through the ring. This shows that heat energy causes expansion in solids. This expansion takes place in liquids and gases also. It is maximum in gases.

DO YOU KNOW?

You would have noticed some space being left in railway tracks. Why? It is because railway tracks which are made up of iron metal expand during summer. When there is a gap, there will not be any damage in the track due to expansion of the metal rod.

1.1.2 Rise in Temperature

Activity 2

Take a cup of water and note its temperature. Heat the water for few minutes and note the temperature again. Do you find any increase in the temperature? What caused the temperature change?

When the water is heated, water molecules receive heat energy. This heat energy supplied increases the kinetic energy of the molecules. When the molecules receive more energy, the temperature of the water increases. This shows that heat energy causes increase in temperature.

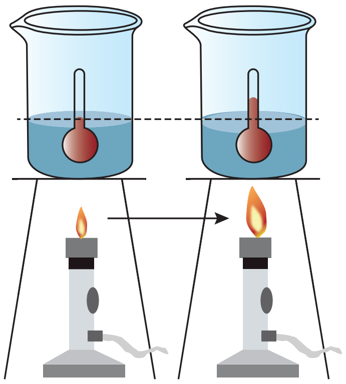


Figure 1.2 Heat energy changes the Temperature

1.1.3 Change of State

Activity 3

Take few ice cubes in a container and heat them for some time. What happens? The ice cubes melt and become water. Now heat the water for some time. What do you observe? The volume of water in the vessel decreases. What do you understand from this activity?

In ice cubes the force of attraction between the water molecules is more. So they are close together. When we heat them the force of attraction between the molecules decreases and the ice cubes become water. When we heat the water, the force of attraction decreases further. Hence they move away from one another and become vapour. Since water vapour escape to the surrounding, water level decreases further. From this we understand that heat energy causes change in the state of the substances. When heat energy is removed, changes take place in reverse direction.

If heat energy is supplied to or taken out from a substance, it will undergo a change from one state of matter to another. One of the following transformations may take place due to heat energy.

- Solid to Liquid (Melting)
- Liquid to Gas (Vapourisation)

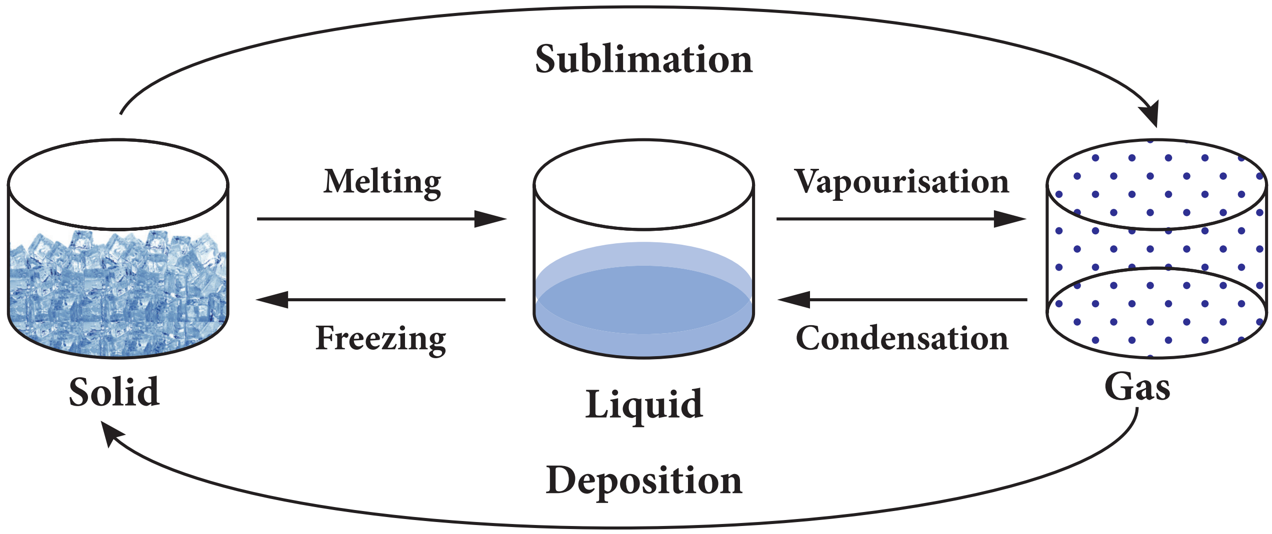


Figure 1.3 Change of state in Water.

- Solid to Gas (Sublimation)
- Gas to Liquid (Condensation)
- Liquid to Solid (Freezing)
- Gas to Solid (Deposition)

> **DO YOU KNOW?** Water is the only matter on the Earth that can be found naturally in all three states - Solid, Liquid and Gas.

1.2 Transfer of Heat

If heat energy is supplied to any substance, it will be transferred from one part of the substance to another part. It takes place in different ways depending on the state of the substance. Three ways of heat transfer are:

- Conduction
- Convection
- Radiation

1.2.1 Conduction

> **Activity 4**
>
> Take hot water in a cup and put a silver spoon in it. Leave the spoon inside the water for some time. Now touch the end of the spoon. Do you feel the heat?

How did the other end of the spoon become hot? It is because heat in the hot water is transferred from one end to other end of the spoon. In solid substances such as silver spoon, atoms are arranged very closely. Hot water molecules which are vibrating transfer the heat energy to the atoms in the spoon and make them vibrate. Those atoms make other atoms to vibrate and thus heat is transferred to the other end of the spoon.

In conduction heat transfer takes place between two ends of the same solid or through two solid substances that are at different temperatures but in contact with one another. Thus, we can define conduction as the process of heat transfer in solids from the region of higher temperature to the region of lower temperature without the actual movement of atoms or molecules.

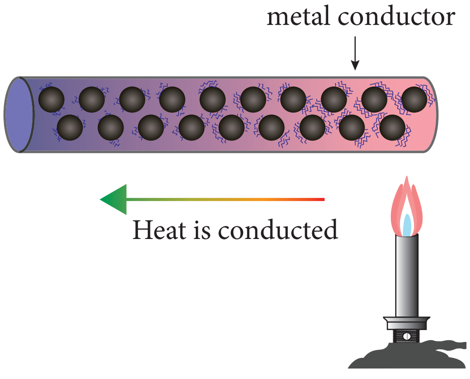


Figure 1.4 Conduction in Solids

All metals are **good conductors** of heat. The substances which does not conduct heat easily are called **bad conductors or insulators**. Wood, cork, cotton, wool, glass, rubber, etc are insulators.

Conduction in daily life

- We cook food in vessels made up of metals. When the vessel is heated, heat is transferred from the metal to the food.
- When we iron dresses heat is transferred from the iron to the cloth.
- Handles of cooking utensils are made up of plastic or wood because they are poor conductors of heat.
- The temperature inside igloo (snow house) is warm because snow is a poor conductor of heat.

1.2.2 Convection

Activity 5

Take some water in a vessel and heat it on a stove. Touch the surface of the water. It will be cold. Touch it after some time. It will be hot now. How did the heat which was supplied at the bottom reach the top?

When water in the vessel is heated, water molecules at the bottom receive heat energy and move upward. Then the molecules at the top comes down and get heated. This kind of heat transfer is known as convection. This is how air in the atmosphere is also heated. Thus the form of heat transfer from places of high temperature to places of low temperature by the actual movement of molecules is called convection. Convection takes place in liquids and gases.

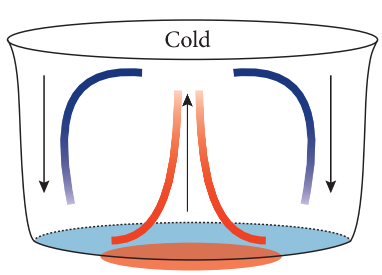


Figure 1.5 Convection in liquid

Convection in daily life

- Formation of land breeze and sea breeze is due to convection of air.
- Wind flows from one region to another region by convection.
- In hot air balloons heat is transferred by convection and so the balloon raises.
- In refrigirators, cool air moves downward and replaces the hot air because of convection.

1.2.3 Radiation

Radiation is the third form of heat transfer. By conduction, heat is transferred through solids, by convection heat is transferred through liquids and gases, but by radiation heat can be transferred through empty space even through vacuum. Heat energy from the Sun reaches the Earth by this

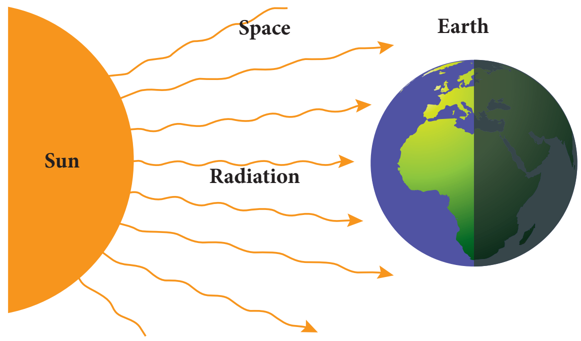


Figure 1.6 Heat transfer by radiation

Heat transfer by radiation is visible to our eyes. When a substance is heated to 500°C the radiation begins to become visible to the eye as a dull red glow, and it is sensed as warmth by the skin. Further heating rapidly increases the amount of radiation, and its perceived colour becomes orange, yellow and finally white.

form of heat transfer. Radiation is defined as the way of heat transfer from one place to another in the form of electromagnetic waves.

Radiation in daily life

- Heat energy from the Sun reaches the Earth by radiation.
- While standing near fire we feel the heat which is transferred as radiation.
- Black surfaces absorb heat radiation. So that the bottom of the cooking vessels are painted black.
- White colour reflects heat radiation. That's why we are advised to wear white cloth during summer.

1.3 Calorimetry

We studied about the effects of heat energy. When heat energy is supplied to substances, physical changes take place in them. Solid form of water (ice) is changed to liquid form, and liquid form of water is changed to gaseous form. These are all the physical changes due to heat energy. Similarly, heat energy produces chemical changes also. To know more about the physical and chemical changes that take place in substances, we need to measure the amount of heat involved. The technique used to measure the amount of heat involved in a physical or a chemical process is known as calorimetry.

1.3.1 Temperature

Temperature is a physical quantity which expresses whether an object is hot or cold. It is measured with the help of thermometer. There are three scales to measure the temperature. They are:

- Celcius scale
- Fahrenheit scale
- Kelvin scale

Among these three scales, Kelvin scale is the most commonly used one. You will study about this in detail in Standard IX.

1.3.2 Unit of Heat

We know that heat is a form of energy. The unit of energy in SI system is joule. So, heat is also measured in joule. It is expressed by the symbol J. The most commonly used unit of heat is calorie. One calorie is the amount of heat energy required to raise the temperature of 1 gram of water through 1°C. The relation between calorie and joule is given as, 1 calorie = 4.186 J.

DO YOU KNOW?

The amount of energy in food items is measured by the unit kilo calorie.

1 kilo calorie = 4200 J (Approximately).

1.3.3 Heat capacity

Activity 6

Take some amount of water and cooking oil in two separate vessels. Heat them till they reach a particular temperature (Caution: Heat the oil under the supervision of your teacher). Which one is heated first? Water will take more time to get heated. Why?

In general, the amount of heat energy gained or lost by a substance is determined by three factors. They are:

- Mass of the substance
- Change in temperature of the substance
- Nature of the material of the substance

Different substances require different amount of heat energy to reach a particular temperature. This nature is known as heat capacity of a substance. Heat capacity is defined as the amount of heat energy required by a substance to raise its temperature by 1°C or 1 K. It is denoted by the symbol C'.

Heat capacity

$$= \frac{\text{Amount of heat energy required (Q)}}{\text{Raise in temperature } (\Delta T)}$$

$$\text{Therefore, } C' = Q / \Delta T$$

The unit of heat capacity is cal / °C. In SI system, it is measured in JK^{-1}.

Problem 1

The temperature of a metal ball is 30° C. When an energy of 3000 J is supplied, its temperature raises by 40° C. Calculate its heat capacity.

Solution

Heat capacity, $C' = Q / \Delta T$

Here, $Q = 3000$ J

$\Delta T = 40°C - 30°C = 10°C = 10$ K

$C' = 3000 / 100 = 300$ JK^{-1}

The heat capacity of the metal ball is 300 JK^{-1}.

Problem 2

The energy required to raise the temperature of an iron ball by 1 K is 500 JK^{-1} . Calculate the amount of energy required to raise its temperature by 20 K.

Solution

Heat capacity, $C' = Q / \Delta T$

$Q = C' \times \Delta T$

Here, $C' = 500$ JK^{-1}

$\Delta T = 20$ K

$Q = 500 \times 20 = 10000$ J.

The amount of heat energy required is 10000 J.

1.3.4 Specific heat capacity

When the heat capacity of a substance is expressed for unit mass, it is called specific heat capacity. Specific heat capacity of a substance is defined as the amount of heat energy required to raise the temperature of 1 kilogram of a substance by 1°C or 1 K. It is denoted by the symbol C.

Specific heat capacity

$$= \frac{\text{Amount of heat energy required (Q)}}{\text{Mass} \times \text{Raise in temperature } (\Delta T)}$$

Therefore, $C = Q / m \times \Delta T$

The SI unit of specific heat capacity is J Kg^{-1} K^{-1}.

Problem 3

An energy of 84000 J is required to raise the temperature of 2 kg of water from 60° C to 70° C. Calculate the specific heat capacity of water.

Solution

Specific heat capacity, $C = Q / m \times \Delta T$

Here, $Q = 84000$ J

$m = 2$ kg

$\Delta T = 70° C – 60° C = 10° C = 10$ K

$C = 84000 / 2 \times 10 = 4200$ J Kg^{-1} K^{-1}

The Specific heat capacity of water is 4200 J Kg^{-1} K^{-1}.

Problem 4

The specific heat capacity of a metal is 160 J $Kg^{-1}K^{-1}$. Calculate the amount of heat energy required to raise the temperature of 500 gram of the metal from 125° C to 325° C.

Solution

Specific heat capacity, $C = Q / m \times \Delta T$

$Q = C \times m \times \Delta T$

Here, $C = 160$ J Kg K^{-1}

$m = 500$ g $= 0.5$ kg

$\Delta T = 325° C – 125° C = 200° C = 200$ K

$= 160 \times 0.5 \times 200 = 16000$ J.

The amount of heat energy required is 16000 J.

1.4 Calorimeter

Q9C5H3

A calorimeter is a device used to measure the amount of heat gained or lost by a substance. It consists of a vessel made up of metals like copper or aluminium which are good conductors of heat and electricity.

The metallic vessel is kept in an insulating jacket to prevent heat loss to the environment. There are two holes in it. Through one hole a thermometer is inserted to measure the temperature of the contents. A stirrer is inserted through another hole for stirring the content in the vessel. The vessel is filled with liquid which is heated by passing current through the heating element. Using this device we can measure the heat capacity of the liquid in the container.

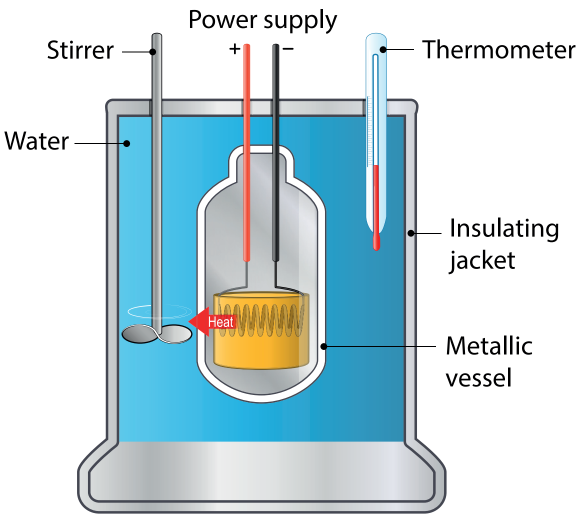


Figure 1.7 Calorimeter

> **DO YOU KNOW?** The world's first ice-calorimeter was used in the year 1782 by Antoine Lavoisier and Pierre-Simon Laplace, to determine the heat generated by various chemical changes.

1.5 Thermostat

A thermostat is a device which maintains the temperature of a place or an object constant. The word thermostat is derived from two Greek words, 'thermo' meaning heat and 'static' meaning staying the same. Thermostats are used in any device or system that gets heated or cools down to a pre-set temperature. It turns an appliance or a circuit on or off when a particular temperature is reached. Devices which use thermostat include building heater, central heater in a room, air conditioner, water heater, as well as kitchen equipments including oven and refrigerators. Sometimes, a thermostat functions both as the sensor and the controller of a thermal system.

Figure 1.8 Thermostat

1.6 Thermos Flask (Vacuum Flask)

The thermos flask (Vacuum flask) is an insulating storage vessel that keeps its content hotter or cooler than the surroundings for a longer time. It is primarily meant to enhance the storage period of a liquid by maintaining a uniform temperature and avoiding possibilities of getting a bad taste.

> **DO YOU KNOW?** The vacuum flask was invented by Scottish scientist Sir James Dewar in 1892. In his honour it is called Dewar flask. It's also known as Dewar bottle.

Working of Thermos flask

A thermos flask has double walls, which are evacuated. It is silvered on the inside. The vacuum between the two walls prevents heat being transferred from the inside to the outside by conduction and convection.

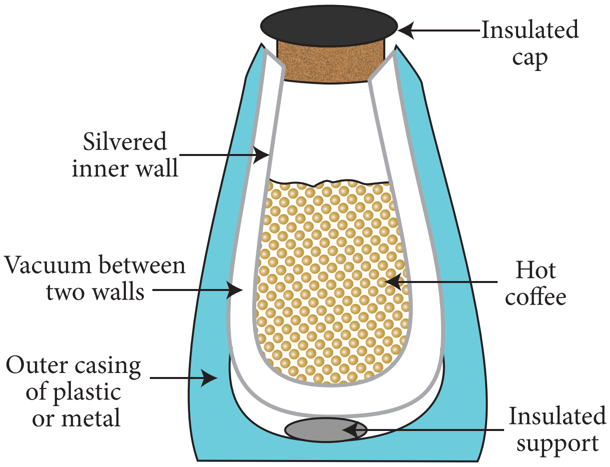


Figure 1.9 Thermos flask

With very little air between the walls, there is almost no transfer of heat from the inner wall to the outer wall or vice versa. Conduction can only occur at the points where the two walls meet, at the top of the bottle and through an insulated support at the bottom. The silvered walls reflect radiated heat back to the liquid in the bottle.

Points to Remember

- Heat is a form of energy which is transferred from one part to another part of a substance.
- Heat transfer causes expansion, increases temperature and changes the state of the substance.
- When thermal energy is supplied to a solid, the atoms or molecules present in it gain energy and vibrate more vigorously about their fixed positions, forcing each other further apart.
- Melting, vapourisation, sublimation, condensation, freezing and deposition are the change of states that take place due to heat energy.
- Heat transfer takes place in three ways: conduction, convection and radiation.
- Conduction occurs in solids, convection in liquids and gases, and radiation takes place in vaccum.
- Capacity of substances to gain or loose heat energy is determined by three factors: mass of the substance, change in temperature and nature of the substance.
- There are three scales to measure temperature: Celcius scale, Fahrenheit scale and Kelvin scale.
- Calorimeter measures the heat capacity of water.

A-Z GLOSSARY

Calorimeter	A device which measures the heat capacity of liquids.
Calorimetry	The technique used to measure the amount of heat involved in a physical or a chemical process.
Conduction	The process of heat transfer in solids from a region of higher temperature to a region of lower temperature without the actual movement of molecules.
Convection	The form of heat transfer from places of high temperature to places of low temperature by the actual movement of liquid or gas molecules.
Heat capacity	Amount of heat energy required to raise the temperature of a substance by 1° C or 1 K.
Radiation	The form of heat transfer from one place to another in the form of electromagnetic waves.
Specific heat capacity	Amount of heat energy required to raise the temperature of 1 kilogram of a substance by 1° C or 1 K.
Temperature	Physical quantity which expresses whether an object is hot or cold.
Thermos flask	An insulating storage vessel that keeps its content hotter or cooler than the surroundings for a longer time.
Thermostat	A temperature sensing device that turns an appliance or circuit on or off when a particular temperature is reached in it.

TEXT BOOK EXERCISES

I. Choose the best answer.

1. Heat is a form of _________.
   a) electrical energy
   b) gravitational energy
   c) thermal energy
   d) None of these

2. If you apply some heat energy to a substance, which of the following can take place in it?
   a) Expansion
   b) Increase in temperature
   c) Change of state
   d) All the above.

3. Which of the following substances will absorb more heat energy?
   a) Solid b) Liquid
   c) Gas d) All the above

4. If you apply equal amount of heat to a solid, liquid and gas individually, which of the following will have more expansion?
   a) Solid b) Liquid
   c) Gas d) All of them

5. The process of converting a liquid into a solid is called__________.
   a) sublimation b) condensation
   c) freezing d) deposition

6. Conduction is the heat transfer which takes place in a_____________.
   a) solid b) liquid
   c) gas d) All of them

II. Fill in the blanks.

1. A calorimeter is a device used to measure the_________.

2. ________ is defined as the amount of heat required to raise the temperature of 1kg of a substance by 1°C.

3. A thermostat is a device which maintains __________.

4. The process of converting a substance from gas to solid is called__________.

5. If you apply heat energy, the temperature of a system will _________.

6. If the temperature of a liquid in a container is decreased, then the interatomic distance will ____________.

L6I2M4

III. State True or False. If false, correct the statement.

1. The applied heat energy can be realized as an increase in the average kinetic energy of the molecules.

2. The dimensions of a substance are increased if the temperature of the substance is decreased.

3. The process of converting a substance from solid to gas is called condensation.

4. Convection is the process by which the thermal energy flows in solids.

5. The amount of heat gained by a substance is equal to the product of its mass and latent heat.

6. In a thermos flask, the silvered walls reflect and radiate the heat to the outside.

IV. Match the following.

1. Conduction	a) Liquid
2. Convection	b) Gas to liquid
3. Radiation	c) Solid to gas
4. Sublimation	d) Gas
5. Condensation	e) Solid