The Gen X Series

SCIENCE OLYMPIAD 7

Useful for Science Olympiads Conducted at School, National & International Levels

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Strictly According to the Latest Syllabus of Science Olympiad

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We wish you All The Best!

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SECTION 1
SCIENCE

Heat and Temperature

1

Learning Objectives

After reading this chapter, students will be able to:

- ☞ define heat and temperature and distinguish them
- ☞ measure the temperature of an object
- ☞ discuss applications of transfer of heat

Heat

"Heat is a form of energy which can heat up a body. Like all other forms, it can also get transformed into other forms of energy."

The direction of flow of heat is always from a body at high temperature to a body at low temperature.

The SI unit of heat is **Joule**. The CGS unit of heat is **erg**. Another common unit of heat is **Calorie**.

1 Calorie = 4.18 joule.

1 Joule = 107 erg.

Transformation of Heat Energy

Heat energy can be 'generated from' as well as 'transformed into' other forms of energy. Some methods to illustrate this are given below:

(i) On rubbing the palms together, they become hot. Thus, mechanical energy gets converted into heat energy.

(ii) In an electric bulb, electrical energy gets converted into heat energy of the filament, which is then converted into light energy.

(iii) During the working of a geyser or heater, electrical energy gets transformed into heat energy.

(iv) In a steam engine, heat energy is transformed into mechanical energy.

(v) In a nuclear power plant, nuclear energy is transformed into heat energy, and then into electrical energy.

(vi) In a thermal power station, heat energy is transformed into electrical energy.

Temperature

The quantity by which we compare hotness or coldness of a body is called temperature. i.e. **The degree of hotness of a body is called its temperature**.

Measurement of Temperature

Temperature is measured by using a thermometer. Earlier, alcohol was used in thermometer. But later **D.G. Fahrenheit** used mercury in place of alcohol.

Properties of Mercury Thermometer

(i) It is shiny and silvery white liquid metal, so it can be seen easily from outside the glass.

(ii) It does not stick to the glass.

(iii) Its freezing point is –39º C and boiling point is 357º C.

(iv) It can be easily obtained in pure form.

Note: A mercury thermometer is used in tropical and temperate climates whereas alcohol thermometer is suitable in extremely cold climate because alcohol freezes at **–117°C**.

Temperature Scale

A temperature scale is determined by fixing two reference points. One is **lower fixed point**, which is the **melting point of ice** and the other is upper fixed point which is the **boiling point** of water. The difference in these two reference points is divided into certain number of degrees.

Most commonly used temperature scales are Celsius scale, Fahrenheit scale and Kelvin scale.

Celsius scale

This scale was made by **Anders Celsius**. Temperature is measured in degree Celsius (°C). Lower fixed point is 0°C and upper fixed point is 100°C. The difference between lower fixed point and upper fixed point is divided into **100 equal parts called degrees**.

The normal temperature of human body is 37°C on Celsius scale. Celsius scale is more convenient and is prefered over Fahrenheit scale.

Fahrenheit scale

This scale was developed by **Gabriel Daniel Fahrenheit**. Temperature is measured in degree Fahrenheit. (°F). Lower fixed point is 32°F and upper fixed point is 212°F. The difference between these two points is divided into **180 equal parts**.

The normal body temperature is 98.4°F on this scale.

Kelvin scale

This scale was developed by **Lord William Thomson Kelvin**. The temperature is fixed between **273 K and 373 K**.

Though the scale of temperature used under the SI system is Kelvin scale, the scale used for measurement of temperature in laboratory is Celsius scale. Clinical thermometers mostly use Fahrenheit scale.

Clinical thermometer

The thermometer which is used to measure the body temperature of humans and animals is called a clinical thermometer. Its temperature ranges from **35°C to 42°C**. No human can survive with a body temperature below 35°C or above 42°C.

A clinical thermometer consists of a long narrow uniform glass tube with a small shining thread of mercury. There is a bulb at one end which contains mercury and a kink inside, which does not allow mercury to fall when thermometer is taken out of mouth.

Laboratory thermometer

It is a commonly used thermometer. The temperature of this thermometer ranges from **–10°C to 110°C**.

Laboratory thermometer consists of a long narrow uniform glass tube having bulb at one end filled with mercury. It does not have a kink.

While reading temperature of a hot or cold body, it should be kept upright. The bulb should be dipped properly in the body. Record the temperature immediately because as soon as the thermometer is pulled out the mercury level starts falling.

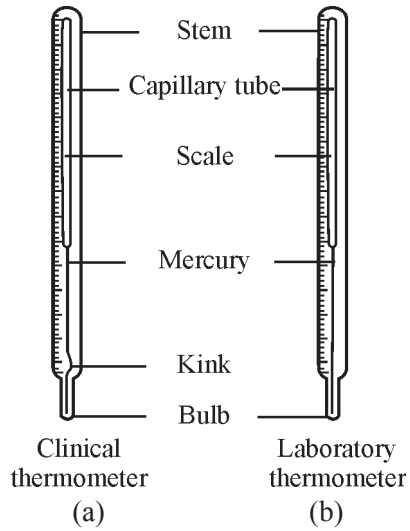


Fig. 1.1

Maximum-minimum thermometer

Another type of thermometer used to record atmospheric temperature is called maximum-minimum thermometer. It gives the maximum and minimum temperature recorded for various cities in weather reports.

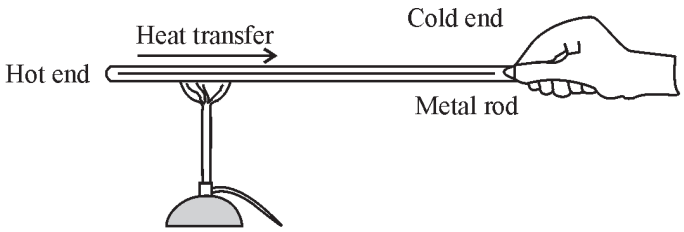
Transfer of Heat

When two bodies are brought into contact, heat flows from the body at higher temperature to the body at lower temperature. Such a transfer of heat energy continues to take place till both the bodies attain as same temperature. It takes place through conduction, convection and radiation.

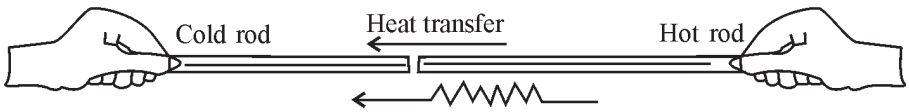
Conduction – Transfer of Heat in Solids

"The process of transmission or transfer of heat energy in solids without actual movement of particles from their position is called conduction."

In solids, particles are very closely packed and have very little space between them. Also, all the particles vibrate at their fixed positions. When a material is heated, its particles vibrate even more. As they vibrate more, they bang into the particles next to them and the adjacent particles also start vibrating. Thus, the heat is automatically transferred from one particle to another, by the vibration of particles. This method of heat transfer is called conduction.



(a) Conduction of heat in same metal



(b) Conduction of heat when hot and cold metal rods are in contact

Fig. 1.2

Certain materials conduct heat very easily while others do not. The materials which conduct heat easily through them are known as **conductors or good conductors**. All metals like copper (Cu), gold (Au), silver (Ag), aluminium (Al), iron (Fe), etc. are good conductors of heat.

The materials which do not conduct heat through them are known as **insulators** or **bad conductors of heat.** For example: Wood, bricks, plastic, paper, glass and glass wool, wool, cotton, ice, snow and air are some poor conductors of heat.

Applications of conductors and insulators of heat

(i) Good conductors like copper, iron and aluminium are used to make the base of an electric iron, solar heating pipes and boilers in chemical and textile industries.

(ii) Good conductors like steel, copper and aluminium are used to make cooking utensils, so that they can easily transfer heat from the source to the food being cooked.

(iii) Bad conductors like thermocol are used to make ice boxes to carry ice.

(iv) Bad conductors like asbestos are used to make roof tops of buildings in places with hot climate.

(v) Bad conductors like ceramic, bakellite are used to make handles of cooking utensils, electric iron, etc.

(vi) Ice is a bad conductor of heat. Eskimos live in Igloos which are made of ice blocks. These houses do not allow heat from inside to escape to the outer cold surroundings.

Convection – Transfer of Heat in Liquids and Gases

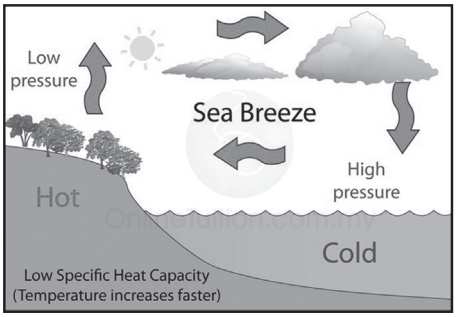
"Convection is the process of heat transfer in which the molecules of a medium actually move from hotter region to the colder region carrying heat with them."

When a liquid or a gas is heated, its particles near the source of heat get heated and move upwards. The space left by them is quickly filled by colder particles. Now these particles get heated and rise upwards. The process continues and gradually more and more particles of liquid or gas keep on getting heated. In the process of convection, the heat gets transferred onto a substance by actual movement of heated particles within the substance.

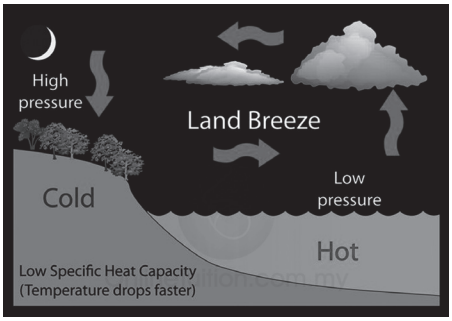
Applications of convectional currents

(i) Sea breeze and land breeze: During the day, the sun shines on both land and sea in coastal areas. The temperature of land rises faster than temperature of water. The air above the land gets heated and hot air rises up. So, cold air from sea starts blowing towards land and is called **sea breeze**.

During the night, the land loses heat more quickly than sea. The air above the land becomes cool. The warm air above sea rises. So, cold air from land starts blowing towards sea and is called land breeze.



(a) *Sea Breeze*



(b) *Land Breeze*

Fig. 1.3

(ii) Ventilation of rooms: The process of replacing warm and impure air inside a room continuously by fresh air from outside is called ventilation. Due to breathing in room or cooking in kitchen, the air gets warm. It rises up and passes out from ventilators, so cold and fresh air from outside comes in through windows and doors that is why, ventilators are placed at the highest point in room.

(iii) Earthquakes: The core of earth is very hot (nearly 6000°C). Between the earth's crust and core, rocks and other material exist in their molten state and are called the magma. Because of a large temperature difference between the crust and the core, huge convection currents are set in the magma. The movement of molten magma due to convection, under the earth's crust results into an immense pressure under the land masses. Sometimes, when the pressure becomes unbearable, some parts of the land masses slide past the other causing earthquakes.



Fig. 1.4 *Earthquake*

(iv) Oceanic currents: The ocean water near the equator of the earth gets heated by sun directly, whereas the ocean water near the poles is cold. Due to this temperature difference, the ocean water at the surface of ocean moves from equatorial region to polar region, while below the surface, the water in the ocean moves from polar region to equatorial region. These convection currents in ocean water cause ocean currents. The ocean currents are helpful in maintaining the temperature of the ocean.

Uses of convection currents in daily life

(i) Air coolers and air conditioners are fitted high on the walls of offices and homes so that the cold air generated by them moves downward for an effective cooling of the whole room quickly.

(ii) The freezers inside refrigerators are always located at the top so as to easily circulate cold air downwards and keep the refrigerator cold.

(iii) The room heaters are placed at or near the floors of the rooms so that the air heated by them rises up, sets in convection current in the room to heat up the air of the room quickly and uniformly.

Radiation–Transfer of Heat without a Medium

When we stand in sunshine, we feel warm. Thus, heat is transferred through another process called **radiation**. Heat from a distant source reaches us by a mode, known as **radiation**. The radiation carrying heat energy is called **thermal radiation**. Thermal radiation needs no medium (solid, liquid or gas) to travel. It can travel through vacuum also.

Absorption of heat radiation by a body

The amount of heat absorbed by an object depends upon:

(i) **The nature of material:** Metals and water absorb more heat than non-metals.

(ii) **The distance from the source of heat:** As the distance between the two objects increases, the heat received by the object decreases.

(iii) **The colour of the object:** The colour affects absorption of thermal radiation. Dark colours absorb more heat as well as give out more thermal radiation. Light colours absorbs less and gives out less thermal radiation.

Applications of heat radiations in our daily life

(i) Room heater reflectors and thermos flasks have bright polished surfaces which act as good reflector of heat. Such surfaces absorb very little heat and reflect most of the heat radiations.

(ii) Radiators in cars and air-conditioners are painted black so as to have cooling effects by radiating most of the heat.

(iii) Solar cooker and solar water heater are painted black from inside. This is because black surface is good absorber of heat.

(iv) Coffee and tea stay hot longer in shining pot than in blackened one.

(v) Light coloured buildings stay cooler in summer because they reflect most of the heat radiations from the sun.

(vi) Dark-coloured clothes make us feel warm in summer. So, people wear light color clothes during summer.

Do You Know

1. The first steam engine invented by James Watt has its principle based on transformation of heat energy into mechanical energy.
2. The standard metre rod is kept in Paris. It is made up of alloy of platinum and iridium so that there is negligible expansion or contraction during summers and winters.
3. Frozen foods, if stored in freezers at –8°C, can stay safe and germ free to eat for almost an year.
4. The uniforms of fire fighters are made of heavy duty poly raisin fibre which is an effective poor conductor of heat and allows the fire fighters to get into fire to save life and property.

Key Points

- ✓ Heat is a form of energy.
- ✓ Heat is transferred from a hot object to a cold object.
- ✓ Mercury has several characteristics, so it is used in making thermometers.
- ✓ The degree of hotness of a body is known as temperature.
- ✓ The commonly used scales to measure the temperature are Celsius, Fahrenheit and Kelvin.
- ✓ The clinical thermometer can measure temperatures from 35°C to 42°C.
- ✓ The transmission of heat in solids takes place by process of conduction.
- ✓ In liquid and gas, heat is transferred by the process of convection.
- ✓ The heat from sun reaches us by the process of radiation.
- ✓ Black-coloured objects are good absorbers of heat.
- ✓ Shiny and white surfaces are good reflectors of heat.

Multiple Choice Questions

1. The property of matter of increase in size on heating is called _____.
   (a) thermal work
   (b) thermal energy
   (c) thermal expansion
   (d) thermal contraction
2. One glass of water at 40°C is mixed with another glass of water at 60°C. The temperature of mixture will be _____.
   (a) 40°C
   (b) 60°C
   (c) between 40°C and 60°C
   (d) more than 60°C
3. The degree of hotness or coldness of a body is measured by its _____.
   (a) energy
   (b) radiation
   (c) heat
   (d) temperature
4. Mercury is an ideal liquid used in a thermometer because _____.
   (a) it expands a lot on heating
   (b) it does not stick to glass and is visible
   (c) it has a high boiling temperature
   (d) all of these
5. At low temperatures _____ type of thermometers is used.
   (a) water thermometer
   (b) alcohol thermometer
   (c) mercury thermometer
   (d) clinical thermometer
6. 1 cal is equal to _____.
   (a) 10 joules
   (b) 4.18 joules
   (c) 4.18 dynes
   (d) none of these
7. The CGS unit for energy is _____.
   (a) dyne
   (b) erg
   (c) joule
   (d) centimeter
8. When we touch a steel rod and a paper simultaneously, we feel that the rod is colder because _____.
   (a) more heat flows from iron to our body.
   (b) iron being a good conductor conducts more heat from our body.
   (c) paper being a good conductor conducts more heat from our body.
   (d) more heat flows from the paper to our body.
9. The lower fixed point on the Celsius scale is _____.
   (a) melting point of ice
   (b) boiling point of water
   (c) mean of melting point and boiling point of water
   (d) melting point of mercury
10. In the Celsius scale, the upper fixed point is _____.
    (a) melting point of ice
    (b) boiling point of water
    (c) boiling point of mercury
    (d) mean of melting point and boiling point of water
11. In which of the following, chemical energy is converted into heat energy?
    (a) motor (b) heater
    (c) candle (d) refrigerator
12. Handles of cooking utensils should be made of materials that _____.
    (a) radiate heat well
    (b) do not radiate heat
    (c) conduct heat well
    (d) do not conduct heat
13. Which of the following is a good conductor of heat?
    (a) plastic (b) glass
    (d) water (d) copper
14. Which of the following is a bad conductor of heat?
    (a) iron (b) wood
    (c) bronze (d) aluminium

15. Radiation depends on _____.
    (a) the colour of the substance
    (b) the temperature of the substance
    (c) both (a) and (b)
    (d) none of these
16. Convection of heat takes place in _____.
    (a) metals only
    (b) liquids only
    (c) gases only
    (d) liquids and gases
17. Sea breeze and land breeze _____.
    (a) are caused by the currents set up in air due to conduction
    (b) are caused by the currents set up in air due to convection
    (c) are caused by the currents set up in air due to radiation
    (d) have no relation to conduction, convection and radiation
18. The incorrect statement is _____.
    (a) convection current causes trade winds
    (b) transmission of heat without actual movement of particles is called conduction
    (c) radiation requires medium for heat flow
    (d) in convection heat is transferred through movement of fluid
19. A wooden spoon dipped in ice cream cup _____.
    (a) becomes cold by conduction
    (b) becomes cold by convection
    (c) becomes cold by radiation
    (d) does not become cold
20. Find the odd one out _____.
    (a) Good absorbers are good radiators
    (b) Shiny surfaces are good reflectors of heat
    (c) We wear dark-coloured clothes in summers.
    (d) Dark colours are good absorbers of heat.
21. A metal ball is droped in a beaker containing water at 50°C. Then the heat will _____.
    (a) flow from water to ball
    (b) flow from ball to water
    (c) not flow
    (d) increase the temperature of both ball and water.
22. Reflecting solar films are used on the top of the car to _____.
    (a) produce electricity
    (b) to absorb more light
    (c) to prevent heating by radiation
    (d) to make it strong
23. The instrument used to detect radiation of heat is _____.
    (a) thermoscope (b) barometer
    (c) kinemoscope (d) stethoscope
24. Gaps are left between railway tracks because _____.
    (a) gaps hold the tracks firmly
    (b) gaps give the space to the tracks to expand in summer heat
    (c) it is customary to leave the gaps
    (d) to produce gentle rhythmic sound when the train moves on the track.
25. Human body temperature is normally _____.
    (a) 32°F (b) 212°F
    (c) 100.4°F (d) 98.6°F



Motion and Time

2

Learning Objectives

After reading this chapter, students will be able to:

- define motion
- correlate and distinguish rest from motion
- differentiate between distance and displacement
- distinguish between uniform and non-uniform motion
- interpret a distance-time graph
- discuss about a pendulum
- describe various devices used for measuring time

Motion

A body is said to be in motion if it changes its position with respect to other objects around it. If the position of a car changes with respect to houses, trees, etc. then the car is said to be in motion with respect to those bodies. So, a body is in motion, if it changes its position with respect to its surroundings. These stationary surroundings are called frame of reference.

Relation Between Rest and Motion

A continuous change in the position of a body relative to other bodies is called **mechanical motion**. A person sitting in a train is moving relative to railway tracks, farms, mountains, etc. but he is in rest with respect to other persons sitting in the same coach.

For a person moving in a car, trees, buildings, etc. appear to be moving in backward direction. For those people who are standing on the road, the car is moving in forward direction. And at the same time people sitting in the car are not changing their position with respect to each other, so they appear at rest. So, **rest and motion are relative terms**.

An object that does not change its position with respect to others is said to be at rest, i.e., it is stationary.

Distance and Displacement

Suppose a particle is initially at the point O. After sometime, it reaches a point P, then OP is the change in its position with time and is called its displacement. See the fig. given below

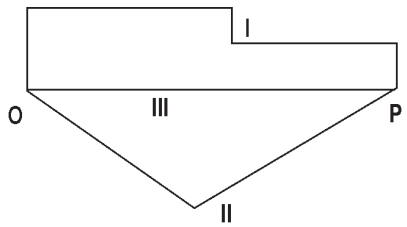


Fig. 2.1

Vector $\overrightarrow{OP}$ represents displacement from O to P.

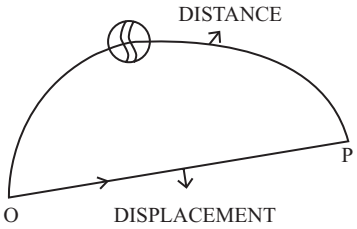


Fig. 2.2 *Displacement*

In the figure, displacement is the distance OP in the direction obtained by joining O to P. Displacement carries both magnitude and direction of a distance.

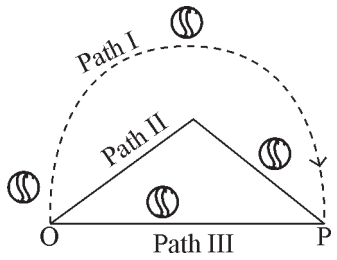


Fig. 2.3: *Distance and Displacement*

All the quantities which possess magnitude as well as direction are called vectors or vector quantities. So, displacement is a vector.

Distance is the actual length of path travelled by a body in certain interval of time. It is a scalar quantity. All the quantities which possess magnitude only but no direction are called scalars or scalar quantities.

Consider two points O and in fig 2.3. If an object moves along paths I or II, then they represent the path travelled by object to reach from point O to P. Paths I and II show the distance. Path III shows the shortest distance between points O and P. It represents displacement. The **SI unit of both displacement and distance is metre (m)**. Displacement is therefore the shortest distance between two points.

Uniform Motion and Non-uniform Motion

Uniform Motion

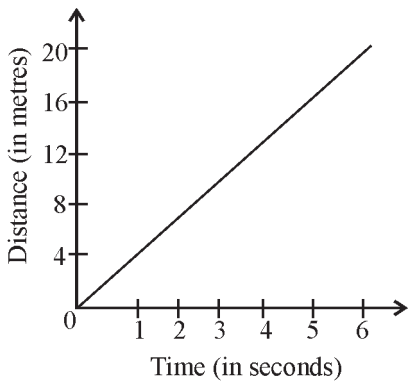


Fig. 2.4

If an object covers equal distances in equal intervals of time, the object is said to be in a uniform motion.

The distance-time graph for a body moving with uniform motion is a **straight line**.

For example: To draw a distance-time graph, let us consider the distances covered by an object in equal intervals of time.

Time (in seconds)	0	1	2	3	4	5
Distance covered (in metres)	0	4	8	12	16	20

The distance covered in first second is 4m. The distance covered in 2nd second is 4m i.e. (8 – 4) = 4m and so on. So, we can say that body covers equal distances in equal intervals of time.

Non-uniform Motion

"When an object covers unequal distances in equal intervals of time, the body is said to be in a non uniform motion."

A car, bus, cycle moving on a busy road describes non-uniform motion. They move slow or fast, so they do not cover equal distances in equal intervals of time. All moving objects are in non-uniform motion.

Speed: Distance travelled by a moving body in unit time is called speed.

Speed is a scalar quantity as it has magnitude only. It tells about the distance travelled in unit time. It does not mention the direction of motion.

The speed of a moving object is defined as the ratio of distance travelled and the time taken to travel that distance.

Mathematically,

$$\text{Speed (v)} = \frac{\text{distance travelled by the object (s)}}{\text{time taken to travel this distance (t)}}$$

$$\boxed{v = \frac{s}{t}}$$

The S.I. unit of speed is metre/second or $\frac{m}{s}$ or m/s

Uniform and Non Uniform Speed

Uniform Speed

The speed of a body is said to be uniform if the body covers equal distances in equal intervals of time. The movement of earth about its axis and movement of hands of watch are examples of uniform speed.

Non Uniform Speed

The speed of a body is said to be non uniform if it covers unequal distances in equal intervals of time.

When a body is moving with non-uniform speed, then to find total distance covered and total time taken to cover that distance, we find the **average speed**.

$$\text{Average speed} = \frac{\text{Total Distance Covered}}{\text{Total Time Taken}}$$

***Example* 1:** A car moves with a constant speed of 40 km/hr for 2 hours. What is the distance covered by the car?

***Solution*:** $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

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

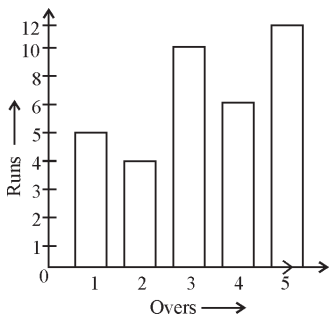
$= 40 \times 2 = 80\text{km}$

***Example* 2:** Study the score table to show runs made by Indian Team per over and draw bar graph.

***Solution*:**

Score table

Overs	Runs
1	5
2	4
3	10
4	7
5	12



Bar Graph

***Example* 3:** Convert 54km/hr into m/sec.

***Solution*:** $54 \text{ km/hr} = \frac{54}{1}$

$= \frac{54{,}000 \text{ m}}{3600 \text{ sec}} = \frac{540 \text{ m}}{36 \text{ sec}}$

$= 15\text{m/sec}$

***Example* 4:** A bus travelled the first 40 kilometres of a journey in one hour and the next 60 kilometres in the next one hour. Calculate the average speed of the bus during this journey.

***Solution*:**

(a) For the first part of journey,

$S_1 = 40$ km, $t_1 = 1$ h

(b) For the second part of journey,

$S_2 = 60$ km, $t_2 = 1$ h

Total distance $(S) = S_1 + S_2$

$= 40 + 60 = 100$

Total time $(t) = t_1 + t_2 = 1 + 1 = 2$

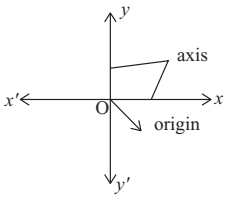
Now,

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

$$= \frac{100}{2} = 50\text{km/h}$$

Distance-Time Graph

A graph is a diagrammatic representation, depicting relation between two quantities. A graph consists of two perpendicular lines meeting at a common point. The common meeting point O is known as the origin of the graph.



These graphs are used to find velocity of a body.

(a) When distance-time graph is parallel to the x-axis or time axis, it means that body is not changing its position with respect to time i.e. body is stationary.

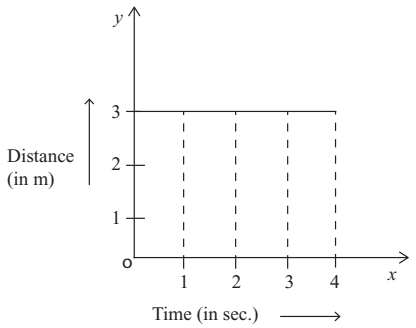


Fig. 2.5: *Graph for Body at Rest*

(b) When distance-time graph is straight line but not parallel to time axis, it means that body is in uniform motion i.e. the body covers equal distances in equal intervals of time.

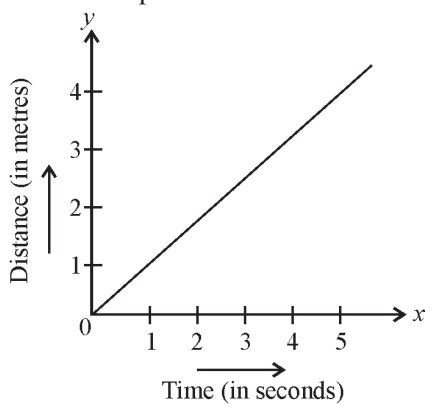


Fig. 2.6: *Graph for Uniform Motion*

(c) When distance-time graph is not a straight line, it means that body is in non-uniform motion. i.e. the body covers unequal distances in equal intervals of time.

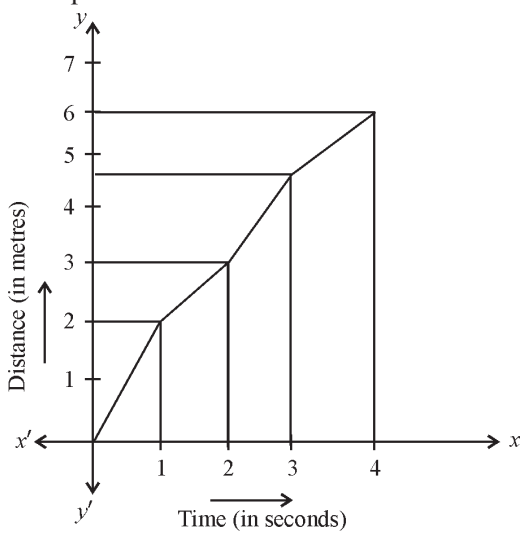


Fig. 2.7: *Graph for Non-uniform Motion*

Time

"Time is an interval between two events." The S.I. unit of time is second.

Measurement of Time (In Ancient Time)

The measurement of length and mass involves comparison of an object with a fixed value. But measurement of time involves movements.

The early man measured time by:

(i) The movement of shadow cast by the sun (sundials)
(ii) The rising and setting of sun
(iii) The movement of the moon around the earth
(iv) The quantity of sand or water dripping in a vessel (sand and water clock)
(v) The burning of candle with markings

Sundial

Sundial was the easiest method of knowing the time by observing the position of the sun in the sky. The sun appears at its highest position at noon. If you look at the fixed pole, you will find that the length of the shadow of pole is maximum in early morning. This length reduces to (shortest) during noon. After noon, the length of shadow starts increasing once again. This decrease and then increase in the length of shadow during the day was used in sundials to measure time.

A sundial is placed in open sky. It has a gnome which points in north-south direction. The shadow of gnome on the circular scale shows the time at that moment. The only drawback of sundial is that it does not work after sunset or on a cloudy day.

Sand Clock

Romans used a sand clock which has two chambers - upper chamber and lower chamber. It works on the principle that all the sand from the upper chamber fall into the lower chamber in a fixed interval of time.

These types of clocks are now commonly available with puzzle games in the market.

Water Clock

Greek used water clock about 2,000 years ago. It consists of two pots. The Egyptian water clock marked time as water dropped from one pot to the other in fixed interval of time.

Measurement of Time (In Modern Times)

Atomic Clock

The atomic clock is the most scientifically developed clock and therefore is the most accurate of all. It is maintained at national physical laboratory (NPL) at Delhi, which is used to provide beeps before the morning news. These

beeps indicate the **standard time**. This clock is accurate upto a millionth part of a second.

Stopwatch

Athletes use different kind of clock known as stopwatch. It measures time up to 1/10 of a second accurately.

Simple Pendulum

It is a device with a metallic heavy point called **bob** suspended by a string. The normal or the resting position of the bob is called its **mean position**. If the bob is displaced from its mean position and taken to a side and released, the bob sets into a to and fro motion, about its mean position. This motion of the bob about its mean position is called **oscillatory motion**.

The pendulum completes **one oscillation** when the bob from one extreme position goes to other end and then comes back again at that point.

The Period of Oscillation

Time taken to complete one oscillation is called the period of oscillation. Time period does not depend on mass and displacement of the bob.

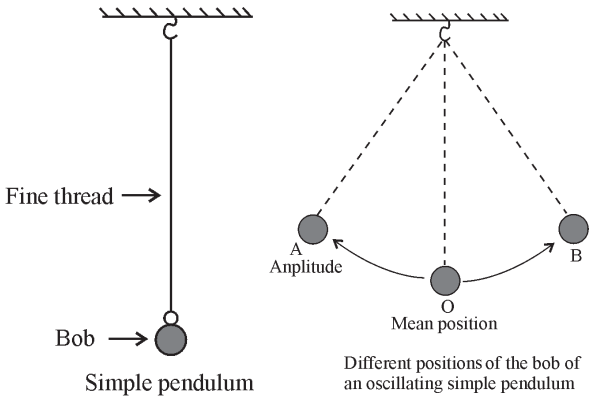


Fig. 2.8

Length of the pendulum

The length of pendulum is the distance between the point of suspension to the centre of gravity of the bob. It depends on length and gravity of earth.

The time period of a pendulum is more if its length is more and it is less for a pendulum of a shorter length.

Amplitude

The maximum displacement of the bob from its mean position to any one side is called amplitude.

Time period does not depend on amplitude of oscillations.

Watches

Galileo discovered that time of oscillation of a pendulum of a given length is always constant. He found that if the length of a string is fixed, the time period of oscillation of bob is constant. A pendulum clock swings continuously under the action of a spring. This spring, in turn, controls the hands of the clocks. Clocks with pendulum were the first instrument for measuring the time accurately.

Do You Know

1. The device fitted in vehicles to measure distance is called an ODOMETER.
2. The device fixed in vehicles to show the speed of vehicle is called the SPEEDOMETER or a TACHOMETER.
3. There are more than 2.6 million seconds in a month.
4. The speed of light is 3×10^8 m/sec and that of sound under normal atmospheric conditions is approximately 340 m/sec.
5. The speed of earth in its orbit around the sun is nearly 30 km/sec.

Key Points

- ✓ Motion and rest are relative terms.
- ✓ Distance is the actual length of path travelled by an object. Distance travelled can never be zero.
- ✓ Displacement is the shortest distance between two points. It can be positive, negative or zero.
- ✓ Speed is the distance travelled by an object in unit time.
- ✓ An atomic clock is the most accurate of all types of clocks.
- ✓ The time period of a pendulum depends upon its length and acceleration due to gravity.
- ✓ Distance-time graph of a body moving in a uniform motion is a sloping straight line.
- ✓ Distance-time graph of a body moving in a non uniform motion is a curved line.
- ✓ Distance-time graph of a body with zero speed or no motion is a horizontal straight line parallel to the time axis.

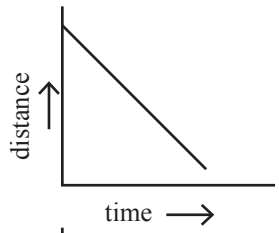
Multiple Choice Questions

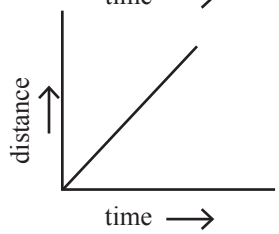
1. If a body moves in a circle, it starts from point A and after completing the circle comes back to A; the displacement of such body is _____.
   (a) equal to the diameter of circle
   (b) equal to the circumference of circle
   (c) zero
   (d) none of these

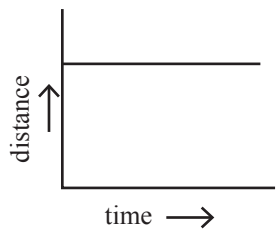
2. The CGS unit of speed is _____.
   (a) cm/g (b) cm/s
   (c) m/s (d) m/g

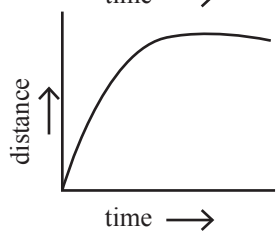
3. One mean solar day is equal to how many seconds?
   (a) 80,406 (b) 80,640
   (c) 86,400 (d) 84,600

4. Which of the following graphs does not represent constant speed?

(a)


(b)


(c)


(d)


5. Which of the following is not in uniform motion?
   (a) a swinging pendulum
   (b) the rotation of earth
   (c) a bullet travelling with a constant speed in a straight line.
   (d) both (a) and (b)

6. Which of the following does not show oscillatory motion?
   (a) swing (b) fan
   (c) see-saw (d) pendulum

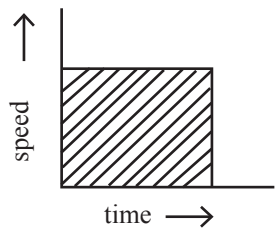
7. A jet is moving with a speed of 180 km/h. What is its speed in m/s?
   (a) 50 m/s (b) 10 m/s
   (c) 500 m/s (d) 100 m/s

8. Which of the following is the fastest?
   (a) wind (b) light
   (c) sound (d) cheetah

9. Which of the following is matched incorrectly?
   (a) Anemometer : wind speed
   (b) Stopwatch : time
   (c) Odometer : odour
   (d) Speedometer : speed

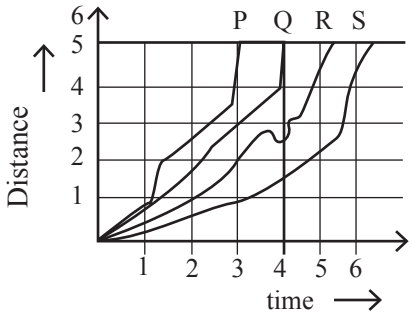
10. Distance travelled will be equal to the displacement if _____.
    (a) object is moving along straight line in forward direction.
    (b) object is moving in different directions.
    (c) object is moving from one point to other along any path
    (d) not possible in any condition.

11. The area of the shaded portion in the graph shown below represents?



    (a) distance (b) speed
    (c) time (d) none of these

12. The following graph shows the motion of four runners. P, Q, R and S in a 5 km marathon. Whose motion is the fastest?

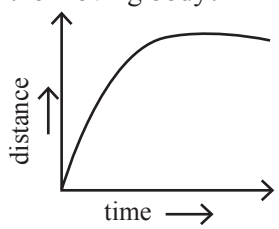


(a) P (b) Q
(c) R (d) S

13. With what speed should a car travel so that it can cover a distance of 5 km in 5 min?
(a) 1 km/h (b) 5 km/h
(c) 12 km/h (d) 60 km/h

14. All of the following are units time except _____.
(a) years
(b) light years
(c) seconds
(d) months

15. Study the graph given below. How is the speed of the moving body?

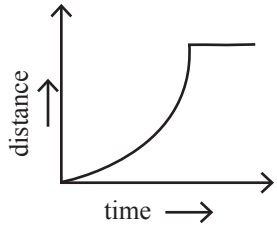


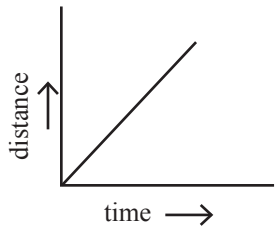
(a) It goes on increasing
(b) It increases and then becomes constant but not zero
(c) First it decreases and then becomes zero
(d) It decreases and then becomes constant but not zero

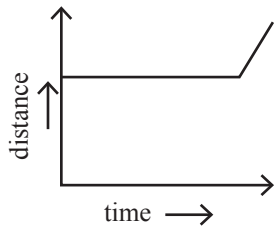
16. Which of the following shows a motion in a straight line?
(a) apple falling from the tree
(b) tree swaying
(c) child on a merry-go-round
(d) none of these

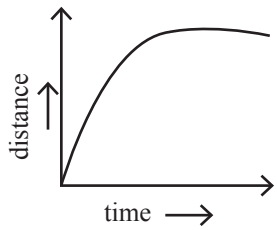
17. Riaz takes 20 min to travel to his schools with a speed of 3m/s. How far is the school?
(a) 2 km (b) 3.2 km
(c) 3.6 km (d) 4.1 km

18. Which of the following graph represents the movement of a car that is slowing down and comes to a complete stop?

(a)


(b)


(c)


(d)


19. Change the speed 20 m/s to km/hr _____.
(a) 27 km/hr (b) 28 km/hr
(c) 72 km/hr (d) 73 km/hr

20. Which of the following is a disadvantage of Sundial?
(a) It's difficult to build a Sundial
(b) It is difficult to predict time with a Sundial
(c) It occupies a large area
(d) It does not work after sunset or on a cloudy day



Electric Current and Its Effects

3

Learning Objectives

After reading this chapter, students will be able to:

- ☞ define electricity
- ☞ explain an electric circuit
- ☞ distinguish between conductors and insulators
- ☞ explain the heating effect of electric current
- ☞ discuss magnetic effects of current
- ☞ explain the working of an electromagnet and electric bell
- ☞ illustrate electromagnetic induction

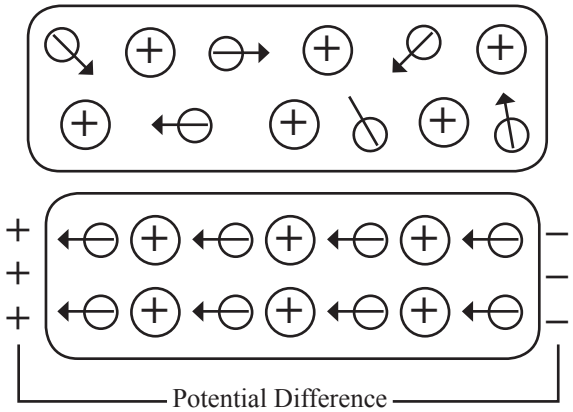
Electricity

When charged particles move, a special kind of effect is produced, which posseses energy. This form of energy is called electrical energy, electric current or electricity. Electricity can also be defined as the flow of electrons through a conductor.

It is convenient to utilize electric energy. Therefore different sources of energy (fossil fuel, water, wind etc) are harvested to generate electrical energy, which is then converted into other forms of energy. i.e, heat energy, light energy, sound energy etc. as per our requirement.

Electron Flow and Conventional Current

The electrons in the outermost shell of an atom (the smallest particle of a matter) are loosely bound and are free to move randomly in all directions inside the metal. When a metal wire is connected across a battery, the electrons move in a particular direction. This flow of electrons causes current in wire. This current is known as electric current. The electric current or conventional current flows from positive to negative end of the wire whereas the direction of flow of electrons will be in the opposite direction.



The randomly moving electrons in a metal wire start moving in a particular direction when a potential difference exists across it.

Fig. 3.1

Current is represented by I.

If current I flows through a wire for time T, then the charge Q transferred is given as:

$$\text{Charge} = \text{Current} \times \text{Time}$$
$$Q = I \times T$$

Or, current is defined as charge flowing per second across a conductor,

$$\text{Current} = \frac{\text{Charge}}{\text{Time}}$$

Or

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

SI unit of current is coulomb/second or Ampere (A).

Cell

A cell is a device which produces electric current through chemical reactions taking place inside it. It converts chemical energy into electrical energy, thus, it is also called electrochemical cell.

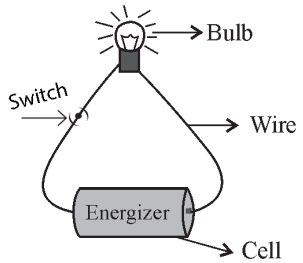
A cell consists of two plates or rods called electrodes which are dipped in solution of chemicals called electrolyte. The reaction between electrodes and electrolyte produces electricity.

Battery

Sometimes, one single cell is not sufficient to meet the requirement of current in an electrical appliance, then we connect cells together to obtain more current or voltage. This combination of cells is called a battery.

Electric Circuit

When charged particles move, electricity is produced. So, the path through which charged particles move is called electric circuit.



Electric circuit

Fig. 3.2

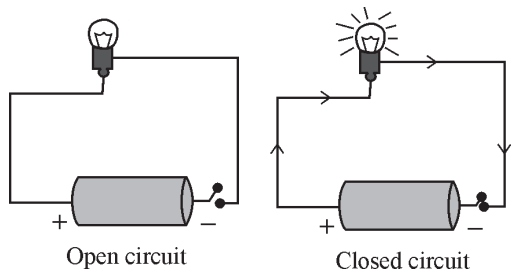
A simple electric circuit comprises of a battery, wire and a switch. One end of the wire is connected to negative terminal of the battery and the other end of the wire is connected to positive terminal of the battery. A switch is fitted in the wire in such a way that when switch is on, the wires of the circuit are connected and current is passed. When the switch is off, the wires are disconnected and the current can not passed through the circuit. Thus, the switch gives us the facility of using electrical energy as per our requirement.

Closed Circuit

When the switch is 'on' and all the wires are connected properly, the current flows in the circuit. The flow of current is observed by glowing of the bulb. Thus, if the current is drawn from the cell, the circuit is said to be closed circuit or complete circuit.

Open Circuit

If the switch is 'off' or wire is cut or circuit is broken, then the flow of current is stopped. Then circuit is said to be open or incomplete circuit. So in open circuit, no current is drawn from the cell.



Open circuit Closed circuit

Fig. 3.3

Symbols of Some Circuit Element

We use standard symbols for the components used while drawing the circuit diagram. The conventional symbols for some common elements of an electric circuit are given below.

Cell
Battery
Resistance
Closed switch
Open switch
Bulb
Ammeter
Voltmeter

Conductors and Insulators

The substance which allows electric charge or electric current to pass through it, is called conductor of electricity, whereas those substances which do not allow electric charge or electric

current to pass through them are called insulators or non-conductors.

In insulators, the electrons do not move easily whereas in metals there are free electrons that take part in conduction of current.

Materials like glass, rubber, wood etc. are insulators whereas metals like silver, copper, aluminium, etc. are good conductors. Graphite is the only non metal which is also a good conductor of electricity (exception).

Pure water is poor conductor of electricity but under special conditions, when salt is added to it, its ability to conduct electricity increases.

Heating Effect of Electric Current

All substances are made up of atoms. When charged particles move through them, they collide with atoms of the substance. This collision changes a part of mechanical energy of electron into heat energy. Therefore, when electric charges flow through a substance, the substance gets heated. This phenomenon is known as heating effect of electricity. In other words, heating effect is the phenomenon in which electric energy changes into heat energy.

The amount of heat produced in the wire depends on the three factors:

(i) Amount of current passed through the wire

As the amount of current through the wire increases, the amount of heat produced in the wire also increases. And, as the amount of current passing through the wire decreases, amount of heat produced in the wire also decreases, i.e., amount of heat produced in the wire is directly proportional to the amount of current passing through the wire.

(ii) The resistance that the wire offer to the moving charged particles

The resistance of a wire depends on its nature. If the wire offers greater resistance, more amount of heat is produced. And if the wire offers less resistance, less amount of heat is produced. Thus, amount of heat produced in the wire is directly proportional to the resistance of the wire.

(iii) Time

As the time of current flow will be increased, the amount of heat produced will also increase, i.e. both are directly proportional to each other.

Fuses

Fuse is a safety device used to protect electric circuit and other electrical devices like, bulbs, tube lights, fans, T.V. refrigerators etc. from being damaged due to excessive current flow.

Sometimes, due to contact of the live wire with neutral wire, known as short circuit, excessive amount of current passes through the wire. This excessive amount of current produces large amount of heat. As a result, the wire gets burnt and the house may catch fire. Overloading is another major danger which sometimes causes fire and other damage. Therefore, a fuse is an essential part of power distribution system to prevent fire or damage due to overload or short circuit.

Characteristics of Fuse

Each type of fuse has a time-current characteristics. It shows the time required to melt the fuse due to overloading of current.

Fuses are characterized as "fast blow" or "slow blow" depending on the time they take to respond to a given condition of heating due to excess current. Fast blow fuses open quickly. Slow blow fuses which are common in household circuits open only if the condition of excess current continues for sometime.

Types of Fuses

(i) Blade fuse: There are different types of fuses commonly used. Most common are plug in type. These fuses are also called as blade or spade fuses. They are made up of plastic body or ceramic body and has two ends that fit into a socket.



Blade or Spade Fuse



Glass Cartridge Fuse



Fuse Box



A MCB

Fig. 3.4: *Types of Fuses*