Fully Revised

Preeti Agarwal

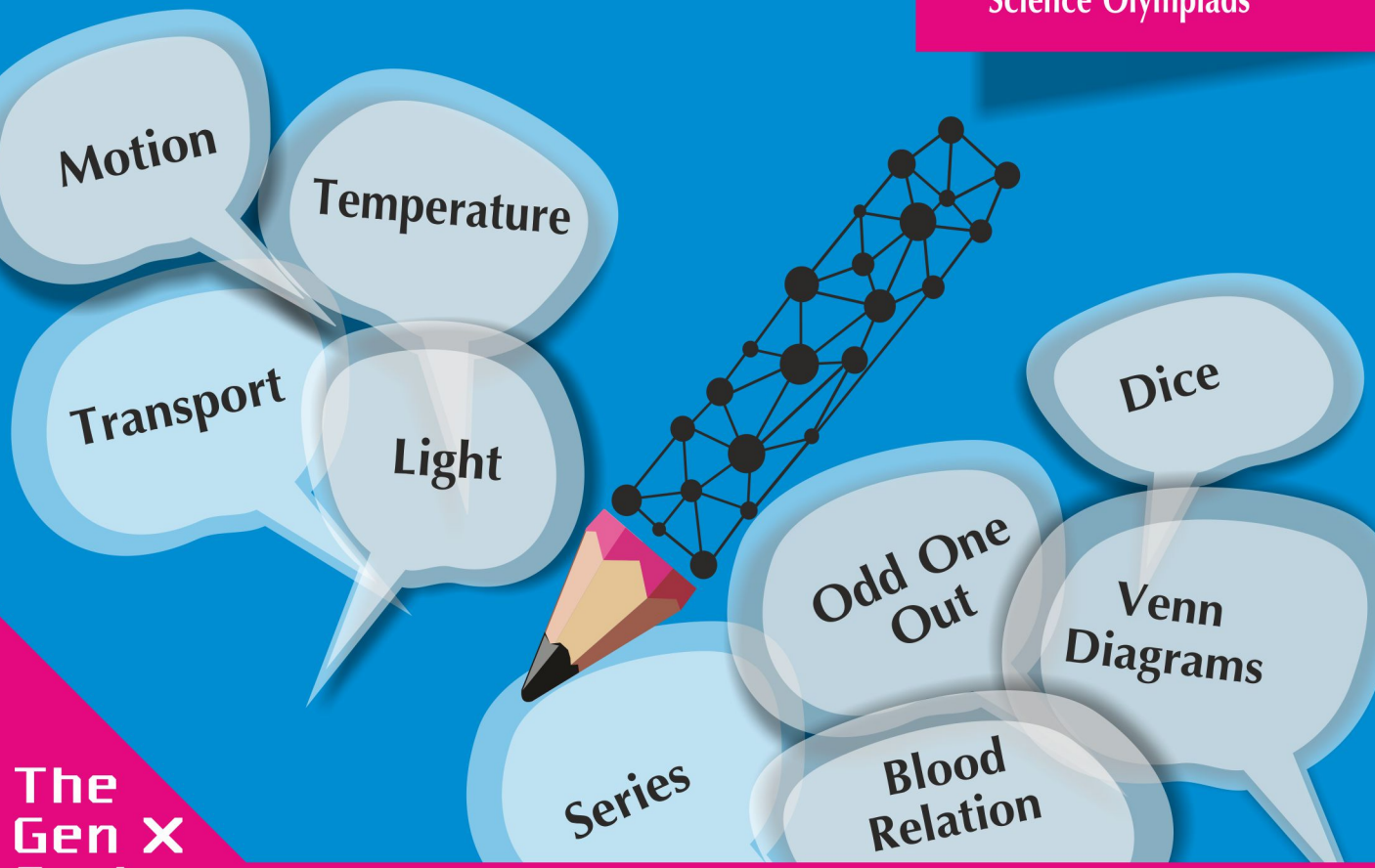
V & S PUBLISHERS

# SCIENCE OLYMPIAD

## National Science Olympiad

# 7

Strictly according to the latest syllabus of Science Olympiads




The Gen X Series

A SUCCESS PACKAGE FOR ASPIRANTS OF SCIENCE OLYMPIADS

# NATIONAL SCIENCE OLYMPIAD

## Exploring the World of Science

**Class 7**

**Preeti Agarwal**

V&S PUBLISHERS

*Published by:*

V&S PUBLISHERS

F-2/16, Ansari road, Daryaganj, New Delhi-110002
☎ 23240026, 23240027 • *Fax:* 011-23240028
*Email:* info@vspublishers.com • *Website:* www.vspublishers.com

**Regional Office : Hyderabad**
5-1-707/1, Brij Bhawan (Beside Central Bank of India Lane)
Bank Street, Koti, Hyderabad - 500 095
☎ 040-24737290
*E-mail:* vspublishershyd@gmail.com

**Branch Office : Mumbai**
Jaywant Industrial Estate, 1st Floor–108, Tardeo Road
Opposite Sobo Central Mall, Mumbai – 400 034
☎ 022-23510736
*E-mail:* vspublishersmum@gmail.com

Follow us on:


ISBN 978-93-505797-9-4

## DISCLAIMER

# Publisher's Note

V&S Publishers, after the grand success of a number of Academic and General books, is pleased to bring out a series of *Science Olympiad books* under *The Gen X series – generating Xcellence in generation X* – which has been designed to focus on the problems faced by students. In all books the concepts have been explained clearly through various examples, illustrations and diagrams wherever required. Each book has been developed to meet specific needs of students who aspire to get distinctions in the field of science and want to become Olympiad champs at national level.

To go through Science Olympiads, students need to do thorough study of topics covered in the *Olympiad syllabus and the topics covered in the school syllabus as well*. The Olympiads not only tests subjective knowledge but Reasoning skills of students also. So the students are required to comprehend the depth of concepts and problems. The Olympiads check efficiency of candidates in problem solving. These exams are conducted in different stages at regional, and national levels. At each stage of the test, a candidate should be fully prepared to go through the exam. Therefore, this test requires careful attention towards comprehension of concepts, thorough practice, and application of concepts and rules.

While other books in market focus selectively on questions or theory; V&S Science Olympiad books are rather comprehensive. Each book has been divided into five sections namely *Science, Logical Reasoning, Achievers section, Subjective section, and Model Papers.* The theory has been explained through solved examples. To enhance problem solving skills of candidates, *Multiple Choice Questions (MCQs)* with detailed solutions are given at the end of each chapter. Two *Mock Test Papers* have been included to understand the pattern of exam. A CD containing Study Chart for systematic preparation, Tips & Tricks to crack Science Olympiad, Pattern of exam, and links of Previous Years Papers is accompanied with this book. The books are also useful for various other competitive exams such as NTSE, NSTSE, and SLSTSE as well.

We wish you all success in the examination and a very bright future in the field of science.

All the best

# Contents

## Section 1 : Science


| | | |
|---|---|---|
| 1. | Heat and Temperature | 9 |
| 2. | Motion and Time | 20 |
| 3. | Electric Current and Its Effects | 32 |
| 4. | Winds, Storms and Cyclones | 45 |
| 5. | Light | 55 |
| 6. | Acids, Bases and Salts | 71 |
| 7. | Physical and Chemical Changes | 80 |
| 8. | Weather, Climate and Adaptations of Animals | 88 |
| 9. | Fibres to Fabrics | 99 |
| 10. | Nutrition in Plants and Animals | 110 |
| 11. | Respiration in Organisms | 125 |
| 12. | Transport and Excretion | 136 |
| 13. | Reproduction in Plants | 149 |
| 14. | Natural Resources and Their Conservation | 165 |


## Section 2 : Logical Reasoning


| | | |
|---|---|---|
| 1. | Pattern | 179 |
| 2. | Number Series | 189 |
| 3. | Alphabetical Series | 193 |
| 4. | Odd One Out | 199 |
| 5. | Coding Decoding | 206 |
| 6. | Alphabet Test | 212 |
| 7. | Blood Relation Test | 217 |
| 8. | Direction Sense Test | 224 |
| 9. | Number Ranking Test | 232 |
| 10. | Odd One Out | 238 |

11. Dice 245
12. Mirror Images 253
13. Water Images 259
14. Embedded Figures 266
15. Venn Diagrams 272

## Section 3 : Achievers Section

Questions Based on Achievers Section 281
High Order Thinking Skills (HOTS) 285

## Section 4 : Subjective Section

Short Answer Questions 293

## Section 5 : Model Papers

Model Test Paper – 1 303
Model Test Paper – 2 309

# Section 1
# Science

# 1 Heat and Temperature

## Learning Objectives

- Heat
- Temperature
- Measurement of temperature
- Transfer of heat
  - Conduction - Transfer of heat in solids
  - Convection - Transfer of heat in liquids and gases
  - Radiation - Transfer of heat without a medium

## Heat

"Heat is a form of **energy** which can cause hotness to a body and like all other forms, it can also get transformed into other forms of energy like others ."

The direction of flow of heat is always from a body at higher temperature to a body at lower 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 = $10^7$ 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:

- On rubbing the palm together, they become hot. Thus, mechanical energy gets converted into heat energy.
- In an electric bulb, electrical energy gets converted into heat energy of the filament, which is then converted into light energy.
- During the working of a geyser or heater, electrical energy gets transformed into heat energy.
- In a steam engine, heat energy is transformed into mechanical energy.
- In a nuclear power plant, nuclear energy is transformed into heat energy, and then into electrical energy.
- 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

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

(b) It does not stick to the glass.

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

(d) 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 **–117ºC.**

## 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 (ºC). Lower fixed point is 0ºC and upper fixed point is 100ºC. 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 37ºC 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. (ºF). Lower fixed point is 32ºF and upper fixed point is 212ºF. The difference between these two points is divided into **180 equal parts**.

The normal body temperature is 98.4ºF 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 thermometer use mostly 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 **35ºC to 42ºC**. No human can survive with a body temperature below 35ºC or above 42ºC.

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 **–10ºC to 110ºC**.

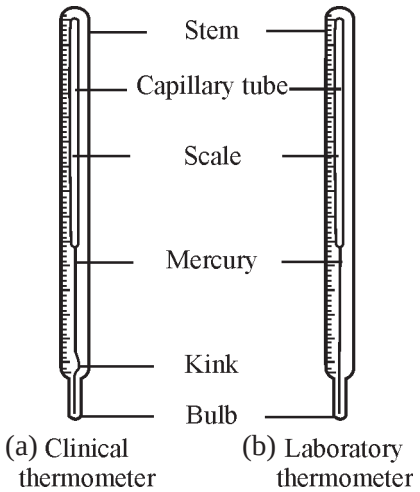



**Fig: 1.1**

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.

### 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.

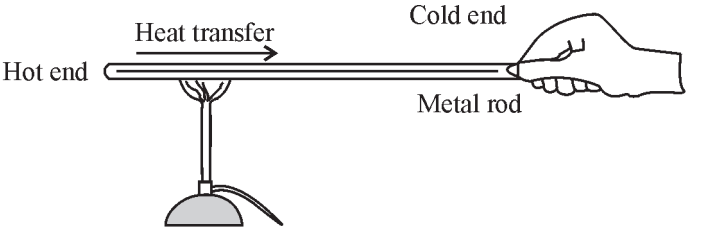
## Transfer of Heat

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.

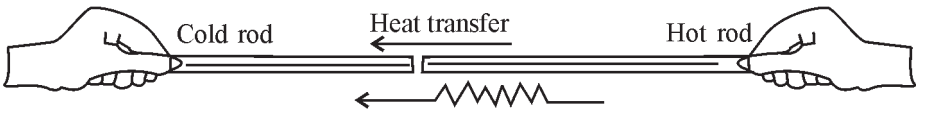
## Conduction-Transfer of Heat in Solids

"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 next ones also start vibrating. Thus, the heat is automatically carried from one particle to another, by way of vibration 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 at 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 surrounding.

## Convection–Transfer of Heat in Liquids and Gases

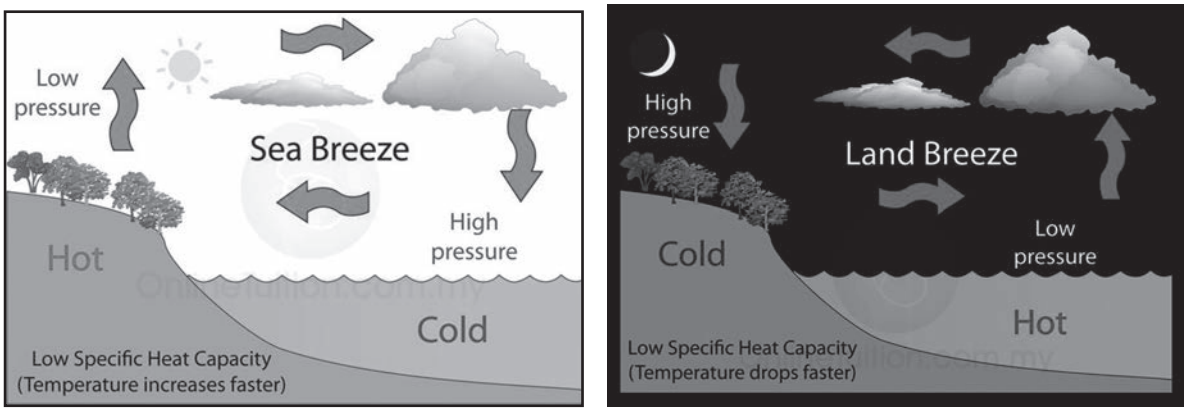
"Convection is the process of heat transfer in which the molecules of a medium actually move from hotter region to the colder region carrying heat with them."

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 colder. The warm air above sea rises. So, colder 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 door and windows flow in. 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.

Damage caured by 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 colder. 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 at higher positions on the walls of offices and homes so that the cold air generated by them moves downward and be more effective in cooling 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 and 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**

1. 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.
2. Radiators in cars and air-conditioners are painted black so as to have cooling effects by radiating most of heat.
3. Solar cooker and solar water heater are painted black from inside. This is because black surface is good absorber of heat.
4. Coffee and tea stay hot longer in shining pot than in blackened one.
5. Light coloured buildings stay cooler in summer because they reflect most of the heat radiations from the sun.
6. Dark-coloured clothes are warmer in summer whereas white or light coloured clothes are cooler.

### Did 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 –8ºC, 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 35ºC to 42ºC.
- ✓ 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 better absorber of heat.
- ✓ Shiny and white surfaces are better reflector of heat.

## Multiple Choice Questions

1. Heat energy flows
   (a) from body at higher temperature to body at lower temperature
   (b) from body at lower temperature to body at higher temperature
   (c) when the temperature of two bodies is equal
   (d) all the above statements are correct.
2. One glass of water at 40ºC is mixed with another glass of water at 60ºC. The temperature of mixture will be:
   (a) 40ºC (b) 60ºC
   (c) between 40ºC and 60ºC (d) more than 60ºC
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 the above
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 & 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 ice
    (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 50ºC. 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) 32ºF
    (b) 212ºF
    (c) 100.4ºF
    (d) 98.6ºF

## Answer Key

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. (a) | 2. (c) | 3. (d) | 4. (d) | 5. (b) | 6. (b) | 7. (b) | 8. (b) | 9. (a) | 10. (b) |
| 11. (c) | 12. (d) | 13. (d) | 14. (b) | 15. (d) | 16. (d) | 17. (b) | 18. (c) | 19. (d) | 20. (c) |
| 21. (c) | 22. (c) | 23. (a) | 24. (b) | 25. (d) | | | | | |

# Hints and Solutions

5. (b)
   Alcohol has a freezing point much lower than other given substances here.
6. (b)
   1 cal = 4.18 joules.
8. (b)
   Heat always flows from a hotter region to a colder region. Since iron is a good conductor of heat, more heat will flow from our body to it and we will feel cold. As paper is a bad conductor, less heat will flow from our body.
9. (a)
   The lower fixed point in the Celsius scale is 0ºC, which is the melting point of ice.
10. (b)
    The upper fixed point in the Celsius scale is 100ºC, which is the boiling point of water.
11. (c)
    The chemicals present in the candle burn with oxygen to give out heat.
13. (d)
    Metals are better conductors of heat than non-metals.
14. (b)
    Wood is a non-metal and bad conductor of heat.
16. (d)
    The molecules of liquids and gases are not rigidly bound to each other and can move freely. This makes transfer of heat by convection possible.

# 2 Motion and Time

## Learning Objectives

- Motion
- Relation between rest and motion
- Distance and Displacement
- Uniform motion and non-uniform motion
- Speed (uniform and non uniform speed)
- Distance-time graph
- Time, Measurement of time
- Simple pendulum

## 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 be 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

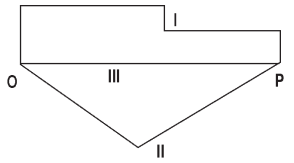
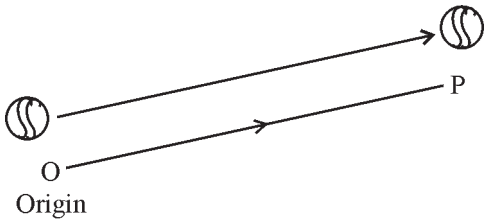



**Fig: 2.1**

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




Displacement

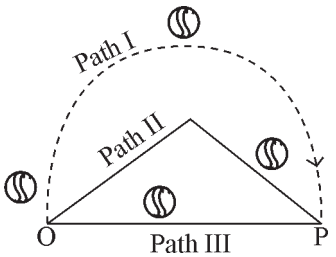
**Fig: 2.2**

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.

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 P. 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).**




Showing distance and displacement

**Fig: 2.3**

## Uniform Motion and Non-uniform Motion

### Uniform Motion

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 4 m. 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.

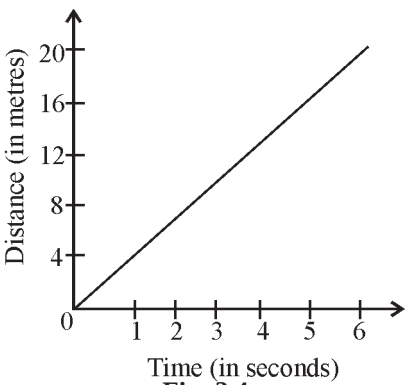



**Fig: 2.4**

### 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 perform 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,

$$\text{Speed} = \frac{\text{distance travelled by the object}}{\text{time taken to travel this distance}}$$

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

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

## 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* :**

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

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

$$= 40 \times 2$$

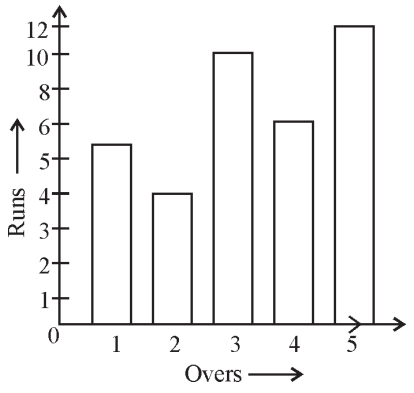
$$= 80 \text{ km}$$

***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) $= t_1 + t_2$

$= 1 + 1 = 2$

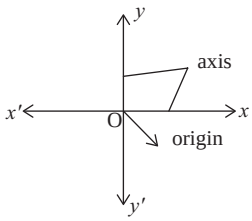
Now,

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

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

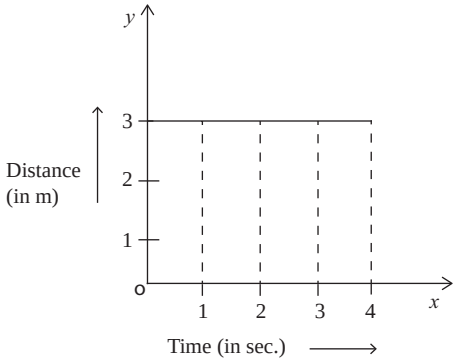
## Distance-Time Graph

A graph is a diagrammatic representation, depicting an interrelation 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.

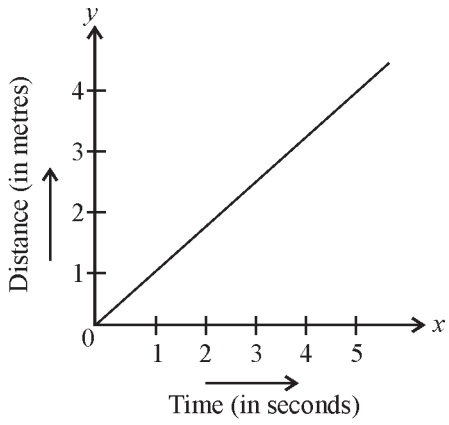
(a) When distance-time graph is parallel to the *x*-axis or time axis, it means that body is not changing its position with respect to time i.e. body is stationary.




Graph for body at rest

**Fig: 2.5**

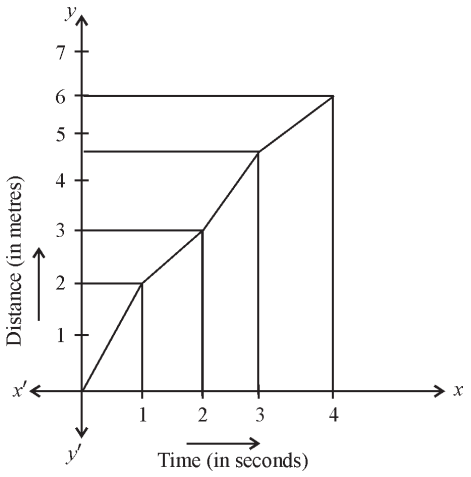
(b) When distance-time graph is straight line but not parallel to time axis, it means that body is in uniform motion i.e. the body covers equal distances in equal intervals of time.




Graph for uniform motion

**Fig: 2.6**

(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.




Graph for non uniform motion

**Fig: 2.7**

## 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:

(a) The movement of shadow cast by the sun (sundials)
(b) The rising and setting of sun
(c) The movement of the moon around the earth
(d) The quantity of sand or water dripping in a vessel (sand and water clock)
(e) 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 nothing (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 and vice versa.

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.

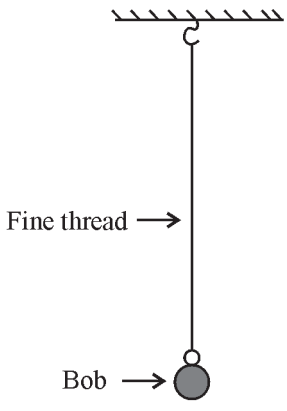
### Simple Pendulum

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**.

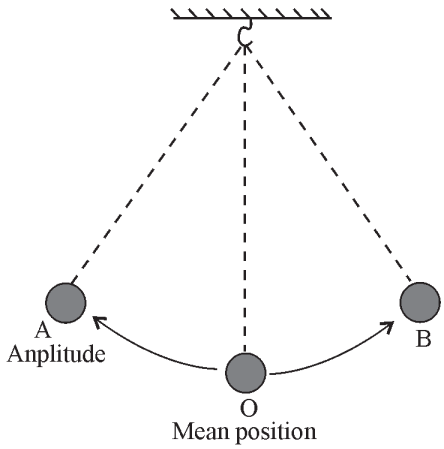
The pendulum completes **one oscillation** when the bob from one extreme position goes to other end and then comes back again at that point.

### 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.




Simple pendulum




Different positions of the bob of an oscillating simple pendulum

**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.

### Did You Know

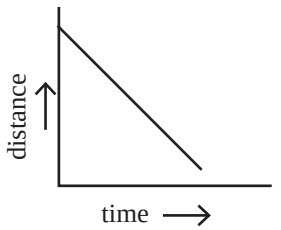
1. The device fitted in vehicles to measure distance is called an ODOMETER.
2. The device fixed in vehicles to show the speed of vehicle is called the SPEEDOMETER or a TACHOMETER.
3. There are more than 2.6 million seconds in a month.
4. The speed of light is $3 \times 10^8$ m/sec and that of sound under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

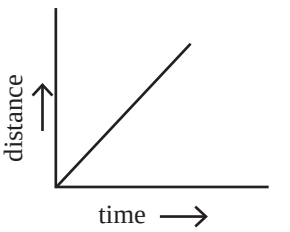
## Key Points

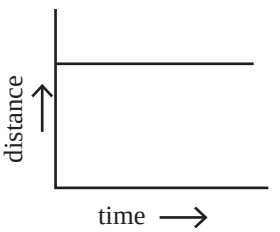
- ✓ Motion and rest are relative terms.
- ✓ Distance is the actual length of path travelled by an object. Distance travelled can never be zero.
- ✓ Displacement is the shortest distance between two points. It can be positive, negative or zero.
- ✓ Speed is the distance travelled by an object in unit 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.

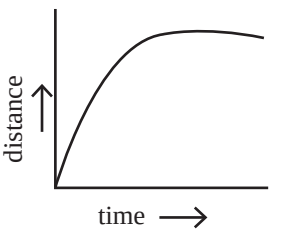
## Multiple Choice Questions

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) 

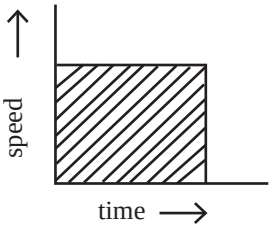

5. Which of the following is not in uniform motion?
   (a) a swinging pendulum
   (b) the rotation of earth
   (c) a bullet travelling with a constant speed in a straight line.
   (d) both (a) and (b)
6. Which of the following does not show oscillatory motion?
   (a) swing (b) fan
   (c) see-saw (d) 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

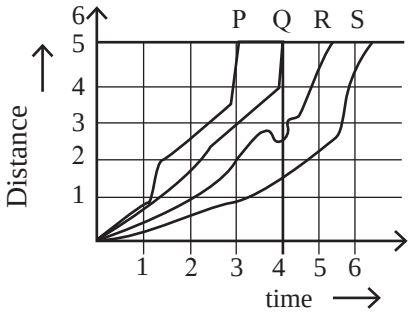
10. Distance travelled will be equal to the displacement if
   (a) object is moving along straight line in forward direction.
   (b) object is moving in different directions.
   (c) object is moving from one point to other along any path
   (d) not possible in any condition.

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