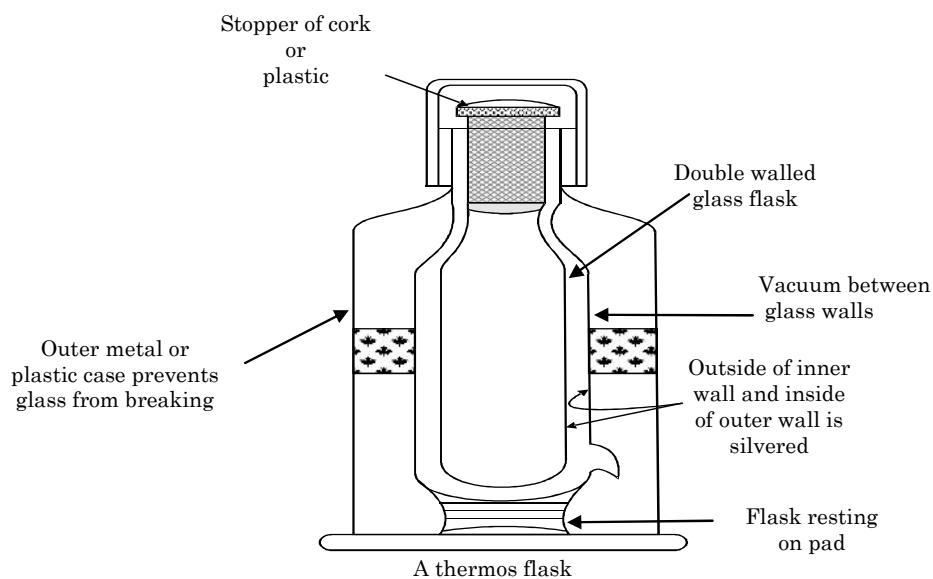
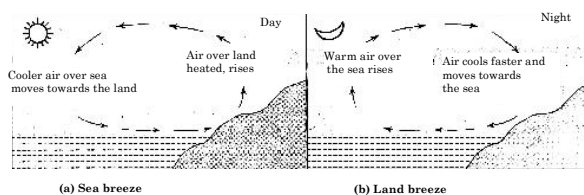
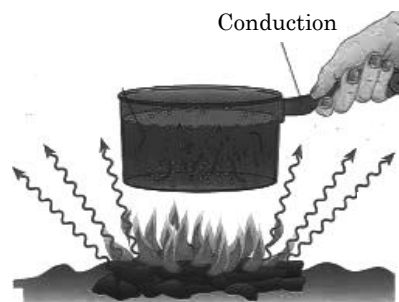
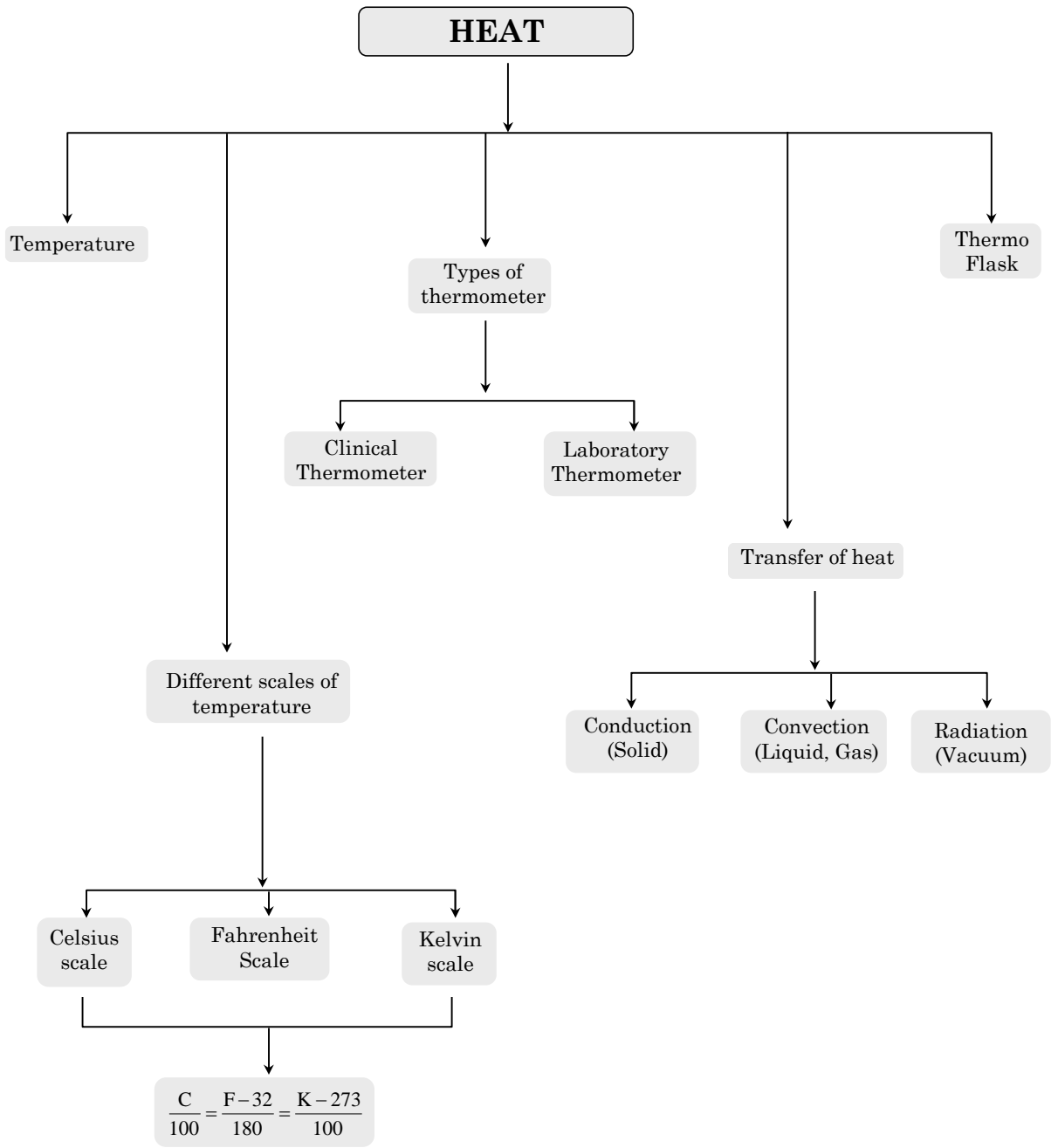


### Chapter Outline

- ❖1 Heat
- ❖1 Temperature
- ❖1 Different Scales of Temperature
- ❖1 Types of Thermometer
- ❖1 Role of Temperature in Transfer of Heat Energy
- ❖1 Specific Heat Capacity/Specific Heat
- ❖1 Specific Heat of Water
- ❖1 Advantage of the High Specific Heat of Water
- ❖1 Effects of Heat
- ❖1 Transfer of Heat
- ❖1 Thermos Flask
- ❖1 Points to Remember



# MIND MAP



# HEAT

## Heat

It is a form of energy which causes the sensation of hotness or coldness.

For example, if we dip our finger in hot water we have a sensation of hotness. Similarly, if we touch a block of ice the sensation is that of coldness. In the former case the heat energy has moved into the finger, while in the later case it has moved out of the finger. Thus, hotness or coldness basically

indicates whether heat energy is flowing into our body or out of it.

The amount of heat energy present in a body is determined by the total sum of the kinetic energy and potential energy of its molecules.

## Temperature

It is the effect of heat energy which determines the thermal state of a given substance. In other words, determines the degree of hotness or coldness of a substance.

When two bodies at different temperatures are brought in contact with each other, the heat energy always flows from a body at higher temperature to a body at lower temperature, till the temperatures equalise. Thus, it is the temperature of a body which determines the direction of flow of heat energy. If a body is at a higher temperature than its surroundings, it means that heat energy will flow out of the body. Similarly, if a body is at a lower temperature than its surroundings, it means that heat energy will flow into the body.

### ◆ Measurement of Temperature

The instrument used for the measurement of temperature is called thermometer.

**Note:** Thermal energy is actually a form of kinetic energy generated by the moment of the particles at the atomic or molecular level.

## Difference Scales of Temperature

### ◆ Celsius or Centigrade Scale

As the name suggests, this scale has 100 divisions between the upper and lower standard points. This scale was introduced by a Swedish astronomer Celsius and is known after his name. Each division on this scale is called one degree centigrade or one degree Celsius and is written as °C. More sensitive thermometers have 200 divisions between standard points and each division is equal to ½°C. Sometimes these thermometers are called half °C thermometers.

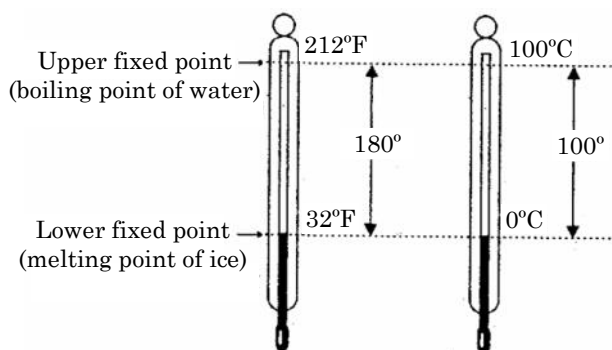
### ◆ Fahrenheit Scale

This scale was introduced by Fahrenheit. On this scale 32° F represents the melting point of ice and 212° F the steam point. Zero is marked 32° F below the ice point. The length in between the standard points is divided into 180 equal parts. Each division on this scale is called 1° F. This scale is widely used for meteorological and clinical purposes.

#### • Relation between Celsius and Fahrenheit scales:

If  $T_C$  and  $T_F$ , are temperature values of a body on Celsius scale and Fahrenheit scale respectively then,

$$\frac{T_C - 0}{100} = \frac{T_F - 32}{180} \Rightarrow \frac{T_C}{5} = \frac{T_F - 32}{9}$$



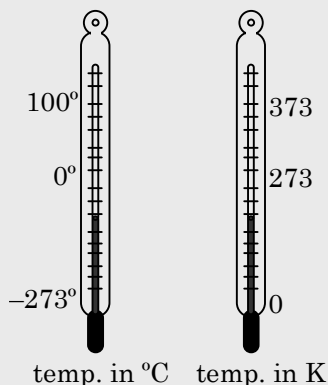
The above relation is very useful for converting temperatures from one scale to another.

### COMPETITIVE LEVEL

#### ◆ Kelvin Scale

The scale of measurement of temperature, in which lowest temperature is zero Kelvin ( $-273^\circ\text{C}$ ) is called

Kelvin scale, This is also called S.I. scale of temperature.



$$\text{Temp in kelvin} = 273.15 + \text{temp in } ^\circ\text{C}$$

$$(T) \text{ K} = 273.15 + (t) \text{ in } ^\circ\text{C}$$

#### • Characteristics of Kelvin scale:

- (i) There cannot be any temperature below zero Kelvin.
- (ii) The temperature is expressed in (K), but no degree symbol is attached to it.
- (iii) Rise in temperature in kelvin = Rise in temperature in degree Celsius.

#### • Relation between different temperature scales:

$$\frac{T_C}{5} = \frac{T_F - 32}{9} = \frac{T_K - 273}{5}$$

**Ex.1** At what temperature, if any, do the following pairs of scales give the same reading:

- (a) Celsius and Fahrenheit,
- (b) Fahrenheit and Kelvin and
- (c) Kelvin and Celsius?

**Sol.** If the temperature is  $\theta$  at which the reading of two scales coincides, then from

$$\frac{T_C - 0}{100} = \frac{T_F - 32}{180} = \frac{T_K - 273.15}{100}$$

(a)  $\frac{\theta}{100} = \frac{\theta - 32}{180}$ , i.e.,  $\theta = -40$

i.e., reading of Celsius and Fahrenheit scale coincides at  $-40^\circ$ .

(b)  $\frac{\theta - 32}{180} = \frac{\theta - 273.15}{180}$ , i.e.,  $\theta = 574.6$

i.e., reading of Fahrenheit and Kelvin scale coincides at  $574.6^\circ$ .

(c)  $\frac{\theta - 273}{100} = \frac{\theta}{100}$  which is not possible

So reading of Celsius and Kelvin scale can never coincide.

**Ex.2** Find the value of  $5^\circ\text{C}$  in  $^\circ\text{F}$  and K scale respectively.

**Sol.** Relation between Celsius and Fahrenheit scale

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

So corresponding value of  $5^\circ\text{C}$  in Fahrenheit scale is

$$\frac{5}{5} = \frac{F - 32}{9} \Rightarrow F = 41^\circ\text{F}$$

Relation between Celsius and Kelvin scale

$$T(\text{K}) = T(^{\circ}\text{C}) + 273 = 5 + 273 = 278 \text{ K}$$

## Role of Temperature in Transfer of Heat Energy

When two bodies at different temperatures are brought in contact with each other, the heat energy always flows from a body at higher temperature to a body at lower temperature, till the temperatures equalise. Thus, it is the temperature of a body which determines the direction of flow of heat energy.

**Note:** Two systems at the same temperature are said to be in a state of thermal equilibrium.

### COMPETITIVE LEVEL

#### ◆ Units of Heat Energy

Heat energy is measured in calories.

The quantity of heat energy required to raise the temperature of 1 g of pure water through  $1^\circ\text{C}$  ( $14.5^\circ\text{C}$  to  $15.5^\circ\text{C}$ ) is called one calorie.

The calorie is a very small unit of heat energy for practical purposes. Thus, a bigger unit called kilocalorie is used.

The quantity of heat energy required to raise the temperature of 1 kg of pure water through  $1^\circ\text{C}$  is called one kilocalorie. 1 kilocalorie = 1000 calories.

Kilocalorie is sometimes called Big calorie or Doctor's calorie or Calorie (with capital C). The energy value of the foods and the fuel is measured in kilocalories.

We know energy is measured in Joules. As heat energy is a form of energy, therefore, it should also be measured in Joules, rather than calories or kilocalories, for strict scientific purpose. However, doctors still continue with kilocalories.

Following are the equivalent of calorie and kilocalorie in joules:

(i) 1 calorie = 4.186 J = 4.2 J (approx)

(ii) 1 Kilocalorie = 4186 J = 4200 J (approx.)

## Specific Heat Capacity/Specific Heat

The amount of heat energy required to raise the temperature of unit mass of a substance through 1 °C or 1 K is called specific heat capacity.

## Specific Heat of Water

We have already defined specific heat of a substance. On the same basis, we define specific heat of water as the amount of heat energy required to raise the temperature of unit mass (say, one gram) of water through unit degree (1°C). specific heat of water,

$$s = 1 \text{ cal g}^{-1}\text{°C}^{-1} = 1 \text{ cal g}^{-1} \text{ K}^{-1}$$

$$s = 4.2 \text{ J g}^{-1} \text{ K}^{-1} = 4200 \text{ J kg}^{-1} \text{ K}^{-1}$$

- Specific heat of a substance depends also on the state of the substance i.e. solid, liquid or gas.  
e.g.: Specific heat of ice = 0.5 cal g<sup>-1</sup> °C<sup>-1</sup>;  
specific heat of water = 1 cal g<sup>-1</sup> °C<sup>-1</sup> and  
specific heat of steam = 0.47 cal g<sup>-1</sup> °C<sup>-1</sup>.

## Advantage of the High Specific Heat of Water

Due to the high specific heat of water, it can be used for heating as well as cooling purposes.

**Fomentation:** Owing to its high specific heat, water can store large quantities of heat energy at a comparatively lower temperature as compared to other substances. Therefore, hot water has a large quantity of stored heat which it is capable of giving off. Thus, water is used in hot water bottles for fomentation purposes.

Prevents freezing of bottled wines and juices. In cold countries, wine and juice bottles are kept under water. Due to its high specific heat, water is capable of giving off large amount of heat which prevents them from freezing.

## Effects of Heat

### ◆ Temperature rises with heat

When you heat something, or supply it with heat, its temperature rises. You would have notice this in the activity in which you measured the temperature of boiling water. The converse is also true. When you cool something, its temperature falls. Cooling something is the same as taking away heat from it.

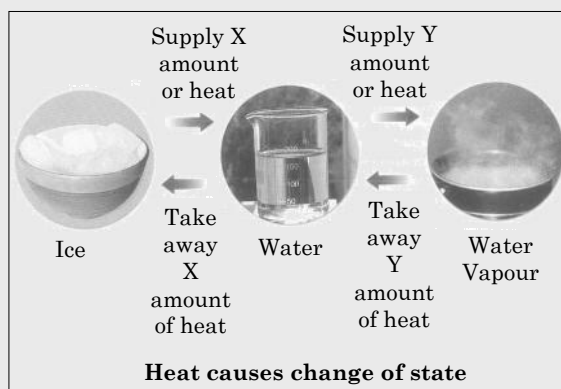
### ◆ Heat causes expansion

All substances, whether solid, liquid or gaseous, expand when they are heated and contract when they are cooled. However, the extent to which they expand is different. Expansion is the greatest in gases, less in liquids, and the least in solid.

e.g.: Fit a balloon to the mouth of a glass bottle. Place the bottle in a pan of water and heat it. The balloon will get inflated as the air inside the bottle becomes warm and expands. Take the bottle out of the pan and allow it to cool. The balloon will get deflated as the air inside the bottle contracts.

### ◆ Heat causes change of state

When you heat a solid, it melts. And when you heat a liquid, it ultimately boils and changes into vapour. Conversely, when you cool a vapour, or take away heat from it, it changes into a liquid. And when you cool a liquid, or take away heat from it, it changes into a solid.



## Transfer of Heat

Heat can be transferred by three methods:

(a) Conduction

(b) Convection

(c) Radiation

### ◆ Conduction

Heat is transferred by the process of conduction when bodies at different temperatures are in direct or indirect physical contact.

Let us take an example of heating a solid rod by the process of conduction. The molecules in the solid rod are oscillating about their fixed position. As the molecule at one end get heated, they gain kinetic energy and start oscillating vigorously. They collide with the neighbouring molecules and transfer the extra energy to them. These gain kinetic energy and transfer it to their neighbouring molecules. In this way, heat is transmitted from one molecule to the next, down the whole rod, without the molecules actually moving from their positions. This process by which heat travels in solids is called conduction.

Conduction is a process of transfer of heat from the hotter end to the colder end from particle to particle of the medium. Conduction is the process of transmission of heat in solids, in which the molecules of the solid do not move from their position (only oscillate back and forth about their fixed positions) but merely transfer the heat energy in the form of kinetic energy from one molecule to the next.

Thus, medium is required for the transfer of heat by conduction, therefore, conduction is not possible in vacuum. In solids, heat is transferred mainly by the process of conduction.

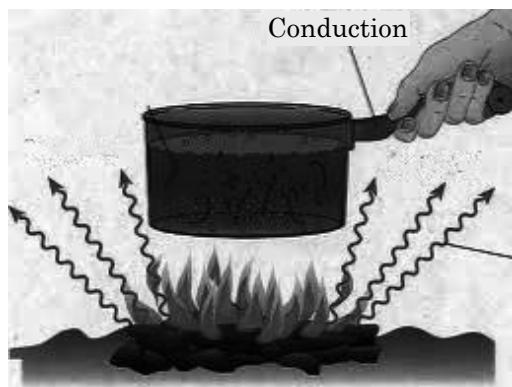
#### • Types of conductors:

**(a) Good conductors:** The substances through which heat energy can easily flow by conduction are called good conductors.

e.g.: Metals in general are good conductors. Amongst the metals, silver is best conductor, next in order are copper, aluminium, gold, etc. Amongst non-metals graphite is a good conductor.

Metals are good conductor of heat. The high conductivity of metals can be attributed to the presence of a large number of free electrons. These electrons drift away from the source of heat when the metal is heated and in doing so carry the heat energy rapidly through the metal.

**(b) Bad conductors:** The substances which do not allow the heat energy to flow through them easily are called poor conductors or bad conductors.



e.g.: Amongst the solid, glass, wood, clay, asbestos, rubber, plastics, wax, etc., are poor conductors.

All liquids except mercury are poor conductors. All gases without any exception are poor conductors.

**Note:** *Non-metals and organic substances are bad conductors. The low conductivity can be attributed to the lack of a large number of free electrons. It is because most of the heat energy can be transferred only through free electrons and not by the actual vibrational movement of its atoms.*

• **Practical Applications of Good Conductors:**

- (i) Copper tubing is used in the automobile radiators, as it readily takes up heat from the hot water coming from the side of engine.
- (ii) Cooking vessels are made out of metals, so that they can readily absorb heat energy and transfer it to the food.
- (iii) Mercury is used as a thermometric liquid, as it is a good conductor of heat.
- (iv) Cooling coils of an air conditioner and the refrigerator are made of copper as they readily conduct heat.
- (v) Tip of the soldering rod is made of copper, as it readily conducts away heat to the solder.

- **Practical applications of bad conductors:** We wear woolen clothes in the winter, because the woolen clothes contains a large amount of the trapped air. Since air is a bad conductor of heat, it does not allow the body heat to flow outward. As our body stops losing heat, we feel warm.

**Note:** *Solids, particularly metals, whose molecules are packed relatively closed together, are the best materials for conduction.*

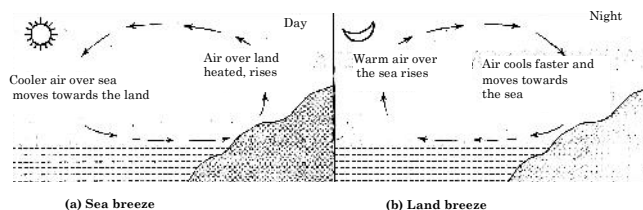
◆ **Convection**

Convection is a process of transfer of heat by the actual movement of the medium particles. Liquids and gases are the bad conductors of heat. They are heated mainly by the process of convection. In a solid, the atoms cannot move, leaving their positions. So solids are not heated by convection. A medium is required for the transfer of heat by convection. Heat cannot be transferred by convection in vacuum.

By the process of convection, the transfer of heat is always vertically upwards. The reason is that the medium particles near the source of heat absorb heat from the source and they start moving faster. As a result, the air at this place becomes less dense so it rises up in the medium which is called a convection current. The current continues till the entire liquid acquires the same temperature.

- **Consequence of convection: Land and sea breeze:** In the coastal regions, during summer it is noticed that a breeze generally blows from land towards the sea during the night (or early morning) which is called the land breeze.

Land is a better absorber of heat than water. During the day, the land gets hotter, the air above it rises and cooler air from over the sea flows in to take its place. This gives rise to a sea breeze that cools the land.



During night, the land radiates the heat it had absorbed during the day and cools down faster than the sea. Above the sea, the air is warmer. It rises and cooler air from the land moves towards the sea to take its place. This gives rise to a land breeze. Thus, we have a sea breeze during day time and a land breeze at night.

### ◆ Radiation

Radiation is the process of heat transfer in which heat directly passes from one body to the other body without affecting the medium.

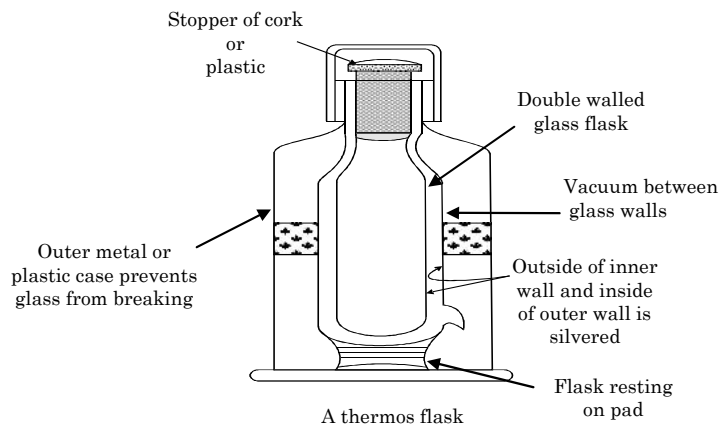
Thus, no medium is required for the heat transfer by the process of radiation. In vacuum, heat transfer takes place only by the process of radiation.

The heat energy transferred by the process of radiation is called the radiant heat or the thermal radiation.

- **Nature of Radiant Heat:** Heat energy is transferred by radiation in the form of electromagnetic waves. These waves can travel even in vacuum. They travel in all directions in straight line with a speed, equal to the speed of **light** ( $= 3 \times 10^8 \text{ m s}^{-1}$ ). They do not heat the medium through which they pass. They are reflected by a polished and white surface. When radiant heat falls on an object, it is partially absorbed and partially reflected. Dull, black or coloured surfaces are good absorber and good radiators of heat.
- **Properties of heat radiations:**
  - (a) Heat radiations travel with the speed of light.
  - (b) Heat radiations can travel through vacuum.
  - (c) Heat radiations travel in straight lines.
  - (d) Heat radiations can travel in all directions.
- **Applications of heat radiations:**
  - (a) Roofs of factories are painted white or with aluminum paint, because shining roofs are bad radiators of heat, but good reflector of heat.
  - (b) Metal teapots are kept shining as shining teapots are bad radiators of heat and hence tea remains hot for a long time.
  - (c) The cooking utensils are kept black from below and shining from the sides, because black surface absorb heat radiation rapidly, but the shining surfaces do not easily radiate heat. Thus, heat is trapped inside the cooking utensil and hence, cooking time is reduced.

## Thermo Flask

Hot tea is poured into the flask which is closed with the stopper at the top. The stopper is usually made of plastic which is a poor conductor of heat and prevents loss of heat from the top due to conduction. Since glass is also a poor conductor of heat, the glass double walls of the flask too prevent loss of heat. The insulation between the flask and the outer cover further prevents heat loss by conduction.



The flask is closed at the top and warm air cannot escape from the top, so there is no loss of heat by convection. Between the two glass walls of the flask, there is vacuum (no air), so no heat can be lost through the walls of the flask due to conduction or convection.

The outer surface of the inner wall and inner surface of the outer wall (of the double glass walls) are silvered and are shiny. Thus, heat from inside cannot escape and heat from outside cannot enter by radiation as the silvered inner and outer surfaces reflect back this heat. Thus, a thermos flask prevents heat loss from inside the flask by conduction, convection and radiation.

## Points to Remember

- Heat is a form of energy. We use this energy to generate electricity, among other things.
- The hotness or coldness of a body is relative.
- The temperature of a body is a measure of the degree of hotness of the body. We measure it by comparing it with a universal standard.
- The Celsius and Fahrenheit scales are commonly used to measure temperature. Ice melts at  $0^{\circ}\text{C}$  or  $32^{\circ}\text{F}$ . and water boils at  $100^{\circ}\text{C}$  or  $212^{\circ}\text{F}$ .
- Heat causes a rise in temperature. It also causes expansion and change in the state of matter.
- Heat flows or travels in three ways – conduction, convection and radiation.
- Conduction is the process by which heat flows through a substance without the movement of the substance itself.
- Convection is the process of transfer of heat in a liquid or gas by the movement of the liquid or gas.
- Radiation is the process by which heat travels without the help of a material medium. Radiant heat travels in straight lines, in all direction from a hot body.
- Every body emits (gives out) radiant heat. The emission of radiant heat from a body depends upon its temperature and colour.
- When radiant heat falls on a body, a part of it is absorbed and the rest is reflected. How much radiant heat a body absorbs and how much it reflects depend on its colour and the nature of its surface. Shiny white bodies are the best reflectors, while rough black bodies are the best absorbers of radiant heat. Black bodies absorb and emit radiant heat the best.

# EXERCISE-1

## Very Short Answer Type Questions

- Q.1** A steel spoon dipped in a pot of boiling soup for a few minutes becomes too hot to touch. How does heat travel through the spoon?
- Q.2** How is it that we can hold a match while it is burning?
- Q.3** How does turning on a heater in a room make the whole room warm?
- Q.4** How does heat from the sun reach the earth?
- Q.5** Mention one similarity between heat and light.

## Short Answer Type Questions

- Q.6** If the hotness or coldness of a body is relative, how do we measure its degree of hotness?
- Q.7** What is temperature? Name the scales used to measure it.
- Q.8** When two bodies are in contact, heat flows from the hotter to the colder body. When does heat stop flowing?
- Q.9** What happens to radiant heat when it falls on a body? What does the absorption of radiant heat by a body depend on?
- Q.10** (a) Mention one difference between the transfer of heat by conduction and that by radiation.  
(b) Mention one difference between the transfer of heat by conduction and that by convection.

## Long Answer Type Questions

- Q.11** Distinguish between the Celsius and Fahrenheit scales.
- Q.12** Why stainless steel parts are usually provided with copper bottoms. The Reason for this could be?
- Q.13** Mention three changes that heat causes in substances.
- Q.14** Explain how land and sea breezes originate.
- Q.15** Explain why -  
(a) It is better to wear lighter shades in summer.  
(b) Two thin sweaters feel warmer than one thick sweater.  
(c) Utensils are made of metal, while their handles are made of plastic.

## Fill in the Blanks

- Q.16** (i) The hotness of an object is determined by its .....
- (ii) Temperature of boiling water cannot be measured by a ..... thermometer.
- (iii) No medium is required for transfer of heat by the process of .....
- (iv) A cold steel spoon is dipped in a cup of hot milk. It transfers heat to its other end by the process of .....
- (v) Clothes of ..... colours absorb heat better than clothes of light colours.

➤ True or False

- Q.17** (i) Water boils at 212°F.  
(ii) Liquids conduct heat better than metals do.  
(iii) Transfer of heat in a substance by convection happens by the movement of the substance.  
(iv) Transfer of heat by radiation needs contact between a hot and a cold body.  
(v) Air is a bad conductor of heat.

➤ Match the Column

**Q.18**

	<b>Column-A</b>		<b>Column-B</b>
(a)	Land breeze blows during	(i)	summer
(b)	Sea breeze blows during	(ii)	winter
(c)	Dark coloured clothes are preferred during	(iii)	day
(d)	Light coloured clothes are preferred during	(iv)	bad radiators and good reflectors of heat
(e)	Shining surfaces	(v)	night

## EXERCISE-2

- Q.1** Convert 293 K into Celsius scale.  
(A) 566°C (B) 293°C  
(C) 20°C (D) 496°C
- Q.2** Which of the following temperature is highest?  
(A) 100 K (B) - 20°C  
(C) - 23°C (D) - 13°F
- Q.3** The normal temperature of human body is:  
(A) 37°C (B) 38°C  
(C) 35°C (D) 98.4°C
- Q.4** Fahrenheit scale divides two fixed points into:  
(A) 180 parts (B) 212 parts  
(C) 100 parts (D) 32 parts
- Q.5** The capillary tube of a clinical thermometer has a kink  
(A) to increase the expansion of mercury  
(B) so that the level of mercury does not fall as soon as the thermometer is taken out of the mouth  
(C) to use less mercury  
(D) to help us see it better
- Q.6** 1 calorie equals to:  
(A) 4.2 J (B) 0.42 J  
(C) 420 J (D) 4200 J
- Q.7** A copper disc with a central hole is heated, the diameter of hole.  
(A) increases  
(B) Decreases  
(C) First decreases then increases  
(D) First increases then decreases
- Q.8** Thermal expansion due to heating at equal temperature will be least:  
(A) In Solid (B) In Liquid  
(C) In gas (D) Equal in all
- Q.9** Conduction cannot takes place in:  
(A) copper (B) iron  
(C) aluminium (D) vacuum
- Q.10** Conduction is possible:  
(A) when the bodies are apart from each other  
(B) when the bodies have same temperature and in thermal contact  
(C) when they have different temperatures maintaining distance between them  
(D) bodies should be in contact and should have different temperatures
- Q.11** Which of the following statements is correct?  
(A) Metals are bad conductors.  
(B) Some metals conduct heat better than others.  
(C) Heat can be conducted from one metal to another even if they are not in contact with each other.  
(D) When two metal rods are placed in contact with each other, heat can flow from one to the other even if they are at the same temperature.
- Q.12** Water can be heated in a cup of paper because:  
(A) Paper is a good conductor of heat  
(B) Paper has high specific heat  
(C) Paper is thin  
(D) Paper is a good radiator of heat
- Q.13** When in thermal contact, the quantity of heat lost by the hotter body is..... the amount of heat gained by the colder body.  
(A) equal to (B) greater than  
(C) less than (D) cannot say
- Q.14** It is warmer to have two thin blankets than to have a single thick blanket because:  
(A) thick blanket cannot give more warmth  
(B) two blankets allow more heat to pass through them  
(C) air between the two blankets is a good conductor of heat  
(D) air between the thin blankets does not allow heat to pass through it since it is a bad conductor

- Q.15** It is easier to drink hot tea from a porcelain mug than from a steel tumbler as:  
 (A) the porcelain mug has a handle  
 (B) porcelain is a heat insulator  
 (C) the tea will cool faster in the steel tumbler  
 (D) all of the above
- Q.16** Ice blocks are covered with sawdust because:  
 (A) sawdust lowers the temperature of the ice  
 (B) the sawdust, together with the air trapped within it, acts as a heat insulator and prevents the heat outside from getting to the ice and melting it  
 (C) the sawdust absorbs excess water from the ice.  
 (D) None of these
- Q.17** Air conditioners are placed high up the walls so that:  
 (A) they create less noise  
 (B) cold air from them comes down and cools the room while hot air rises up.  
 (C) they are out of the way.  
 (D) all of the above
- Q.18** Land and sea breezes are based on:  
 (A) the phenomenon of conduction of heat  
 (B) the phenomenon of convection of heat  
 (C) the phenomenon of absorption and radiation of heat  
 (D) all of the above
- Q.19** Radiation  
 (A) does not require a material medium  
 (B) is the process of the transfer of heat in liquids  
 (C) is the process of the transfer of heat in which heat travels in one direction  
 (D) occurs in solids
- Q.20** A polished, silvery surface is a  
 (A) good absorber and good reflector of heat  
 (B) good absorber and bad radiator of heat  
 (C) poor absorber and good reflector of heat  
 (D) poor reflector and good radiator of heat
- Q.21** A black body with a rough surface is a good  
 (A) reflector and poor absorber of heat  
 (B) good absorber and good radiator of heat  
 (C) absorber and poor radiator of heat  
 (D) reflector and poor radiator of heat
- Q.22** The heat energy emitted by sun reaches the earth through:  
 (A) conduction (B) convection  
 (C) radiation (D) None of these
- Q.23** It is known that a thermos flask is made of two layers of glass. The air between these two layers is removed and the flask is sealed. This is done to minimize the transfer of heat by the processes of:  
 (A) conduction, convection and radiation  
 (B) radiation and conduction  
 (C) conduction and convection  
 (D) convection and radiation
- Q.24** Copper tubing is used in automobile radiators as copper is a:  
 (A) bad conductor (B) semiconductor  
 (C) good conductor (D) radiator.
- Q.25** In vacuum, heat can be transferred through:  
 (A) conduction & convection only  
 (B) conduction only.  
 (C) radiation only  
 (D) convection only

## EXERCISE-3

**Q.1** When you heat a system, its temperature \_\_\_\_\_.

- (A) Always increases
- (B) Sometimes decreases
- (C) May stay the same
- (D) Always goes up or down, depending on the heat

**Q.2** Metal pots are often made shiny on surface outside especially on the top and side and that makes sense thermally because this \_\_\_\_\_.

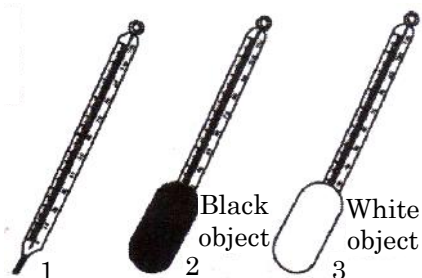
- (A) Conducts heat better
- (B) Radiates less energy out from the pot
- (C) Lowers the loss due to conduction
- (D) Appreciably decreases convection losses

**Q.3** Which of the following statements are correct about pots?

- (i) Black pots are used for cooking because they increase the rate of cooking.
- (ii) Silver pots are used for keeping food warm because they decrease the rate of heat dissipation.
- (iii) Pots are made of clay to increase the rate of cooking

- (A) (i) and (ii) only
- (B) (i) and (iii) only
- (C) (ii) and (iii) only
- (D) (i), (ii) and (iii)

**Q.4** Rohan wants to test whether a white object or a black object would heat up faster in the Sun. The picture shows you has experiment which uses three thromometers 1, 2 and 3. These thermometers when left out in the Sun for 30 minutes.



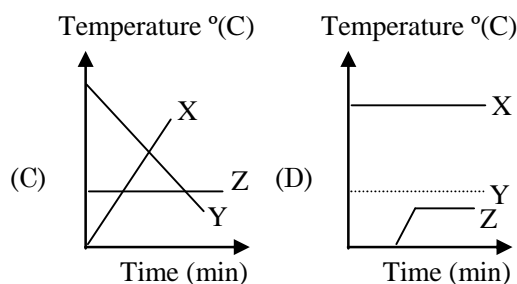
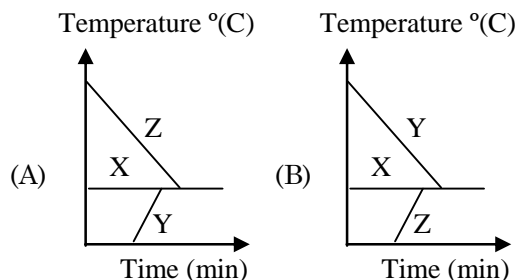
(A) Thermometer 1 reads the same as thermometer 2

(B) Thermometer 2 shows a higher temperature than thermometer 3.

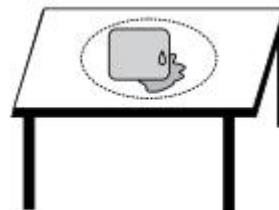
(C) Thermometer 3 shows higher temperature than thermometer 1.

(D) Thermometer 1 reads the same as thermometer 2.

**Q.5** Three identical containers X, Y and Z were filled with the same amount of tap water, boiling water and ice respectively and left in a room. Which one of the following graphs correctly shows the change in the temperature of the content in each container after some time?



**Q.6** An ice cube was left on the table as shown in the diagram. After a while, the ice cube started to melt. What inference can we make about the observation?



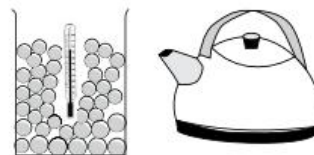
- (1) The ice cube had gained heat.
  - (2) The ice cube had lost heat.
  - (3) The temperature of the ice had increased.
  - (4) The temperature of the ice had decreased.
- (A) 1 only
  - (B) 1 and 3 only
  - (C) 2 and 3 only
  - (D) 2 and 4 only.

**Q.7** Two dented ping pong balls were each placed in two beakers of water at different temperatures. What happened to the ping pong balls?

Beaker	P	Q
Volume of water (mL)	500	500
Temperature of water (°C)	25	80

- (A) Balls expanded in both the beakers.
- (B) Ball expanded in beaker P and contracted in beaker Q.
- (C) Ball expanded in beaker P and remained as such in beaker Q.
- (D) Ball expanded in beaker Q and remained as such in beaker P.

**Q.8** The warm water is poured slowly into a beaker of ice cubes as shown in figure. Which of the following options is correct, when the warm water was being poured into the beaker?



- (1) The ice starts to melt.
  - (2) The glass expands.
  - (3) The temperature of the ice increases
  - (4) The temperature of the warm water decreases.
- (A) 1 and 4 only
  - (B) 2 and 4 only
  - (C) 1, 3 and 4 only
  - (D) All of these

**Q.9** The temperature shown by a mercury-in-glass thermometer increases. Which of the following is constant?

- (A) Density of the mercury
- (B) Internal energy of the mercury
- (C) Mass of the mercury
- (D) Volume of the mercury

# ANSWER KEY

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## EXERCISE - 1

➤ **Fill in the Blanks:**

16. (i). temperature  
(ii). clinical  
(iii). radiation  
(iv). conduction  
(v). dark

➤ **True & False:**

17. (i). True  
(ii). False  
(iii). True  
(iv). False  
(v). True

➤ **Match the Column:**

18. [a → (v); b → (iii); c → (ii); d → (i); e → (iv)]

## EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	A	A	B	A	A	A	D	D	B	C	A	D	B
Ques.	16	17	18	19	20	21	22	23	24	25					
Ans.	B	B	B	A	C	B	C	C	C	C					

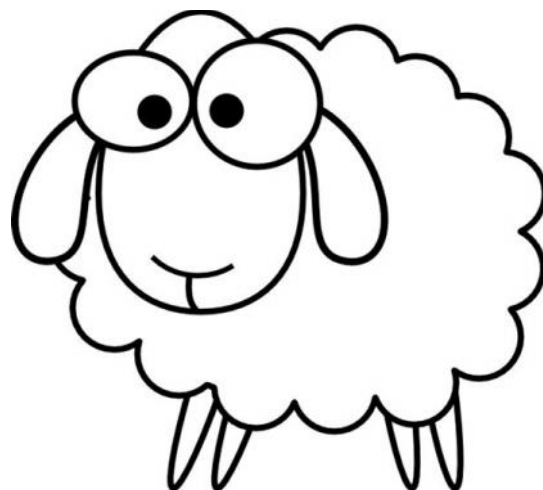
## EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9
Ans.	C	B	A	B	B	A	D	A	C

# MATERIALS OF DAILY USE : CLOTHES

## *Chapter Outline*

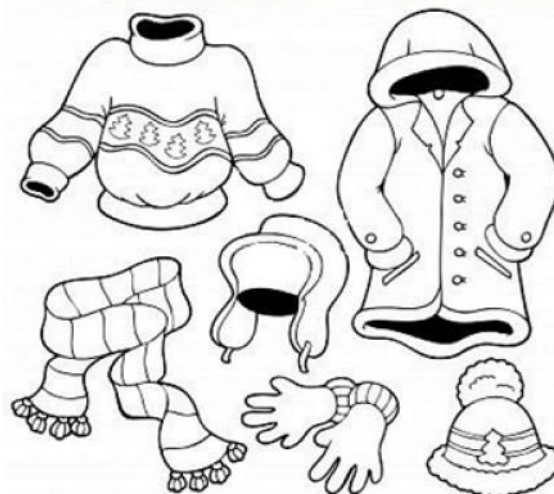
- ❖1 Introduction to Fibre and Fabric
- ❖1 Different types of Fibres:
  - ◆ Natural Fibres
    - (i) Plant Fibres
    - (ii) Animal Fibres
  - ◆ Synthetic Fibres
- ❖1 Important Animal Fibres 1
  - 11 (a) Wool and Production of Wool
  - 11 (b) Silk and Production of Silk



Sheep

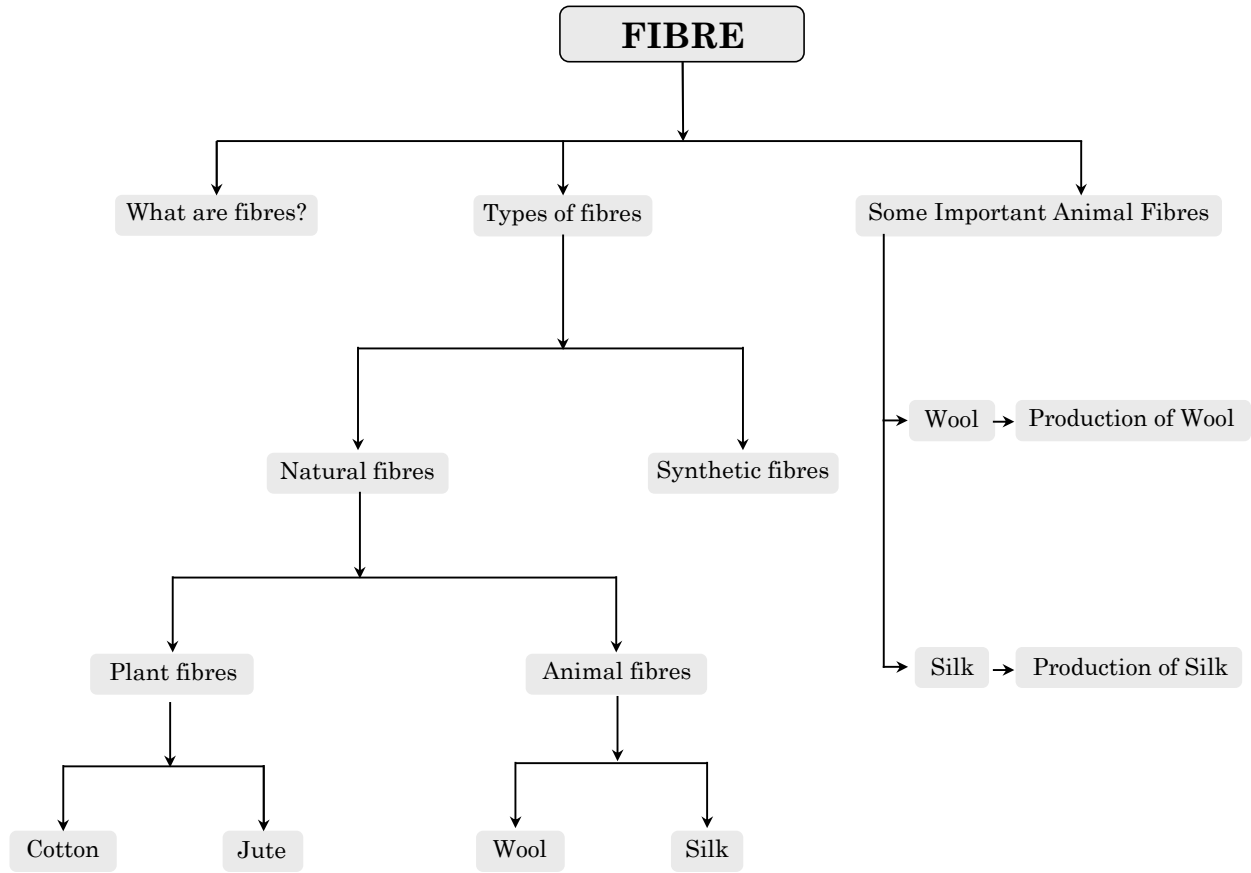


Silkworm



Various clothes

# MIND MAP



# MATERIALS OF DAILY USE : CLOTHES

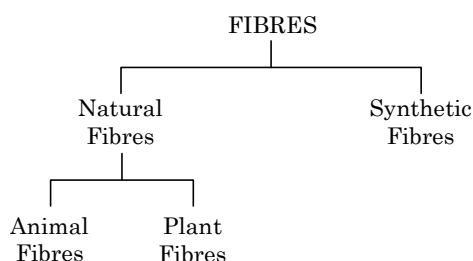
## Introduction

Nature has endowed us with beautiful things that makes our living not only efficient but also easier. One of those wonderful things are Fibres. The woollen, cotton & silk clothes, jute bags are few examples of how fibres are important to us. In this chapter, we will learn about how to extract these fibres from mother nature and turn it into something useful for us.

## Fibres

Fibres are long, thin and flexible thread like structures which can be woven into yarn and hence can be used to make clothes and other useful materials.

Fibres can be further divided into the following categories:



### ◆ Natural fibres

*Natural fibres are those which we obtain from natural resources directly.*

- (i) **Animal Fibre:** These fibres are obtained from animals, for example, wool and silk.
- (ii) **Plant Fibre:** These fibres are obtained from plants, for example, cotton, jute, flax and hemp.

### ◆ Artificial fibres

*Artificial(Synthetic) fibres are those which are manufactured in industries by humans, for example, Nylon, Rayon, Polyester and Plastic.*

**Note:** A simple flow chart showing the conversion of fibre to fabric can be represented as:

*Fibre → Spinning → Yarn → Weaving / Knitting → Fabric*

## Some Important Natural Fibres

### ◆ Wool

Wool is a fibre obtained from animals such as sheep, goats, yak and some other animals. All wool-yielding animals have a thick layer of hair on their bodies. This is because wool traps air, which is a bad conductor of heat. The air trapped inside acts as a barrier against harsh cold weather and keep animals warm.

Wool is a fibre obtained from the fleece (hairy growth) of these animals. Wool is made of proteins and is usually found in white colour. It can also be brown or grey, depending on sheep breed.

Just like the human body, the hairy skin of sheep has two types of hair that forms the fleece:

- (i) Fine soft under-hair that are close to the skin.
- (ii) Coarse beard hair.

Out of these, the fine soft under hair is suitable for making wool. Some breeds of sheep have only fine under - hair.

- 1 Ñ Their parents are specially chosen to give birth to sheep who have only fine under-hair.
- Ñ Selective Breeding is the process of selecting parents for obtaining a special characteristic in the offspring.
- Ñ Some other animals which gives wool are Llama & Alpaca (South America), Camel, Angora Goats (J&K).

**Note:** *Fleece:* Thick covering of wool on a sheep, used to make a piece of clothing.

*Hair:* The mass of thin thread like structure that grows out of the skin.

Wool has several qualities that distinguish it from hair or fur. It is crimped (tight curls), it has a different texture, it is elastic and grows in staples (clusters).

### ◆ Production of Wool from Sheep

Sheeps are reared by Grazers to obtain high quality wool in different parts of our country. Rearing of sheep is mainly done on hilly areas such as Himachal Pradesh, Jammu and Kashmir, Uttrakhand, Sikkim and plains of Rajasthan, Gujarat, Punjab and Haryana. The fine quality wool of which sweaters are made up of are actually finished product of a long process.

This process is explained in following steps:

- (i) **Shearing:** Once the reared ship develops thick layer of wool, their hair are removed for getting wool. Their fleece is shaven off by machines (similar to electric razor used by barber). This process of removing topmost layer of fleece (hair) is known as *Shearing*. Shearing is done generally in summers so that sheep face no problem with all their hairs gone.



**Shearing of Sheep**

- (ii) **Scouring:** The sheared skin with thick coat of hair is then washed thoroughly in tanks or by machines to remove grease, dirt or dust. This is called *Scouring*.



**Scouring in Tanks**

**Scouring in Machine**

- (iii) **Soting:** After scouring, sorting of hairs is done on the basis of their texture.
- (iv) **Removing Burr:** The small fluffy fibres called *fuzz* (burrs) are separated from the hair. The remaining fibres are again scoured and dried.
- (v) **Dyeing:** Next stage is giving required colors to the fibres by using dyes. Natural colour of fleece is black, brown or white.

(vi) **Carding and Spinning:** The dyed fibres are then passed through metal teeth to straighten them. This process is called *carding*. They are further combed and rolled into *Yarn*. Threads of wool are produced by spinning strands from these yarns. No. of strands can be increased to increase the thickness of the thread. The longer fibres of wool are used to make sweaters and the shorter ones are used for making woollen clothes.



**Rolling into Yarn**

**Note:** ¶11 The wool, straight off the sheep, contain a lot of oil called lanolin. It is removed from the wool, and later used in cosmetic industry.

¶1 The best quality of wool comes from the shoulders and sides of the sheep.

**COMPETITIVE LEVEL** ▶ 1

- 1 ¶1 Wool is damaged by certain insects such as moths, beetles etc.
- 1 ¶1 The common type of wool used for the production of apparel is **Merino wool**, obtained from **Merino sheep**. Merino wool is the softest wool in the world.
- 1 ¶1 '**Mohair**' (obtained from Angora goat) is composed mostly of **keratin**, a protein found in the hair, horns and skin of all mammals. Mohair does not feel as wool does, but it is very durable and resilient. Due to its high luster and sheen, it has been nicknamed as the "**Diamond Fibre**".
- 1 ¶1 **Woolmark** is a symbol of quality to assure that the woollen cloth is made from pure wool. This logo is assigned by International Wool Secretariat (IWS) established in North Yorkshire, United Kingdom.

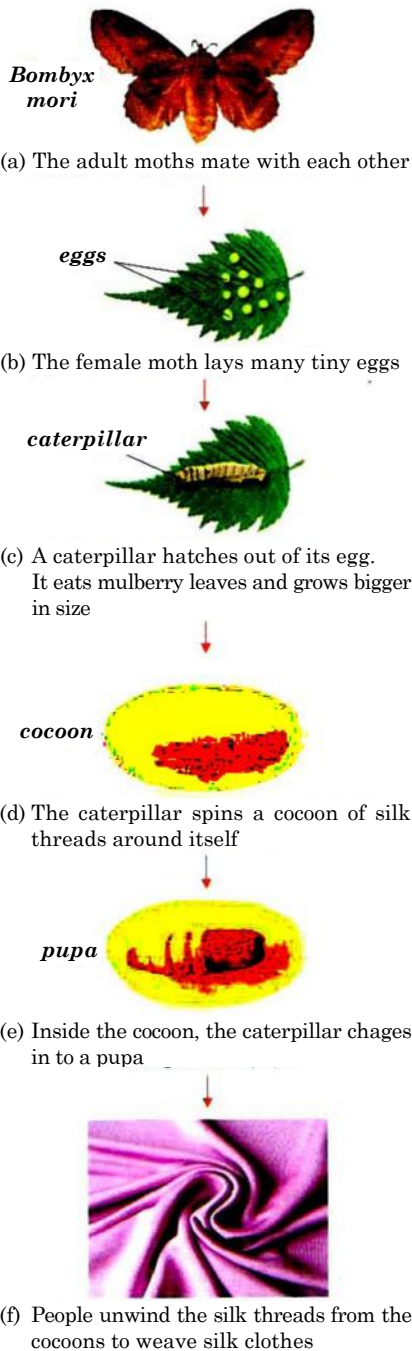
Many people in our country earn their livelihood from the wool industry. During sorting of wool, sometimes workers get infected by a bacterium, *Anthrax* which causes a fatal blood disease called Sorter's disease. Such risks faced by workers during their jobs or because of their occupation are called occupational hazards.

- 1 ¶ Some workers also develop **respiratory diseases** like asthma as they constantly breathe in dust and fine wool fibres.
- 1 ¶ Various chemicals used in the industry for degreasing, disinfection, bleaching, dyeing etc. result in **poisoning, irritation of eyes, affect lungs and skin** etc.
- 1 ¶ Noise, high temperature and humidity levels required for wool processing have a deleterious effect on **general health** unless they are strictly controlled.

◆ **Silk**

Silk is an animal fibre derived from silkworms. Silk is produced by a moth (species) known as silk moth. The scientific name of silk moth is "*Bombyx Mori*". The breeding of these silk moths for production of silk is known as Sericulture.

- 1 ◆1 **Production of Silk:** The female species of silk moth lays eggs on leaves. After 20 days, eggs hatch into larvae. These hatched larvae are known as Silkworms or Caterpillars.



#### LIFE CYCLE OF SILK MOTH

- (i) The silkworms feed on mulberry leaves for about 4 weeks. As a result, they grow in size and enter their next life cycle called Pupa. Pupa holds itself by weaving a net around its body by swinging its head in figure of eight (8). While swinging their head, silkworm secretes a wet sticky substance. This substance is made up of protein, which hardens on exposure to air and becomes silk fibre. This way silkworm covers itself completely in the covering known as Cocoon. By the time of completion of cocoon, pupae develop into Adult Moths.
- (ii) After complete development of silkworm, the cocoons are gathered and kept under the sun or boiled or exposed to steam. Boiling releases the silk fibres from cocoon. The silk fibres from many cocoons are brought together to form a single silken thread. This process is known as Reeling of silk. Reeling is done in special machines which unwind the fibres of silk from the cocoons.

- (iii) Broadly, 3 grades of silk are obtained from a cocoon. The unwound fibres forms the finest quality of silk called as reeled silk. It is dazzling white in colour. Silk that remains after the reeling process from the damaged or waste cocoon is carded and combed. It constitutes an inferior quality of silk called the spun silk. It is slightly honey-coloured. After carding or combing, the short fibres which are left behind constitute an even inferior quality of silk called the Nail Silk. It has rough texture as compared to reeled and spun silk.
- (iv) Throwing is the process by which the obtained silk fibres are twisted into a strand for weaving to prevent silk yarn from splitting into individual fibres. These strands are industry ready to be turned into clothes.

**Note:** Pheromones are chemicals secreted by an insect to attract the attention of other members of its species.

◆1 **More about Silk:**

- (i) Silk fibre is made up of Sericine and Fibronin. Sericine is used to join the two ends of cocoon it has shine and lustre. It is so strong that it is comparable to steel.
- (ii) Silk fibres doesn't conduct heat. They act as insulators and keeps our body cooler in summer and warmer in winter season.
- (iii) Silk is known as "Queen of fibres". It is used for making sarees, dress materials, jackets, scarves etc.
- (iv) There are many types of silk depending upon the variety of silk moth who produced it. Crepe, Mulberry, Chanderi, Eri, Tussar, Mooga and Kosa are few varieties of silk. The mulberry one is the most common of all.

**Note:** ¶1 Fibre optics are the fibres made up of glass which can be used to transmit signals at the speed of light. This way we can achieve amazing speed for internet purpose. E.g. Google fibre achieved speed of 998 gbps.

¶1 Kevlar is the synthetic fibre bounded tightly to form net-like structure to be used as Bulletproof material.

¶1 Nylon was first made in New York and London. This gave rise to the name "Nylon".

**COMPETITIVE LEVEL**

**Kosa silk:** Kosa silk is obtained from an Indian silkworm - *Antheraea mylitta* and is a variety of tassar silk. It is drawn out of silkworms which are fed upon the trees such as arjun, saja and sal. Kosa silk is mainly produced in Chattisgarh state of India. Its is known all over the world for its soft texture and purity, and is produced exclusively in India.

Characteristic	Fibre	Observation
Burns or Melts	Silk	Burns
	Wool	Burns
	Artificial	Melts
Smell	Silk	Charred
	Wool	Burning hair
	Artificial	Characteristic
Residue	Silk	Dull black hollow bead which crushes easily to powder dark hard bead
	Wool	
	Artificial	
Any other feature	Silk	Self-extinguishing
	Wool	
	Artificial(nylon)	Drops of melted nylon may fall to the ground

**Occupational Hazards:** Workers employed in almost all the processes of sericulture industry are adversely affected by a number of health related problems.

- (i) Respiratory diseases** - Workers of sericulture industry are affected by respiratory diseases such as asthma and bronchitis because of inhalation of vapours arising from cocoons when being steamed, boiled and reeled.
- (ii) Skin infections** - During the boiling of cocoons in water to kill the pupae, constant dipping of hands in boiling water results in blisters, peeling of skin and other infectious skin diseases on worker's hands.
- (iii) General health problems** - Severe headache, fever and pain in neck and lower back are also observed in the workers of silk industry.

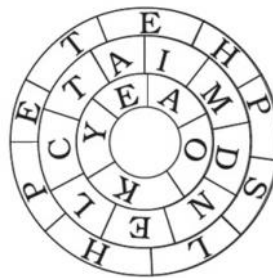
## EXERCISE-1

### Very Short Answer Type Questions

- Q.1** The following is an answer given by Boojho to a question asked by his teacher — “Cotton, wool, silk and jute are classified as natural fibres whereas nylon and polyester are classified as synthetic fibres.”  
Can you tell what question the teacher has asked?
- Q.2** Classify the following fibres as natural or synthetic: nylon, wool, cotton, silk, polyester, jute.
- Q.3** From which parts of the plant cotton and jute are obtained?
- Q.4** Name the protein which is the chief component of wool fibres.
- Q.5** Why sheep have a thick coat of hair?

### Short Answer Type Questions

- Q.6** Some words related with silk are jumbled up. Write them in their correct form.  
(a) TURECULRISE  
(b) WILSMORK  
(c) BELMURRY  
(d) RINGLEEE
- Q.7** Various steps involved to obtain wool from fleece are given here -  
(i) Picking out the burrs  
(ii) Dyeing in various colours  
(iii) Shearing  
(iv) Scouring  
(v) Sorting  
Write the above steps in the correct sequence in which they are carried out.
- Q.8** Shows three rings of circles with letters in them. Some of these letters in each ring can form the name of one wool yielding animal. Find the names of these animals.



- Q.9** Some terms related to fabrics are jumbled up and given below.  
Write them in their correct form.  
(a) onttoc (b) sinnping  
(c) vingwea (d) bisref
- Q.10** On what factors does our type of clothing depend?

### Long Answer Type Questions

- Q.11** Steps for the production of silk are given below in a jumbled order. Arrange them in their proper sequence.  
(a) Eggs are warmed to a suitable temperature for the larvae to hatch from eggs.  
(b) Fibers are taken out from the cocoon.  
(c) After 25 to 30 days, the caterpillars stop eating and start spinning cocoons.  
(d) The larvae/caterpillars or silkworms are kept in clean trays along with freshly chopped mulberry leaves.  
(e) Female silk moths lay eggs.  
(f) Cocoons are kept under the sun or boiled in water.
- Q.12** Paheli went to the market to buy sarees for her mother. She took out a thread from the edge of the two sarees shown by the shopkeeper and burnt them. One thread burnt with a smell of burning hair and the other burnt with the smell of burning paper. Which thread is from a pure cotton saree and which one from a pure silk saree? Give reason for your answer.
- Q.13** Explain the phrase – “Unity is Strength” on the basis of the making of fabric from fibre.

**Q.14** Write various steps for processing fibres into wool.

**Q.15** Explain the process of making yarn from fibre.

**➤ Fill in the Blanks**

**Q.16** (i) \_\_\_\_\_ and \_\_\_\_\_ fibres are obtained from animals.

(ii) \_\_\_\_\_ is the largest producer of silk.

(iii) Silk is a \_\_\_\_\_ conductor of heat.

(iv) A \_\_\_\_\_ is a long continuous thread.

(v) \_\_\_\_\_ of yarn makes a piece of fabric.

**➤ True or False**

**Q.17** (i) Silkworms are caterpillars of silk moth.

(ii) In India, camels and goats are generally reared for obtaining wool.

(iii) In the process of obtaining wool from fleece, sorting is done after scouring.

(iv) Silk fibre is obtained from the stem of a plant.

(v) Polyester is a natural fibre.

**➤ Match the Column**

**Q.18**

Column-A		Column-B	
(a)	Yak wool	(i)	Sheared hair
(b)	Angora goats	(ii)	Silkworm
(c)	Mulberry leaves	(iii)	Tibet and Ladakh
(d)	Scouring	(iv)	Jammu and Kashmir

## EXERCISE-2

- Q.1** Which type of wool is common in Tibet and Ladakh?  
(A) Yak (B) sheep wool  
(C) Angora wool (D) Pashmina wool
- Q.2** Pashmina shawls are found in -  
(A) South America  
(B) Kashmir  
(C) South Africa  
(D) Gujarat
- Q.3** The process of removing the fleece of sheep along with a thin layer of skin is called -  
(A) Rearing (B) shearing  
(C) Sorting (C) Scouring
- Q.4** The bacteria by which the people working in wool industry get infected is -  
(A) Rhizobium (B) Anthrax  
(C) Streptococcus (D) Bacillus
- Q.5** Wool is soluble in  
(A) alcohols.  
(B) aldehydes.  
(C) acids and bases both.  
(D) salts.
- Q.6** Food of the caterpillar in case of silk moth is -  
(A) Mulberry leaves  
(B) Neem leaves  
(C) Tulsi Leaves  
(D) Pudina leaves
- Q.7** Silk fibre obtained from silk moth is \_\_\_\_\_.  
(A) Carbohydrate (B) Fat  
(C) Protein (D) Sugars
- Q.8** Find from the following where Silk Industry began -  
(A) India (B) China  
(C) Tibet (D) Africa
- Q.9** For how long do the caterpillars eat mulberry leaves?  
(A) 10 to 15 days  
(B) 15 to 30 days  
(C) 30 to 45 days  
(D) 45 to 60 days
- Q.10** Woollen clothes are made from -  
(A) Animals (B) Plants  
(C) Insects (D) Bacteria
- Q.11** The process of removing topmost layer of fleece is known as -  
(A) Shearing (B) Scouring  
(C) Throwing (D) None of these
- Q.12** Which of the following is not a type of silk?  
(A) Mulberry silk (B) Tassar silk  
(C) Mooga silk (D) Moth silk
- Q.13** Paheli wanted to buy a gift made of animal fibre obtained without killing the animal. Which of the following would be the right gift for her to buy?  
(A) Woollen shawl (B) Silk scarf  
(C) Animal fur cap (D) Leather jacket
- Q.14** Silk fibre is obtained from  
(A) fleece of sheep (B) cotton ball  
(C) cocoon (D) shiny jute stalk
- Q.15** Wool fibre cannot be obtained from which of the following?  
(A) Goat (B) Llama  
(C) Alpaca (D) Moth
- Q.16** Selective breeding is a process of  
(A) selecting the offsprings with desired properties.  
(B) selecting the parents with desired properties.  
(C) selecting an area for breeding.  
(D) selecting fine hair for good quality wool.

**Q.17** The general process that takes place at a sheep shearing shed is  
(A) removal of fleece.  
(B) separating hair of different textures.  
(C) washing of sheep fibre to remove grease.  
(D) rolling of sheep fibre into yarn.

**Q.18** The term sericulture is used for -  
(A) culture of bacteria.  
(B) rearing of silkworm.  
(C) making silk fabric from silk yarn.  
(D) production of sarees.

**Q.19** Reeling of silk is -  
(A) a process of making silk reels.  
(B) spinning of silk fibres.  
(C) weaving of silk cloth.  
(D) the process of taking silk threads from cocoon.

**Q.20** Silkworms secrete fibre made of -  
(A) fat (B) cellulose  
(C) protein (D) nylon

## EXERCISE-3

**Q.1** The clean and selected wool fibres are passed through rollers, which straightens the fibres and removes the unwanted matter. This process is called as \_\_\_\_\_.

- (A) Shearing                      (B) Scouring  
(C) Carding                        (D) Spinning

**Q.2** Silk obtained from silkworm is a product of \_\_\_\_\_.

- (A) Skin of caterpillar  
(B) Salivary glands of silk moth  
(C) Salivary glands of caterpillar  
(D) Skin of silk moth

**Q.3** Which of the following is an incorrect statement?

- (A) Cotton yarn shrinks away from flame and burns and smells like burning paper  
(B) Silk has come under fire from animal right activists  
(C) Wool fibres have an outer layer scales that reduce the ability of dirt and dust to penetrate the fibre  
(D) A spinneret is used to make nylon but is not needed to make cotton or wool fibres.

**Q.4** Which of the following is an incorrect match?

(A)	Ginning	Separation of fibres from seeds
(B)	Recycling	Making useful things from waste
(C)	Stratosphere	It is the coldest layer of atmosphere
(D)	Refuse	The fourth 'R'

**Q.5** Methods of separation depend on the nature of the constituents in a mixture. Study the methods of separation as given below

	Types of mixture	Methods of separation
1.	Solid-Solid	Handpicking, Sieving
2.	Solid-Liquid (insoluble)	Sedimentation, decantation, filtration
3.	Liquid-Liquid (immiscible)	Decantation, Separating funnel
4.	Solid-Liquid (soluble)	Filtration, Decantation
5.	Liquid-Liquid (miscible)	distillation

Which of these is incorrect method of separation?

- (A) 1 and 2                      (B) 5  
(C) 1 and 5                     (D) 4

**Q.6** Select the option which on reshuffling gives term used for the process of separating jute fibres.

- (A) GGNINI                      (B) GCRDIAN  
(C) GINIPNNS                (D) GETINTR

# ANSWER KEY

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## EXERCISE - 1

➤ **Fill in the Blanks:**

16. (i). wool, silk  
(ii). china  
(iii). poor  
(iv). yarn  
(v). weaving

➤ **True & False:**

17. (i). True  
(ii). False  
(iii). True  
(iv). False  
(v). False

➤ **Match the Column:**

18. [a → (iii); b → (iv); c → (ii); d → (i)]

## EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	B	B	B	C	A	C	B	B	A	A	D	A	C	D
Ques.	16	17	18	19	20										
Ans.	B	A	B	D	C										

## EXERCISE - 3

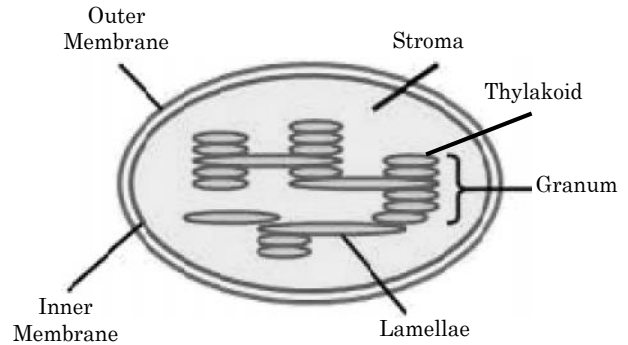
Ques.	1	2	3	4	5	6
Ans.	C	C	D	C	D	D

# NUTRITION IN PLANTS

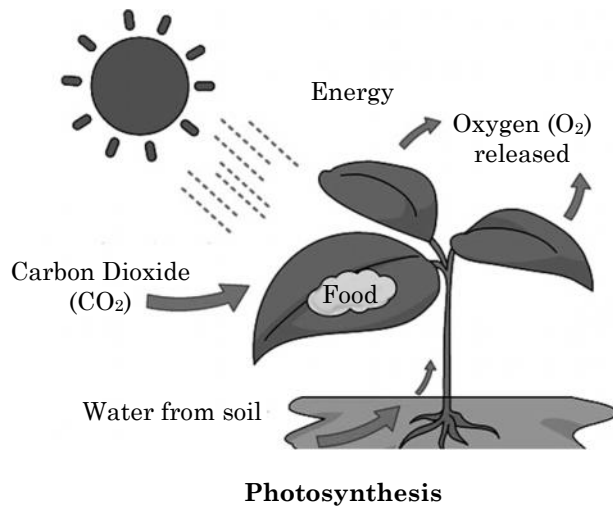
## Chapter Outline

1

- ❖1 Nutrition and Nutrients
- ❖1 Mode of Nutrition
- ❖1 Nutrition in Plants
- ❖1 Heterotrophic Nutrition in Plants

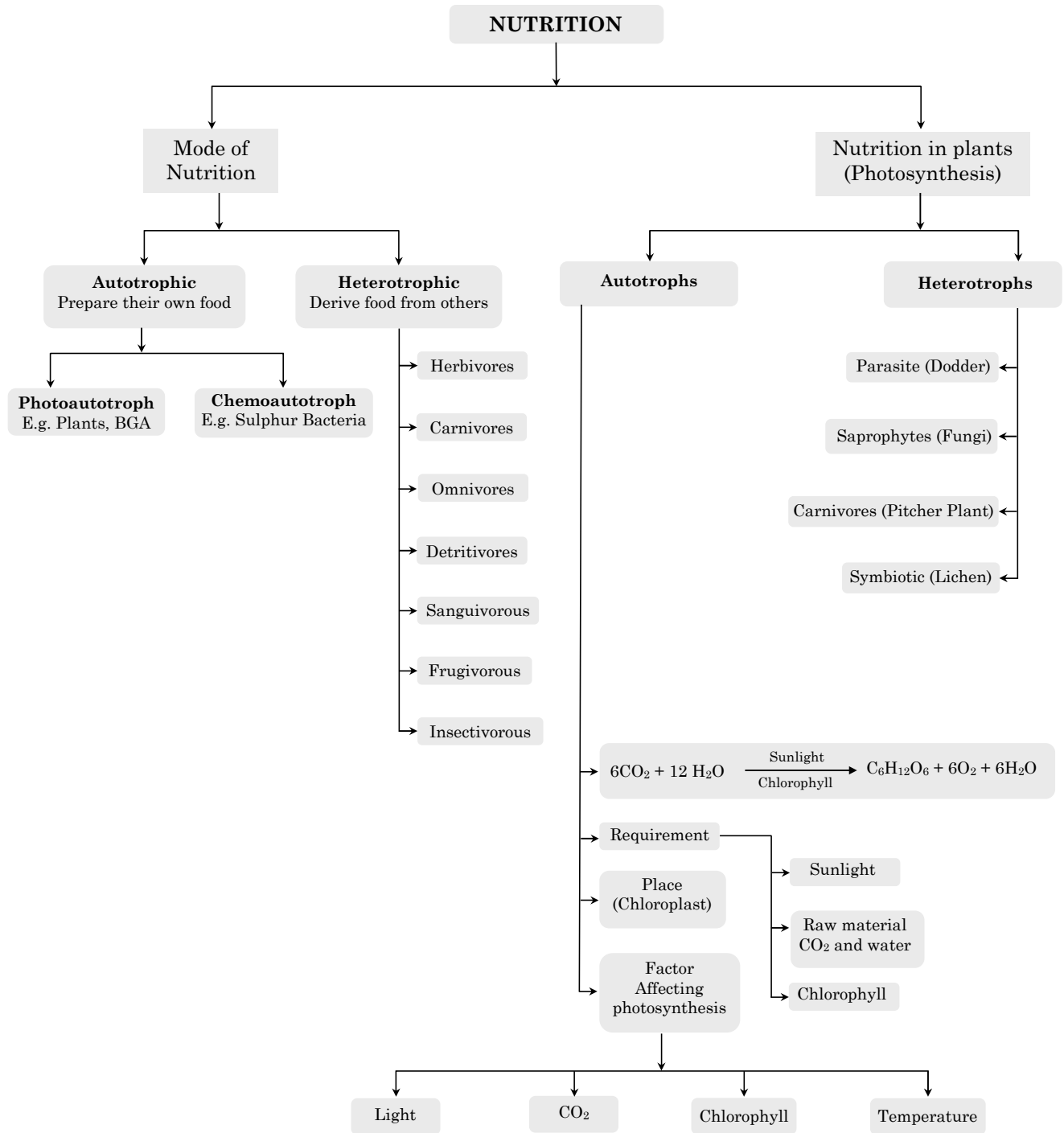


Chloroplast



Amarbel plant

# MIND MAP



# NUTRITION IN PLANTS

## Nutrition and Nutrients

"**Nutrition**" is a process of intake as well as utilization of nutrients by an organism. Food provides us nutrition and energy.

**Nutrients** : These are the substances required by our body for its growth, repair, work and maintenance of the body. Different types of nutrients are carbohydrates, fats, proteins, vitamins, minerals etc.

### COMPETITIVE LEVEL

- Ñ Fats provide the most energy followed by carbohydrates and proteins respectively.
- Ñ Proteins are the building blocks of body.

## Mode of Nutrition

All living organism show 2 types of modes of nutrition-

- (A) Autotrophic (B) Heterotrophic

### (A) Autotrophic : (Auto – self, trophic = food)

It is a mode of nutrition in which organisms prepare their own food. Inorganic molecules like  $\text{CO}_2$  &  $\text{H}_2\text{O}$  are converted into organic molecules like carbohydrates in the presence of sunlight & chlorophyll. E.g. Green plants.

### COMPETITIVE LEVEL

Autotrophs are further categorized as :

- 1 Ñ **Photoautotrophs** : Those which utilize sunlight for preparing their food
- 1 1 e.g. All green plants, Blue green algae.
- 1 Ñ **Chemoautotrophs** : Those which utilize chemical energy for preparing their food
- 1 1 e.g.  $\text{H}_2\text{S}$  for sulphur bacteria.

### (B) Heterotrophic : (Hetero = different ; trophic = food)

It is a mode of nutrition in which organisms derive their food from some other animals or plants. They cannot prepare their own food e.g. human being. Heterotrophs are further categorized depending on the nature of food they consume.

- (i) **Herbivores** : Animals which eat only plants e.g. cow, goat.
- (ii) **Carnivores** : They feed on flesh of other animals e.g. Lion, vulture.
- (iii) **Omnivores** : They feed on plants and animals both e.g. Dog, human.

### COMPETITIVE LEVEL

- 1 Ñ **Detritivores** : Feed on detritus or dead organic remains e.g. Earthworm.
- 1 Ñ **Sanguivorous** : Feed on blood e.g. Leech, female mosquito.
- 1 Ñ **Frugivorous** : Feed on fruits e.g. Parrot.
- 1 Ñ **Insectivores** : Feed on insects e.g. Bats, House sparrow, Nepenthes plant.

## Nutrition in Plants

Plants are autotrophic organisms so they make their own food by the help of a specific process that called photosynthesis.

- (A) Definition of photosynthesis
- (B) Equation of photosynthesis
- (C) Requirements of photosynthesis
- (D) Place of photosynthesis
- (E) Mechanisms of photosynthesis
- (F) Importance of photosynthesis
- (G) Factors affecting the photosynthesis

**(A) Definition :** The process by which green plants prepare their own food is called photosynthesis (photo = light, synthesis = to combine).

Or

Plant converts the inorganic material ( $\text{CO}_2$  and  $\text{H}_2\text{O}$ ) into the organic material (glucose) by the help of light energy. This process is called photosynthesis.

**(B) Equation of Photosynthesis :**  $6\text{CO}_2 + 12\text{H}_2\text{O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O}$

**Note :** Presence of starch in the leaves is used as an evidence of photosynthesis taking place. Its presence is tested by iodine test.

**(C) Requirements of Photosynthesis :**

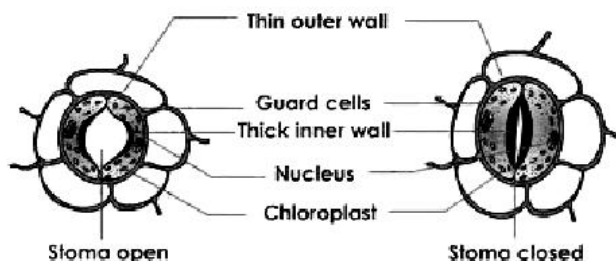
- (i) Sunlight
- (ii) Raw material
- (iii) Chlorophyll

**(i) Sunlight :** Plant uses the light energy for the preparation of their food. Sun is an unlimited source of the energy for all living beings. Highest rate of photosynthesis found in red light and lowest in green light.

**(ii) Raw Material :** Raw material for the photosynthesis is  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .

**(a) Carbon dioxide :**  $\text{CO}_2$  is present in atmosphere. Plant obtains the atmospheric  $\text{CO}_2$  through the tiny pores present on the surface of leaf that are called as stomata.

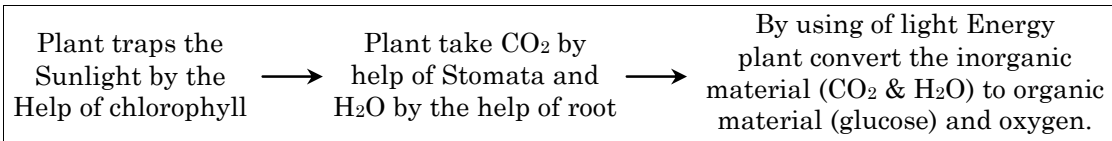
**Stomata** are the small tiny pores present on both of the surfaces of leaf. They help in the **gaseous exchange** and **transpiration**. Stomata are formed by two kidney shaped cells that are called as **guards cells**.



**Note :** The process of loss of water in vapour form through the surface of leaves is called transpiration.



### (E) Mechanisms of Photosynthesis :



### (F) Importance of Photosynthesis :

- Ñ It is primary source of food production for all other living organisms.
- Ñ Oxygen is the by-product of photosynthesis which is required for the respiration of living beings.
- Ñ It maintains balance of oxygen & CO<sub>2</sub> in the atmosphere.

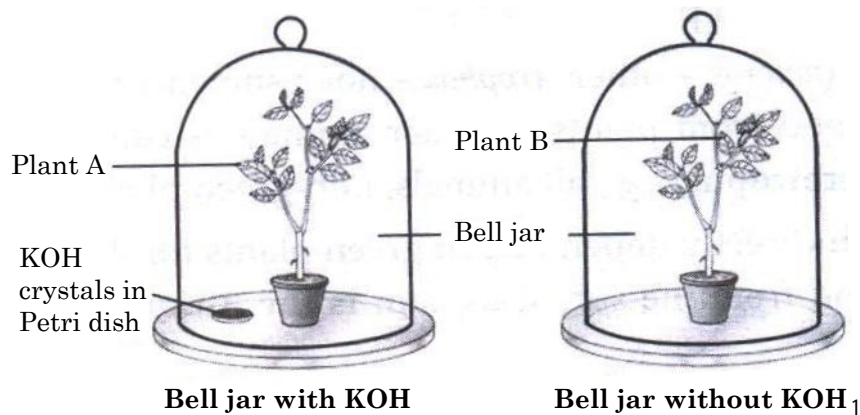
### (G) Factors affecting the Photosynthesis :

- (a) **Light** : Normally plants utilize sunlight but marine algae can perform photosynthesis even in the moon light. Plants can also perform photosynthesis in the artificial lights.
- (b) **Temperature** : Optimum range = 25° to 30°C.
- (c) **Carbon dioxide** : The atmospheric concentration of CO<sub>2</sub> ∝ rate of photosynthesis.
- (d) **Chlorophyll** : Chlorophyll content is directly proportional to rate of photosynthesis.

### ◆ Activities

A. To demonstrate that carbon dioxide is essential for photosynthesis to take place

- Ñ **Materials Required** : Two healthy potted plants, two bell jars, glass plates, watch-glass, conc. potassium hydroxide solution, Vaseline, iodine solution, ethanol, burner, test tube, water, beaker, forceps etc.



- 1 1 Ñ **Procedure** :
- 1 1 1 (i) Take two healthy potted plants which are of nearly the same size, label them as A and B, and keep them in a dark room for 2-3 days to destarch them.
- (ii) Now place each plant on separate glass plate. Place a watch-glass containing potassium hydroxide (KOH) by the side of plat A. Potassium hydroxide is used to absorb carbon dioxide.
- (iii) Cover both plants with separate bell-jars as shown in the figure.
- (iv) Use Vaseline to seal the bottom of the jars to the glass plates so that the set-up is air-tight.
- (v) Keep the plats in sunlight for about 4-6 hours.
- (vi) Pluck a leaf from each plant and check for the presence of starch by carrying out iodine test.

1 1 Ñ1 **Observation** : Leaf taken from plant A did not turn blue-black showing the absence of starch whereas leaf taken from plant B turned blue-black showing the presence of starch.

1 1 Ñ1 **Conclusion** : Plant B got CO<sub>2</sub> present in the air under the bell jar. Thus, plant B carried out photosynthesis and synthesized starch. On the other hand, plant A was deprived of CO<sub>2</sub> because KOH absorbed all the CO<sub>2</sub> present in air under the bell jar. In the absence of CO<sub>2</sub>, plant A could not carry out photosynthesis and did not synthesize starch.

1 1 1 This concludes that CO<sub>2</sub> is necessary for photosynthesis.

### **B. To demonstrate that starch is formed during photosynthesis**

1 1 Ñ1 **Materials required** : Two green potted plants, water, beaker, Bunsen burner, ethyl alcohol/ethanol, iodine solution, dropper, test tube, forceps, etc.

1 1 Ñ1 **Procedure** :

(i) Take two green potted plants and label them as A and B. Keep plant A in dark for 48 hours (2 days) so that starch is removed from the leaves and keep plant B in sunlight for about 24 hours (one day).

(ii) Pluck one leaf from plant A and one leaf from plant B. Mark them as A and B, respectively.

(iii) Boil the two leaves in water for 5-10 minutes to kill and soften them.

(iv) Put the leaves in a test tube containing alcohol. Place the test tube in a beaker of water and boil the water gently until the alcohol begins to boil. By boiling the leaf in alcohol. Its chlorophyll is destroyed and leaf loses its colour.

(v) Take out the leaves from alcohol, wash them in warm water to remove alcohol and place them on a glass plate.

(vi) Put a few drops of iodine solution on each leaf.

1 1 Ñ1 **Observation** : Leaf B turns blue-black indicating the presence of starch, but leaf A does not turn blue-black indicating the absence of starch.

1 1 Ñ1 **Conclusion** : Photosynthesis occurred in plant B because it was kept in sunlight but not in plant A as it was kept in dark. This shows that photosynthesis occurs in the presence of sunlight and starch is formed during photosynthesis.

### **C. To show that chlorophyll is essential for photosynthesis.**

Ñ1 **Material Required** : A potted plant of variegated leaf such as money plant, white paper sheet, pencil, beaker, water bath, iodine solution and alcohol.

Ñ1 **Procedure** :

- 1 1 1 1. A potted plant with variegated leaves is placed in sunlight for about six hours.
2. Pluck a variegated leaf from the plant and trace the outline of this leaf on a piece of paper.
3. Dip the leaf in boiling water for a few minutes and then immerse it in a beaker containing alcohol and boil it in a water bath till it decolorizes.
4. The leaf is then dipped in a dilute solution of iodine for a few minutes.
5. Take out the leaf and rinse off the iodine solution.
6. Observe the changes in colour of the leaf.



A leaf before (a) and after (b) starch test

¶ **Observation :**

1. The leaf has two type of patches- bluish black and yellow. The bluish black area contains starch and the yellow areas without starch.
2. Bluish black areas are the ones, which were green previously, while non-green areas remain pale coloured.

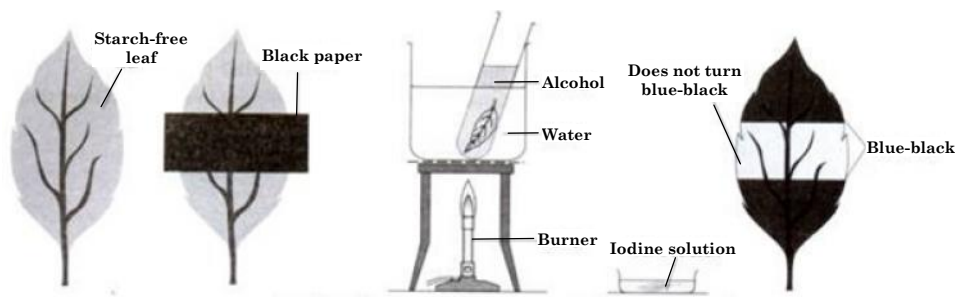
¶ **Conclusion :** This experiment proves that only chlorophyll containing areas i.e., green parts of the leaf produce starch which is a product of photosynthesis. Thus, chlorophyll is essential for photosynthesis.

**D. To show that light is essential for photosynthesis**

¶ **Material Required :** A healthy potted plant, a petri dish, a beaker containing water, forceps, a water bath, a piece of wire gauze, a tripod, a burner, a box of matches, alcohol a strip of black paper, iodine solution and clips.

¶ **Procedure :**

1. Take the potted plant and keep it in a dark place for 2-3 days so that the leaves get destarched.
2. Cover a part of one of its leaves with the strip of black paper. Make sure that you cover both the sides of the leaf.
3. Now place this plant in sunlight for 3—4 hours.
4. Pluck the selected covered leaf and remove the black paper covering it.
5. Place this leaf in the beaker containing water and boil it for about 10 minutes.
6. Take out the leaf and now boil it in alcohol, using the water bath, for 10 minutes. This removes the chlorophyll.
7. Take out the leaf and wash it under running water.
8. Place this leaf in the Petri dish and put a few drops of iodine solution on it. Now observe the change in colour.



### Experiment to Show that Light is Essential for Photosynthesis

Ñ1 **Observations :** The leaf turns blue-black except in the covered region.

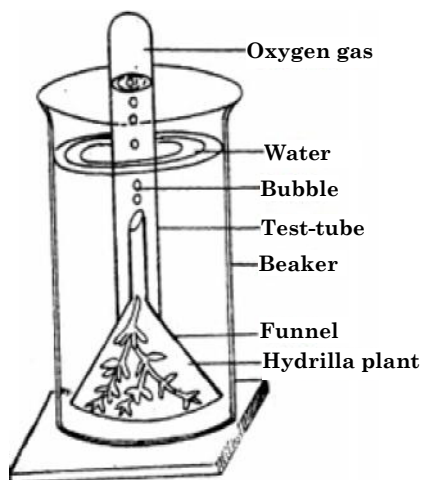
Ñ1 **Conclusion :** This experiment proves that light is essential for photosynthesis, as this covered region did not receive light, photosynthesis did not occur. Hence no starch was formed there. The uncovered region received light and starch was formed there due to photosynthesis.

### E. To show that oxygen is released during photosynthesis.

Ñ1 **Requirements :** A large Beaker, Some Hydrilla Plant, One Funnel, One Test tube, water and a glowing splinter of wood.

Ñ1 **Procedure :**

1. The Hydrilla plant should be kept in the beaker and covered with the funnel. Hydrilla plant be placed in such a way that its cutting ends remain towards the stem of the funnel.
2. Water should be poured in the beaker in such a way that the stem of the funnel kept beneath the water level.
3. A test tube completely filled with water should be inverted over the stem of the funnel. At this position the experimental set should be placed in Sunlight (or under electric light in the laboratory).

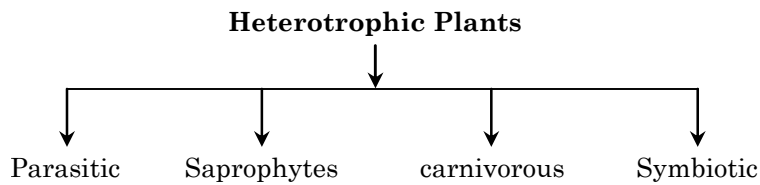


Ñ1 **Observation :** After sometimes it will be seen that bubbles are coming out from the Hydrilla plant and are accumulating in the test tube. After accumulation of some gas the test tube should be taken out carefully and a glowing splinter of wood be thrust into the test tube, it will burst into flame.

Ñ1 **Conclusion :** As the gas helps the glowing splinter to flame so the gas is Oxygen, because Oxygen does not flame itself but helps other to flame.

## Heterotrophic Nutrition in Plants

Non green plants like bacteria & fungi do not contain chlorophyll. So they cannot prepare their food by photosynthesis. These types of plants are heterotrophic plants.



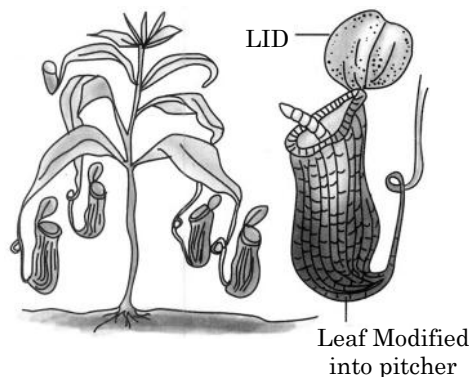
- (1) **Parasites** : Plants which depends on other living organism for their nutritional requirement known as parasitic plants. Cuscuta (Amarbel) is a plant parasite which produces special sucking roots called haustoria for absorption of food from the host plant.
- (2) **Saprophytes** : Plants which depends on dead organic matter for their nutrition, known as saprophytic plants. For Example – fungi, Mushroom.

**Note :**

- 1 ¶ The world's largest flower bearing plant, **Rafflesia**, is a parasite.
- 1 ¶ **Lichens** are excellent indicators of air pollution. These are sensitive primarily to sulphur dioxide and other air pollutants and will not grow at places which are polluted.

- (3) **Carnivorous & insectivorous plants:** Some plants also take food just like animals. Their food consists of small insects. For example – Pitcher plants, sundew plant, bladderwort, venus flytrap.

In a pitcher plant leaf is modified into a pitcher like structure when any insects sits on it, the lid is closed & the insect is trapped in pitcher. It is then digested by the secretion of enzymes.



**Fig. Pitcher Leaves are Modified to Capture Insects**

- (4) **Symbiosis:** It is a partnership between two organisms in which both partner get benefited from each other. For Example : Lichen.

Lichen is a combination of an alga & a fungus. In which, the fungus provides water & minerals to the alga whereas the alga supplies organic food to fungus.

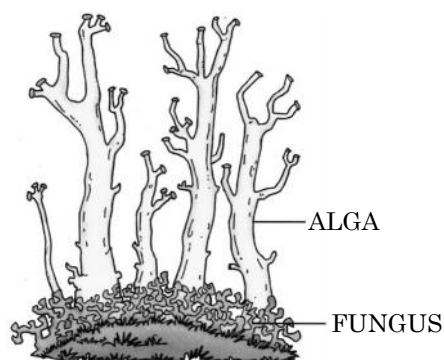


Fig. Lichen

#### COMPETITIVE LEVEL

##### ◆ Symbiosis :

- Algal partner is called **phycobiont**.
- Fungal partner is called **mycobiont**.

##### ◆ Replenishment of nutrients in soil :

- Ñ1 We know that plants continuously take nutrients from the soil in order to synthesize food. As a result of this amount of nutrients in the soil decreases.
- Ñ1 Nutrients in the soil are replenished by adding fertilisers and manures.
- Ñ1 Fertilisers and manures contain plants nutrients and minerals like nitrogen, phosphorus and potassium.
- Ñ1 Another way to replenish soil is to grow leguminous crops (for example gram, peas, pulses etc.) in the soil.
- Ñ1 The bacterium called Rhizobium can take atmospheric nitrogen and convert it into a soluble form.
- Ñ1 But Rhizobium cannot make its own food. So it lives in the roots of gram, peas, moong, beans and other legumes and provides them with nitrogen. In return plants provide food and shelter to the bacteria.
- Ñ1 Thus plants and bacteria have a **symbiotic relationship** here.

## EXERCISE-1

### Very Short Answer Type Questions

- Q.1 What is the meaning of autotrophic nutrition ?
- Q.2 What is symbiotic relationship?
- Q.3 What are producers?
- Q.4 Which type of nutrition is found in Doddar ?
- Q.5 Write down the equation of photosynthesis?

### Short Answer Type Questions

- Q.6 What is the meaning of 'nutrition'?
- Q.7 How do algae & fungi benefit each other?
- Q.8 What are insectivores? Name an insectivorous plant.
- Q.9 What factors are essential for photosynthesis ?
- Q.10 How do plants exchange gases with the atmosphere?

### Long Answer Type Questions

- Q.11 How do you show that chlorophyll is necessary for photosynthesis?
- Q.12 Describe symbiotic mode of nutrition with an example?
- Q.13 How dodder takes their nutrients from the host?
- Q.14 Describe the methods of nutrition in non green plants?
- Q.15 Write in brief about –  
herbivores, carnivores & omnivores.

### Fill in the blanks

- Q.16 \_\_\_\_\_ & \_\_\_\_\_ are insectivorous plants.
- Q.17 Green plants use \_\_\_\_\_, \_\_\_\_\_ & \_\_\_\_\_ to make food.
- Q.18 Lichen is the mutual combination of \_\_\_\_\_ & \_\_\_\_\_.
- Q.19 Doddar is an example of \_\_\_\_\_ .
- Q.20 \_\_\_\_\_ is modified into pitcher in pitcher plant.

### True and False

- Q.21 Animals do not depend on plant for their food.
- Q.22 Omnivorous eats only flesh.
- Q.23 Sucking roots are called haustoria.
- Q.24 The living organism from which parasite derives its food called host.
- Q.25 Rafflesia is a largest flower and is a parasite.

### Match the column

- | Q.26 | Column A         | Column B           |
|------|------------------|--------------------|
|      | (a) Amarbel      | (i) Saprophytes    |
|      | (b) Rhizobium    | (ii) Insectivorous |
|      | (c) Mushroom     | (iii) Autotrophs   |
|      | (d) Drosera      | (iv) Stomata       |
|      | (e) Green plants | (v) Symbiosis      |
|      |                  | (vi) Parasite      |

## EXERCISE-2

- Q.1** The plant that feeds & traps on insects is -  
(A) Drosera (B) Sunflower  
(C) Cuscuta (D) Mango
- Q.2** Organisms who work together for mutual benefit for food and habitat:  
(A) Mutualism (B) Parasitic  
(C) Saprophyte (D) Autotrophic
- Q.3** The green pigment in the leaves is called -  
(A) Chlorophyll (B) Anthocyanin  
(C) Chloroplast (D) None
- Q.4** Identify the odd one out :  
(A) Neem (B) Amaranthus  
(C) Rose (D) Cuscutta
- Q.5** Which one of the following is a parasite?  
(A) Mushroom (B) Fungi  
(C) Dodder (D) Pitcher's plant
- Q.6** Insectivorous plant is –  
(A) Mustard (B) Cuscutta  
(C) Nepenthes (D) Neem
- Q.7** Rhizobium is a good example of -  
(A) Insectivorous (B) Symbiosis  
(C) Parasitic (D) None of these
- Q.8** The mode of nutrition in Cuscutta (Amarbel) is known as –  
(A) Autotrophic (B) Saprophytic  
(C) Parasitic (D) All
- Q.9** Mushroom is an example of -  
(A) Autotroph (B) Saprophyte  
(C) Parasite (D) Host
- Q.10** Chlorophyll is present in –  
(A) Chloroplast (B) Ribosome  
(C) Leucoplast (D) Chromoplast
- Q.11** Autotrophic nutrition is found only in -  
(A) Plants (B) Animals  
(C) Both (D) None
- Q.12** Plants are green in colour because –  
(A) They absorb green light only  
(B) They reflect green light  
(C) They absorb green light but reflect all other lights  
(D) None of the above are correct
- Q.13** The plant that feeds and traps on insects is -  
(A) Venus-fly trap (B) Cuscuta  
(C) Sunflower (D) None of these
- Q.14** Green colour of leaves is due to the presence of –  
(A) Haemoglobin (B) Chlorophyll  
(C) Chloroform (D) None of these
- Q.15** Association of two different organisms in which both are benefited is called -  
(A) Symbiosis (B) Nutrition  
(C) Saprophytic (D) Parasitic
- Q.16** The raw materials for photosynthesis are -  
(A) CO<sub>2</sub> & O<sub>2</sub>  
(B) Sunlight and CO<sub>2</sub>  
(C) Water and chlorophyll  
(D) CO<sub>2</sub> and water
- Q.17** CO<sub>2</sub> & O<sub>2</sub> balance in atmosphere is due to -  
(A) Photorespiration  
(B) Photosynthesis  
(C) Reproduction  
(D) Leaf anatomy
- Q.18** Chlorophyll is present in –  
(A) Grana (B) Stroma  
(C) Leucoplast (D) Chromoplast
- Q.19** Plants are –  
(A) Autotrophic (B) Heterotrophic  
(C) Saprophytic (D) Holozoic
- Q.20** Green plants synthesize their food in the form of  
(A) starch (B) glucose  
(C) proteins (D) cellulose

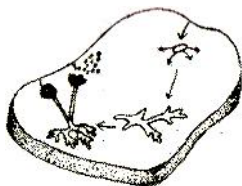
## EXERCISE-3

**Q.1** Which of the following statements is/are true (T) or false (F) regarding nutrition in organisms ?

- (i) Photosynthesis also occurs in leaves having colour other than green.
- (ii) The process of photosynthesis first produces a simple carbohydrate called glucose which then gets converted into a complex carbohydrate called starch.
- (iii) Cuscuta is a yellow-coloured plant but it can synthesize its own food by photo-synthesis.
- (iv) In a symbiotic association, Rhizobium bacteria derive their nutrition from fungus.

	(i)	(ii)	(iii)	(iv)
(a)	F	T	T	T
(b)	T	T	T	F
(c)	F	F	F	T
(d)	T	T	F	F

**Q.2** Which of the following statements best describe the organism growing on the given piece of bread ?



- (i) It belongs to flowering plants.
  - (ii) It reproduces by spores.
  - (iii) It is a chlorophyllous organism.
  - (iv) It prepares its own food.
  - (v) It obtains food from dead and decaying organic matter.
- (a) (ii), (iii) and (iv)  
 (b) (i), (ii) and (v)  
 (c) (ii) and (v)  
 (d) (iii) and (iv)

**Q.3** Refer to the given table.

Name of the plant	Presence/Absence of leaves	Mode of Nutrition
Mistletoe	L	Partially parasitic
Nepenthes	Present	M
Cuscuta	N	Completely parasitic

Select the correct option for L, M and N.

	L	M	N
(a) Present		Partially heterotrophic	Absent
(b) Absent		Partially heterotrophic	Absent
(c) Present		Autotrophic	Present
(d) Present		Partially parasitic	Absent

# ANSWER KEY

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## EXERCISE - 1

➤ Fill in the Blanks :

16. Pitcher plant and sundew plant  
19. Parasitic plant

17. CO<sub>2</sub>, H<sub>2</sub>O and sunlight  
20. Leaf

18. Alga and fungus

➤ True and False :

21. False

22. False

23. True

24. True

25. True

➤ Match the Column :

26. a-(vi) ; b-(v) ; c-(i) ; d-(ii) ; e-(iii)

## EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	A	A	D	C	C	B	C	B	A	A	B	A	B	A
Ques.	16	17	18	19	20										
Ans.	D	B	A	A	B										

## EXERCISE - 3

Ques.	1	2	3
Ans.	D	C	A

## INTEGERS

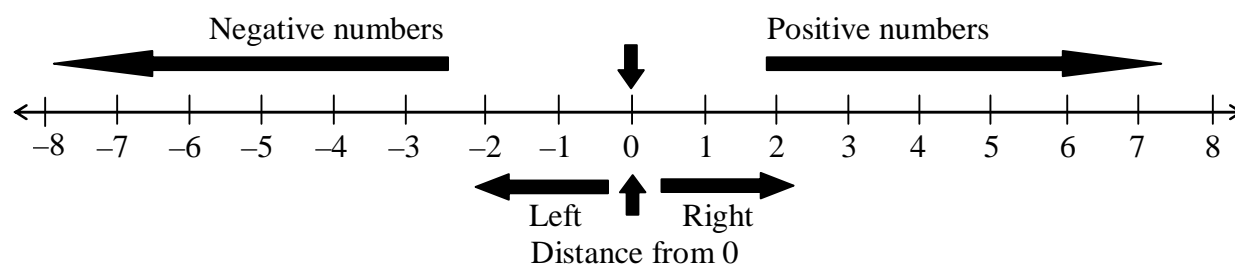
*Chapter Outline*

- ✧1 Integers
- ✧1 Types of Integers
- ✧1 Absolute Value of an Integer
- ✧1 Integers on Number Line
- ✧1 Addition of Integers
- ✧1 Subtraction of Integers
- ✧1 Properties of Addition and Subtraction of Integers
- ✧1 Multiplication of Integers
- ✧1 Division of Integers
- ✧1 Properties of Multiplication and Division of Integers
- ✧1 Rule of BODMAS

+   -   Integer   ×   ÷  
Rules

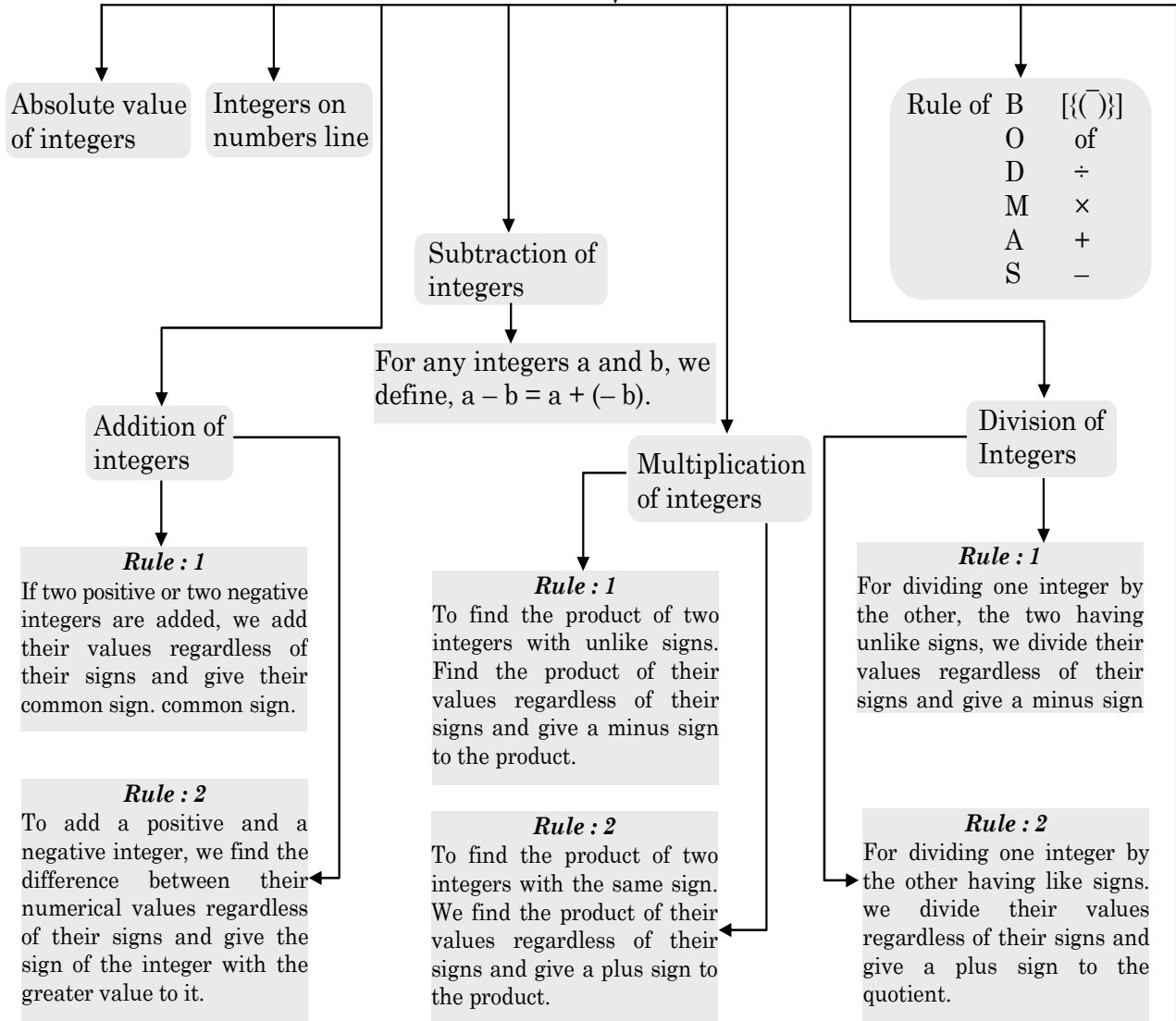
<b><u>Adding</u></b> <i>Same Signs</i> <i>Add and Keep the Sign</i> $13 + 35 = 48$ $-5 + -23 = -28$	<b><u>Subtract</u></b> <i>Copy, Change sign of subtracting term</i> <i>Then add</i> $-65 - 24 =$ $-65 + -24 = -79$
<b><u>Adding</u></b> <i>Different Signs</i> <i>Subtract and Take Sign of Number with Larger absolute value</i> $-13 + 35 = 22$	<b><u>Multiply &amp; Divide</u></b> <i>Same Signs</i> <i>Positive Answer</i> <i>Different Signs</i> <i>Negative Answer</i>

## NUMBER LINE



# MIND MAP

## INTEGERS



Properties of Integers				
	Addition	Subtraction	Multiplication	Division
Closure Property	$a + b = \text{integer}$	$a - b = \text{integer}$	$a \times b = \text{integer}$	$a \div b = \text{not necessary integer}$
Commutative Property	$a + b = b + a$	$a - b \neq b - a$	$a \times b = b \times a$	$a \div b \neq b \div a$
Associative Property	$a + [b + c] = [a + b] + c$	$a - [b - c] \neq [a - b] - c$	$a \times [b \times c] = [a \times b] \times c$	$a \div [b \div c] \neq [a \div b] \div c$
Distributive Property			$a \times [b \pm c] = a \times b \pm a \times c$	

# INTEGERS

## Integers

Collection of all natural numbers, 0 and negatives of natural numbers are called **integers**.

Thus, { ..., -4, -3, -2, -1, 0, 1, 2, 3, 4, ... } etc., are all integers.

The collection of integers is denoted by I and  $I = \{ \dots -3, -2, -1, 0, 1, 2, 3, \dots \}$

### ◆ Types of Integers

- (1) **Positive Integers** : The numbers 1, 2, 3, 4, 5, ... i.e., the natural numbers are called **positive integers**.
- (2) **Negative Integers** : The numbers -1, -2, -3, -4, -5, ... are called **negative integers**.
- (3) The number 0 is simply an integer. It is **neither positive nor negative**.

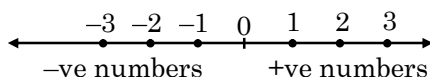
## Absolute Value of an Integer

The absolute value of an integer is the numerical value with no regard to its sign and it is always positive.

**For example** :  $|-27| = 27$ ,  $|-31| = 31$ ,  $|29| = 29$ ,  $|3| = 3$ .

## Integers on Number Line

Positive numbers are always on right side of zero & negative numbers are on left side of zero.



Or, we can say all integers are in ascending order from left to right.

**Ex.1** Fill the square by '<', '>' or '='

- |        |       |                          |       |
|--------|-------|--------------------------|-------|
| (i)    | 0     | <input type="checkbox"/> | -2    |
| (ii)   | -31   | <input type="checkbox"/> | -21   |
| (iii)  | -3    | <input type="checkbox"/> | 8     |
| (iv)   | -7    | <input type="checkbox"/> | 7     |
| (v)    | 11    | <input type="checkbox"/> | -6    |
| (vi)   | 3     | <input type="checkbox"/> | 3     |
| (vii)  | -1132 | <input type="checkbox"/> | -2    |
| (viii) | -1039 | <input type="checkbox"/> | -2138 |

**Sol.** (i)  $0 > -2$       (ii)  $-31 < -21$       (iii)  $-3 < 8$       (iv)  $-7 < 7$   
(v)  $11 > -6$       (vi)  $3 = 3$       (vii)  $-1132 < -2$       (viii)  $-1039 > -2138$

## Addition of Integers

**Case - I** : When the integers are of like signs.

**Rule** : To add two integers 'a' and 'b' of like signs, we add their absolute values and then put the common sign before the sum.

**For example** : Add : (i)  $(+300) + (+150) = 450$

(ii)  $(-3) + (-5) = -8$

**Case – II :** When the integers are of unlike signs.

**Rule :** To add two integers 'a' and 'b' of unlike signs, we find the difference of their absolute values and then put the sign of the bigger absolute value before the difference.

**For example :** Add : (i)  $(-23) + (+15) = -8$

$$(ii) (+18) + (-6) = +12$$

## Subtraction of Integers

Subtraction is the opposite of addition. So to subtract an integer 'a' from another integer 'b' we add the additive inverse (or negative) of a to b, i.e.,  $b - (a) = b + (-a)$  and  $b - (-a) = b + (+a)$ .

**For example :**

Subtract : (i)  $-36$  from  $-15$

$$= -15 - (-36) = -15 + (36) = 21$$

(ii)  $17$  from  $-41$ .

$$= -41 - (17) = -41 + (-17) = -58$$

## Properties of Addition and Subtraction of Integers

### ◆ Closure Property of Addition :

The sum of two integers is always an integer.

**For example :**

(i)  $5 + 4 = 9$ , which is an integer.

(ii)  $4 + (-8) = -4$ , which is an integer.

### ◆ Closure Property of Subtraction :

If a and b are any two integers. Then  $(a - b)$  is always an integer.

### ◆ Commutative Property of addition :

If a and b are any two integers, then  $a + b = b + a$

**For example: :**

(i)  $(-4) + 9 = 5$  and  $9 + (-4) = 5$

$$\therefore (-4) + 9 = 9 + (-4)$$

### ⚠ Subtraction of Integers is not Commutative :

**For example: :**

$$3 - 5 = 3 + (-5) = -2, 5 - 3 = 5 + (-3) = 2$$

Thus,  $3 - 5 \neq 5 - 3$ .

### ◆ Associative Property of Addition :

If a, b, c are any three integers, then  $(a + b) + c = a + (b + c)$

**For example:**

Consider the integers  $(-6)$ ,  $(-8)$  and  $5$ . We have

$$\{(-6) + (-8)\} + 5 = (-14) + 5 = -9.$$

$$\text{And, } (-6) + \{(-8) + 5\} = (-6) + (-3) = -9$$

$$\therefore \{(-6) + (-8)\} + 5 = (-6) + \{(-8) + 5\}.$$

¶ **Subtraction of integers is not associative :**

**For example :**

Consider the integers 3, -4 and -5 we have

$$\begin{aligned}\{3 - (-4)\} - (-5) &= \{3 + (\text{additive inverse of } -4)\} - (-5) \\ &= (3 + 4) - (-5) = 7 - (-5) \\ &= 7 + (\text{additive inverse of } -5) = (7 + 5) = 12\end{aligned}$$

$$\begin{aligned}\text{And, } 3 - \{(-4) - (-5)\} &= 3 - \{(-4)\} + (\text{additive inverse of } -5)\} \\ &= 3 - \{-4 + 5\} = (3 - 1) = 2\end{aligned}$$

Hence,  $\{3 - (-4)\} - (-5) \neq 3 - \{(-4) - (-5)\}$ .

◇ **Existence of Additive Identity :**

For any integer a, we have  $a + 0 = 0 + a = a$

¶ 0 is called the additive identity for integers.

**For example :**

$$(i) 9 + 0 = 0 + 9 = 9$$

$$(ii) (-6) + 0 = 0 + (-6) = (-6)$$

◇ **Existence of Additive Inverse :**

For any integer a, we have  $a + (-a) = (-a) + a = 0$

The opposite of an integer a is (-a).

The sum of an integer and its opposite is 0.

Additive inverse of a is (-a).

Similarly, additive inverse of (-a) is a.

**For example:**

$$\text{We have } 5 + (-5) = (-5) + 5 = 0.$$

So, the additive inverse of 5 is (-5).

And, the additive inverse of (-5) is 5.

**Ex.2** Write a pair of integers whose (i) sum is -7 and (ii) difference is -9.

**Sol.** (i)  $-9 + 2 = -4 + (-3) = -7$

(ii)  $1 - 10 = 2 - 11 = -9$

**Ex.3** Write a pair of integers whose difference is :

(i) a negative number

(ii) an integer greater than only one of the integers.

**Sol.** (i)  $-14 - (-5) = -9$  (Negative integer)

(ii)  $(-11) - (-3) = -8$  (It is greater than -11 and less than -3)

## Multiplication of Integers

There can be following cases

**Case – I :** When the integers are of like sign i.e., either both are positive or both are negative.

**Case – II :** When the integers are of unlike sign i.e., one positive and other negative.

We follow the following rules :

$(+) \times (+) = +$	Positive $\times$ Positive = Positive
$(-) \times (+) = -$	Negative $\times$ Positive = Negative
$(+) \times (-) = -$	Positive $\times$ Negative = Negative
$(-) \times (-) = +$	Negative $\times$ Negative = Positive

**For example :**

(i)  $5 \times 6 = 30$

(ii)  $7 \times 9 = 63$

(iii)  $9 \times 10 = 90$

(iv)  $-3 \times 1 = -3$

(v)  $-7 \times 9 = -63$

(vi)  $-11 \times 11 = -121$

(vii)  $13 \times -5 = -65$

(viii)  $10 \times -10 = -100$

(ix)  $-40 \times -20 = 800$

(x)  $-5 \times -1 = 5$

**Note:** (i) If negative integers are multiplied even number of times, product is always a positive integer.

(ii) If negative integers are multiplied odd number of times, product is always a negative integer.

(iii) **Property of Zero :** For any integer, we have

$$a \times 0 = 0 = 0 \times a$$

(iv) If a, b, c are integers, such that  $a > b$ , then

(a)  $a \times c > b \times c$ , if c is positive

(b)  $a \times c < b \times c$ , if c is negative.

**Ex.4** Complete the following multiplication :

$\times$	-7	-6	5	4
-7				
-6				
-5				
-4				
0				

**Sol.**

$\times$	-7	-6	5	4
-7	49	42	-35	-28
-6	42	36	-30	-24
-5	35	30	-25	-20
-4	28	24	-20	-16
0	0	0	0	0

## Division of Integers

Division is the reverse process of multiplication.

**Case – I :** The quotient of two integers involving two like signs is positive

or  $(+) \div (+) = +$  and  $(-) \div (-) = +$ .

**For example :**  $(-48) \div (-12) = 4$ .

**Case – II :** The quotient of two integers having opposite signs is negative

or  $(+) \div (-) = -$  and  $(-) \div (+) = -$ .

**For example :**  $(-48) \div (16) = -3$ .

### Note :

(i) If  $a$  is an integer different from 0, then  $a \div a = 1$ .

(ii) For every integer  $a$ , we have  $a \div 1 = a$ .

(iii) If  $a$  is a non-zero integer, then  $0 \div a = 0$

(iv) If  $a$  is an integer, then  $a \div 0$  is meaningless.

## Properties of Multiplication and Division

### ◆ Closure Property :

The product of two integers is always an integer.

That is, for any two integers 'a' and 'b',  $a \times b$  is always an integer.

**Verification :** We have

(i)  $4 \times 3 = 12$ , which is an integer.

(ii)  $3 \times (-5) = -15$ , which is an integer.

(iii)  $(-7) \times (-6) = 42$ , which is an integer.

If  $a$  and  $b$  are integers, then  $a \div b$  is not necessarily an integer.

**For example:**  $15 \div 4$ ,  $-14 \div 3$  are not integers.

Thus, the collection of integer is not closed under division.

### ◆ Commutativity :

For any two integers  $a$  and  $b$ , we have  $a \times b = b \times a$  that is multiplication of integers is commutative.

**Verification :** We have ,

(i)  $7 \times (-6) = -(7 \times 6) = -42$

and  $(-6) \times 7 = -(6 \times 7) = -42$

$\therefore 7 \times (-6) = (-6) \times 7$

Commutative property holds good.

(ii)  $(-5) \times (-9) = 5 \times 9 = 45$

and  $(-9) \times (-5) = 9 \times 5 = 45$

$\therefore (-5) \times (-9) = (-9) \times (-5)$ .

Division of integers is not commutative.

### ◆ Associativity :

The multiplication of integers is associative, i.e., for any three integers  $a$ ,  $b$ ,  $c$ , we have :

$a \times (b \times c) = (a \times b) \times c$

**Verification :** We have

$$(i) \quad (-3) \times \{4 \times (-7)\} = (-3) \times (-28) = 3 \times 28 = 84 \text{ and, } \{(-3) \times 4\} \times (-7) = (-12) \times (-7) = 12 \times 7 = 84 \\ \therefore (-3) \times \{4 \times (-7)\} = \{(-3) \times 4\} \times (-7)$$

Thus, associative property holds good.

$$(ii) \quad (-2) \times \{(-3) \times (-5)\} = (-2) \times 15 = -(2 \times 15) = -30 \text{ and,} \\ \text{Division of integers is not associate.}$$

◆ **Distributive Property of Multiplication Over Addition :**

The multiplication of integers is distributive over their addition. That is, for any three integers a, b, c, we have :

$$(i) \quad a \times (b + c) = a \times b + a \times c$$

$$(ii) \quad (b + c) \times a = b \times a + c \times a$$

**Verification :** We have ,

$$(-4) \times \{(-2) + (-3)\} = (-4) \times (-5) = 4 \times 5 = 20$$

$$\text{and, } (-4) \times (-2) + (-4) \times (-3) = (4 \times 2) + (4 \times 3) = 8 + 12 = 20$$

$$\therefore (-4) \times \{(-2) + (-3)\} = (-4) \times (-2) + (-4) \times (-3).$$

**Remark :** A direct consequence of the distributivity of multiplication over subtraction is :

$$a \times (b - c) = a \times b - a \times c.$$

◆ **Existence of Multiplicative Identity :**

For every integer a, we have  $a \times 1 = a = 1 \times a$

Thus, the integer 1 is called the multiplicative identity for integers.

◆ **Existence of Multiplicative Inverse :**

Multiplicative inverse of a non-zero integer a is the number  $\frac{1}{a}$  , as  $a \times \left(\frac{1}{a}\right) = \left(\frac{1}{a}\right) \times a = 1$

**For example :** Multiplicative inverse of 6 is  $\frac{1}{6}$ .

**Ex.5** In a class test containing 20 questions, 3 marks are given for every correct answer and -1 mark is given for every incorrect answer.

(i) Ritu attempt all questions but only 11 of her answers are correct. What is her total score ?

(ii) One of her friends attempt 8 questions but only one answer is incorrect. What is her friend's total score ?

**Sol.** (i) Marks given for one correct answer = 3

$$\text{So, marks given for 11 correct answer} = 3 \times 11 = 33$$

$$\text{Marks given for one incorrect answer} = -1$$

$$\text{So, marks given for 9 incorrect answers} = -1 \times 9 = -9$$

$$\text{Therefore, Ritu's total score} = 33 - 9 = 24$$

(ii) Marks given for one correct answer = 3

$$\text{So, marks given for 7 correct answer} = 3 \times 7 = 21$$

$$\text{Marks given for one incorrect answer} = 1 \times -1 = -1$$

$$\text{Therefore, her friend's total score} = 21 - 1 = 20$$

**Ex.6** The product of two integers is  $-120$ . If one of the number is  $-30$ , find the other integer.

**Sol.** Let the other number be 'a'

Then according to questions

$$(a) \times (-30) = -120$$

$$a = -120 \div -30 = 40$$

**Ex.7** A shopkeeper earns a profit of ₹ 2 by selling one pen and incurs a loss of 50 paise per pencil while selling pencils of her old stock.

(i) In a particular month she incurs a loss of ₹ 10. In this period, she sold 45 pens. How many pencils did she sell in this period ?

(ii) In the next month, she earns neither profit nor loss. If she sold 80 pens, how many pencils did she sell ?

**Sol.** (i) Profit earned by selling one pen = ₹ 2

$$\therefore \text{Profit earned by selling 45 pens} = 2 \times 45 = ₹ 90$$

$$\text{Total loss given} = ₹ 10,$$

Therefore,

$$\begin{aligned} \text{Loss incurred} &= \text{Total loss} + | \text{Profit earned} \\ &= ₹ (10 + 90) = ₹ 100 = 10000 \text{ paise} \end{aligned}$$

$$\text{So, Number of pencils sold} = (10000) \div (50) = 200 \text{ pencils}$$

(ii) In the next month, there is neither profit nor loss.

$$\text{It means profit earned} = \text{Loss incurred}$$

$$\text{Now, profit earned by selling 80 pens} = 2 \times 80 = ₹ 160$$

$$\text{Hence, loss incurred by selling pencils} = ₹ 160 = 16000 \text{ paise}$$

$$\text{Total number of pencils sold} = (16000) \div 50 = 320 \text{ pencils}$$

## Rule of BODMAS

B stands for **brackets**, O for the operation 'Of' D for **division**, M for **multiplication**, A for **addition** and S for **subtraction**.

### ◆ Types of bracket

Bar or vinculum —

Round brackets or parenthesis ( )

Curly brackets or braces { }

Square brackets [ ]

Vinculum or bar is used as the innermost brackets and then ( ), then { }, and finally [ ].

In order to simplify expression involving more than one brackets, we use the following steps.

**Step-I** : See whether the given expression contains a vinculum or not. If a vinculum is present, then perform operations under it. Otherwise go to next step.

**Step-II** : See the innermost bracket and perform operations within it.

**Step-III** : Remove the innermost bracket by using following rules :

**Rule 1** : If a bracket is preceded by a plus sign, remove it by writing its terms as they are.

**Rule 2** : If a bracket is preceded by minus sign, change positive signs within it to negative and vice-versa.

**Rule 3** : If there is no sign between a number and a grouping symbol, then it means multiplication.

**Rule 4** : If there is a number before some brackets then we multiply the number inside the brackets with the number outside the brackets.

**Step-IV** : See the next innermost bracket and perform operations within it. Remove the second innermost bracket by using the rules given in step III. Continue this process till all the brackets are removed.

**Ex.8** Simplify :  $10 + [5 \times \{48 \div (2 \times 4)\}]$

**Sol.**  $10 + [5 \times \{48 \div (2 \times 4)\}]$   
 $= 10 + [5 \times \{48 \div 8\}]$   
 $= 10 + [5 \times 6]$   
 $= 10 + 30$   
 $= 40$

**Ex.9** Simplify :  $57 - [28 - \{16 + (5 - \overline{3 - 1})\}]$ .

**Sol.**  $57 - [28 - \{16 + (5 - \overline{3 - 1})\}]$   
 $= 57 - [28 - \{16 + (5 - 2)\}]$  [Removal of bar]  
 $= 57 - [28 - \{16 + 3\}]$  [Innermost brackets removed]  
 $= 57 - [28 - 19]$  [Next Innermost brackets removed]  
 $= 57 - 9 = 48$

**Ex.10** Simplify : (i)  $7 - \{13 - 2(4 \text{ of } -4)\}$   
(ii) 81 of  $[59 - \{7 \times 8 + (13 - 2 \text{ of } 5)\}]$

**Sol.** (i)  $7 - \{13 - 2(4 \text{ of } -4)\}$   
 $= 7 - \{13 - 2(4 \times -4)\}$   
 $= 7 - \{13 - 2(-16)\} = 7 - \{13 - (-32)\}$   
 $= 7 - \{13 + 32\} = 7 - 45 = -38$   
(ii) 81 of  $[59 - \{7 \times 8 + (13 - 2 \text{ of } 5)\}]$   
 $= 81 \times [59 - \{7 \times 8 + (13 - 2 \times 5)\}]$   
 $= 81 \times [59 - \{7 \times 8 + (13 - 10)\}]$   
 $= 81 \times [59 - \{56 + 3\}]$   
 $= 81 \times [59 - 59]$   
 $= 81 \times 0 = 0$

**Ex.11** Simplify :  $63 - (-3) \{-2 - \overline{8 - 3}\} \div 3\{5 + (-2) (-1)\}$

**Sol.**  $63 - (-3) \{-2 - \overline{8 - 3}\} \div 3\{5 + (-2) (-1)\}$   
 $= 63 - (-3) \{-2 - 5\} \div 3\{5 + (-2) (-1)\}$  [Removal of bar]  
 $= 63 - (-3) \{-2 - 5\} \div 3 \{5 + 2\}$  [ $(-2) (-1) = 2$ ]  
 $= 63 - (-3) \{-7\} \div 3 \times 7$  [Removal of curly brackets]  
 $= 63 + 3 \times \left(\frac{-7}{3}\right) \times 7 = 63 - 49 = 14$

## EXERCISE-1

### Very Short Answer Type Questions

- Q.1** Write the value of  
(i)  $|+22|$   
(ii)  $|-8|$   
(iii)  $|18 - 8|$   
(iv)  $|-5 - 4|$   
(v)  $-|3 - 2|$
- Q.2** Evaluate the following :  
(i)  $(-40) \div 10$   
(ii)  $60 \div (-6)$   
(iii)  $(-49) \div (-7)$   
(iv)  $(-79) \div 79$   
(v)  $13 \div [(-4) + 3]$   
(vi)  $0 \div (-14)$   
(vii)  $(-41) \div [(-40) + (-1)]$   
(viii)  $[(-48) \div 12] \div 4$   
(ix) Is  $[(-7) + (6)] = [(-3) + 2]$  ?
- Q.3** Write down a pair of integers whose :  
(i) sum is  $-7$   
(ii) difference is  $-10$   
(iii) sum is  $0$
- Q.4** Arrange the following integers in ascending order  
(i)  $-20, 13, 4, 0, -5, +5$   
(ii)  $+30, -2, 0, -6, -20, 8$
- Q.5** Which temperature is higher ?  
(i)  $40^{\circ}\text{C}$  or  $-40^{\circ}\text{C}$       (ii)  $-18^{\circ}\text{C}$  or  $12^{\circ}\text{C}$   
(iii)  $-2^{\circ}\text{C}$  or  $-4^{\circ}\text{C}$       (iv)  $17^{\circ}\text{C}$  or  $27^{\circ}\text{C}$

### Short Answer Type Questions – Type I

- Q.6** The temperature at 12 noon was  $10^{\circ}\text{C}$  above zero. At what time the temperature will be  $8^{\circ}\text{C}$  below  $0^{\circ}\text{C}$ , if it decreases at the rate of  $2^{\circ}\text{C}$  per hour ? If it decreases at the rate of  $2^{\circ}\text{C}$  per hour till midnight, what would be the temperature at midnight ?
- Q.7** In a class test (+3) marks are given for every correct answer and ( $-2$ ) marks are given for every incorrect answer and no marks for not attempting any questions.  
(i) Ram scored 20 marks. If he has got 12 correct answers, how many questions has he attempted incorrectly?  
(ii) Mohan scores  $-5$  marks in the test though he has written 7 correct answers. How many questions has he attempted incorrectly ?
- Q.8** A boy has ₹ 350 in his bank account. He deposits ₹ 40 everyday for 10 days. What will be the amount in his account at the end of 10 days ?
- Q.9** A cement company earns a profit of ₹ 11 per bag of white cement sold out and a loss of ₹ 6 per bag of grey cement sold.  
(i) The company sells 4,000 bags of white cement and 8,000 bags of grey cement in a month. What is its profit or loss ?  
(ii) What is the number of white cement bags it must sell to have neither profit nor loss, if the number of grey bags sold is 1,100 bags.
- Q.10** An elevator moves into a mineshaft at the rate of  $7\text{m}/\text{min}$ . If it starts from 15 m below the ground level, how long will it take to reach 475 m above the ground level ?

### ➤ Short Answer Type Questions – Type II

- Q.11** A certain freezing process requires that room temperature be lowered from  $43^{\circ}\text{C}$  at the rate of  $8^{\circ}\text{C}$  every hour. What will be the room temperature 6 hours after the process begins ?
- Q.12** The temperature at 12 noon was  $15^{\circ}\text{C}$  above zero. If it decreases at the rate of  $3^{\circ}\text{C}$  per hour until midnight, at what time would the temperature be  $9^{\circ}\text{C}$  below zero ?
- Q.13** A water tank has steps inside it. A monkey is sitting on the topmost step (i.e., the first step). The water level is at the ninth step.
- (i) He jumps 3 steps down and then jumps 2 steps up. If he continues in this way, in how many jumps will he reach the water level ?
- (ii) After drinking water, he wants to go back, for this he jumps 4 steps up and then jumps 2 steps down in every move. In how many jumps will he reach back the top step ?

**Q.14** Simplify :  $18 - 8 \div 4 \times 3$

**Q.15** Simplify :  $9 \div (15 - 7 - 5) + 6$

### ➤ Long Answer Type Questions

**Directions (Q.16 to Q.20 ) Simplify :**

**Q.16**  $25 - 12 \div 6 - 3 \times 8$

**Q.17**  $72 - [3 - \{18 - \overline{19 - 2}\}] \times \{1 + 5 \text{ of } 7 - (3 - 1)\}$

**Q.18**  $5 \div [5 + \{5 - (5 + \overline{5 - 5})\}]$

**Q.19**  $9 + \{6 + 5 \times 3 - (9 \div 3 - 8 \times 2)\}$

**Q.20**  $-5 - [4 + 15 \div 5 - \{6 - (2 + 8)\}]$

### ➤ Fill in the Blanks

- Q.21** (i) The product of 200 negative integers is ..... integer.  
 (ii) The product of 999 negative and 999 positive integers is .....  
 (iii) The additive inverse of 0 is .....  
 (iv) When we divide a negative integer by a positive integer, the result so obtained is ....  
 (v) The value of  $|28 - 18|$  is .....

### ➤ True or False

- Q.22** (i) The greatest positive integer is 100.  
 (ii) Zero is positive integer.  
 (iii) Division in integers is closed.  
 (iv) On dividing any integer by zero, the result is always zero.  
 (v)  $18 - |-12|$  is equal to 6.

### ➤ Match the Column

**Q.23** Match the following :

Column-I	Column-II
(i) $(-7) + 9 = 9 + (-7)$	(a) property of multiplicative identity
(ii) $6 + [3 + (-2)] = [(6 + 3)] + (-2)$	(b) Commutative property of addition
(iii) $4[5 \times (-5)] = (4 \times 5)(-5)$	(c) Multiplicative property of zero
(iv) $7 \times 0 = 0$	(d) Associative property of multiplication
(v) $13 \times 1 = 13$	(e) Associative property of addition

## EXERCISE-2

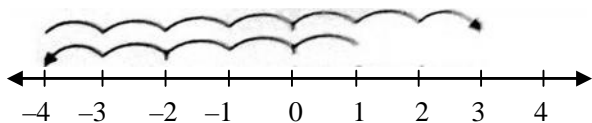
- Q.1** The additive identity of integers is :  
(A) -1 (B) 1  
(C) 0 (D) none of these
- Q.2** Which is the smallest negative integer in the collection of integers :  
(A) 0 (B) -100  
(C) -1 (D) none of these
- Q.3** Which is the greatest positive integer in the collection of integers :  
(A) 0 (B) 100  
(C) 999 (D) none of these
- Q.4** The integer which is its own additive inverse is :  
(A) 0 (B) -1  
(C) +1 (D) none of these
- Q.5** The value of  $5(10 - 9)$  is :  
(A) 5 (B)  $5 \times 10 - 5 \times 9$   
(C) (A) and (B) (D) none of these
- Q.6** The absolute value of -6 is :  
(A) 6 (B) -6  
(C) 0 (D) none of these
- Q.7** If  $4 + (-7) = (-7) + 4$ , this property of integers is called :  
(A) Closure (B) Commutative  
(C) Associative (D) None of these
- Q.8** If  $[-7 + (-8)] + 9 = -7 + [(-8) + 9]$ , this property is called :  
(A) Closure (B) Commutative  
(C) Associative (D) None of these
- Q.9** The sum of two integers is also an integer, this property of integers is called:  
(A) Closure (B) Commutative  
(C) Associative (D) None of these
- Q.10** If a and b ( $b \neq 0$ ) are integers, then  $a \div b$  :  
(A) may or may not be an integer  
(B) always an integer  
(C) never be an integer  
(D) none of these
- Q.11** Choose appropriate number for blank :  
 $-7 - (\quad) = 2$   
(A) 5 (B) -5 (C) 9 (D) -9
- Q.12** Multiplication of -2, -7 and -10 gives  
(A) -34 (B) 19 (C) -140 (D) 90
- Q.13**  $16 \times 10 + 2$  is equal to  
(A) 162 (B) 192 (C) 52 (D) 320
- Q.14** Solve:  $(-3) \times (-4) + (-18) \div (6) - (-5)$   
(A) +4 (B) +14 (C) 10 (D) 0
- Q.15** Which of the following does not represent pair of integer (a, b) such that  $a \div b = 2$   
(A) (-6, -3) (B) (-2, 1)  
(C) (-10, -5) (D) (8, 4)
- Q.16** Which correctly answers the following:  
 $[(-2) \times (-4)] + [(-12) \div (+3)]$   
(A) +4 (B) +12  
(C) -12 (D) 0
- Q.17** Which of the following is the value of  $(-4) \times [(-5) + (-3)]$  ?  
(A) -32 (B) 120 (C) 32 (D) -23
- Q.18** A shop keeper makes a profit of Rs.5 on each pen & incurs a loss of Rs. 2 on each pencil box. What will be his net profit if he sells ten pens & ten pencil boxes?  
(A) 20 (B) 30 (C) 50 (D) 100
- Q.19** If the temperature at 7:00 am was  $-7^\circ \text{C}$  and the temperature rose  $8^\circ \text{C}$  during the morning, what was the temperature by noon ?  
(A)  $-15^\circ \text{C}$  (B)  $-1^\circ \text{C}$   
(C)  $+15^\circ \text{C}$  (D)  $+1^\circ \text{C}$
- Q.20** What integers or number should be added to -5 to get 4  
(A) 1 (B) -1 (C) -9 (D) 9

## EXERCISE-3

- Q.1** Which of the following sign will replace \* in  $2 \times 6 - 12 \div 4 * 2 = 5 * 6$  ?  
 (A) +      (B) -      (C)  $\times$       (D)  $\div$

- Q.2** Find the value of the expression.  
 $-1152 + (-118) - (-32) - (13) - (-56) + (-2183) + 5$   
 (A) -993      (B) -3373  
 (C) 993      (D) 389

- Q.3** Which of the following number sentence is represented on the number line shown below ?

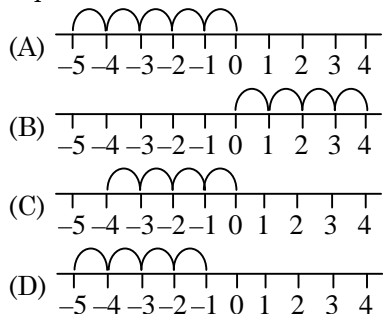


- (A)  $-2 + (-3) = 1$       (B)  $1 + (-2) = -2$   
 (C)  $1 - (+2) = -1$       (D) None of these

- Q.4** A boy multiplied 987 by an integer and obtained 559981 as his answer. If in the answer both 9's are wrong and the other digits are correct, then the correct answer would be .....  
 (A) 553681      (B) 555181  
 (C) 555681      (D) 556581

- Q.5** A cricket team won 3 matches more than they lost. If a team win gives them 2 points and loss (-1) point, how many matches, in all, they have played if the score is 23 ?  
 (A) 17      (B) 20  
 (C) 37      (D) 40

- Q.6** Which of the following number line represents  $-1 - 4$ ?



- Q.7** Temperature of a place at 12 : 00 noon was  $5^{\circ}\text{C}$ . Temperature increased by  $3^{\circ}\text{C}$  in first hours and decreased by  $1^{\circ}\text{C}$  in the second hours. What was the temperature at 2:00 Pm?  
 (A)  $5^{\circ}\text{C}$       (B)  $7^{\circ}\text{C}$   
 (C)  $8^{\circ}\text{C}$       (D)  $6^{\circ}\text{C}$

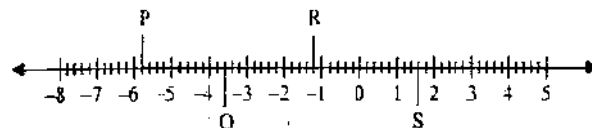
- Q.8** Which of the following options hold with respect to given below statements?

**Statements 1 :** Value of  $(-85) \times 43 + 43 \times (-15) = (-85 + (-15)) \times 43 = 4300$

**Statements 2 :** If \* is a multiply operation for integers p, q and r, then we have  $P * (q + r) = (p * q) + (p * r)$

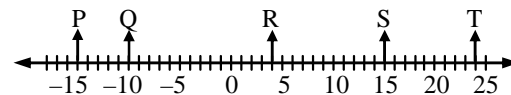
- (A) Statements 1 is false and statements 2 is false  
 (B) Statements 1 is false and statements 2 is true  
 (C) Both statements 1 and 2 are true  
 (D) Both statements 1 and are false.

- Q.9** Find the value of  $(P + Q) + (S - P) - R$ .



- (A) -2.5      (B) 3.2  
 (C) -0.8      (D) 1.4

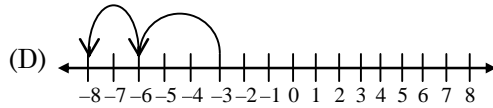
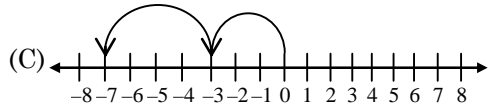
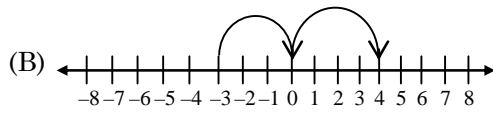
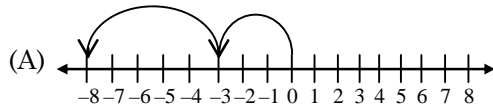
- Q.10** The following number line shows the temperature in degree celsius ( $^{\circ}\text{C}$ ) at different places (P to T) on a particular day.



What is the difference in temperature between the hottest and coldest places as shown on the number line ?

- (A)  $30^{\circ}\text{C}$       (B)  $39^{\circ}\text{C}$   
 (C)  $15^{\circ}\text{C}$       (D)  $40^{\circ}\text{C}$

**Q.11** Which of the following number line represents  $-3 - 4$ ?



**Q.12** A certain freezing process requires room temperature be lowered from  $50^{\circ}\text{C}$  at the rate of  $6^{\circ}\text{C}$  every hour. What will be the room temperature 12 hours after the process begins?

- (A)  $22^{\circ}\text{C}$                       (B)  $30^{\circ}\text{C}$   
 (C)  $-22^{\circ}\text{C}$                     (D)  $-30^{\circ}\text{C}$

# ANSWER KEY

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## EXERCISE - 1

1. (i) 22 (ii) 8 (iii) 10 (iv) 9 (v) -1
2. (i) -4 (ii) -10 (iii) 7 (iv) -1 (v) -13 (vi) 0 (vii) 1 (viii) -1 (ix) yes
3. (i) -1, -6 or -9, 2 (ii) -11, -1 or 2, 12 (iii) -1, 1 or 20, -20
4. (i) -20, -5, 0, 4, 5, 13 (ii) -20, -6, -2, 0, 8, 30
5. (i) 40°C (ii) 12°C (iii) -2°C (iv) 27°C
6. 9 pm, -14°C      7. (i) 8 (ii) 13      8. ₹ 750
9. (i) Loss of ₹ 4,000 (ii) 600 bags
10. 1 hr 10 min.      11. -5°C      12. 8 pm      13. (i) 11 jumps (ii) 5 jumps
14. 12      15. 9      16. -1      17. 4      18. 1      19. 43      20. - 16
21. (i) positive (ii) negative (iii) 0 (iv) negative integer (v) 10
22. (i) False (ii) False (iii) False (iv) False (v) True
23. (i) b (ii) e (iii) d (iv) c (v) a

## EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	D	D	A	C	A	B	C	A	A	D	C	A	B	B
Ques.	16	17	18	19	20										
Ans.	A	C	B	D	D										

## EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12
Ans.	A	B	D	C	C	A	B	C	B	D	C	C

# NUMBER SERIES

**Mental ability** is the ability of mind to observe and understand things or patterns in a logical way and reach to a conclusion or judgment based on that logic.

It is the ability to distinguish between important, less important and more important.

**Number Series** is a collection of numbers which follow a particular pattern or rule. The pattern followed by the numbers in the series remains the same throughout. Each number in a number series is called a term. Series move with certain mathematical operation like :

- Consecutive odd/even numbers.
- Consecutive prime / composite numbers.
- Squares/cubes of some numbers with/without variation of addition or subtraction of some number.
- Sum/product/difference of preceding number(s) .
- Addition/subtraction/multiplication/division by some number.
- Many more combinations of the relationship given above.

Type of questions asked in the examination:

- (i) Find the missing term(s).
- (ii) Find the wrong term(s).

### ◆ Type of Series

A series can be created in many ways. Some of these are discussed below :

- (i) **A series in which the next number can be obtained by adding or subtracting a fixed number.**

For example,

**Ex.1** 3, 5, 7, 9, 11, ?

- (A) 12                      (B) 13  
(C) 14                      (D) 15

**Sol.** (B) Next term is obtained by adding 2 in preceding term. So the next term is 13.

**Ex.2** 10, 8, 6, 4, 2, ?

- (A) 0                      (B) 3  
(C) 1                      (D) 5

**Sol.** (A) Next term is obtained by subtracting 2 from preceding term so next term is 0.

- (ii) **A series in which the next number can be obtained by multiplying (or dividing) the previous number by a fixed number.**

For example,

**Ex.3** 4, 8, 16, 32, 64, ?

- (A) 128                      (B) 130  
(C) 136                      (D) 138

**Sol.** (A) Next term is obtained by multiplying preceding term by 2. so the next term is 128.

**Ex.4** 1024, 512, 256, 128, 64, ?

- (A) 8                      (B) 16  
(C) 32                      (D) 15

**Sol.** (C) Next term is obtained by dividing preceding term by 2. so the next term is 32.

- (iii) **Series of squares, cubes**

These series can be formed by squaring or cubing every successive number.

For example,

- 2, 4, 16, 256,.....
- 3, 9, 81, 6561,....
- 2, 8, 512,.... etc.

are such series. (In the first and second, every number is squared to get the next number while in the third it is cubed).

- (iv) **Mixed Series**

Find the next number of the series

**Ex.5** 8, 14, 26, 50, 98, 194, ?

- (A) 388 (B) 384  
(C) 386 (D) 382

**Sol.** (C) Sharp increase and terms roughly doubling every time. On checking with 2 as multiple the series is:

$$\text{next term} = \text{previous term} \times 2 - 2$$

$$\text{next term} = 194 \times 2 - 2 = 386$$

**Ex.6** 8, 8, 9, 9, 11, 10, 14, 11, ?

- (A) 14 (B) 18  
(C) 19 (D) 20

**Sol.** (B) Irregular. Very irregular. Likely to be, therefore, mixed. On checking it is a mix of two series:

8, 9, 11, 14, (+1, +2, +3 etc.) and 8, 9, 10, 11.

$$\text{Next term} = 14 + 4 = 18.$$

**Ex.7** 325, 259, 204, 160, 127, 105, ?

- (A) 90 (B) 94  
(C) 98 (D) 89

**Sol.** (B) Gradual slow decrease. Likely to be arithmetical decrease. Check the differences of successive terms. They are 66, 55, 44, 33, 22. Hence, next decrease will be : 11.

$$\text{Next term} = 105 - 11 = 94.$$

**Ex.8** 54, 43, 34, 27, 22, 19, ?

- (A) 15 (B) 16  
(C) 17 (D) 18

**Sol.** (D) Gradual slow decrease. Likely to be arithmetical decrease. Check the differences. They are 11, 9, 7, 5, 3. Hence, next decrease will be 1. Next term =  $19 - 1 = 18$

**Ex.9** 824, 408, 200, 96, 44, 18, ?

- (A) 10 (B) 9  
(C) 5 (D) 7

**Sol.** (C) Sharp decrease and terms roughly being halved every time. Checking with 2 as divisor the series is :

$$\text{Next term (previous term} - 8) \div 2.$$

$$\text{Next term} = 5.$$

**Ex.10** Which number would replace question mark in the series 7, 12, 19, ?, 39.

(A) 29 (B) 28

(C) 26 (D) 24

**Sol.** (B) Clearly, the given sequence follows the pattern:

$$+5, +7, +9 \dots \text{i.e., } 7 + 5 = 12, 12 + 7 = 19, \dots$$

$$\therefore \text{Missing number} = 19 + 9 = 28$$

**Ex.11** Which is the number that comes next in the sequence : 0, 6, 24, 60, 120, 210 ?

(A) 240 (B) 290 (C) 336 (D) 504

**Sol.** (C) Clearly, the given series is

$$1^3 - 1, 2^3 - 2, 3^3 - 3, 4^3 - 4, 5^3 - 5, 6^3 - 6.$$

$$\therefore \text{Next number} = 7^3 - 7 = 343 - 7 = 336$$

**Ex.12** Which is the number that comes next in the following sequence ?

4, 6, 12, 14, 28, 30, ?

(A) 32 (B) 60 (C) 62 (D) 64

**Sol.** (B) The given sequence is a combination of two series :

I. 4, 12, 28 ? and II. 6, 14, 30.

Now, the pattern followed in each of the above two series is : +8, +16, +32 ....

$$\text{So, missing number} = (28 + 32) = 60$$

**Ex.13** Which fraction comes next in the sequence

$\frac{1}{2}, \frac{3}{4}, \frac{5}{8}, \frac{7}{16}, ?$

(A)  $\frac{9}{32}$  (B)  $\frac{10}{17}$  (C)  $\frac{11}{34}$  (D)  $\frac{12}{35}$

**Sol.** (A) Clearly, the numerators of the fractions in the given sequence form the series 1, 3, 5, 7, in which each term is obtained by adding 2 to the previous term. The denominators of the fractions form the series 2, 4, 8, 16,

i.e.  $2^1, 2^2, 2^3, 2^4$ .

So, the numerator of the next fraction will be  $(7 + 2)$  i.e., 9 and the denominator will be  $2^5$  i.e. 32.

$$\therefore \text{The next term is } \frac{9}{32}$$

**Direction : (Ex.14)** A number series is given. After the series, below it in the next line, a number is given followed by (a), (b), (c), (d) and (e). You have to complete the series starting with the number given following the sequence of the given series.

**Ex.14** 4 14 36 114 460

2 a b c d e

Find the value of e.

- (A) 2060 (B) 2062  
(C) 2064 (D) 2066

**Sol.** (B) The first series is

$\times 1 + 10, \times 2 + 8, \times 3 + 6, \times 4 + 4, \dots$

$\therefore a = 2 \times 1 + 10 = 12, b = 12 \times 2 + 8 = 32,$   
 $c = 32 \times 3 + 6 = 102, d = 102 \times 4 + 4 = 412,$   
and finally  $e = 412 \times 5 + 2 = 2062$

**Ex.15** 1, 4, 9, 16, 25, ?

- (A) 35 (B) 36 (C) 48 (D) 49

**Sol.** (B) The numbers are  $1^2, 2^2, 3^2, 4^2, 5^2$

$\therefore$  Missing number =  $6^2 = 36$

**Ex.16** 20, 19, 17, ?, 10, 5

- (A) 12 (B) 13 (C) 14 (D) 15

**Sol.** (C) The pattern is  $-1, -2, \dots$

$\therefore$  Missing number =  $17 - 3 = 14$

**Ex.17** 2, 3, 5, 7, 11, ?, 17

- (A) 12 (B) 13 (C) 14 (D) 15

**Sol.** (B) Clearly, the given series consists of prime numbers starting from 2. The prime number after 11 is 13. So, 13 is the missing number.

**Ex.18** 3, 9, 27, 81, ?

- (A) 324 (B) 243 (C) 210 (D) 162

**Sol.** (B) Each term of the given series is obtained by multiplying its preceding term by 3.

$\therefore$  Missing number =  $81 \times 3 = 243$

**Ex.19** 1, 9, 17, 33, 49, 73, ?

- (A) 97 (B) 98 (C) 99 (D) 100

**Sol.** (A) The pattern is  $+8, +8, +16, +16, +24, \dots$

$\therefore$  Missing number =  $73 + 24 = 97$

**Ex.20** 2, 5, 9, ?, 20, 27

- (A) 14 (B) 16 (C) 18 (D) 24

**Sol.** (A) The pattern is  $+3, +4, \dots$

$\therefore$  Missing number =  $9 + 5 = 14$

**Ex.21** 5, 9, 17, 29, 45, ?

- (A) 60 (B) 65 (C) 68 (D) 70

**Sol.** (B) The pattern is  $+4, +8, +12, +16, \dots$

$\therefore$  Missing number =  $45 + 20 = 65$

**Ex.22** 3, 7, 15, 31, 63, ?

- (A) 92 (B) 115 (C) 127 (D) 131

**Sol.** (C) Each number in the series is the preceding number multiplied by 2 and then increased by 1.

Thus,  $(3 \times 2) + 1 = 7, (7 \times 2) + 1 = 15,$

$(15 \times 2) + 1 = 31$  and so on.

$\therefore$  Missing number =  $(63 \times 2) + 1 = 127$

**Ex.23** 1, 6, 15, ?, 45, 66, 91

- (A) 25 (B) 26 (C) 27 (D) 28

**Sol.** (D) The pattern is  $+5, +9, \dots, +21, +25$

$\therefore$  Missing number =  $15 + 13 = 28$

**Ex.24** 1, 2, 3, 5, 8, ?

- (A) 9 (B) 11 (C) 13 (D) 15

**Sol.** (C) Each term in the series is the sum of the preceding two terms.

Thus,  $1 + 2 = 3; 2 + 3 = 5; 3 + 5 = 8$  and so on.

$\therefore$  Missing number =  $5 + 8 = 13$

#### ◆ Wrong Term in Series

In examinations, a series is more likely to be given in the format of a complete series in which an incorrect number is included & it is required to find out the wrong number. On studying a given series and applying the concepts employed so far you should be able to understand and thus "decode" the formation of the series. Usually six terms are given and it means that at least five correct terms are given.

**Ex.25** 24, 27, 31, 33, 36

(A) 24 (B) 27 (C) 31 (D) 33

**Sol.** (C) Each term in the series is increased by 3 to obtain the next term.

So, 31 is wrong and must be replaced by  $(27 + 3)$  i.e. 30.

**Ex.26** 196, 169, 144, 121, 80

(A) 80 (B) 121 (C) 169 (D) 196

**Sol.** (A) The sequence is  $(14)^2$ ,  $(13)^2$ ,  $(12)^2$ ,  $(11)^2$ ,  $(10)^2$ .

So, 80 is wrong and must be replaced by  $(10)^2$  i.e. 100.

**Ex.27** 3, 5, 7, 9, 11, 13

(A) 3 (B) 5 (C) 7 (D) 9

**Sol.** (D) The series consists of consecutive prime numbers. So, 9 is wrong.

**Ex.28** 121, 143, 165, 187, 210

(A) 143 (B) 165 (C) 210 (D) 187

**Sol.** (C) Each term of the series is increased by 22 to obtain the next term.

So, 186 is wrong and must be replaced by  $(187 + 22)$  i.e. 209.

**Ex.29** 1, 2, 4, 8, 16, 32, 64, 96

(A) 4 (B) 32 (C) 64 (D) 96

**Sol.** (D) Each term of the series is obtained by multiplying the preceding term by 2

So, 96 is wrong and must be replaced by  $(64 \times 2)$  i.e. 128.

## EXERCISE

**Direction : (Q.1 to Q.15) Find the missing term**

- Q.1** 3, 6, 5, 20, 7, 42, 9, ?  
(A) 54 (B) 60 (C) 66 (D) 72
- Q.2** 1, 3, 4, 8, 15, 27, ?  
(A) 37 (B) 44 (C) 50 (D) 55
- Q.3** 2, 15, 41, 80, ?  
(A) 111 (B) 120 (C) 121 (D) 132
- Q.4** 8, 10, 14, 18, ?, 34, 50, 66  
(A) 24 (B) 25 (C) 26 (D) 27
- Q.5** 1, 2, 6, 24, ?  
(A) 60 (B) 95 (C) 120 (D) 150
- Q.6** 2, 3, 8, 63, ?  
(A) 1038 (B) 1998 (C) 3008 (D) 3968
- Q.7** 95, 115.5, 138, ?, 189  
(A) 154.5 (B) 162.5 (C) 164.5 (D) 166.5
- Q.8** 4, 10, ?, 82, 244, 730  
(A) 24 (B) 28 (C) 77 (D) 218
- Q.9** 4, 32, 128, ?  
(A) 128 (B) 144 (C) 192 (D) 256
- Q.10** 2, 5, 9, 19, 37, ?  
(A) 76 (B) 75 (C) 74 (D) 72
- Q.11** 24, 60, 120, 210, ?  
(A) 300 (B) 336 (C) 420 (D) 525
- Q.12** 165, 195, 255, 285, 345, ?  
(A) 375 (B) 420 (C) 435 (D) 390
- Q.13** 5, 17, 37, 65, ?, 145  
(A) 95 (B) 97 (C) 99 (D) 101
- Q.14** 9, 11, 20, 31, ?, 82  
(A) 41 (B) 51 (C) 60 (D) 71
- Q.15** 5, 16, 49, 104, ?  
(A) 115 (B) 148 (C) 170 (D) 181

**Direction : (Q.16 to Q.30) Find the wrong term**

- Q.16** 196, 169, 144, 121, 101  
(A) 101 (B) 121 (C) 169 (D) 196
- Q.17** 3, 10, 27, 4, 16, 64, 5, 25, 125  
(A) 3 (B) 4 (C) 10 (D) 27
- Q.18** 36, 49, 81, 121, 169, 225  
(A) 36 (B) 49 (C) 169 (D) 225
- Q.19** 2, 5, 10, 17, 26, 37, 50, 64  
(A) 17 (B) 26 (C) 37 (D) 64
- Q.20** 5, 27, 61, 122, 213, 340, 509  
(A) 27 (B) 61 (C) 122 (D) 509
- Q.21** 121, 143, 165, 186, 209  
(A) 143 (B) 165 (C) 186 (D) 209
- Q.22** 16, 22, 30, 45, 52, 66  
(A) 30 (B) 45 (C) 52 (D) 66
- Q.23** 125, 126, 124, 127, 123, 129  
(A) 126 (B) 124 (C) 123 (D) 129
- Q.24** 105, 85, 60, 30, 0, -45, -90  
(A) 105 (B) 60 (C) 0 (D) -45
- Q.25** 380, 188, 92, 48, 20, 8, 2  
(A) 8 (B) 20 (C) 48 (D) 188
- Q.26** 89, 78, 86, 80, 85, 82, 83  
(A) 83 (B) 82 (C) 86 (D) 78
- Q.27** 15, 16, 22, 29, 45, 70  
(A) 16 (B) 22 (C) 45 (D) 70
- Q.28** 1, 2, 4, 8, 16, 32, 64, 96  
(A) 4 (B) 32 (C) 64 (D) 96
- Q.29** 24576, 6144, 1536, 386, 96, 24  
(A) 96 (B) 386 (C) 1536 (D) 6144
- Q.30** 6, 15, 35, 77, 165, 337  
(A) 35 (B) 77 (C) 165 (D) 221

## Definition

### What is a noun?

A noun is a part of speech that is used to name a person, place, thing, quality, or idea. A noun can function as a subject, object, complement, appositive, or object of a preposition.

## Classification of Nouns

### ◆ Proper Nouns

- Proper nouns are nouns that refer to specific entities.
- They refer to the name of a particular person, place, animal or thing.
- Writers of English capitalize proper nouns .
- Examples are *Nebraska, Steve, Harvard, White House* .

### ◆ Common Nouns

- Common nouns refer to general, unspecific categories of entities.
- Its a name given in common to every person or thing of the same class or kind.
- Whereas *Nebraska* is a proper noun because it signifies a specific state, the word *state* itself is a common noun because it can refer to any of the 50 states in the United States. *Harvard* refers to a particular institution of higher learning, while the common noun *university* can refer to any such institution.

### ◆ Material Nouns

- Material nouns refer to materials or substances from which things are made.
- While *cotton* is an adjective when used in *cotton dress*, *cotton* is a material noun when used to describe a crop being grown - The farm grew *cotton*.

### ◆ Collective Nouns

- A collective noun refers top a collection of people or things.
- A collective noun contains two or more persons, animals or things of a same kind joined together to make a single noun.
- Examples are :- a bouquet of flowers, a bunch of grapes, an army of soldiers etc.
- Consider the following sentences :-  
Look at the *gaggle* of geese. There used to be *herds* of wild buffalo on the prairie. A *bevy* of swans is swimming in the pond. A *colony* of ants live in the anthill.  
In the above examples, *gaggle, herds, bevy, and colony* are collective nouns.

### ◆ Abstract Nouns

- An abstract noun refers to a quality or state.
- Concepts like *freedom, love, power, and redemption* are all examples of abstract nouns.

They *hate* us for our *freedom*. All you need is *love*. We must fight the *power*.

In these sentences, the abstract nouns refer to concepts, ideas, philosophies, and other entities that cannot be concretely perceived.

## Countable & Uncountable Nouns

Here we will learn about countable and uncountable nouns but before we continue the lesson, look at the following chart and study the nouns.

Countable	Uncountable
books	money
friends	meat
teachers	juice
tables	milk

### ◆ Countable nouns

**Countable nouns** have a singular and a plural form. In plural, these nouns can be used with a number- they can be counted. (That's why they are called "countable nouns").

**Example:**

1 friend,            2 friends,            3 friends...  
1 book,              2 books,              3 books...

Countable nouns take *many*.

**Example:**

100 friends – *many* friends

### ◆ Uncountable nouns

**Uncountable nouns** can only be used in singular. These nouns cannot be used with a number- they can't be counted. (That's why they are called "uncountable nouns").

**Examples:**

I have a lot of money. (Not 1000 money)  
You say I drink a lot of milk. (Not 5 milk)

### ◆ Uncountable nouns take *much*.

**Example:**

100 money – *much* money

**Note:** Of course we can count money, milk, meat; but then we would use the currency, liter, kilo, glass:

- 5 euros or dollars... (but not 5 money).
- 2 liters, pints, glasses... of milk (but not 2 milk)
- 3 kilos... of meat (but not 3 meat)
- 10 bottles of mineral water... (but not 10 mineral water)

## Plurals

**English plural nouns:**

In order to change a singular noun to its plural form in English, we usually add "s". For example, the plural of *book* is *books*. The plural of *table* is *tables*. These are **regular plurals**.

But there are many nouns which don't follow this rule. For example the plural of *fish* is *fish*. The plural of *tooth* is *teeth*. These are **irregular plurals**.

**Regular plurals:**

**Form:**

Add "s" to the noun:

Noun + **S**

While many plural nouns follow this rule, the spelling sometimes differ.

**Examples:**

<b>Singular</b>	<b>Plural</b>
snake	snakes
window	windows
box	boxes
boy	boys
lorry	lorries
potato	potatoes
knife	knives

**Spelling of plurals:**

The plural form of most nouns is created simply by adding the letter "s".

- more than one snake = snakes
- more than one girl = girls
- more than one window = windows

Nouns that end in *-ch, x, s, z* or *s-like* sounds, however, will require an 'es' for the plural:

- more than one witch = witches
- more than one box = boxes
- more than one gas = gases
- more than one bus = buses
- more than one kiss = kisses

Nouns that end in a vowel + *y* take the letter **s**:

- more than one boy = boys
- more than one way = ways

Nouns that end in a consonant + *y* drop the *y* and take 'ies':

- more than one baby = babies
- more than one lorry = lorries

A lot of nouns that end in 'o' take 'es' in the plural:

- more than one potato = potatoes
- more than one hero = heroes

<b><i>o</i> becomes <i>oes</i></b>	
echo	echoes
embargo	embargoes
hero	heroes
potato	potatoes
tomato	tomatoes
torpedo	torpedoes
veto	vetoes

Some nouns ending in 'o' break the above rule and get 'os' in the plural form:

<b><i>o</i> becomes <i>os</i></b>	
auto	autos
kangaroo	kangaroos
kilo	kilos
memo	memos
photo	photos
piano	pianos
pimento	pimentos
pro	pros
solo	solos
soprano	sopranos
studio	studios
tattoo	tattoos
video	videos
zoo	zoos

Other nouns ending in 'o' get either 'os' or 'oes' in the plural forms:

<b><i>o</i> becomes <i>os</i> or <i>oes</i></b>	
buffalo	buffalos/buffaloes
cargo	cargos/cargoes
halo	halos/haloes
mosquito	mosquitos/mosquitoes
motto	mottos/mottoes
no	nos/noes
tornado	tornados/tornadoes
volcano	volcanos/volcanoes
zero	zeros/zeroes

Plurals of nouns that end in 'f' or 'fe' usually change the 'f' sound to a 'v' sound and add 's' or '-es.'

- more than one knife = knives
- more than one leaf = leaves
- more than one hoof = hooves

- more than one life = lives
- more than one self = selves
- more than one elf = elves

◆ **Irregular plurals**

There are several nouns that have irregular plural forms.

Singular	Plural
fish	fish
sheep	sheep
barracks	barracks
foot	feet
tooth	teeth
goose	geese
tooth	teeth
goose	geese
child	children
man	men
woman	women
person	people
mouse	mice

Plurals formed in this way are sometimes called *irregular plurals or mutated (or mutating) plurals*.

- more than one child = **children**
- more than one woman = **women**
- more than one man = **men**
- more than one person = **people**
- more than one goose = **geese**
- more than one mouse = **mice**
- more than one barracks = **barracks**
- more than one deer = **deer**

**Other irregular plural forms include the following:**

Some foreign nouns retain their plural. (Note that some of them adapted the *s* of the English plural form!)

	<i>Foreign plural</i>	<i>English plural</i>
alga	algae	
amoeba	amoebae	amoebas
antenna	antennae	antennas
formula	formulae	formulas
larva	larvae	
nebula	nebulae	nebulas
vertebra	vertebrae	

Nouns ending in 'us' get 'a', 'I' or the 's' of the English plural:

<i>Singular</i>	<i>Foreign plural</i>	<i>English plural</i>
corpus	corpora	
genus	genera	
alumnus	alumni	
bacillus	bacilli	
cactus	cacti	cactuses
focus	foci	
fungus	fungi	funguses
nucleus	nuclei	
octopus	octopi	octopuses
radius	radii	
stimulus	stimuli	
syllabus	syllabi	syllabuses
terminus	termini	

Nouns ending in 'um' get 'a', 'I' or the 's' of the English plural:

<i>Singular</i>	<i>Foreign plural</i>	<i>English plural</i>
addendum	addenda	
bacterium	bacteria	
curriculum	curricula	curriculumms
datum	data	
erratum	errata	
medium	media	
memorandum	memoranda	memorandums
ovum	ova	
stratum	strata	
symposium	symposia	symposiums

Nouns ending in 'ex' or 'ix' get 'ice's or get the 's' of the English plural:

<i>Singular</i>	<i>Foreign plural</i>	<i>English plural</i>
apex	apices	apexes
appendix	appendices	appendixes
cervix	cervices	cervixes
index	indices	indexes
matrix	matrices	matrixes
vortex	vortices	

Nouns ending in 'Is' becoming 'es' in plural :

<i>Singular</i>	<i>Plural form</i>
analysis	analyses
axis	axes
basis	bases
crisis	crises
diagnosis	diagnoses
emphasis	emphases
hypothesis	hypotheses
neurosis	neuroses
oasis	oases
parenthesis	parentheses
synopsis	synopses
thesis	theses

Nouns ending in 'on' becoming 'a' in plural :

<b>singular</b>	<b>plural</b>
criterion	criteria
phenomenon	phenomena
automaton	automata

### **Nouns that are always singular:**

A handful of nouns appear to be plural in form but take a singular verb:

- The **news** is bad.
- **Gymnastics** is fun to watch.
- **Economics/mathematics/statistics** is said to be difficult.

Some nouns never take the s of the plural and are always singular:

- Your **luggage / baggage** is so heavy.
- I'd like to buy new **furniture** for the house.
- You can find more **information** in our website.

## **Masculine and Feminine Nouns**

### ◆ **Grammatical gender**

Grammatical gender is a system of noun classification. A common gender classification includes masculine and feminine categories. Masculine nouns are words used for men, boys and male animals. Feminine nouns are words for women, girls and female animals.

**Masculine and feminine nouns :**

<i>Masculine</i>	<i>Feminine</i>
actor	actress
author	authoress
bachelor	spinster
boy	girl
bridegroom	bride
brother	sister
conductor	conductress
count	countess
czar	czarina
dad	mum
daddy	mummy
duke	duchess
man	woman
emperor	empress
father	mother
god	goddess
grandfather	grandmother
heir	heiress
hero	heroine
host	hostess
husband	wife
king	queen
man	woman
master	mistress
murderer	murderess
nephew	niece
poet	poetess
policeman	policewoman
prince	princess
sir	madam
son	daughter
uncle	aunt
wizard	witch
waiter	waitress

**Common gender nouns :**

Some nouns are used for both males and females. These nouns are referred to as *common gender nouns*.

**Examples**

- baby
- bird
- cat
- cattle

- child
- companion
- comrade
- cousin
- dancer
- deer
- friend
- guardian
- guest
- infant
- owner
- parent
- passenger
- pig
- president
- pupil
- relative
- sheep
- singer
- student
- swan
- teacher

### Animals

There is one general word for the animal. There are however many species of animals, particularly those domesticated, have been given specific names for the male and the female.

<i>animal</i>	<i>masculine</i>	<i>feminine</i>
<b>rabbit</b>	buck	doe
<b>horse</b>	stallion	mare
<b>sheep</b>	ram	ewe
<b>pig</b>	boar	sow
<b>chicken</b>	rooster	hen
<b>duck</b>	drake	duck
<b>cattle</b>	bull	cow
<b>goose</b>	gander	goose
<b>fox</b>	fox	vixen
<b>tiger</b>	tiger	tigress
<b>lion</b>	lion	lioness

## EXERCISE

### I. Find Common, Proper, Abstract, Material, Collective, Countable, Uncountable, Concrete Nouns from the following list.

- Which of the following noun is a Proper Noun?  
(A) singer (B) Peter (C) milk (D) sister
- Which of the following noun is a Common Noun?  
(A) birds (B) London (C) iron (D) India
- Which of the following noun is a Collective Noun?  
(A) team (B) book (C) marbles (D) ships
- Taj Mahal is a ..... Noun?  
(A) Proper (B) Abstract (C) Concrete (D) Countable
- Family is a ..... Noun?  
(A) Collective (B) Abstract (C) Concrete (D) Countable
- Which of the following noun is not an Abstract Noun?  
(A) goodness (B) bravery (C) family (D) childhood
- Which of the following noun is not a Countable Noun?  
(A) books (B) gold (C) horse (D) apple
- Which of the following noun is not a Proper Noun?  
(A) team (B) London (C) Monday (D) Nelson
- Birds fly in the sky -  
(A) Proper Noun (B) Common Noun (C) Abstract Noun (D) Collective Noun
- I saw a bunch of grapes-  
(A) Common Noun (B) Material Noun (C) Collective Noun (D) Abstract Noun

### II. Fill in the blanks in the following sentences with suitable collective nouns :

(good ness, bunch, iron, gallery, queen, school, hive, set, wood, horse, paper)

- I have lost a ..... of keys.
- There seems to be a plan behind this ..... of events.
- There is a large ..... of fish near the coast.
- Do not disturb that ..... of bees.
- There is a fine ..... of pictures in the palace.

**III. Fill in the blanks in the following sentences with Feminine forms of the words given at the end :**

(lass, niece, mare, baroness, spinster, heroine, priestess, heiress, hostess)

16. She is the ..... of the story. (hero)
17. The young ..... did not know what to say. (lad)
18. She remained a ..... all her life. (bachelor)
19. He bought a beautiful chestnut .....(horse)
20. The ..... wore a diamond necklace. (baron)

**IV. Fill in the blanks with the correct forms of the Plural of the words given at the end :**

21. She is the ..... of the story. (synopsis)
22. I saw many ..... on the underside of the leaf. (larva)
23. The building was six ..... high. (storey)
24. My two ..... have come to see me.(son-in-law)
25. He is good at telling funny ..... (story)

**V. Common Nouns Exercises: Name the professionals**

26. One who cuts hair is a
27. One who cures sick people is a
28. One who sells medicines and drugs is a
29. One who makes bread is a
30. One who operates on sick people is a
31. One who makes chairs and tables is a
32. One who sells tickets on a bus is a
33. One who cultivates the land is a

**Pronoun**

**Pronoun** is a word used instead of a Noun.

**e.g.** Look at Jack. He is studying. John and Mary have come to see him. They are glad to see him studying.  
He is also glad to see them.

The different kinds of Pronouns are as follows.

**(a) Personal Pronouns :**

They stand for three Persons :

**(i) First Person :**

- The Pronouns which refer to the person or persons speaking:

**e.g.** I, we, me, us, mine, ours.

**(ii) Second Person:**

- The pronouns which refer to the person or persons spoken to.

**e.g.** you, your, yours, thou, thee

**(iii) Third Person:**

- The pronouns which refer to the person or thing spoken of.

**e.g.** he, she, him, her, hers, they, them, theirs, it.

**(b) Reflexive or Emphatic Pronouns :**

**(i) Reflexive pronouns** act as Object to the Verb but they refer to the same persons as the Subject of the Verbs:

**e.g.** myself, ourselves, yourself, yourselves, himself, herself, itself and themselves.

- I blame **myself** for my failure.

We often talk to **ourselves**.

He hanged **himself**.

They always talk about **themselves**.

She put **herself** to trouble for nothing.

**(ii) Emphatic Pronouns** are used with a Noun or a Pronoun for the sake of emphasis :

**e.g.** I **myself** was present at the accident site.

You **yourself/yourselfs** must do the assignment.

She **herself** cooked food for the guests.

Boys, you **yourselves** should prepare your timetable.

He **himself** told me the story.

**(c) Demonstrative Pronouns :**

They are used to point out the object or objects for which they are used.

- **This & These** refer to things near at hand.

- **That & Those** refer to things lying at a distance.

**e.g.** **This** is my book. **That** is my house. **These** are your friends. **Those** are her friends.

(d) **Distributive Pronouns :**

It refers to a number of persons or things, one at a time. These pronouns are always singular and are always followed by a Verb in the singular.

- **Each, Either, Neither** are such pronouns.

e.g. **Each** student secured a reward. **Neither** of your answer is correct.

At **either** end of the road was a Park.

(e) **Interrogative Pronouns** are used for asking questions.

- **Who, Whom and Whose** are used for asking questions about things.

e.g. **Who** is calling you ?      **Whom** do you want to meet ?      **Whose** book is this ?

- **What** is used for asking questions about things.

e.g. **What** shall you do after graduation ?

- **Which** is used for asking a question about the particular person or thing.

e.g. **Which** is the most intelligent student in this class? (Person)

**Which** is the best book ? (Thing)

(f) **Reciprocal pronoun :**

They are pronouns that denote reciprocal or mutual action. They are :

- **Each other:** generally used when two persons or things are referred to.

e.g. Jack and Jill loved **each other**.

- **One another:** generally used when more than two persons or things are referred.

e.g. The people of India love **one another**.

(g) **Relative Pronoun :**

- The Pronouns 'Who, Whose, Whom, Which, That', which join two sentences and relate or refer to Nouns which have gone before are called Relative Pronouns.

- The Noun to which a Relative Pronoun refers or relates is called its Antecedent.

e.g. This is the boy **who** was punished.

In this example 'boy' is the Antecedent of 'who'.

## Use of Relative Pronouns

(i) **Who :**

- Used for persons only.

e.g. The man **who** is honest succeeds in his life.

The students **who** were lazy were punished.

They **who** live in glass houses should not throw stones at others.

The children **who** work hard always succeed.

(ii) **Whose:**

- It is the possessive case of 'Who'. It refers to persons but may also refer to things.

e.g. This is the question **whose** solution baffles me.

The school building **whose** roof was damaged, has now been repaired.

(iii) **Which:**

- Used for animals and for things without life.

e.g. These are the books **which** we purchased yesterday.

The horse **which** won the race is John's.

The things **which** we lost have been found.

**(iv) Whom :**

- Is used in formal written English. It is common to use ‘Who’ in place of ‘Whom’ in ordinary conversation.

**e.g.** The man **who (m)** the police caught was a dreaded terrorist.

The students **who (m)** we praised were good in their studies.

**Note:** ‘**whom**’ is often replaced by ‘That’ except after a preposition. The preposition may be placed at the end and ‘**that**’ used for ‘whom’.

**e.g.** That is the man about **whom** we were speaking.

That is the man **that** we were speaking about.

**(v) That :** Used for persons, animals and things.

- It may refer to singular or plural.

**e.g.** These are the boys **that** can be trusted.

This is the book **that** I want to buy.

This is the ring **that** I lost yesterday.

These are the only horses **that** neigh.

**Note :** ‘That’ is preferred to ‘who’ or ‘which’ though ‘who’ or ‘which’ can be equally used.

**e.g. a)** After the superlative degree of adjectives:

Ashoka was the best king **that** (= who) ruled in India.

This is the best book **that** (= which) I have read.

**b)** After the words ‘all, none, nothing, any, only, same’ etc.

All **that** (= which) glitters is not gold.

It is only you **that** (= who) can speak in such a way.

Nothing **that** (= which) we can do now will save him.

## Pronouns at a Glance

PERSON	Nominative or Subjective	Objective	Reflexive	Possessive & Vocative
FIRST	I We	Me Us	Myself Ourselves	My, Mine Our, Ours
SECOND	You	You	Yourself/ Yourselves	Your, Yours
THIRD	He She It They	Him Her It Them	Himself Herself Itself Themselves	His, His Her, Hers Its Their, Theirs

## EXERCISE

### I. Fill each blank with I, me, we or us

1. Did you ask David or \_\_\_\_\_ (I, me)
2. Sachin and \_\_\_\_\_ (I, me) went to the railway station.
3. Will you let John and \_\_\_\_\_ (I, me) go to the cinema?
4. Mother gave \_\_\_\_\_ (we, us) more mangoes than she gave to Antony and Rosy.
5. \_\_\_\_\_ (I, we) are going to the park.
6. Sit her between Rosy and \_\_\_\_\_ (I, me) .
7. My sister and \_\_\_\_\_ (I, me) had a nice dinner.
8. Between you and \_\_\_\_\_ (I, me) it is not true.

### II. Fill each blank with he, him, she, her they or them

9. Where is Diana? I want to see \_\_\_\_\_ (*she, her*)
10. I am younger than \_\_\_\_\_ . (*he, him*)
11. They sent for you and \_\_\_\_\_ (*she, her*)
12. Tell \_\_\_\_\_ (*they, them*) to go away.
13. I can play much better than \_\_\_\_\_ (*she, her*)
14. How do you know \_\_\_\_\_ (*they, them*) are Italians?

### II. Fill up the blanks in the following sentences with suitable relative pronouns (which or who) :

15. I like girls \_\_\_\_\_ speak the truth.
16. Where is the book \_\_\_\_\_ I gave you?
17. God helps those \_\_\_\_\_ help themselves.
18. I know the man \_\_\_\_\_ lives here.
19. I do not know the person \_\_\_\_\_ called me this morning.
20. The house in \_\_\_\_\_ we live is very old.