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3. Heat Transfer in Nature

1. INTRODUCTION

Heat is a form of energy. We know that energy means capacity to do work. So we can say, heat, being a form of energy, can do work. For example, when pressure cooker is heated, steam is formed within the cooker and this steam can lift the lid of the pressure cooker. In this chapter we shall study about the meaning of hot and cold and how things are heated or cooled.

2. MODES OF TRANSFER OF HEAT :

The materials which allow heat to pass through them easily are called conductor of heat. For example aluminium, iron, copper. The materials which do not allow heat to pass through them are poor conductors of heat called insulators. For example plastic wood.

There are three modes of heat transfer-

1. **Conduction of Heat:** Conduction is the flow of heat through a substance without the movement of the particles of the substance.

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.

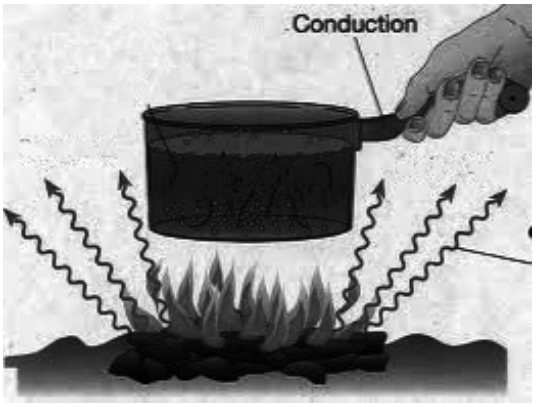
- **Types of conductors :**

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

Eg.: 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.

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



Eg. : 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.

2. Conductors and Insulators

Matrials that allow theat energy to pass through them easily are called conductors. Metals are good conductors of heat.

➢ **Applications of Insulator :**

(i) Handles of cooking utensils are made up of insulators so that we can hold them through the insulated handle which do not become hot even when the utensil is very hot.

(ii) We wear woollen clothes and use blankets in winter as they contain large amount of trapped air which is a bad conductor of heat and therefore does not allow heat energy to flow outward from our body. Thus, our body stops losing heat and we feel warm,

(iii) The gap between double walls of an ice box is filled with glass, wool, which is a bad conductor of heat. It prevents the heat from flowing in so that ice does not melt.

(iv) Hollow bricks are used in construction of houses that keep them warm in winters and cool in summer.. This happens becuase air that gets trapped in hollow bricks in a poor conductor of heat.

Let's know

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

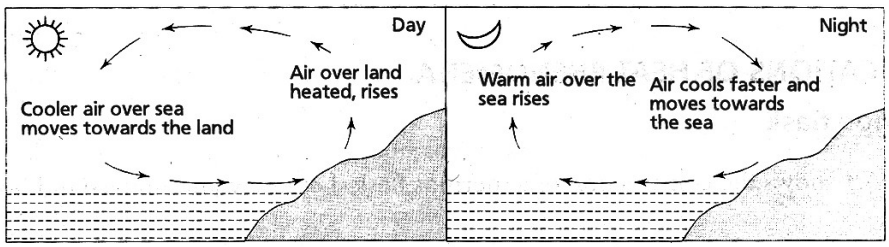
(b) Convection :

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.

(c) 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.

(i) 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 ($= 3 \times 10^8$ 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.

(ii) 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.

(iii) Applications of heat radiations :

(A) Roofs of factories are painted white or with aluminium 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.

Let's know

Can you think why ?

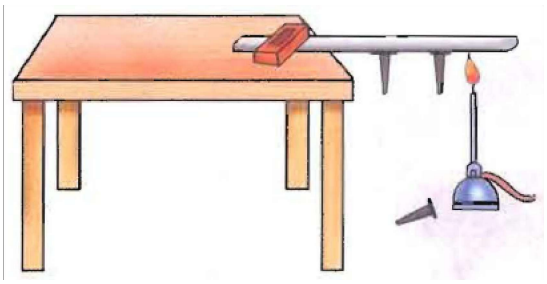
- Why heat does not transfer from one body to another body having same temperature?

EXTENDED LEARNING - ACTIVITES AND PROJECTS

1. To prove that heat travels in metals via conduction :

- Take an iron rod.
- Fix four iron nails on it with wax.
- Place the rod as shown in figure.
- Heat the free end of the rod with a candle.
- What do you observe?

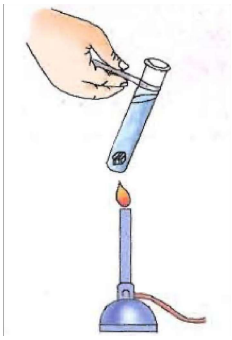
You will observe that the iron nail closest to the heated end of the rod falls as the wax melts. After some time, the second nearest nail falls and so on. From this activity, you can conclude that heat travels from one end to another through conduction.



Heat flow through a metal rod

2. To show that water is a bad conductor of heat :

- Take a test tube and half fill it with cold water.
- Wrap a piece of ice in a copper wire gauze and drop it in the test tube.
- You will observe that it sinks to the bottom.
- Now hold the top end of the test tube with a test tube holder and heat it over a flame.You will notice that the water soon begins to boil but the ice is still not fully melted .This is because heat has not been transferred through the molecules of water. Thus, water is a poor conductor of heat.

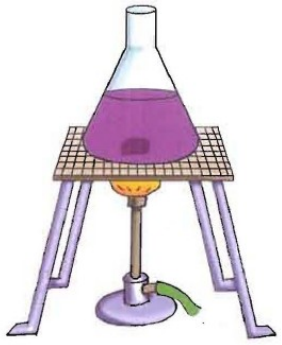


Water is a bad conductor of heat

3. To show that water transfers heat via convection :

- Take a conical flask and keep it on an iron stand.
- Fill it half with cold water.
- To it, add a large crystal of potassium permanganate.
- Heat it over a burner as shown is figure.
- What do you observe?

You will observe that when the crystal is dropped in water, some of it dissolves and gives pink colour to water. As the water near the crystal is heated, it becomes lighter and rises. The rising water is hot and its molecules vibrate fast. In this process, they strike the molecules of cold water which come in their way and transfer some of their energy to them . As a result, their vibrations are reduced and the rising water becomes cold. In the meantime, more hot water rises pushing the cold water towards the sides of the flask. From the sides cold water comes down. This shows that water transfers heat by the movement of molecules from hotter to colder regions through convection.



Heat transfer through convection in water

4. To show that air transfers heat via convection :

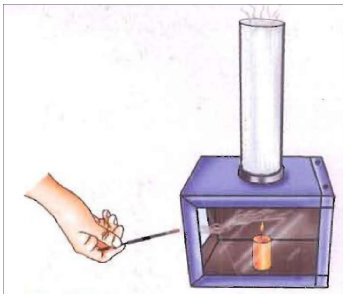
- Take a rectangular box with a glass front.
- Make a small window on one of its sides and a hole on its top .
- Fix a paper pipe into the hole at the top to form a chimney.
- Place a lighted candle in the box below the chimney.
- Keep your hand above the chimney.
- What do you observe?

You will observe that hot air is coming out of the chimney.

- Now hold a lighted incense stick near the window.
- What do you observe now?

You will notice that smoke of the incense stick enters the box through the window. It then gets heated by the candle and comes out of the chimney. This happens because air inside the box gets heated and becomes lighter. This lighter air starts rising. To replace this air, smoke from the incense stick issucked into the box. You will see that smoke moves towards the candle flame, gets heated and rises. Finally, it leaves the box through the chimney.

This shows that convection current is set up in the box.



Heat transfer through convection in air

5. To prove that black bodies absorb and radiate heat better than white bodies :

- Take two identical cold drink cans filled with equal amount of water.
- Paint one can black and the other white.
- Place a thermometer in each can with the bulb of the thermometer properly dipped in water.
- Now place both the cans at an equal distance from the room heater.
- Switch the heater on and let it remain on for 15 minutes.
- Observe the readings in the thermometers.

You will observe that the temperature reading in the thermometer placed in the black can is higher than the thermometer placed . in the white can . This is so because black surface is a better absorber of heat radiation than white surface.

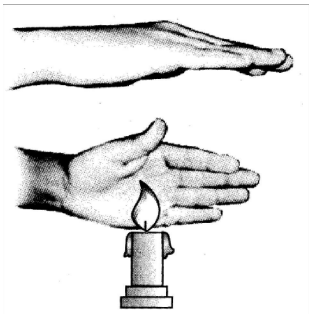
After switching off the heater, both the cans start emitting heat radiation to the surroundings.

- Leave them undisturbed for 10 minutes.
- Now check the readings in the thermometers . You will observe that the reading in the thermometer placed in the black can falls more rapidly than the thermometer placed in the white can. This is so because black surface is a better radiator of heat radiation than white surface.

Black bodies absorb and radiate more heat than white bodies.

Absorption of radiant heat by black and white cans

6. Light a candle. Keep one hand above the flame and one hand on the side of the flame (Fig.). Do your hands feel equally hot? If not which hand feels hotter? And why?



Transfer of heat by convection in air :

No. The hand above the flame feels hotter. This is because towards the top, the air gets heated by convection.

7. Go to a doctor or your nearest health centre. Observe the doctor taking temperature of patients. Enquire:

(a) why she dips the thermometer in a liquid before use.

(b) why the thermometer is kept under the tongue.

(c) whether the body temperature can be measured by keeping the thermometer at some place other than the mouth.

(d) whether the temperature of different parts of the body is the same or different.

You can add more questions which come to your mind.

(a) For disinfecting it.

(b) Thermometer is kept under the tongue because temperature under the tongue is near same as body temperature.

(c) Yes. Under the armpit.

(d) Differs slightly but average temperature is same.

8. Wrap a thin paper strip tightly around an iron rod. Try to burn the paper with candle while rotating the iron rod continuously. Does it burn? Explain your observation.

No, it does not burn. The iron being a good conductor of heat absorbs the heat supplied thus preventing the paper to attain ignition temperature.

9. Take a sheet of paper. Draw a spiral on it as shown in the Fig. Cut out the paper along the line. Suspend the paper as shown in Fig. above a lighted candle. Observe what happens. Think of an explanation.

Spiral ring of papers moves continuously. This may be due to the upward movement of hot air.

10. Take two similar transparent glass bottles having wide mouths. Put a few crystals of potassium permanganate or pour a few drops of ink in one bottle. Fill this bottle with hot water. Fill the other bottle with cold water. Cover the cold water bottle with a thick piece of paper such as a postcard. Press the postcard firmly with one hand and hold the bottle with the other hand. Invert the bottle and place it on top of the hot water bottle. Hold both the bottles firmly. Ask some other person to pull the postcard. Observe what happens. Explain.

In this activity hot water molecules move up to cold water. The process continues till the whole water gets uniformly coloured. Heat flows from a hot body to a cold body. Transfer of heat in liquid and gases is by the method of convection. Both liquids and gases are fluids.

6. WATER CYCLE

The water cycle is a continuous and natural process by which water circulates between the Earth's surface and the atmosphere. It is driven mainly by the Sun's heat and the force of gravity. During this cycle, water changes its physical state from liquid to vapour and back to liquid or solid, but the total quantity of water on Earth remains the same. Water from oceans, rivers, lakes, soil, and plants turns into water vapour due to heating, rises into the atmosphere, cools down to form clouds, and finally returns to the Earth in the form of rain, snow, or hail. This process not only supplies fresh water to land but also plays a vital role in regulating weather, climate, and supporting all forms of life on Earth.

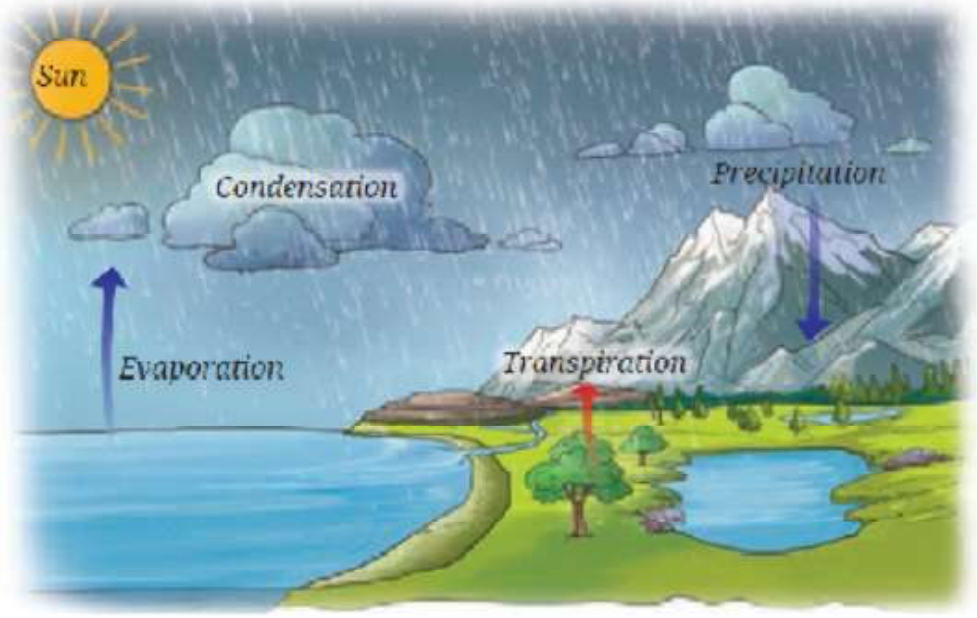


Fig. Water Cycle

Stages of the Water Cycle

- **Evaporation:**
  Evaporation occurs when heat from the Sun causes water present in oceans, rivers, lakes, ponds, and wet soil to change into water vapour. This process happens at temperatures below the boiling point of water and is faster on hot, dry, and windy days. Evaporation removes water from the Earth's surface and sends it into the atmosphere.
- **Transpiration:**
  Transpiration is the process by which plants release water vapour into the atmosphere through tiny openings in their leaves called stomata. Plants absorb water from the soil through their roots, and excess water is released as vapour. Evaporation and transpiration together are known as **evapotranspiration**.
- **Condensation:**
  As water vapour rises higher in the atmosphere, it cools due to lower temperatures at higher altitudes. This cooling causes the vapour to change back into tiny droplets of water or ice crystals. These droplets group together to form clouds, mist, or fog. Condensation is essential for cloud formation.
- **Precipitation:**
  When water droplets or ice crystals in clouds become too heavy to remain suspended in the air, they fall back to the Earth due to gravity. This falling of water is called precipitation and may occur as rain, snow, sleet, or hail depending on temperature conditions.
- **Collection (Accumulation):**
  After precipitation, water collects in oceans, seas, rivers, lakes, ponds, glaciers, and underground reservoirs. Some water also seeps into the soil and becomes groundwater. This stored water eventually evaporates again, restarting the water cycle.
- **Sublimation (Special Case):**
  In very cold and dry regions, snow or ice can change directly into water vapour without melting into liquid water. This process is called sublimation and is commonly observed on mountain peaks and polar regions.
- **Condensation:**
  Water vapour present in the atmosphere cools down at higher altitudes due to low temperatures. As a result, it changes into tiny droplets of water or ice crystals. These droplets combine to form clouds.
- **Precipitation:**
  When the condensed water droplets become large and heavy, they fall to the Earth due to gravity. This process is called precipitation. It may occur as rain, snow, sleet, or hail depending on temperature and air pressure conditions.
- **Infiltration:**
  A portion of rainwater seeps into the ground through soil and rocks. This process is called infiltration. The amount of water absorbed depends on the nature of the soil or rock. Infiltration helps in replenishing groundwater and maintaining the water table.
- **Runoff:**
  When rainwater does not seep into the ground, it flows over the land surface due to gravity. This flowing water moves downhill and eventually forms streams, rivers, and lakes. This process is known as runoff.
- **Formation of Ice Caps:**
  In colder regions, when snowfall occurs faster than melting or evaporation, snow accumulates and forms ice caps and glaciers. The largest ice caps on Earth are found near the polar regions.

Importance of the Water Cycle

- The water cycle plays a major role in regulating Earth's climate and temperature.
- It helps control global warming by providing a cooling effect through evaporation.
- The water cycle supports all life processes by supplying freshwater to plants, animals, and humans.
- It is closely connected with other natural cycles such as the carbon and nitrogen cycles.
- The water cycle helps in cleaning the atmosphere, as raindrops carry dust, smoke, bacteria, and pollutants down to the Earth.
- In polluted areas, rainwater absorbs harmful gases and particles, helping to purify the air.

Infiltration is the process by which rainwater or surface water moves downward through soil and rocks to replenish underground water reserves. This groundwater is an important source of freshwater and helps maintain wells, springs, and water supply during dry periods.

7. SEEPAGE OF WATER BENEATH THE EARTH

Not all rainwater flows into rivers or is used by plants; a large part of it slowly sinks into the ground through soil and rocks. This downward movement of water beneath the Earth's surface is called **seepage** or **infiltration**. The speed and amount of water that seeps underground depend on the type of soil or rock it passes through. This underground water is very important because it gets stored as groundwater and later helps in supplying water to wells, springs, rivers, and living organisms, thus maintaining the balance of water on Earth.

Fig. Aquifer

Key Points

- Seepage is the process by which rainwater sinks into the ground instead of flowing on the surface.
- It depends on the nature of soil or rocks; sandy soil allows faster seepage than clayey soil.
- Seepage helps in forming **groundwater**, which is stored beneath the Earth's surface.
- Groundwater replenishes rivers, lakes, and wells during dry seasons.
- It supports the survival of plants, animals, and humans by providing a continuous supply of water.
- Seepage helps keep the total amount of water on Earth nearly constant.

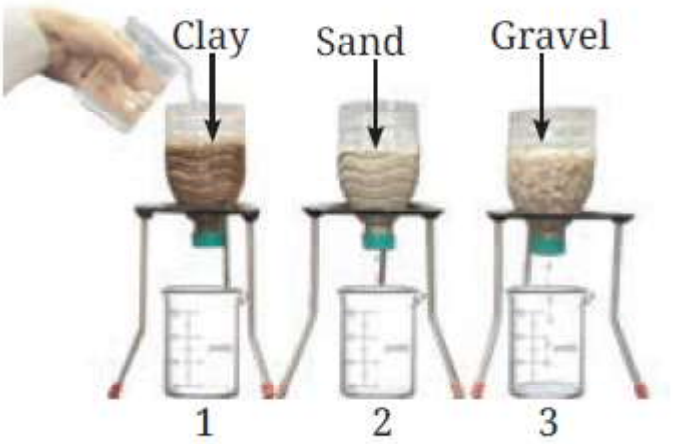
When rain falls on the land, not all of it flows into rivers or lakes. A significant portion of rainwater slowly moves downward through the pores, cracks, and spaces present in soil and rocks. This process is called **seepage** or **infiltration**. As water seeps deeper, it gets stored in underground layers of rock and soil that can hold water. These water-holding underground layers are known as **aquifers**. Aquifers store groundwater, which can later be drawn out using wells and hand pumps, making seepage an important process for maintaining freshwater supply.

Key Points

- Seepage (infiltration) is the downward movement of rainwater into the ground.
- Water seeps through **pores and cracks** in soil and rocks.
- **Gravel** has large gaps, so water seeps **fastest** through it.
- **Sand** has smaller gaps, so water seeps **more slowly**.
- **Clay** has very tiny gaps and is tightly packed, so water seeps **slowest** through it.
- Underground layers that store seeped water are called **aquifers**.
- **Wells** draw water from aquifers for human use.
- Seepage helps recharge groundwater and supports rivers, plants, animals, and humans.

➢ **ACTIVITY**

AIM : To investigate how water seeps (infiltrates) through different materials : clay, sand and gravel.



An activity to compare the flow of water through clay, sand and gravel

- ❖ Take three transparent, used plastic bottles of 1 L capacity.
- ❖ Cut them in the middle and make a small hole in the cap of each bottle.
- ❖ Keep them inverted and put some clay in one bottle, sand in the second, and gravel in the third, as shown in Figure.
- ❖ Place three identical beakers below each bottle.
- ❖ Add 200 mL of water to each bottle.
- ❖ Predict the amount of water fl owing out of each bottle.
- ❖ Collect the water that fl ows through each bottle for 10 minutes.
- ❖ Compare the amount of water that comes through each bottle.

Observation Table :

Bottles filled with	**Prediction (Seepage rate)**	**Observation (Seepage rate)**
Clay (Bottle 1)	Very Slow	Very slow
Sand (Bottle 2)	Slow	Slow
Gravel (Bottle 3)	Fast	Fast

8. GROUNDWATER USE AND ICE STUPAS

Groundwater is an important source of water for drinking, farming, and daily needs, and people obtain it by digging wells and drilling bore wells. However, groundwater is not unlimited. Rapid population growth, excessive extraction, increased concrete surfaces, and reduced vegetation have decreased natural water infiltration into the ground. To overcome this problem, methods such as rainwater harvesting and recharge pits are used to replenish groundwater. In cold desert regions like **Ladakh**, where water is scarce in summer, people have developed a unique traditional method called **Ice Stupas** to store water during winter and use it later.

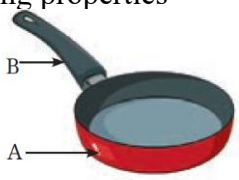
Key Points

- Groundwater is obtained by **digging wells** and **drilling bore wells**.
- This water becomes part of the **groundwater**, which people use for drinking, farming, and daily needs.
- Groundwater resources are **limited** and can get depleted due to overuse.
- **Concrete surfaces** and **less vegetation** reduce water infiltration into the soil.
- **Rainwater harvesting** and **recharge pits** help replenish groundwater.
- In **Ladakh**, water is difficult to find during summers due to freezing winters.
- To solve this, people build **Ice Stupas** in winter.
- Ice stupas are **cone-shaped ice towers**.
- They **store water in frozen form during winter**.
- In summer, ice stupas **melt slowly**, releasing water for farming and use.
- Ice stupas are an excellent example of **traditional knowledge combined with modern science** to conserve water.

EXERCISE-I NCERT Essentials

Q.1 Choose the correct option in each case.

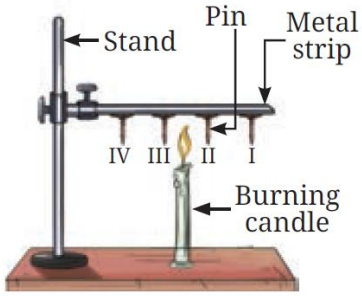
(i) Your father bought a saucepan made of two different materials, A and B, as shown in Fig. The materials A and B have the following properties —



Saucepan

(a) Both A and B are good conductors of heat
(b) Both A and B are poor conductors of heat
(c) A is a good conductor and B is a poor conductor of heat
(d) A is a poor conductor and B is a good conductor of heat

(ii) Pins are stuck to a metal strip with wax and a burning candle is kept below the rod, as shown in Fig. Which of the following will happen?



Heat transfer set-up

(a) All the pins will fall almost at the same time
(b) Pins I and II will fall earlier than pins III and IV
(c) Pins I and II will fall later than pins III and IV
(d) Pins II and III will fall almost at the same time

(iii) A smoke detector is a device that detects smoke and sounds an alarm. Suppose you are fitting a smoke detector in your room. The most suitable place for this device will be:

(a) Near the floor
(b) In the middle of a wall
(c) On the ceiling
(d) Anywhere in the room

Q.2 A shopkeeper serves you cold *lassi* in a tumbler. By chance, the tumbler had a small leak. You were given another tumbler by the shopkeeper to put the leaky tumbler in it. Will this arrangement help to keep the *lassi* cold for a longer time? Explain.

Q.3 State with reason(s) whether the following statements are True [T] or False [F].

(i) Heat transfer takes place in solids through convection.
(ii) Heat transfer through convection takes place by the actual movement of particles.
(iii) Areas with clay materials allow more seepage of water than those with sandy materials.
(iv) The movement of cooler air from land to sea is called land breeze.

Q.4 Some ice cubes placed in a dish melt into water after sometime. Where do the ice cubes get heat for this transformation?

Q.5 A burning incense stick is fixed, pointing downwards. In which direction would the smoke from the incense stick move? Show the movement of smoke with a diagram.

Q.6 Two test tubes with water are heated by a candle flame as shown in Fig. Which thermometers (Fig. (a) or Fig. (b) will record a higher temperature? Explain.

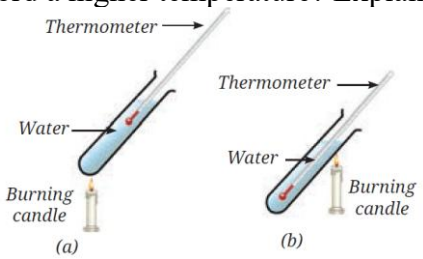


Fig. : Two thermometers dipped in two test tubes

Q.7 Why are hollow bricks used to construct the outer walls of houses in hot regions?

Q.8 Explain how large water bodies prevent extreme temperature in areas around them.

Q.9 Explain how water seeps through the surface of the Earth and gets stored as groundwater.

Q.10 The water cycle helps in the redistribution and replenishment of water on the Earth. Justify the statement.

EXERCISE-II Brain Booster MCQs

Q.1 Materials that allow heat to pass through them easily are called:
(A) Insulators
(B) Poor conductors
(C) Good conductors
(D) Non-metals

Q.2 Heat transfer in liquids and gases takes place mainly by:
(A) Conduction
(B) Convection
(C) Radiation
(D) Reflection

Q.3 During day time, the direction of sea breeze is:
(A) From sea to land
(B) From land to sea
(C) No specific direction
(D) Upward only

Q.4 The underground layers that store water are called:
(A) Water table
(B) Aquifers
(C) Reservoirs
(D) Wells

Q.5 The process of surface water seeping through soil and rocks is called:
(A) Percolation
(B) Infiltration
(C) Precipitation
(D) Transpiration

Q.6 The continuous movement of water in nature is called:
(A) Water flow
(B) Water current
(C) Water cycle
(D) Water stream

Q.7 Clay pots keep water cool because clay is:
(A) Good conductor
(B) Poor conductor
(C) Transparent
(D) Smooth

Q.8 The traditional room heater used in Himalayan regions is called:
(A) Bukhari (B) Angithi
(C) Chulha (D) Sigri

Q.9 Hollow bricks are used in construction because:
(A) They are cheaper
(B) Air trapped in them acts as insulator
(C) They are lighter
(D) All of these

Q.10 The water that falls from clouds is called:
(A) Evaporation
(B) Condensation
(C) Precipitation
(D) Transpiration

Q.11 In the water cycle, water vapor in atmosphere comes from:
(A) Only evaporation
(B) Only transpiration
(C) Both evaporation and transpiration
(D) Only precipitation

Q.12 Varahamihira was famous for predicting:
(A) Earthquakes
(B) Seasonal rainfall
(C) Temperature
(D) Wind patterns

Q.13 Smoke from incense stick rises because:
(A) It is lighter than air
(B) Wind blows it up
(C) It is hot and less dense
(D) It is pulled upward

Q.14 The process by which plants lose water is:
(A) Evaporation
(B) Transpiration
(C) Condensation
(D) Precipitation

Q.15 Heat transfer by radiation can occur in:
(A) Solids only
(B) Liquids only
(C) Gases only
(D) Vacuum also

Q.16 During night, the land becomes:
(A) Warmer than sea
(B) Cooler than sea
(C) Same temperature as sea
(D) Very hot

Q.17 Conduction occurs mainly in:
(A) Solids (B) Liquids
(C) Gases (D) Vacuum

Q.18 Water seeps slowest through:
(A) Gravel
(B) Sand
(C) Clay
(D) All same

Q.19 Heat from a candle flame reaches us by:
(A) Conduction only
(B) Convection only
(C) Radiation only
(D) All three methods

Q.20 Dark colored clothes are preferred in winter because they:
(A) Look good
(B) Absorb more heat
(C) Reflect heat
(D) Are warmer material

Q.21 Convection currents are formed due to:
(A) Density differences
(B) Color differences
(C) Size differences
(D) Shape differences

Q.22 Air is a:
(A) Good conductor
(B) Poor conductor
(C) Perfect conductor
(D) Variable conductor

Q.23 Houses in Uttarkashi have walls with:
(A) Only wood
(B) Only mud
(C) Two wooden layers with mud between
(D) Only concrete

Q.24 Gangtok is located in:
(A) Kerala
(B) Sikkim
(C) Uttarakhand
(D) Ladakh

Q.25 The pins in the metal strip experiment are attached using:
(A) Glue
(B) Tape
(C) Wax
(D) Clips

EXERCISE-III Concept Check

TRUE/FALSE QUESTIONS

Q.1 Radiation requires a medium for heat transfer. (True/False)

Q.2 Ice stupas are made in Kerala. (True/False)

Q.3 Aquifers store groundwater. (True/False)

Q.4 Hollow bricks are poor insulators. (True/False)

Q.5 Clay pots keep water warm. (True/False)

Q.6 Good conductors have handles made of metals. (True/False)

FILL IN THE BLANKS

Q.1 Heat from the Sun reaches Earth through _____.

Q.2 The underground layers that store water are called _____.

Q.3 Plants lose water through _____.

Q.4 Ice stupas are made in _____.

Q.5 The spaces between _____ particles are wider than clay.

Q.6 Handles of cooking utensils are made of _____ conductors.

ASSERTION & REASON

Instructions: Each question has an Assertion (A) and a Reason (R). Choose the correct option:

(A) Both A and R are true, and R is the correct explanation of A

(B) Both A and R are true, but R is not the correct explanation of A

(C) A is true, but R is false

(D) A is false, but R is true

Q.1 **Assertion (A):** Sea breeze occurs during the day. **Reason (R):** Land heats up faster than water.

Q.2 **Assertion (A):** Hot air rises upward. **Reason (R):** Hot air is less dense than cold air.

Q.3 **Assertion (A):** Clay pots keep water cool. **Reason (R):** Clay is a poor conductor of heat.

Q.4 **Assertion (A):** Two thin blankets are warmer than one thick blanket. **Reason (R):** Air trapped between blankets acts as insulator.

Q.5 **Assertion (A):** Handles of cooking utensils are made of wood or plastic. **Reason (R):** Wood and plastic are poor conductors.

CASE STUDY

Case Study 1: Sea and Land Breezes in Kerala

Palden visited Kerala during winter vacation and noticed that during the day, a cool breeze blew from the sea towards the land. However, at night, he felt the wind direction had reversed, now blowing from land towards the sea.

Q.1 What is the name of the breeze that blows from sea to land during day?

Q.2 Why does sea breeze occur during the day?

Q.3 What happens at night regarding wind direction?

Q.4 Which heats up faster - land or water?

Case Study 2: Water Seepage Experiment

Students performed an experiment using three bottles filled with clay, sand, and gravel respectively. They poured equal amounts of water and observed the rate of seepage.

Q.5 Through which material will water seep fastest?

Q.6 Why does water seep fastest through gravel?

Q.7 Which material will have slowest water seepage?

Q.8 How does this experiment relate to groundwater formation?

Case Study 3: Ice Stupa in Ladakh

During spring in Ladakh, streams dry up causing water scarcity. Local people channel mountain stream water through underground pipes and spray it into cold air, where it freezes to form ice stupas.

Q.9 Why are ice stupas made during winter?

Q.10 How does the sprayed water freeze?

Q.11 How do ice stupas help during spring?

Q.12 What happens to the ice stupa during summer?

MATCH THE COLUMNS

Q.1 Match the column

Column A		Column B	
(i)	Aquifers	(a)	Water seeping through soil
(ii)	Infiltration	(b)	Underground water storage layers
(iii)	Groundwater	(c)	Water stored in pore spaces

(A) (i)–(b), (ii)–(a), (iii)–(c)
(B) (i)–(a), (ii)–(b), (iii)–(c)
(C) (i)–(c), (ii)–(a), (iii)–(b)
(D) (i)–(b), (ii)–(c), (iii)–(a)

Q.2 Match the column

Column A		Column B	
(i)	Fireplace to people	(a)	Radiation
(ii)	Heated water in pot	(b)	Conduction
(iii)	Flame to metal utensil	(c)	Convection

(A) (i)–(a), (ii)–(b), (iii)–(c)
(B) (i)–(b), (ii)–(a), (iii)–(c)
(C) (i)–(c), (ii)–(b), (iii)–(a)
(D) (i)–(a), (ii)–(c), (iii)–(b)

Q.3 Match the column

Column A		Column B	
(i)	Evaporation	(a)	Water vapor forming clouds
(ii)	Condensation	(b)	Water changing to vapor
(iii)	Precipitation	(c)	Rain, snow and hail falling

(A) (i)–(a), (ii)–(b), (iii)–(c)
(B) (i)–(b), (ii)–(a), (iii)–(c)
(C) (i)–(c), (ii)–(a), (iii)–(b)
(D) (i)–(b), (ii)–(c), (iii)–(a)

Q.4 Match the column

Column A		Column B	
(i)	Conduction	(a)	Heat transfer without medium
(ii)	Convection	(b)	Heat transfer through direct contact
(iii)	Radiation	(c)	Heat transfer by movement of particles

(A) (i)–(c), (ii)–(a), (iii)–(b)
(B) (i)–(a), (ii)–(b), (iii)–(c)
(C) (i)–(b), (ii)–(c), (iii)–(a)
(D) (i)–(b), (ii)–(a), (iii)–(c)

EXERCISE-IV Subjective Assessment

SHORT QUESTION

Q.1 What is convection? Give an example.

Q.2 Explain sea breeze.

Q.3 Define infiltration.

Q.4 Why are hollow bricks used in house construction?

Q.5 What happens when potassium permanganate is heated in water?

Q.6 Why should smoke detectors be placed on the ceiling?

Q.7 Why does land heat up faster than water?

Q.8 Why does smoke from incense stick rise up?

Q.9 How do large water bodies affect nearby climate?

Q.10 Why is concrete bad for groundwater recharge?

LONG ANSWER

Q.1 Describe the formation of sea breeze and land breeze with diagrams and explanations.

Q.2 Discuss groundwater, its formation, importance, and conservation methods.

Q.3 Describe various practical experiments to demonstrate the three types of heat transfer.

Q.4 Discuss the applications of heat transfer principles in cooking and food preservation.

Q.5 Describe how understanding heat transfer helps in energy conservation and sustainable living.

ANSWER KEY

EXERCISE-II

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

EXERCISE-III

TRUE/FALSE QUESTIONS

Q.1	False	**Q.3**	True	**Q.5**	False
Q.2	False	**Q.4**	False	**Q.6**	False

FILL IN THE BLANKS

Q.1	radiation**.**	**Q.3**	transpiration**.**	**Q.5**	sand
Q.2	aquifers**.**	**Q.4**	Ladakh**.**	**Q.6**	poor

ASSERTION & REASON

Q.1	(A)	**Q.2**	(A)	**Q.3**	(B)	**Q.4**	(A)	**Q.5**	(A)

CASE STUDY

Q.1 **Sea breeze**

Q.2 During the day, **land heats up faster than water**. Warm air over land rises, and **cool air from the sea moves towards land** to replace it.

Q.3 At night, the wind blows **from land to sea**, called **land breeze**.

Q.4 **Land heats up faster than water**.

Q.5 **Gravel**

Q.6 Gravel has **large spaces between particles**, allowing water to pass quickly.

Q.7 **Clay**

Q.8 It shows how **water seeps through soil and rocks** to form **groundwater stored in aquifers**.

Q.9 Because **temperatures are very low**, allowing water to freeze easily.

Q.10 When water is sprayed into **cold air**, it **loses heat and freezes**.

Q.11 They **melt slowly**, providing **water for drinking and irrigation**.

Q.12 The ice stupa **melts completely**, releasing stored water.

MATCH THE COLUMNS

Q.1	(A)	**Q.2**	(D)	**Q.3**	(B)	**Q.4**	(C)

1. Exploring Substances Acidic, Basic and Neutral

1. INTRODUCTION

We all know that everything around us is composed of matter. Matter is composed of one or more than one type of substances. All substances can be classified as pure and impure substances. **Pure substances** include elements and compounds and have constant properties throughout the sample. **Impure substances** are mixture, obtained by combining two or more substances together without any change in their chemical properties.

2. ELEMENTS

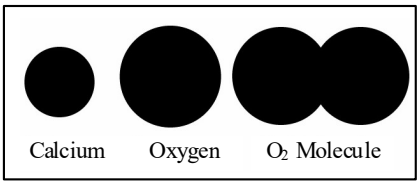
Elements are the simplest form of pure substances and is made up of only one kind of atoms. It can not be chemically changed into simpler substances by chemical process.

E.g.: Gold(Au), Silver(Ag), Mercury(Hg), Sulphur(S) etc.

3. ATOM

It is the smallest unit of an element that shows all the properties of that element. Some atoms are capable of independent existence while others are found in combination with atoms of same element or different atoms.

E.g.: Ca (Calcium) exists freely but an atom of oxygen can't exist freely and joins with another oxygen atom to form O_2 molecule.



4. SYMBOL

To avoid writing full names of elements every time while writing equations, International Union of Pure and Applied Chemistry (IUPAC) gave specific symbols for element representation, hence it is accepted as the standard symbol throughout the world. Every element has it's own symbol to represent it's atom.

➢ **Writing symbols of element :**

(i). Some elements are represented by the first letter of the alphabets of their names.

E.g.:

Carbon	–	C	
Nitrogen	–	N	
Oxygen	–	O	
Fluorine	–	F	

(ii). However, there are more than one element whose name begin with the same letter, then only one of the elements is represented by the 1st letter of its name.

E.g.: S – Sulphur
Si – Silicon

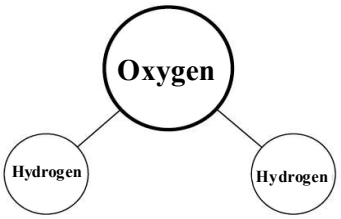
(iii). Symbols of some elements are derived from its name in other language.

E.g.: Latin name of Copper is Cuprum and its symbol is Cu.
Latin name of Potassium is Kalium and its symbol is K.

5. MOLECULE

A group of two and more atoms of the same element or different elements held together by chemical forces and which is capable of independence existence is known as molecule.

E.g.: HCl is compound made of two elements - Hydrogen and Chlorine.
Similarly water is made up of two elements - Hydrogen and Oxygen.



H_2O Molecule

6. COMPOUND

Whenever two or more different atoms or molecules combine in a definite ratio by mass with each other, they form a compound.

E.g.: CO_2 is a compound made up of 1 carbon atom and an oxygen molecule (2 oxygen atom).

Note: All molecules are compound but all compounds are not molecule.

E.g.: H_2O is a molecule made up of hydrogen and oxygen atom.

7. FORMULAE

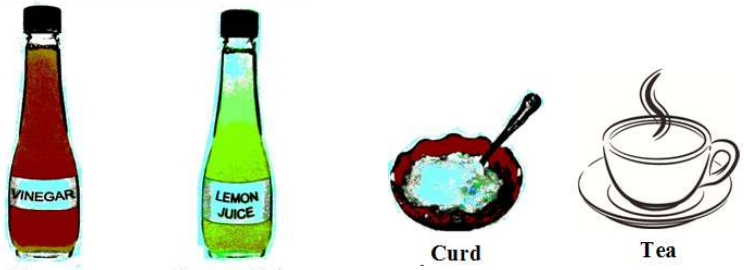
Just like atom is represented by a symbol, similarly a molecule or a compound is also represented using a formula. It also tells us about the number of atoms present in a molecule of the compound.

➢ **Steps to write formulae :**

1. Write symbols of the elements present in the molecule side by side.
2. Write the number of atoms of each atom in the molecule of the compound below the symbol of that element as a subscript.
   E.g.: Ammonia contains Nitrogen and Hydrogen. Number of nitrogen atom is one and hydrogen atom is three. So the formula for the ammonia is NH_3.

8. ACIDS

The term acid is derived from the Latin word acidus meaning sour. Lemons, oranges and grapes taste sour because they contain citric acid. Tamarind and vinegar contain tartaric acid and acetic acid respectively.



Vinegar Lemon Juice Curd Tea

Definition :

"An acid is defined as a substance which gives H^+ ions on dissolution in water."

e.g.

$$\underset{\text{hydrochloric acid}}{HCl} \xrightarrow{\text{Water}} H^+ + Cl^-$$

$$\underset{\text{acetic acid}}{CH_3COOH} \xrightarrow{\text{Water}} CH_3COO^- + H^+$$

Nitric acid (HNO_3), Phosphoric acid (H_3PO_4) , formic acid (HCOOH) etc. have one and sulphuric acid (H_2SO_4) has two replaceable hydrogen atom, thus they are acids.

Let's know

Vitamin C which is very important for our body is also an organic acid known as ascorbic acid.

➢ **Examples of some important acids and their sources :**

S.No.	Name acid	Substances in which its is found
1.	Acetic acid	Vinegar
2.	Ascorbic acid (Vitamin C)	Amla, citrus fruits
3.	Citric acid	Citrus fruits such as lemon and orange
4.	Formic acid	Ant's sting or Bee's sting
5.	Lactic acid	Sour milk, curd
6.	Hydrochloric acid	Gastric juice (present in the stomach)
7.	Malic acid	Apple
8.	Oxalic acid	Spinach
9.	Tannic acid	Tea
10.	Tartaric acid	Tamarind (imli), grapes, raw mango

8.1 Classification of Acids:

(a) On the basis of occurrence:

(i) Mineral acids : Acids which are obtained from the minerals present in earth's crust are called mineral acids.

e.g. HCl, H_2SO_4, HNO_3 etc.

(ii) Organic acids : Acids that are found in animals and plants are known as organic acids.

e.g. Lactic acid , citric acid, tartaric acid, acetic acid and formic acid.

(b) On the basis of strength:

(i) Strong Acids : Acids, which almost completely ionise (break up into ions) in water, are called strong acids.

e.g. Hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3) etc.

$$HCl + Water \longrightarrow H^+(aq) + Cl^-(aq)$$

$$H_2SO_4 + Water \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

(ii) Weak Acids:

Acids, which partially ionise in water, are called weak acids.

e.g. Carbonic acid (H_2CO_3), phosphoric acid (H_3PO_4), formic acid (HCOOH), acetic acid (CH_3COOH).

$CH_3COOH + Water \longrightarrow CH_3COO^-(aq) + H^+(aq)$ (Partially ionised)

Let's know

- The sharp pain caused by the sting of ants and bees is due to formic acid, which they push into the body or spray on the skin.
- Acids like conc. H_2SO_4 and conc. HNO_3 are corrosive in nature. They destroy organic matter like clothes, paper, wood and cause burn to human skin.
- In general mineral acids are strong while organic acids are weak.

(c) On the basis of concentration :

(i) Concentrated acid : The acid containing very less amount of water is called concentrated acid. HCl is prepared by dissolving HCl gas in water. The solution of this acid is called conc. HCl.

(ii) Dilute acid : The acid containing excess amount of water is called dilute acid. Strength can be decreased by dissolving the acid in more water. In a laboratory, we generally use either concentrated acid or it's solution diluted to a definite strength.

Let's know

Dilution of acids :

It is always desirable to add acid to water, keeping the solution continuously stirred, while preparing dilute solutions of acids, specially mineral acids. We should always slowly add acid to water; otherwise, so much heat is produced during the dilution process that the container, specially that of glass, may break. The hot contents may also cause an explosion and spill on our clothes and body. This may result into serious acid burns.

(d) On the basis of basicity :

(i) Monobasic Acids : When one molecule of an acid on complete ionisation produces one hydronium ion (H_3O^+) in aqueous solution, the acid is said to be a monobasic acid.

Examples of Monobasic Acids.

Some examples of monobasic acids are :

(i) Hydrochloric acid (HCl) **(ii)** Hydrobromic acid (HBr)

(iii) Nitric acid (HNO_3) **(iv)** Acetic acid (CH_3COOH)

(v) Formic acid (HCOOH)

(ii) Dibasic Acids :

When one molecule of an acid on complete ionisation produces two hydronium ions (H_3O^+) in aqueous solution, the acid is said to be a dibasic acid.

Examples of Dibasic Acids :

Some examples of dibasic acids are :

(i) Sulphuric acid (H_2SO_4) **(ii)** Sulphurous acid (H_2SO_3)

(iii) Carbonic acid (H_2CO_3) **(iv)** Oxalic acid [$(COOH)_2$]

(v) Hydrofluoric acid (HF)

(iii) Tribasic Acids :

When one molecule of an acid on complete ionisation produces three hydronium ions (H_3O^+) in aqueous solution, the acid is said to be a tribasic acid.

An example of tribasic acids is Phosphoric acid (H_3PO_4).

(iv) Tetrabasic Acids :

When one molecule of an acid on complete ionisation produces four hydronium ions (H_3O^+) in aqueous solution, the acid is said to be a tetrabasic acid.

An example of tetrabasic acids is silicic acid (H_4SiO_4)

Let's know

The atmosphere of Venus is made up of thick white and yellow clouds of Oil of Vitriol (H_2SO_4). (e

8.2 Properties of Acids

Acids are substances that show certain common characteristics when dissolved in water. They usually have a sour taste and can change the colour of indicators like litmus and methyl orange. Acids are corrosive in nature, meaning they can damage materials such as metals, clothes, skin, and paper. A key feature of acids is that they contain hydrogen, which is responsible for many of their chemical properties.

Key Points:

- Acids are **sour in taste**.
- Acids turn **blue litmus paper red**.
- Acids change **methyl orange to reddish-pink** colour.
- Acids are **corrosive** and can destroy clothes, skin, and paper.
- All acids **contain hydrogen**.

8.3 Uses of Acids

Acids are widely used in our daily life as well as in industries. Different acids serve different purposes such as cleaning, manufacturing, food preservation, and preparation of useful products. Some acids are used in batteries and fertilizers, while others are used in food items to enhance flavour or act as preservatives. Acids are also important for digestion, as hydrochloric acid is naturally present in our stomach.

Key Points:

- **Hydrochloric acid** is used for cleaning sinks and sanitary wares and as a bleaching agent in the textile industry.
- **Sulphuric acid** and **nitric acid** are used in the manufacture of fertilizers, paints, explosives, etc.
- **Sulphuric acid** is used in batteries for cars and inverters.
- **Acetic acid (vinegar)** containing about 5%–8% acetic acid is used for food preservation, such as in pickles, and for enhancing food flavour.
- **Citric acid** is commonly used as an ingredient in cosmetics.
- **Tartaric acid** is used in making baking powder by mixing it with baking soda.

9. ACID RAIN

Rain that contains an excess of acids is called **acid rain**. Rainwater becomes acidic when gases like carbon dioxide, sulphur dioxide, and nitrogen dioxide released into the air mix with water droplets in clouds. These gases dissolve in rainwater to form **carbonic acid, sulphuric acid, and nitric acid**. When this acidic rain falls on the Earth, it causes serious damage to buildings, historical monuments, plants, animals, and soil.

Key Points:

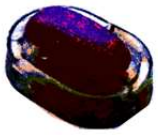
- Acid rain is formed due to the presence of **carbon dioxide (CO,)**, **sulphur dioxide (SO,)**, and **nitrogen dioxide (NO,)** in the air.
- **Carbon dioxide** dissolves in rainwater to form **carbonic acid**.
- **Sulphur dioxide** forms **sulphuric acid** in rainwater.
- **Nitrogen dioxide** forms **nitric acid** in rainwater.
- Acid rain damages **buildings and historical monuments** by corroding stone and marble.
- It harms **plants and animals** and reduces soil fertility.

10. BASES

These chemical substances are bitter in taste and soapy to touch . The chemical nature of such substances is basic.

Milk of magnesia


Window cleaner


Soap

Definition :

A base is a compound which gives hydroxyl group (OH^-) on dissolution in water are known as bases.

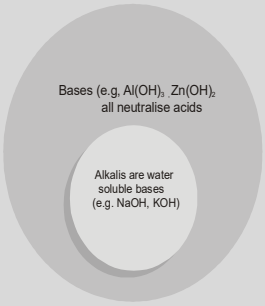
e.g.

Sodium hydroxide	NaOH
Calcium hydroxide	$Ca(OH)_2$
Aluminium hydroxide	$Al(OH)_3$

Let's know

Alkalis :

Bases which dissolves in water are called alkalis. e.g. KOH, NaOH.
All alkalis are bases but all bases are not alkalis. e.g. $Al(OH)_3$ is a base, but not an alkali.



➢ **Examples of some important bases and their uses :**

S.N.	Chemical Name	Commercial Name	Chemical Formula	Uses
1.	Sodium hydroxide	Caustic soda	NaOH	In manufacturing of soap, paper pulp,rayon, refining of petroleum etc.
2.	Potassium hydroxide	Caustic potash	KOH	In alkaline storage batteries, manufacture of soap, absorbing CO_2 gas etc.
3.	Calcium hydroxide	Slaked lime	$Ca(OH)_2$	In manufacture of bleaching powder, softening of hard water etc.
4.	Magnesium hydroxide	Milk of magnesia	$Mg(OH)_2$	As an antacid to remove acidity from stomach.
5.	Aluminium hydroxide	–	$Al(OH)_3$	As foaming agent in fire extinguishers.
6.	Ammonium hydroxide	–	NH_4OH	In removing grease stains from clothes and in cleaning window panes.

Let's know

- Sodium carbonate (Na_2CO_3) is commonly called Washing soda.
- Sodium bicarbonate($NaHCO_3$) is commonly called baking soda.
- CaO is used to neutralize acidic nature of soil.
- $Ca(OH)_2$ is used to prepare mortar, bleaching powder and to neutralize acid in water supplies.
- KOH (caustic potash) is used to conduct electricity between two electrodes.
- Both NaOH and KOH are deliquescent in nature which means that they absorb moisture from air.

10.1 Classification of Bases :

(A) On the basis of strength :

(i) Strong Bases : Bases which are almost completely dissociated in water are known as strong bases.

e.g. Sodium hydroxide (NaOH), potassium hydroxide (KOH), barium hydroxide $Ba(OH)_2$ etc .

$$NaOH(s) + Water \longrightarrow Na^+(aq) + OH^-(aq)$$

$$KOH(s) + Water \longrightarrow K^+(aq) + OH^-(aq)$$

(ii) Weak Bases : Bases which dissolve in water only slightly and produce a low concentration of hydroxide ions are called weak bases.

e.g. Ammonium hydroxide (NH_4OH), silver hydroxide (AgOH) etc.

(B) On the Basis of their Concentration :

By the term concentration, we mean the amount of water present in the given sample of alkali solution in water. On the basis of concentration, the alkalis can be classified as under :

(i) Concentrated alkali : A solution of alkali having a relatively high percentage of alkali in its aqueous solution is known as concentrated alkali.

(ii) Dilute alkali : A solution of alkali having a relatively low percentage of alkali in its aqueous solution is known as a dilute alkali.

If the concentration of alkali in the solution is less than 1 mole per litre, then it is considered to be a dilute alkali.

(C) On the Basis of their Acidity :

The number of hydroxide (OH^-) ions produced by one molecule of an alkali on complete dissociation in water or the number of hydrogen ions (of an acid) with which a molecule of that alkali reacts to produce salt and water only is known as acidity of an alkali.

For water insoluble hydroxides, acidity of the base is equal to the number of OH^- ions present in one molecule of that base.

On the basis of acidity, the bases can be classified as under :

(i) Monoacidic Bases (or alkalis) :

OR

A monoacidic base (or alkali) may be defined as one whose one molecule reacts with one hydrogen (H^+) ion completely to form salt and water as the only products.

Examples of Monoacidic Bases (or alkalis) :

Sodium hydroxide (NaOH), Potassium hydroxide (KOH), Ammonium hydroxide (NH_4OH). All these substances produce only one hydroxyl ion on complete ionisation in aqueous solution.

$$NaOH(aq.) \longrightarrow Na^+(aq) + OH^-(aq)$$

$$KOH(aq.) \longrightarrow K^+(aq) + OH^-(aq)$$

The dissociation of monoacidic bases or alkalis takes place in a single step.

(ii) Diacidic Bases (or alkalis) :

When one molecule of a base or alkali on complete ionisation produces two hydroxide (OH^-) ions in aqueous solution, the base or alkali is said to be diacidic.

Examples of Diacidic Bases

$Ca(OH)_2(aq) \longrightarrow Ca^{2+}(aq) + 2OH^-(aq)$
Calcium hydroxide
$Mg(OH)_2(aq) \longrightarrow Mg^{2+}(aq) + 2OH^-(aq)$
Magnesium hydroxide

One molecule of both the bases are producing $2OH^-$ ions in aqueous solution, therefore, these are termed as diacidic bases .

(iii) Triacidic Bases :

When one molecule of a base or alkali on complete ionisation produces three hydroxide (OH^-) ions in aqueous solution, the base or alkali is said to be triacidic base.

Examples of Triacidic Bases :

$Al(OH)_3(aq) \longrightarrow Al^{3+}(aq) + 3OH^-(aq)$
Aluminium hydroxide

$Al(OH)_3 + 3HCl(aq) \longrightarrow AlCl_3 + 3H_2O$

In the above equations, one molecule of $Al(OH)_3$ is producing three OH^- ions and one molecule of $Al(OH)_3$ is reacting with three hydrogen (H^+) ions to form salt and water only, therefore, it is termed as a triacidic base.

10.2 Properties of Bases

Bases are substances that show characteristic physical and chemical properties which help us identify them easily. They generally have a bitter taste and feel soapy when touched. Bases change the colour of indicators in a specific way, which helps distinguish them from acids. These properties are commonly used in laboratories as well as in everyday life to recognise basic substances.

Key Points:

- Bases are **bitter in taste**.
- They are **soapy or slippery to touch**.
- All bases **turn red litmus paper blue**.

10.3 Uses of Bases

Bases are widely used in our daily life as well as in industries. They are useful in cleaning agents, medicines, manufacturing processes and even in agriculture. Different bases have different applications depending on their chemical nature and strength. These uses make bases very important substances in science and everyday activities.

Keu Points:

- **Calcium hydroxide (slaked lime)** is used in whitewashing, neutralisation of acidic soil, making bleaching powder and softening hard water.
- **Magnesium hydroxide** (milk of magnesia) is used as an **antacid** to reduce acidity in the stomach.
- **Sodium hydroxide** (caustic soda) is used in the manufacture of **soaps, paper and textiles**.
- **Aluminium hydroxide** is used as a **foaming agent in fire extinguishers**.
- **Ammonium hydroxide** is used in **household cleaners** and in **fertilisers**.
- **Sodium carbonate**, along with sulphuric acid, is used in **fire extinguishers**.

11. INDICATORS

It is not possible to taste each and every substance to identify its chemical nature and also, it may be dangerous to touch each and every substance.

To overcome this problem, special types of substances called indicators are used to get to know the chemical nature of substances.

An indicator is a substance which indicates the nature of particular solution whether acidic, basic or neutral. Hence they indicate the change in nature of the solution from acidic to basic and vice versa. Indicators are basically coloured organic substances.

11.1 Different types of indicators :

(A) Litmus : Litmus is a purple dye which is extracted from a plant 'lichen'. It can also be applied on paper in the form of strips and is available as blue and red strips.

(i) A blue litmus strip, when dipped in an acid solution acquires red colour. Similarly a red strip when dipped in a base solution becomes blue.

(B) Also, in case of some substances like water, alcohol, oxygen, salt and sugar solution, the colour of red as well as blue litmus remain unchanged. Such substances called as Neutral substances.

Lichen (a plant)

Red and blue litmus papers

➢ **ACTIVITY–1**

Aim : To test the chemical nature of a few substances.

- Collect lemon juice, lime water, tap water, washing soda solution, milk of magnesia, and sugar solution in separate test tubes.
- With the help of dropper, one by one, put a drop of each solution on separate red and blue litmus papers.
- Record your observations in Table.

Observation and Conclusion :

S.N.	Solution	Effect on red litmus paper	Effect on blue litmus paper	Chemical nature
1.	Lemon juice	Red	Red	Acidic
2.	Lime water	Blue	Blue	Basic
3.	Tap water	No change	No change	Neutral
4.	Washing soda solution	Blue	Blue	Basic
5.	Milk of magnesia	Blue	Blue	Basic
6.	Sugar solution	No change	No change	Neutral

(ii) Phenolphthalein : It is also an organic dye. In neutral or acidic solution, it remains colourless while in the basic solution, the colour of indicator changes to pink.

(iii) Methyl Orange : Methyl orange is an orange coloured dye and keeps this colour in the neutral or basic medium. In the acidic medium the colour of indicator becomes red.

(iv) **Red Cabbage Juice :** It is purple in colour in neutral medium and turns red or pink in the acidic medium. In the basic or alkaline medium, its colour changes to green.

(v) **Turmeric juice :** Turmeric is commonly used as kitchen ingredient , is a natural indicator. It is yellow in colour and remains as such in the neutral and acidic medium. In the basic medium its colour becomes reddish or deep brown.

(vi) **China Rose :** Indicator from China rose can be made by keeping the rose petals in warm water for sometime. After some time, the solution become pink. This solution is used as indicator. It becomes magenta in acidic and turns green in basic solution.

China Rose

➢ **ACTIVITY–2**

Aim : To test the nature of different sbstances using temeric as an indicator.

Method :

- Make turmeric paste in a bowl
- Now leave it to dry for 15-20 minutes.
- cut thin strips of yellow turmeric paper
- Collect lemon juice, lime water, tap water, washing soda solution, milk of magnesia and sugar solution in separate test tubes
- With the help of dropper, one by one, put a drop of each solution on the thin strip of yellow turmeric paper.
- Record your observation in Table

Observation and Conclusion: :

S.N.	Solution	Effect on Yellow turmeric paper	Chemical nature
1.	Lemon juice	Yellow	Acidic
2.	Lime water	Reddish brown	Basic
3.	Tap water	Yellow	Neutral
4.	Washing soda solution	Reddish brown	Basic
5.	Milk of magnesia	Reddish brown	Basic
6.	Sugar solution	Yellow	Neutral

Colour of indicators in acidic and basic medium

S.N.	Indicator	Colour in acidic medium	Colour in basic medium
1.	Blue litmus	Red	Blue
2.	Red litmus	Red	Blue
3.	Turmeric	Yellow	Raddish-brown
4.	China rose	Dark pink(magenta)	Green
5.	Methyl orange	Red	Orange
6.	Phenolphthalein	Colourless	Pink

➢ **ACTIVITY–3**

Aim : To observer the effect of various indicators on acidic and basic solution

Method :

- Collect 5 mL each of dilute sulphuric acid, dilute sodium hydroxide, dilute hydrochloric acid, dilute potassium hydroxide, dilute nitric acid, dilute ammonium hydroxide and dilute calcium hydroxide in separate test tubes.
- One by one test the acidic or basic nature of each of the sample solutions with blue litmus paper, red litmus paper, phenolphthalein, methyl orange, China rose and turmeric indicators.
- Record your observation in Table

Observation and Conclusion :

S. N.	Sample	Effect on blue litmus paper	Effect on red litmus paper	Effect on phenolph-thalein	Effect on methyl orange	Effect on China rose	Effect on turmeric
1.	Dilute sulphuric acid	red	red	colourless	red	dark pink	yellow
2.	Dilute sodium hydroxide	blue	blue	pink	orange	green	reddish brown
3.	Dilute hydrochloric acid	red	red	colourless	red	dark pink	yellow
4.	Dilute potassium hydroxide	blue	blue	pink	orange	green	reddish brown
5.	Dilute nitric acid	red	red	colourless	orange	dark pink	yellow
6.	Dilute ammonium hydroxide	blue	blue	pink	orange	green	reddish brown
7.	Dilute calcium hydroxide	blue	blue	pink	orange	green	reddish brown

12. NEUTRALISATION

The reaction between an acid and a base is known as **neutralisation.** Salt and water are produced in this process with the evolution of heat. Evolved heat is known as **heat of neutralisation .**

Acid + Base $\longrightarrow$ Salt + Water

e.g.

$HCl + NaOH \longrightarrow NaCl + H_2O + 57.1\ kJ$

Hydrochloric acid — Sodium hydroxide — Sodium chloride — water

Where 57.1kJ energy is the heat of neutralisation for above reaction. This value remains same if both acid and base are strong. If one out of these is weak then amount of energy released will be lesser than 57.1 kJ

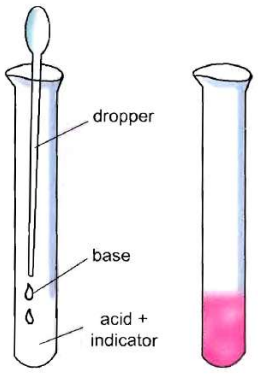
➢ **ACTIVITY–4**

Aim : To observe the neutralization reaction.

Method :

- Take a test tube and fill it one-fourth with dilute hydrochloric acid (HCl).
- With the help of a dropper, add 2–3 drops of phenolphthalein indicator (colourless) to it.
- Gently shake the test tube.
- Note down its colour.

Observation : you will observe that the solution is colourless.



Neutralization reaction

- Now put a drop of dilute sodium hydroxide with the help of a dropper and shake it gently.
- Continue adding dilute sodium hydroxide and shaking it till the pink colour just appears.
- At this point, the solution is just neutral.
- Add a drop of dilute hydrochloric acid to it
- What do you observe now ?
- You will notice that the pink colour disappears.
- Again add a drop of dilute sodium hydroxide.
- You will notice that the pink colour reappears.
- This happens because phenolphthalein is colourless in an acidic medium and pink in a basic medium.

Conclusion : Drop by drop addition of dilute sodium hydroxide neutralizes dilute hydrochloric acid.

12.1 Neutralisation in everyday life:

(i) **Indigestion :** People particularly of old age suffer from acidity problems in the stomach which is caused mainly due to release of excessive gastric juices containing HCl. The acidity is neutralised by antacid tablets which contain sodium hydrogen carbonate (baking soda, $NaHCO_3$), magnesium hydroxide (milk of magnesia, $Mg(OH)_2$) etc.

Note : Antacid is medicine that neutralises acid formed in the stomach.

(ii) **Ant and bee sting :** The stings of bees and ants contain formic acid. Its corrosive and poisonous effect can be neutralised by rubbing soap which contains NaOH (an alkali) or by rubbing baking soda ($NaHCO_3$) or by calamine solution ($ZnCO_3$).

The stings of wasps contain an alkali and its poisonous effect can be neutralised by an acid like acetic acid (present in vinegar).

Ant sting

Bee sting

(iii) **Soil treatment :** Excessive use of chemical fertilisers makes the soil acidic. Plants do not grow well when the soil is either too acidic or too basic. When the soil is too acidic, it is treated with bases like *quick lime* (CaO) or *slaked lime* $Ca(OH)_2$. If the soil is basic, organic matter is added to neutralize the basic nature of soil.

(iv) **Factory wastes :** The wastes of many factories contain acids. If they are allowed to flow into the water bodies, the acids will kill fish and other organisms. The factory wastes are, therefore, neutralised by adding basic substances.

SUMMARY

- **Atom :** The smallest particle of an element that takes part in a chemical reaction is an atom.
- **Element :** Element is the basic constituent of all matter.
- **Chemical Compound :** A substance whose each molecule contains two or more atoms of different elements in a fixed ratio is a chemical compound.
- **Acid :** The substance which contains hydrogen and produces H^+ ions in aquesous solution is called Acid. Acids are sour in taste.
- **Base:** The substance which produces OH^- ions in aqueous solution is called the chemical substances which are bitter in taste and soapy base touch.
- **Alkalis :** Bases which dissolves in water are called alkalis.
- **Neutralisation :** The reaction between an acid and a base is known as neutralisation.
- **Antacid :** It is a medicine that neutralize acid formed in the stomach.
- Litmus, turmeric and china rose petal are naturally occurring indicators, while methyl orange and phenolphthalein are prepared in laboratories.
- On the basis of chemical nature, all chemical substances are broadly classified as acidic, basic and neutral substances.
- **Acid Rain :** When pollutent like sulphur dioxide and nitrogen oxides dissolve in rain water, it forms an acid. The rain of that acid is called acid rain.

EXERCISE-I NCERT Essentials

Q.1 A solution turns the red litmus paper to blue. Excess addition of which of the following solution would reverse the change?
(i) Lime water
(ii) Baking soda
(iii) Vinegar
(iv) Common salt solution

Q.2 You are provided with three unknown solutions labelled A, B, and C, but you do not know which of these are acidic, basic, or neutral. Upon adding a few drops of red litmus solution to solution A, it turns blue. When a few drops of turmeric solution are added to solution B, it turns red. Finally, after adding a few drops of red rose extract to solution C, it turns green.
Based on the observations, which of the following is the correct sequence for the nature of solutions A, B, and C?
(i) Acidic, acidic, and acidic
(ii) Neutral, basic, and basic
(iii) Basic, basic, and acidic
(iv) Basic, basic, and basic

Q.3 Observe and analyse Figs. 2.13, 2.14, and 2.15, in which red rose extract paper strips are used. Label the nature of solutions present in each of the containers.


Fig. 2.13


Fig. 2.14


Fig. 2.15

Q.4 A liquid sample from the laboratory was tested using various indicators:

Indicator	Red litmus	Blue litmus	Turmeric
Change	No change	Turned red	No change in colour

Based on the tests, identify the acidic or basic nature of the liquid and justify your answer.

Q.5 Manya is blindfolded. She is given two unknown solutions to test and determine whether they are acidic or basic. Which indicator should Manya use to test the solutions and why?

Q.6 Could you suggest various materials which can be used for writing the message on the white sheet of paper (given at the beginning of the chapter) and what could be in the spray bottle? Make a table of various possible combinations and the colour of the writing obtained.

Q.7 Grape juice was mixed with red rose extract; the mixture got a tint of red colour. What will happen if baking soda is added to this mixture? Justify your answer.

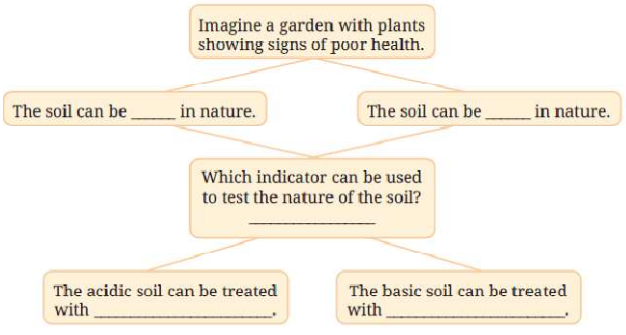
Q.8 Keerthi wrote a secret message to her grandmother on her birthday using orange juice. Can you assist her grandmother in revealing the message? Which indicator would you use to make it visible?

Q.9 How can natural indicators be prepared? Explain by giving an example.

Q.10 Three liquids are given to you. One is vinegar, another is a baking soda solution, and the third is a sugar solution. Can you identify them only using turmeric paper? Explain.

Q.11 The extract of red rose turns the liquid X to green. What will the nature of liquid X be? What will happen when excess of *amla* juice is added to liquid X?

Q.12 Observe and analyse the information given in the following fl owchart. Complete the missing information.



EXERCISE-II

Brain Booster MCQs

MCQ BASED QUESTIONS:

Q.1 Lime water is -
(A) dilute solution of $Ca(OH)_2$
(B) $Mg(OH)_2$ solution
(C) NaOH solution
(D) KOH solution

Q.2 Which of the following is a base and not an alkali ?
(A) NaOH (B) KOH
(C) $Fe(OH)_3$ (D) None of these

Q.3 Nature of aqueous solution of Ammonia is -
(A) acidic (B) basic
(C) neutral (D) None of these

Q.4 Neutralization reaction is an example of -
(A) Exothermic reaction
(B) Endothermic reaction
(C) Oxidation
(D) None of these

Q.5 An indicator that turns reddish brown when dissolved in soap solution is -
(A) litmus (B) china rose
(C) turmeric powder (D) None of these

Q.6 Which of the following is not an indicator ?
(A) Methyl orange (B) Litmus
(C) China rose (D) Sunflower

Q.7 Which of the following is a strong acid ?
(A) Acetic acid (B) Citric acid
(C) Nitric acid (D) Tartaric acid

Q.8 Acetic acid is used -
(A) as soda water
(B) for preparing soaps
(C) in flavouring food items
(D) to manufacture detergents.

Q.9 The acid present in lemon is -
(A) citric acid (B) oxalic acid
(C) acetic acid (D) hydrochloric acid

Q.10 ..... is known as ascorbic acid which is present in citrus fruits.
(A) Vitamin D (B) Vitamin C
(C) Vitamin A (D) Vitamin K

Q.11 When a drop of phenolphthalein is introduced in lime water, the solution turns.
(A) blue (B) red
(C) milky (D) pink

Q.12 Acids are ---------- in taste while bases are ---------- in taste.
(A) sweet, salty (B) sweet, sour
(C) sour, salty (D) sour, bitter

Q.13 A base which dissolves in water is called -
(A) a soluble base (B) an alkali
(C) an acid (D) an oxide

Q.14 Choose the correct statement (s)
(i) Most of the acids are water soluble.
(ii) Acids react with metallic oxides and hydroxides form metallic salt and water only.
(iii) Acids react with metallic carbonates to form metallic salt and hydrogen gas and water.
(iv) Acetic acid is used as a food preservative.
(A) (i) & (ii) only (B) (iii) & (iv)
(C) (i), (ii) & (iv) (D) All the above

Q.15 Acidic soil which is not good for healthy growth of plants , is neutralized by
(A) potassium hydroxide (KOH)
(B) calcium oxide (CaO)
(C) sodium hydroxide (NaOH)
(D) magnesium hydroxide ($Mg(OH)_2$)

Q.16 The acid present in our stomach which helps in digestion of food -
(A) sulphuric acid (H_2SO_4)
(B) nitric acid (HNO_3)
(C) hydrochloric acid (HCl)
(D) phosphoric acid (H_3PO_4)

Q.17 When turmeric stain on white clothes is washed with soap it turns red in colour because -
(A) soap solution is acidic
(B) soap solution is neutral
(C) soap solution is basic
(D) both (A) and (B)

Q.18 When magnesium oxide (MgO) react with water to form magnesium hydroxide [$Mg(OH)_2$], a base, it turns _____ litmus to _____ .
(A) blue, red
(B) blue, colourless
(C) red, blue
(D) colourless, blue

Q.19 Which of the following is the outcome of a neutralisation reaction ?
(A) A solution (B) Salt
(C) A mixture
(D) A acid and bose mixture

Q.20 Which of the following indicatirs are typically found as strips ?
(A) China rose
(B) Turmeric
(C) Litrnus
(D) All of the above

Q.21 What color does red litmus paper turn in basic solutions?
(A) Red (B) Blue
(C) Green (D) Purple

Q.22 Which of the following is an acidic substance?
(A) Soap solution (B) Lime water
(C) Lemon juice (D) Baking soda

Q.23 Substances that are neither acidic nor basic are called:
(A) Indicators (B) Neutral
(C) Salts (D) Bases

Q.24 Which acid is present in lemon?
(A) Acetic acid (B) Citric acid
(C) Tartaric acid (D) Formic acid

Q.25 Which acid is present in vinegar?
(A) Citric acid (B) Acetic acid
(C) Lactic acid (D) Oxalic acid

Q.26 The process by which an acid and base cancel each other's effect is called:
(A) Oxidation (B) Reduction
(C) Neutralization (D) Precipitation

Q.27 Lime water is chemically known as:
(A) Calcium oxide solution
(B) Calcium hydroxide solution
(C) Calcium carbonate solution
(D) Calcium chloride solution

Q.28 Which of the following can be used as a natural indicator?
(A) Turmeric (B) Red rose petals
(C) Red hibiscus (D) All of the above

Q.29 Hydrangea flowers are:
(A) Always blue
(B) Always pink
(C) Color depends on soil nature
(D) Always white

Q.30 Olfactory indicators work based on:
(A) Color change
(B) Taste change
(C) Odor change
(D) Temperature change

Q.31 Onion can be used as:
(A) Visual indicator
(B) Olfactory indicator
(C) Taste indicator
(D) Temperature indicator

Q.32 P.C. Ray is known as:
(A) Father of Indian Chemistry
(B) Father of Modern Indian Chemistry
(C) Father of Organic Chemistry
(D) Father of Physical Chemistry

Q.33 Litmus paper is available in:
(A) Only blue color
(B) Only red color
(C) Both blue and red colors
(D) Multiple colors

Q.34 During neutralization, heat is:
(A) Absorbed (B) Released
(C) Neither absorbed nor released
(D) Sometimes absorbed, sometimes released

Q.35 Purple cabbage can be used as:
(A) Food only (B) Indicator only
(C) Both food and indicator
(D) Medicine only

Q.36 Beetroot can act as:
(A) Acid (B) Base
(C) Indicator
(D) Neutral substance

Q.37 Indian blackberry (jamun) can be used as:
(A) Acid (B) Base
(C) Indicator
(D) Neutral substance

Q.38 Filter paper is used in turmeric indicator preparation for:
(A) Cleaning (B) Drying
(C) Absorbing turmeric paste
(D) Storage

Q.39 Tap water is generally:
(A) Acidic (B) Basic
(C) Neutral
(D) Varies with source

Q.40 Mortar and pestle are used for:
(A) Measuring (B) Heating
(C) Crushing (D) Filtering

Q.41 Test tubes are arranged in:
(A) Test tube stand (B) Beaker
(C) Flask (D) Petri dish

EXERCISE-III Concept Check

TRUE / FALSE :

Q.1 Bases turn blue litmus red. [ ]

Q.2 Phenolphthalein is colourless in basic medium. [ ]

Q.3 If soil is too acidic, quicklime is added to it. [ ]

Q.4 Sulphuric acid is present in the stomach. [ ]

Q.5 China rose has different colour in acidic, basic and neutral medium. [ ]

Q.6 Nitric acid turns red litmus blue. [ ]

Q.7 Sodium hydroxide and hydrochloric acid neutralize each other and form salt and water.

Q.8 Indicator is a substance which shows different colors in acidic and basic solutions. [ ]

Q.9 Tooth decay is caused by the presence of a base. [ ]

Q.10 Sulphuric acid is known as a strong acid. [ ]

FILL IN THE BLANKS :

Q.1 When acid and base react, _____ and _____are formed.

Q.2 China rose _____ in acidic medium and _____ in basic medium.

Q.3 _____ are used to test acidic and basic nature of solution.

Q.4 Calamine solution contains_____

Q.5 _____ indicator is redish-brown in basic medium.

Q.6 Acids do not show acidic behavior in absence of water because …….. dissociates from an acid only in in presence of water.

Q.7 …….. base is also used in cooking.

Q.8 …….. gas is usually liberated when an acid reacts with a metal.

Q.9 Aqueous solution of sodium chloride (NaCl) is known as …….. .

Q.10 water molecules present in salt is known as …….. .

ASSERTION & REASON:

Instructions: Choose the correct option:

(A) Both assertion and reason are true, and reason is the correct explanation of assertion

(B) Both assertion and reason are true, but reason is not the correct explanation of assertion

(C) Assertion is true, but reason is false

(D) Assertion is false, but reason is true

Q.1 **Assertion:** Salt solution is neutral. **Reason:** Salt solution does not change litmus color.

Q.2 **Assertion:** Ant bite is treated with baking soda.
Reason: Ant bite injects acidic liquid.

Q.3 **Assertion:** Vinegar contains acetic acid. **Reason:** All liquids contain some acid.

Q.4 **Assertion:** Curd is acidic in nature. **Reason:** Curd contains lactic acid.

Q.5 **Assertion:** All edible acids taste sour. **Reason:** Sourness is a characteristic property of acids.

CASE STUDY :

Case Study 1: The Garden Problem

A farmer noticed that his plants were not growing well despite proper watering and fertilization. Soil testing revealed that excessive use of chemical fertilizers had made the soil acidic. The agricultural department suggested using lime to treat the soil.

Q.1 Why were the plants not growing well in acidic soil?

Q.2 How does lime help in treating acidic soil?

Q.3 What would happen if the soil was basic instead? How would it be treated?

Q.4 Name the chemical process involved in soil treatment.

Q.5 What indicators could be used to test soil nature?

Case Study 2: The Ant Bite Incident

During a picnic, Ravi was bitten by red ants and experienced stinging pain. His friend applied moist baking soda to the affected area, which provided immediate relief from the pain.

Q.6 What causes the stinging pain in ant bites?

Q.7 Why does baking soda provide relief from ant bite pain?

Q.8 What type of chemical reaction occurs when baking soda is applied?

Q.9 Could soap solution also provide similar relief? Why?

Q.10 What other basic substances could be used for treatment?

MATCH THE COLUMN:

Q.1

Column-A

(a) A substance which turns turmeric solution reddish brown
(b) A reaction between an acid and a base.
(c) An acid present in vinegar
(d) An indicator derived from lichen
(e) An insect whose sting contains acid

Column-B

(p) Base
(q) Acetic acid
(r) Neutralisation
(s) Ant
(t) Litmus

(A) (a)-(q), (b)-(r), (c)-(s), (d)-(p), (e)-(t)
(B) (a)-(p), (b)-(r), (c)-(q), (d)-(t), (e)-(s)
(C) (a)-(r), (b)-(t), (c)-(s), (d)-(q), (e)-(p)
(D) (a)-(p), (b)-(q), (c)-(t), (d)-(s), (e)-(r)

Q.2

Column-A	Column-B
(a) Tartaric acid	(p) Soap
(b) Calcium hydroxide	(q) Curd
(c) Formic acid	(r) Unripe mangoes
(d) Sodium hydroxide	(s) Ant sting
(e) Lactic acid	(t) Lime water

(A) (a)-(q), (b)-(r), (c)-(s), (d)-(p), (e)-(t)
(B) (a)-(t), (b)-(q), (c)-(p), (d)-(r), (e)-(s)
(C) (a)-(r), (b)-(t), (c)-(s), (d)-(p), (e)-(q)
(D) (a)-(p), (b)-(q), (c)-(t), (d)-(s), (e)-(r)

Q.3

Column-A	Column-B
(a) Tamarind	(p) Acetic acid
(b) Vinegar	(q) Lactic acid
(c) Lemon	(r) Tartaric acid
(d) Sour milk	(s) Citric acid
(e) Apple	(t) Malic acid

(A) (a)-(q), (b)-(r), (c)-(s), (d)-(p), (e)-(t)
(B) (a)-(t), (b)-(q), (c)-(p), (d)-(r), (e)-(s)
(C) (a)-(r), (b)-(t), (c)-(s), (d)-(q), (e)-(p)
(D) (a)-(r), (b)-(p), (c)-(s), (d)-(q), (e)-(t)

Q.4

Column-A

(a) Caustic soda
(b) Phosphoric acid
(c) Calcium hydroxide
(d) Hydrochloric acid

Column-B

(p) Bleaching powder
(q) Dyeing industry
(r) Manufacture of medicine
(s) Manufacture of phosphatic fertilizers

(A) (a)-(q), (b)-(r), (c)-(s), (d)-(p)
(B) (a)-(s), (b)-(q), (c)-(p), (d)-(r)
(C) (a)-(r), (b)-(s), (c)-(p), (d)-(q)
(D) (a)-(p), (b)-(q), (c)-(r), (d)-(s)

Q.5

Column-I	Column-II
(a) Strong acid	(p) KOH
(b) Strong base	(q) HNO_3
(c) Weak acid	(r) CH_3COOH
(d) Weak base	(s) NH_4OH

(A) (a)-(q), (b)-(r), (c)-(s), (d)-(p)
(B) (a)-(s), (b)-(q), (c)-(p), (d)-(r)
(C) (a)-(r), (b)-(p), (c)-(s), (d)-(q)
(D) (a)-(q), (b)-(p), (c)-(r), (d)-(s)

EXERCISE-IV

Subjective Assessment

VERY SHORT TYPE QUESTIONS :

Q.1 Name the source from which litmus solution is obtained ?

Q.2 Name the acid present in :
(i) Tomato (ii) Vinegar
(iii) Apples (iv) Tamarind

Q.3 What is deliquescence ?

Q.4 What will be the litmus test for a solution of vitamin C ?

Q.5 What colour change occurs when a stain of turmeric is washed with soap ?

Q.6 Name three organic and three inorganic acids.

Q.7 Name the most commonly used household indicator.

Q.8 Name the acid present in our stomach.

Q.9 Name the acid present in sting of an ant.

Q.10 Why baking soda taste bitter ?

SHORT TYPE QUESTIONS:

Q.1 Describe the process of neutralization with the help of an example.

Q.2 What are indicators ? Name any three indicators and state the colour change which takes place in
(i) acids (ii) bases.

Q.3 Explain why :
(a) An antacid tablet is taken when you suffer from acidity.
(b) Calamine solution is applied on the skin when an ant bites

Q.4 Identify the number of replaceable hydrogen ions (H^+) in the following acids: HCl, CH_3COOH, H_2SO_4, H_3PO_4.

Q.5 Name a salt of acid HNO_3 and base NH_4OH. Represent the reaction that takes place.

Q.6 Define the term "pH"; what does" pH" stand for ?

Q.7 What are antacids? Why are they used for ?

Q.8 Define a base and acid in terms of proton.

Q.9 What do you mean by salt ? Give examples.

Q.10 What is the cause of tooth decay?

Q.11 What acids are present in common edible substances?

Q.12 Why do bases feel slippery to touch?

Q.13 How can red rose extract be used as an indicator?

Q.14 Why is turmeric called the 'golden spice'?

Q.15 How can you test if a substance is neutral?

LONG TYPE QUESTIONS:

Q.1 State the differences between acids and bases.

Q.2 Define neutralisation. Give examples of neutralisation reaction in everday life.

Q.3 Why do acids not show acidic behavior in the absence of water ?

Q.4 Explain why :
(a) An antacid tablet is taken when you suffer from acidity.
(b) Calamine solution is applied on the skin when an ant bites.
(c) Factory waste is neturalised before disposting it into the water bodies.

Q.5 Why should curd and sour substances not be kept in brass and copper vessels ?

Q.6 Analyze the relationship between chemical properties and practical applications of acids and bases. Explain how understanding these properties helps in solving real-world problems.

Q.7 Describe the classification of substances as acidic, basic, and neutral. Explain the criteria used for classification and how indicators help in this process.

Q.8 Explain the concept of pH and its importance in different fields. Discuss how pH affects plant growth, human health, and environmental balance.

Q.9 Discuss the safety measures and precautions necessary when working with acids and bases. Explain why these precautions are important and what can happen if they are not followed.

Q.10 Analyze the interdisciplinary nature of chemistry with other subjects. Explain how the study of acids and bases connects to biology, agriculture, medicine, and environmental science.

EXERCISE-V Competition Edge

Q.1 Match column-I with column-II and select the correct from the codes given below **[NSO 2015]**

Column-I		Column-II	
(a)	Ammonium hydroxide	(i)	Spinach
(b)	Tartaic acid	(ii)	Window cleaner
(c)	Zinc carbonate	(iii)	Tamarind
(d)	Oxalic acid	(iv)	Calamine

(A) (a)-(ii), (b)-(iii), (c)- (iv), (d) - (iii)
(B) (a)-(iv), (b)-(i), (c)- (ii), (d) - (iii)
(C) (a)-(ii), (b)-(iii), (c)- (i), (d) - (iv)
(D) (a)-(iii), (b)-(ii), (c)- (iv), (d) - (i)

Q.2 Read the following statements :**[NSO 2015]**
(a) It is reaction between an acid and a base
(b) Salt and water are produced in this reaction
(c) It is an exothermic reaction
Which reaction is being referred to ?
(A) Displacement reaction
(B) Neutralization reaction
(C) Redox reaction
(D) Decomposition reaction

Q.3 The damaging effect of acid rain is caused due to : **[NSO 2015]**
(A) Carbonic acid (B) Sulphuric acid
(C) Nitric acid (D) All the these

Q.4 How do you think a soil should be treated, to which excessive chemical fertilizers have been added ? **[NSO 2015]**
(A) Such soil can be treated by adding base
(B) Such soil can be treated by adding CaO
(C) Such soil can be treated by adding $Ca(OH)_2$
(D) All of these

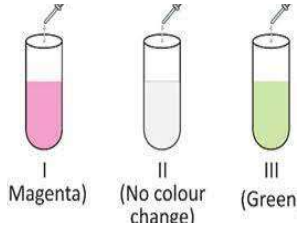
Q.5 Alkalies are **[NSO 2015]**
(A) Bases which are insoluble in water
(B) Acids which are soluble in water
(C) Bases which are soluble in water
(D) Acids which are insoluble

Q.6 Study the table carefully **[NSO 2010]**

Sample	Blue litmus to red	Red litmus to blue
(i) Tamaride juice	✓	×
(ii) Sugar syrup	×	✓
(iii) Lime water	×	✓
(iv) Soap solution	✓	×

Which of the above are correctly matched ?
(A) (i) & (iii) (B) (ii) & (iv)
(C) (i), (ii) & (iii) (D) (i), (ii) & (iv)

Q.7 The given figure shown the colour changes in test tubes I, II and III when china rose indicator is added to them. The respective solutions is test tubes I, II and III are : **[NSO 2010]**



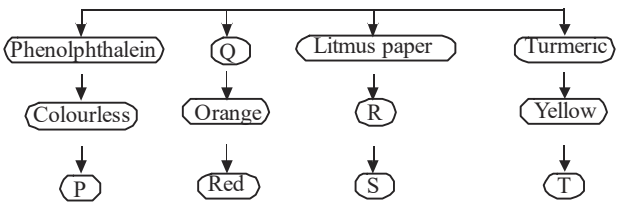
(A) (I)- Sugar solution, (II)-Lime water, (III)-Lime juice
(B) (I)- Sugar solution, (II)- Lime juice, (III)-Lima water
(C) (I)-Lima water, (II)-Sugar solution, (III)-Lima juice
(D) (I)- Lemon juice, (II)-Sugar solution, (III)-Lime water

Q.8 Based on which of the following changes is an indicator useful ? **[NSO 2010]**
(A) Colour (B) Physical state
(C) Temperature (D) Pressure

Q.9 X is present in the stomach. However, Presence of excess of it causes infigestion, which requires the intake of milk of magnesia to undo the effect of X. What is X ? **[NSO 2011]**
(A) NCl (B) H_2SO_4
(C) NaCH (D) KOH

Q.10 If OH ions are more than H^+ ions in a solution, then the solution is : **[NSO 2011]**
(A) Acidic (B) Basic
(C) Neutral (D) None of these

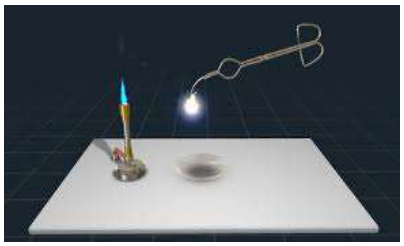
Q.11 When acids are added to different indicators, some colour changes occur. These colour changes are listed below. **[NSO 2011]**



Identify P. Q. R. S. and T respectively.

	P	Q	R	S	T
(A)	Colourless	Methyl orange	Blue	Red	Yellow
(B)	Colourless	China rose	Blue	Red	Yellow
(C)	Pink	Methyl orange	Blue	Red	Reddish brown
(D)	Pink	China rose	Red	Blue	Reddish brown

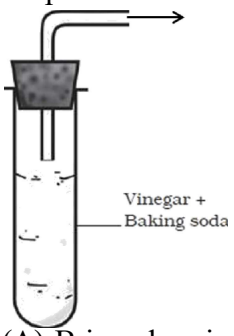
Q.12 Rishi burn a magnesium ribbon, and it burnt with a dazzling white flame. A powdery ash was formed. He collected the ash and dissolved it in water. The peoduct formed and nature of the product could be **[NSO 2012]**



(A) MgO, acidic (B) MgO basic
(C) $Mg(OH)_2$ basic (D) $Mg(OH)_2$ acidic

Q.13 In summers, if milk is not refrigerated, it becomes sour. Which of the following os added by milk man to fresh milk to prevent the milk form spoiling ? **[NSO 2011]**
(A) Caustic soda (B) Potash alum
(C) Baking soda (D) Lome water

Q.14 A Reaction is carried out in test tube as shown in figure. A gas comes out with hissing sound and bubbles. Which of the give will confirm the presence of the gas which comes out ?



[NSO 2012]

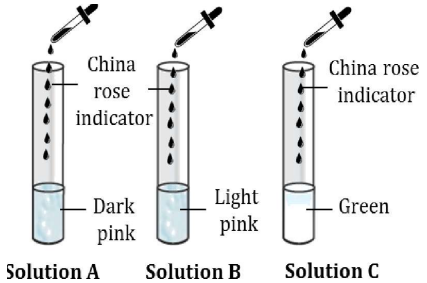
(A) Bring a burning splinter near the mouth of the gas tube, it burns brightly.
(B) Pass the gas into lime water, it turns milky.
(C) Pass the gas in red litmus solution, it turns blue.
(D) Pass the gas into copper sulphate solution, it turns green

Q.15 Five solutions have been taken in five test tubes labelled as A, B, C, D and E. They are tested with four indicators and the observations are recorded. **[NSO 2012]**

Soloution	Methyl Orange	Blue litmus	Red litmus	Phenolphthalein
(A)	Red	Red	Red	Colourless
(B)	Red	Red	Red	Colourless
(C)	Yellow	Blue	Blue	Pink
(D)	Orange	Blue	Red	Colourless
(E)	Red	Red	Red	Colourless

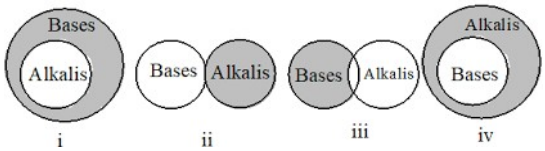
Which of the above solotions can neutralise each other ?
(A) A and B (B) D and E (C) B and C (D) B and D

Q.16 Reena prepared china rose indicator by keeping the petals of the flower in hot water for some time. She used the coloured solution for testing three solutions A, B and C. Solution A turns tp dark pink, solution B remains light pink and solution C turn to green. Mark the Correct option. **[NSO 2012]**



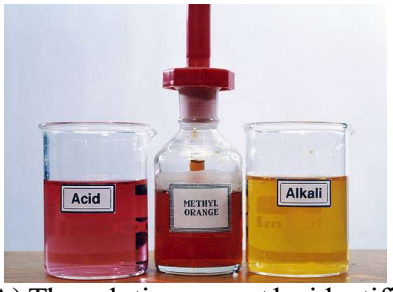
	Soloution A	Soloution B	Soloution C
(A)	Lemon juice	Sugar solution	Milk of magnesia
(B)	Lemon juice	Orange juice	Sugar solution
(C)	Orange juice	Vinegar	Salt solution
(D)	Salt solution	Milk magnesia	Lemon juice

Q.17 Which of the following diagram (s) represents alkalis and bases in the correct form ?



(A) (i) Only (B) (iii) Only
(C) (i) and (iv) (D) (iii) and (iv)

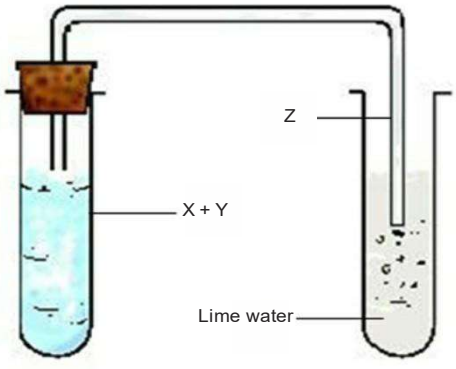
Q.18 How will you identify the given solution if you are provided with only one indicator-methyl orange ? **[NSO 2012]**



(A) The solution cannot be identified by the help of methyl orange only.
(B) Methyl orange changes to red in both acidic and natural solutions and yellow in basic solution.
(C) Methyl orange remains orange in acidic solution while changes to yellow in basic and neutral solution.
(D) Methyl orange chamges to red in acidic solution, yellow in basic solution and remains orange in neutral solution.

Q.19 Ranjana was given three unknown solution P.O and R. she performed certain test and observe the following. **[NSO 2012]**
Solution P gives green colour with China rose indicator.
Solution Q phenolphthalein remains colourless.
Solution R + sugar solution turns methyl orange to yellow.
Identifiy the solutions P. Q and R respectively.
(A) Orange juice, Salt solution, Baking soda
(B) Soap solution, Lime water, Lemon juice
(C) Soda water, Vinegar solution, Shampoo
(D) Salt solution, Milk of magnesia, Antacid

Q.20 Study the given set up to pass gas Z through lime water.
X is ____and Y is _____. when ____ (Z) is passed through lime water _____ is formed which makes lime water milky.**[NSO 2012]**



(A) Hydrochloric acid, zinc carbonate, hydrogen gas, calcium hydroxide
(B) Vinegar, sodium carbonate, hydrogen gas, calcium carbonate
(C) Acetic acid, balomg soda, carbon dioxide, calcium carbonate
(D) Hydrochloric acid, vinegar, carbon dioxide, calcium hydroxide

Q.21 The rols underneath the take located close to Rahul's house are made of limestone. which of the following are correct about the lake's water after an acid rain? **[NSO 2013]**
(i) It turns red litmus to blue.
(ii) Neutralisation reaction occurs.
(iii) Phenolphthalein remains colourless
(A) (i) and (ii) (B) (i) and (iii)
(C) (ii) and (iii) (D) (i), (ii) and (iii)

Q.22 Read the given statements and select he correct option. **[NSO 2013]**
Statement 1 : The ash produced from burning a magnesium ribbon is dissolved in water to get a basic solution.
Statement 2 : It is a physical change as the substamce formed is also composed of same elements Mg, H and O.
(A) Both statements 1 and 2 are true and statement 2 is the correct explanation of statement 1.
(B) Both statements 1 and 2 are true but statement 2 is not correct explanation of statement 1.
(C) Statement 1 is true and statement 2 is false.
(D) Both statements 1 and 2 are false.

Q.23 Rinta prepared an indicator paper by dipping a paper strip on solution of X. She put a few drops of an unknown solution Y which contains H inons less than OH inos on this paper. She observed that the colour of paper changed to yellow. What do you think was solution X ? **[NSO 2013]**
(A) Red litmus solution (B) Phenolphthalein
(C) Methyl orange (D) Turmeric solution

Q.24 Fill in the blanks by choosing the correct option.

Vinegar → Turns China rose to
Baking soda → Turns phenolphthalein to
P → Q + Other substances

$$P + Ca(OH)_2 \rightarrow Q + H_2O$$

	P	Q	R	X	Y
(1)	Sodium hydrogen Carbonate	CO_2	$CaCO_3$	Magenta	Pink
(2)	Lime water	H_2	CaO	Colourless	Green
(3)	Sodium hydrogen carbonate	Ca	Ca	Pink	Red
(4)	Magnesium Hydroxide	CO_2	$CaCO_3$	Colourless	Green

Q.25 Match the given chemical reactions with the products listed in the box and select the correct option from the given codes.

(i) CaO; (ii) Mg (OH)

(iii) NO_2 (iv) Cu

(v) $MgCl_2$; (vi) O_2

(vii) Fe_2O_3, (viii) $CaCO_3$

P. Mixinf magnesium oxide with water

Q. Brown deposit on iron nail dip in copper sulphate solution

R. Carbon dioxide is passed through lime water

S. Absorption of ultraviolet radiations by ozone **[NSO 2016]**

(A) P-(v), Q-(vii), R-(i), S-(vi)

(B) P-(iv), Q-(ii), ;kR-(i), S-(iii)

(C) P- (ii), Q-(iii), R-(viii), S- (iv)

(D) P- (ii), Q-(iv), R-(viii), S- (vi)

Q.26 Smita took a spoon of turmeric powder and made a paste by adding little water to it. She cut thin stripes of a peper and appliet this paste on them. After drying she put few drops of given sample solutions (i)-(iv) on these strips. What would be the changes in the colour she observed ? **[NSO 2016]**

(i) Amla juice (ii) Lime water

(iii) Common salt solution

(iv) Baking soda solution

(A) (i)-Yellow, (ii)- Red, (iii)- Yellow, (iv)- Red

(B) (i)- Red, (ii)-Yellow, (iii)-Yellow, (iv)- Red

(C) (i)-Red, (ii)- Red, (iii)- Yellow, (iv)- Yellow

(D) (i)- Yellow, (ii)-Yellow, (iii)-Red, (iv)-Red

Q.27 Which of the following statements is /are correct ? **[NSO 2016]**

I. Coffee is bitter in taste hence, it is basic in nature.

II. All mineral acids are strong acids

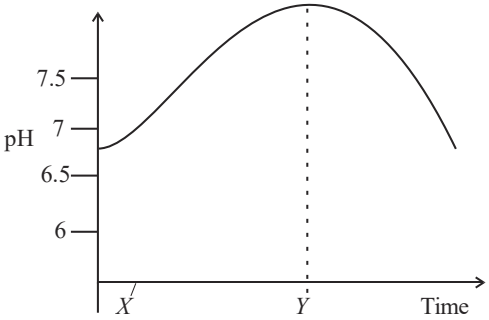
III. Phenolphthalein is a synthetic indicator.

IV. If the soil is too basic, organic matter is added to it.

(A) III and IV (B) I and III

(C) I, III and IV (D) III only

Q.28 The given graph shows changes in pH of water in an undisturbed freshwater lake on a summer day. What is the probable cause of the rise in pH of water between time period X and Y ? **[NSO 2017]**



(A) Decreased level of mineral nutrients in water.

(B) Decreased level of carbon dioxide in water due photosynthesis preformed by water plants.

(C) Increased level of carbon dioxide in water due to respiration performed by water plants and animals.

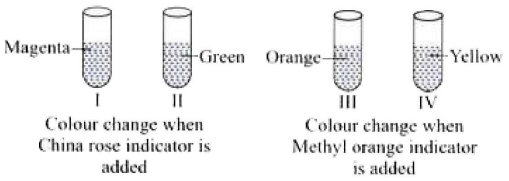
(D) None of these.

Q.29 Fill in the blanks in the given table by choosing an appropriate option. **[NSO 2017]**

Solution	Indicators		
	Methyl orange	Phenolphthalein	China rose
(i)	Orange	Colourless	Pink
Lime water	Yellow	Pink	(ii)
(iii)	Red	Colourless	(iv)
(v)	Yellow	Pink	Green

	(i)	(ii)	(iii)	(iv)	(v)
(1)	Vinegar	Red	Spinach	Yellow	Sugar solution
(2)	Sugar solution	Yellow	Salt solution	Pink	Lime water
(3)	Common	Green	Tomato juice	Magenta	Caustic soda
(4)	Lime juice	Green	Salt solution	Yellow	Aerated drink

Q.30 Shruti tested the nature of a few common substances eith the help of some inducator used and changers she observed are as follows: **[NSO 2017]**



Substances present in test tubes I, II, III and IV are resoectively

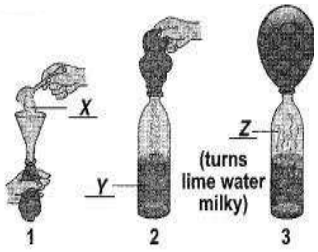
(A) Salt solution, curd , lemon juice and vinegar

(B) Orange juice, window cleaner, sugar solution and lime water

(C) Vinegar, soda water , soap solution and lemon juice

(D) Lemon juice, lime water, window cleaner and soap solution.

Q.31 Observe the given figure carefully and fill in the blanks by choosing an appropriate option. **[NSO 2018]**



	X	Y	Z
(A)	Sugar	Nitric acid	Nitrige n
(B)	Salt	Ammo nium hydroxi de	Ammo nia
(C)	Baking soda	Acetic acid	Carbon dioxide
(D)	Copper	Hydroc hloric acid	Hydrog en

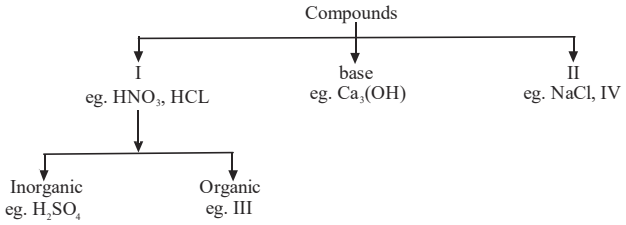
Q.32 Kanika identified the nature of few substances with the help of three different indicators. She listed down her observations in the given table with some blanks. **[NSO 2018]**

S. No.	Substance	Red Litmus paper	Turmeric solution	Chine rose indicator
1.	Lime water	Blue	_P_	Green
2.	Curd	No change	No change	Ammonium hydroxide
3.	Table salt	No change	No change	Acetic acid
4.	Toothpaste	_r_	Red	Hydrochlori c acid
5.	Lemon juice	No change	No change	magenta

Identify p, q, r and s.

	p	q	r	S
(A)	Magenta	Green	Blue	Magenta
(B)	Red	Magenta	Blue	Green
(C)	Blue	Magenta	Red	Green
(D)	Green	Red	Magenta	Blue

Q.33 Observe the given flowchart carefully and mark the optins which best represent I, II, III and IV **[NSO 2018]**



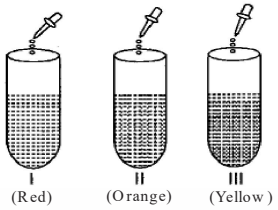
	I	II	III	IV
(A)	Salt	Acid	Acetic acid	Limestone
(B)	Alkali	Soda ash	Iron sulphate	Iron oxide
(C)	Acidic	Salt	Hydrochlo ric acid	Copper sulphate
(D)	Acid	Salt	Formic acid	Baking soda

Q.34 Fill in the blanks in the given table by selecting an approproate option. **[NSO 2019]**

S. No.	Substance	Colour change with phenolphthalein indicator	Colour change with methyl orange indicator
1.	Apple juice	(i)	Red
2.	Soda water	(ii)	(iii)
3.	Calamin solution	Pink	(iv)

	I	II	III	IV
(A)	Yellow	Colourless	Red	Pink
(B)	Red	Yellow	Green	Pink
(C)	Red	Red	Colourless	Pink
(D)	Colourless	Colourless	Red	Yellow

Q.35 The givem figure shows the colour changes in test tubes I, II and III, when methyl orange insicator is added to them. The respective solutions in test tubes I, II and III are **[NSO 2018]**



(A) Carbonated drink, curd, spinach juice
(B) Curd, window cleaner, glucose solution
(C) Lime water, lemon juice, washing soda
(D) Tarmarind juice, glucose solution, baking soda solution.

Q.36 Rahul took a turmeric paper and tried to draw flowers on it with the help of cotton buds dipped in solution P and Q. The flower drawn with solution P was not visible while one drawn with solution Q turned red. Solution P and Q could be respectively **[NSO 2019]**

(A) Lime water and lemon juice
(B) Vinegar and soap solution
(C) Common salt solution and baking soda
(D) Both 2 and 3.

Q.37 Read the statements given below :
Statement 1- Factory wastes are treated with calcium chloride to neutralize the acid.
Statement 2- Magnesium hydroxide is used as an antacid to neutralize the excessive acidity in the stomach.
Statement 3- Common salt neutralizes the acid in the stomach. Which of the above statements are false ? **[CSO 2021]**
(A) Statements 1 and 2
(B) Statements 1 and 3
(C) Statements 2 and 3
(D) Statements 1, 2, and 3

Q.38 Fill in the blanks : A few petals of China rose were taken in a beaker. Some water was added and the beaker was heated until the water in it became warm. The mixture was kept for some tine until the water became coloured. The given samples ware tested with China rose indicator to find if they are acidic, basic or neutral. The indicator gave different colours in different media.The given samples were lemon joice, soap solution, distilled water, sugar solution, limewater, curd abd window cleaner. The indicator gave green colour with_____. **[CSO 2019]**

(A) Soap solution, limewater and window cleaner
(B) lemon juice, distilled water, sugar solution
(C) lime water , curd , window cleaner
(D) soap solution, lemon juice, sugar solution

Q.39 Match the acids with their uses : **[CSO 2019]**

Acid		Use	
P.	Benzoic acid	a.	As an eyewash, antiseptic and grain preservation
Q.	Oxalic acid	b.	For making explosices
R.	Nitric acid	c.	In food preservation
S.	Boric acid	d.	Soft drinks to give it fizz
T.	Carboic acid	e.	As a constituent of ink stain remover

(A) P- a, Q- e, R- b, S- d, T- c
(B) P- c, Q- e, R- b, S- a, T- d
(C) P- d, Q- c, R- b, S- a, T- e
(D) P- b, Q- a, R- d, S- e, T- c

Q.40 Non-mentals react with oxygen to form respective non-metallic oxides. Which non-metallic oxide on hydrolysis gives only a strong acid ? **[NSTSE 2022]**
(A) Sulphur dioxide
(B) Carbon dioxide
(C) Sulphur trioxide
(D) Nitrogen dioxide

Q.41 Lemon juice and coffee both are
(A) acidic **[NSTSE 2022]**
(B) basic
(C) Lemon juice is acidic, coffee is basic
(D) lemon juice is bsoc , coffee is acidic

Q.42 Which of the given acids are present in spinach, amla and unripe grapes ? **[NSTSE 2022]**
(A) Hydrochloric, Tartaric, Tannic
(B) Oxalic, Ascorbic, Tartaric
(C) Sulphuric, Carbonic, Lactic
(D) Malic, Ethanoic, Nitric

Q.43 A non- metal forms only two oxides. One oxide on hydrolysis gives an acid. Identify the non- metal. **[NSTSE 2022]**
(A) Oxygen (B) Carbon
(C) Hydrogen
(D) None of the above

Q.44 What are the solutions which do not change the colour of either red or blue litmus papers are called ? **[NSTSE 2022]**
(A) Acidic (B) Basic
(C) Neutral (D) Alcohol

ANSWER KEY

EXERCISE-II

MULTIPLE CHOICE QUESTIONS :

Q.1	A	**Q.2**	C	**Q.3**	B	**Q.4**	A	**Q.5**	C	**Q.6**	D	**Q.7**	C
Q.8	C	**Q.9**	A	**Q.10**	B	**Q.11**	D	**Q.12**	D	**Q.13**	B	**Q.14**	C
Q.15	B	**Q.16**	C	**Q.17**	C	**Q.18**	C	**Q.19**	C	**Q.20**	B	**Q.21**	B
Q.22	C	**Q.23**	B	**Q.24**	B	**Q.25**	B	**Q.26**	C	**Q.27**	B	**Q.28**	D
Q.29	C	**Q.30**	C	**Q.31**	B	**Q.32**	B	**Q.33**	C	**Q.34**	B	**Q.35**	C
Q.36	C	**Q.37**	C	**Q.38**	C	**Q.39**	C	**Q.40**	C	**Q.41**	A		

EXERCISE-III

TRUE AND FALSE :

Q.1	F	**Q.2**	F	**Q.3**	T	**Q.4**	F	**Q.5**	T	**Q.6** F	**Q.7** T
Q.8	F	**Q.9**	F	**Q.10**	T						

FILL IN THE BLANKS :

Q.1	Salt and water	**Q.2**	Dark pink, Green	**Q.3**	Indicators	**Q.4**	$ZnCO_3$
Q.5	Turmeric	**Q.6**	hydrogen ions	**Q.7**	Baking Soda	**Q.8**	H_2
Q.9	Brine	**Q.10**	water of crystallization				

ASSERTION & REASON :

Q.1	**(A)**	**Q.2**	**(A)**	**Q.3**	**(C)**	**Q.4**	**(A)**	**Q.5**	**(A)**

CASE STUDY :

Q.1 Acidic soil **damages roots and reduces the availability of essential nutrients**, affecting plant growth.

Q.2 Lime is **basic in nature** and **neutralizes the excess acid** present in the soil.

Q.3 Basic soil also harms plants. It is treated by **adding organic matter** or **acidic substances** like compost or manure.

Q.4 **Neutralization**

Q.5 **Litmus paper, pH paper, universal indicator, or natural indicators** like turmeric.

Q.6 Ant bites inject **formic acid**, which causes irritation and pain.

Q.7 Baking soda is **basic** and **neutralizes the acid** injected by the ant.

Q.8 **Neutralization reaction**

Q.9 **Yes**, because soap solution is **basic** and can neutralize the acid.

Q.10 **Lime, calamine lotion, milk of magnesia**, or **weak soap solution**.

MATCH THE COLUMN :

Q.1	**B**	**Q.2**	**C**	**Q.3**	**D**	**Q.4**	**C**	**Q.5**	**D**

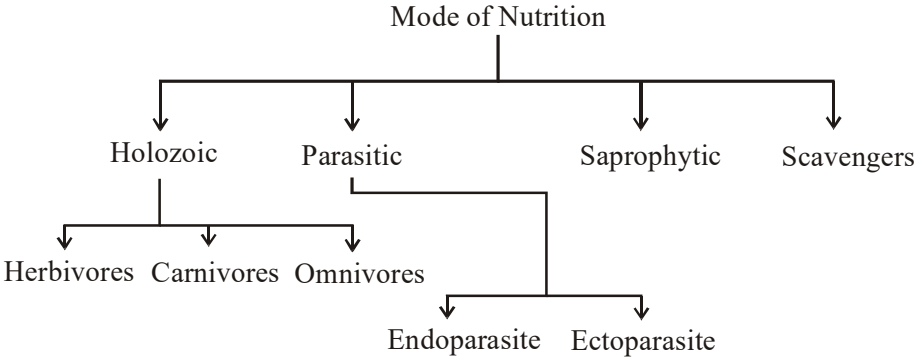
EXERCISE-V

Q.1	A	**Q.2**	B	**Q.3**	D	**Q.4**	D	**Q.5**	C	**Q.6**	A	**Q.7**	D
Q.8	A	**Q.9**	A	**Q.10**	B	**Q.11**	A	**Q.12**	C	**Q.13**	C	**Q.14**	B
Q.15	C	**Q.16**	A	**Q.17**	A	**Q.18**	D	**Q.19**	C	**Q.20**	C	**Q.21**	C
Q.22	C	**Q.23**	C	**Q.24**	A	**Q.25**	D	**Q.26**	A	**Q.27**	A	**Q.28**	C
Q.29	C	**Q.30**	B	**Q.31**	C	**Q.32**	B	**Q.33**	C	**Q.34**	B	**Q.35**	B
Q.36	D	**Q.37**	B	**Q.38**	A	**Q.39**	B	**Q.40**	C	**Q.41**	A	**Q.42**	B
Q.43	B	**Q.44**	C										

2. Life Processes in Animals

1. NUTRITION IN ANIMALS

Animals are heterotrophs in nature. They obtain food from plants or other sources. The mode of nutrition in animals is **holozoic nutrition.** Some animals may be parasites, saprophytes or scavengers.



I. **Holozoic Nutrition:** In this type of nutrition, animals take in solid food and follow the complete steps of nutrition.

- **(A)** **Herbivores:** An animal which feed on plants. **e.g. Cow, Buffalo, Goat, Deer, Rabbit, Horse, Elephant.**
- **(B)** **Carnivores:** An animal which feed on flesh of other animals. **e.g. Lion, Tiger, Leopard**
- **(C)** **Omnivores:** An animal which feed on both plant and animals. **e.g. Crow, Man, Pig, Cockroach.**

II. **Parasitic animals :-** Obtain food & Shelter from host body. They may be

- **(A)** **Ectoparasite -** Live outside the host body, e.g. Ticks, Mites, Body louse, Beg bug.
- **(B)** **Endoparasite -** Live inside the host body, e.g. Malarial Parasite Plasmodium., Flatworms, Round worms.

III. **Saprophytic animals :-** Feed on dead and decaying organic matter.
e.g. Earthworm, Spiders, Termite, Euglena.

IV. **Scavengers :-** Feed on decaying animals. eg. Vulture, Crow, Jackal.

2. BASIC STEPS OF HOLOZOIC NUTRITION

I. **Ingestion :-** Taking food items into the body.

II. **Digestion :-** Break down complex insoluble organic compound into simple soluble compounds by action of digestive enzymes.

III. **Absorption :-** Simple molecules of digested food are absorbed by intestinal wall and than transported to blood stream.

IV. **Assimilation :-** This digested food is utilized by body cells for energy and synthesize new protoplasm.

V. **Egestion :-** Getting rid of undigested part of food and is also called **defecation.**

3. NUTRITION IN AMOEBA

Amoeba feeds on minute microscopic organisms or bacteria. It is a microscopic single celled organisms. The mode of Nutrition in Amoeba is **Holozoic** in which solid food is engulfed in following steps:

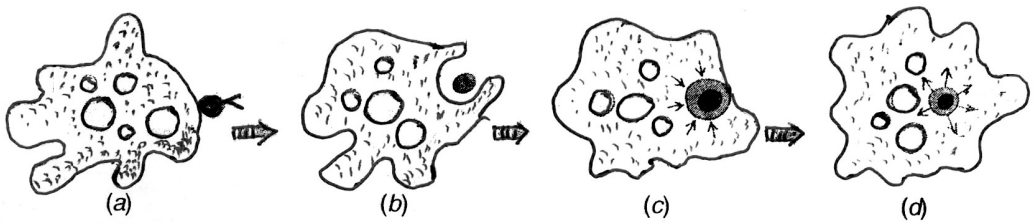
I. **Ingestion:-** When Amoeba comes in contact with prey, the finger like **Pseudopodia** surrounds it and engulf it. This food is trapped in a **food vacuole**. This food vacuole now moves into the cytoplasm.

II. **Digestion:-** Food in the food vacuole is digested by digestive enzymes secreted by cytoplasm. The reaction in the food vacuole is first **acidic** due to **HCl** and than becomes **alkaline.** In acidic medium prey is killed. In alkaline medium the prey is digested.

III. **Absorption:-** Digested food now diffuses into the cytoplasm. After absorption, the food vacuole disappear.

IV. **Assimilation :** The absorbed food is used to obtain energy which leads to growth and reproduction of *Amoeba*.

V. **Egestion :-** Now food vacuoles moves to the body surface and than ruptures, so undigested food expelled out of the body at any point because amoeba has no **Anus.**



Steps involved in ingestion (a, b), digestion (c) and absorption (d) in *Amoeba*

4. DIGESTION IN HUMAN BEINGS

Digestion is the process in which the insoluble complex food material is broken down by physical and chemical methods into simple soluble food materials. In this process

- Carbohydrates are converted into glucose.
- Proteins are converted into Amino Acids.
- Lipids are converted into fatty acid and glycerol.

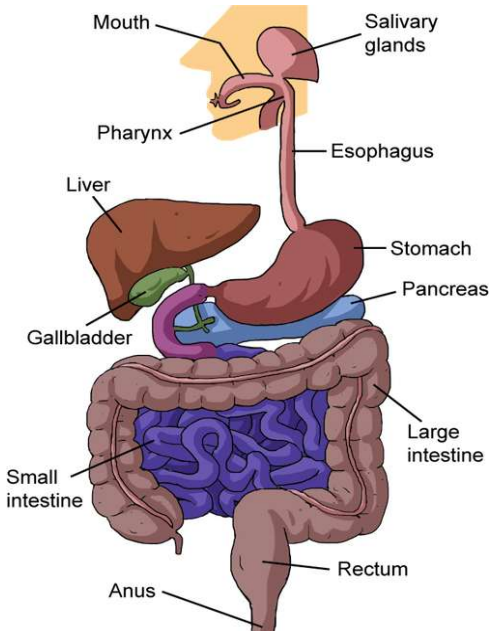
➢ **Types of Digestion :**

- **Intracellular digestion:-** When digestion takes place inside the cells. **e.g.** *Amoeba*, *Paramecium*, *Euglena,* Sponges.
- **Extracellular digestion:-** When digestion takes place outside the cells. **e.g.** Earthworm, Starfish and Human beings etc. Human beings are **omnivorous.** They feed on different parts of the plant like root, shoot, fruits, seeds and also on animal products like eggs, meat and milk.

➢ The Human digestive system is divided into two parts -

I. **Alimentary Canal :** It has following parts

A. Mouth
B. Buccal cavity – Known as bucco-pharyngeal cavity
C. Pharynx
D. Oesophagus or food pipe
E. Stomach.
F. Small intestine — Duodenum, Jejunum, Ileum
G. Large intestine — Caecum, Colon, Rectum



II. **Digestive Glands :**

A. Liver
B. Pancreas
C. Salivary gland
D. Gall bladder
E. Gastric gland in stomach
F. Intestinal gland in intestine

In human the alimentary canal is about 9 m long tube. The small intestine is about 6 m and large intestine about 1.5 m long.

I. Mouth and Buccal Cavity :

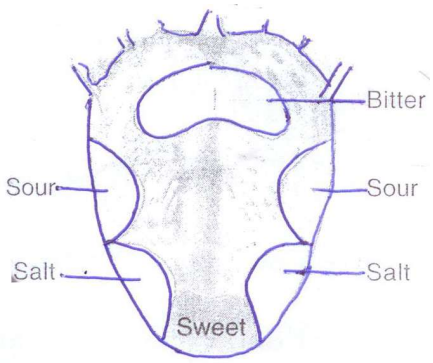
Food is taken into the alimentary canal through mouth. It is called **ingestion.** Mouth is surrounded by lips. The food is chewed with the help of teeth, tasted with the help of tongue and moistened with saliva.

(A) Tongue:- It is a muscular organ found in buccal cavity. It is free in front but posterior region is attached with a structure known as **Frenulum.**

It contain two important structures

(i) Papillae (ii) Taste buds

Papillae has taste buds for identification of taste. Sweet, Sour, Salty, Bitter.



Tongue showing location of different tastes

➢ **Function of the tongue**

- Essential for swallowing and mastication.
- Essential for talking & speech
- Essential for taste the food.
- For mixing of saliva with food.

(B) Teeth:- The arrangement of teeth on upper and lower jaw is known as **dentition.** Teeth are rooted in sockets in the gums. Human has **Heterodont** dentition. There are four types of teeths.

1. **Incisors -** For cutting
2. **Canines** - For piercing and tearing
3. **Premolars**
4. **Molars**

] – These are also known as **cheek** teeth or **grinders**.

Dental formula:-

$$\frac{\text{No. of teeth in half upper jaw}}{\text{No. of teeth in half lower jaw}} \times 2$$

$$= \frac{I}{I}, \frac{C}{C}, \frac{PM}{PM}, \frac{M}{M} \times 2$$

$$= \frac{2}{2}, \frac{1}{1}, \frac{2}{2}, \frac{3}{3} \times 2 = 32$$

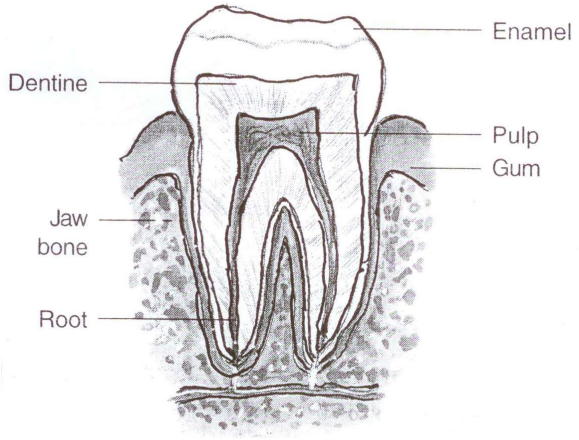
So Total No. of teeth in Human being is **32** in a adult.

- The Ist set of teeth grows during infancy and they fall off at the age between 6 - 8 years. These are called **milk teeth.** Their number is about 20.
- The second set of teeth that replaces them are called **permanent teeth,** which last through out life or fall off during old age. The number of permanent teeth are 28 including 8 molars.

Structure of tooth:- A typical tooth is made up of three parts.

(A) Crown (B) Neck (C) Root.

Crown is externally covered by **enamel** whereas **neck & root** is covered by cement.



Structure of a tooth

Tooth Decay:- If we do not clean our teeth after eating, they turn yellowish because a yellowish and sticky film formed from food particles, saliva and bacteria. This is called **plaque.**
The bacteria in the plaque convert sugar and starch of food into **acids**. This acid dissolve the enamel and damage the teeth. This is called **tooth decay.** This leads to the formation of cavity in the tooth & than tooth loss. Chocolates, sweets and cold drinks are responsible for tooth decay and tooth loss.

(C) Salivary Gland

This gland secretes **saliva.** In human 3 pairs of salivary gland are found. These are

(a) Parotid gland:- Found near the ear.

(b) Sublingual gland:- Found below the tongue.

(c) Sub-maxillary gland or sub mandibular :- Found at the angle of lower jaw.

Saliva helps in digestion of starch because it contains **salivary amylase or ptyalin** enzyme. This enzyme convert starch into maltose. The maltose is than converted into glucose.

Activity :-

Aim : To study the effect of saliva on food.

Procedure:

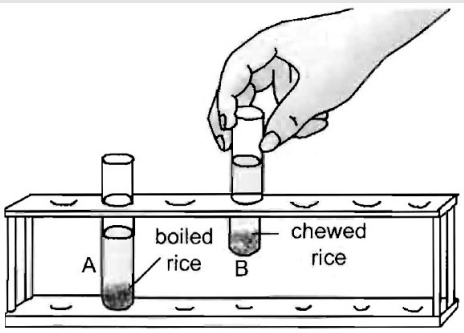
- Take two test tubes and label them as 'A' and 'B'.
- In test tube A, put some boiled rice. In test tube B, put boiled rice which has been chewed for 4-5 minutes (chewed rice).
- Now, add 4-5 mL of water and 2-3 drops of iodine solution in each test tube.

Observe what happens.

You will find that a blue-black colour develops in test tube A and no such colour develops in test tube B.

Inference: The boiled rice in test tube A contains starch which gives blue-black colour on being tested with iodine. In the chewed rice in test tube B, starch has been broken down (digested) into sugar. Therefore, no blue-black colour develops with iodine.

Digestion of starch is completed in the buccal cavity so it is also called **Buccal digestion.**



Effect of saliva on starch

(D) Palate:- This structure is found only in mammals & Human being which separates respiratory and food passage from each other.

II. Pharynx:- It is commonly called **throat.** Its main functions are
(i) Transmission of air from nose to larynx.
(ii) Production of voice.
(iii) Transportation of food from mouth to oesophagus.

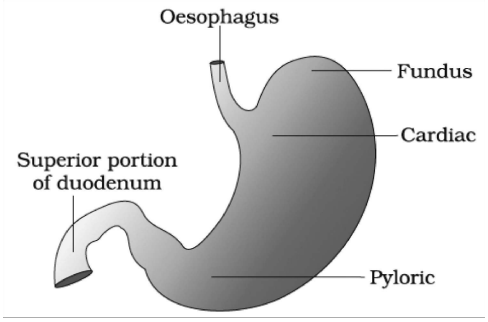
III. The food pipe or Oesophagus :
After swallowing, food passes from mouth to pharynx and than oesophagus. It is about 25 cm long tube which runs along the neck and chest. Food slides down the oesophagus by the **Peristaltic movements** of its muscular wall. **No digestion occurs in the oesophagus.**

Let's know

- Cooked starch $\xrightarrow[(\text{Ptyalin})]{\text{Amylase}}$ Maltose
- **Peristalsis** is a series of contraction and relaxation of muscles of alimentary canal that pushes the food downward and forward.
- Reverse peristalsis or retroperistalsis usually occur at the time of vomiting.

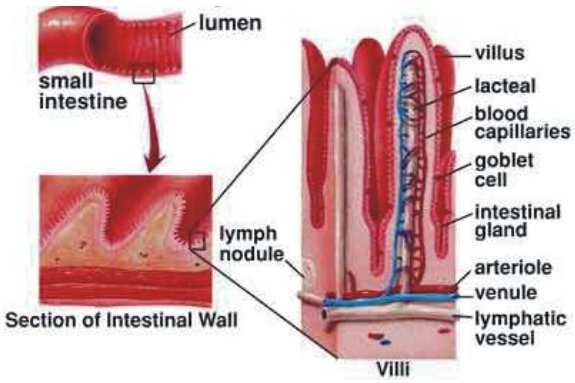
IV. Stomach :
Stomach is a J-shaped thick walled bag of muscles. It is located in abdominal cavity, below the diaphragm on left side of body. The junction between oesophagus and stomach is known as **cardiac orifice.** Posterior part of stomach opens into small intestine by **pyloric orifice.**

- Stomach is divided into three parts
  (A) Cardiac stomach
  (B) Fundic stomach
  (C) Pyloric stomach
- **Cardiac part** of stomach secrete **mucus** for protection of stomach.
- **Fundic part** have **gastric glands** which secretes **gastric juice** for digestion of proteins and fats.
- **Gastric Juice** have three enzymes.
  (i) **Pepsin** - Act on food proteins and forms peptones & proteases.
  (ii) **Renin** - Act on milk proteins namely **casein** and forms **calcium paracaseinate.** This process is called **curdling of milk.**
  (iii) **Lipase** - Act on fats.
- Stomach is highly acidic due to HCl or Hydrochloric acid.
- Acid kills many bacteria present in food and provides acidic medium for the action of digestive juices.



V. The Small Intestine :

- Stomach is followed by the small intestine.
- It has three regions
  (i) Duodenum - Complete digestion of food
  (ii) Jejunum
  (iii) Ileum - Absorption of food.
- Small intestine is very long and is about 25 feet (7.6 meters). The great length of small intestine helps in complete digestion and absorption of food.
- Intestine have many finger like structure called **villi.** Villi helps in absorption of food.



- The digestion of food is completed in the small intestine. It receive **bile Juice** from **liver** or **gall bladder**. (bile stored in gall bladder) and makes the food **alkaline** and helps in the digestion of fat.

(A) **Liver :** It is the largest gland, secretes bile into the small intestine. Bile contains bile juice and bile pigments. Bile juice does not contain enzymes. It is alkaline in nature and it is temporarily stored in gall bladder and helps in digestion and absorption of fats.

(B) **Pancreas :** It lies parallel to and below the stomach. It secretes pancreatic juice into small intestine. Pancreas secretes pancreatic juice which contains digestive enzymes like pancreatic amylase, trypsin and lipase.
Pancreatic Juice received from pancreas by pancreatic duct helps in the digestion of protein and carbohydrate.

(C) **Intestinal glands :** They secrete intestinal juice (succus entericus) and mucus. It digestes the food completely in the small intestine.

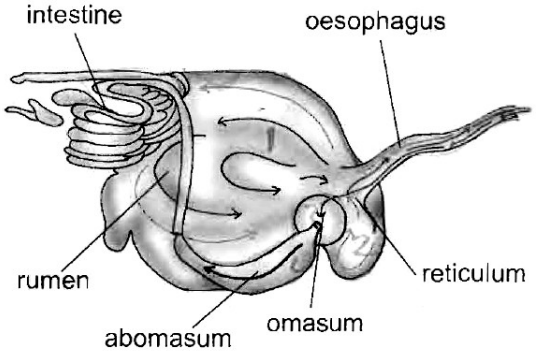
VI. **Large Intestine:-** The small intestine is followed by large intestine which has three parts
(i) **Colon -** It absorb water from undigested food.
(ii) **Rectum -** The rectum functions as a reservoir for the faces and followed by **anal canal.** The anal canal opens outside by **anus.**
(iii) **Caecum -** It is the structure found between ileum of small intestine and large intestine. Its main function is digestion of cellulose in **ruminants.**

Let's know

- **Vermiform Appendix -** At the posterior part of small intestine a worm like structure is found it is vestigial part of Alimentary canal.
- **Egestion of Food:-** The semisolid undigested food is pushed out of the anus. This is called **egestion or defecation.**

5. DIGESTION IN HERBIVORES OR RUMINANTS:

- Grass eating animals like cows, buffaloes, horses etc have a part of their stomach specialised to store half-chewed food. This is called the **rumen** and these animals are called **ruminants.**



Four-chambered stomach of a ruminant (cow)

Ruminants have a special stomach with 4 chambers, which are as follows

(i) Rumen : This is the largest chamber of the stomach. It is mainly used for storing food.

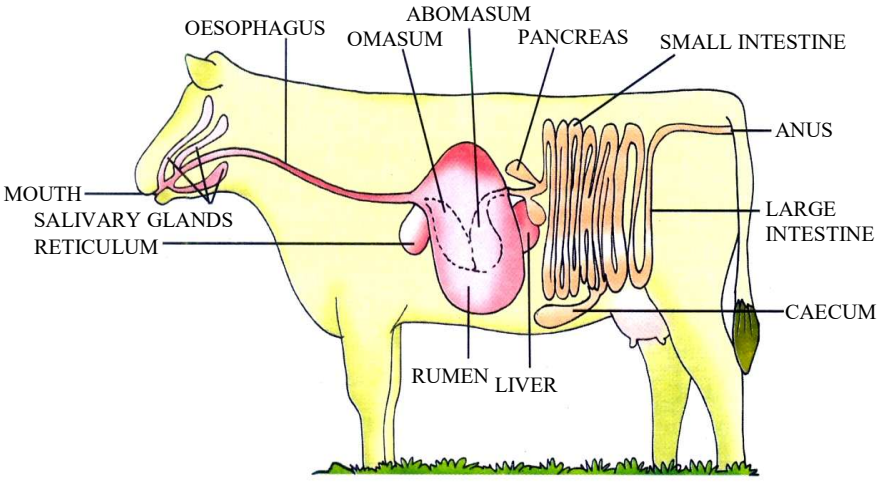
(ii) Reticulum : It helps in moving the food back to the mouth when needed.

(iii) Omasum : This is the smallest chamber of the stomach. Its main function is to absorb excess water.

(iv) Abomasum : This is a true stomach where gastric juices are secreted to help digestion. Here the food is digested just like in the human stomach.

➢ **Digestion of food in ruminants**

The ruminants mostly eat grasses and leaves which are rich in cellulose, The ruminants can digest cellulose becuase celluose-digesting bacteria and protozoa are present in their stomach.



Four chambered stomach of cow (ruminant)

Half-chewed grass travels from the mouth to the first chamber of the stomach called rumen where it is acted upon by bacteria and microorganism. It then goes into the reticulum from where it is returned to the mouth as cud for through chewing called rumination. It enters a third chamber called omasum. Here it is broken down into still smaller pieces. Finally, it enters the fourth chamber called abomasum where enzymes act upon it and digestion is completed. It is finally sent to the small intestine where the absorption of the nutrients takes place.

Let's know

Some times due to infection in alimentary canal, food poisoning or indigestion occurs, watery stool passes out frequently. It is very common in children of India. In severe cases it can be fatal. It causes dehydration due to excess loss of water & salts from the body. Patient should be given plenty of boiled & cooled water with a pinch of salt & sugar dissolved in it. It is called **Oral Rehydration Solution (ORS).**

6. RESPIRATION IN ANIMALS

Respiration : The process by which nutrients are converted into usable energy is called respiration.

➢ **Why do We Respire ?**

Living organism respire because.

- Respiration give energy to organisms for movement, excretion, growth, reproduction etc.
- By the respiration food is broken down with in the cell.

7. TYPES OF RESPIRATION

There are two types of respiration – aerobic and anaerobic respiration.

I. Aerobic Respiration : When the breakdown of food substances (like glucose) takes place in the presence of oxygen with the release of a large amount of energy, it is called **aerobic respiration**. In this process, carbon dioxide and water are released as waste products.

The overall equation for aerobic respiration is:

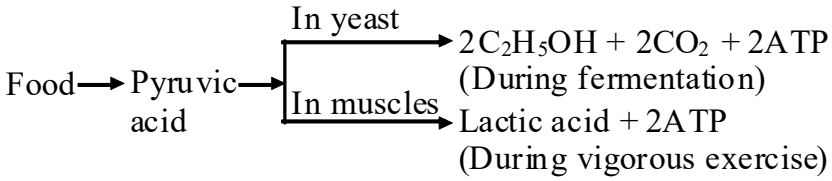
$$\underset{\text{(Glucose)}}{\text{Food}} + \text{Oxygen} \longrightarrow \text{Energy} + \text{Carbon dioxide} + \text{Water}$$

Most animals including **humans** and **green plants** respire aerobically.

II. Anaerobic Respiration : Anaerobic respiration is the breakdown of food substances with the release of a small amount of energy in the absence of oxygen. It occurs in certain organisms like **yeast** and some **bacteria**. These organisms are called **anaerobes**.

In the absence/lack of oxygen, glucose breaks down either into alcohol or into lactic acid with the release of comparatively less energy.

The equation for anaerobic respiration is:



➢ **Aerobic respiration In Human Being**

Differences between aerobic and anaerobic respiration

S.NO.	Aerobic	Anaerobic
1.	It occurs in all living cells of higher organisms.	It occurs in bacteria, certain fungi, germinating seeds fleshy fruits and muscle cells.
2.	It requires oxygen.	Oxygen is not required.
3.	The end products are CO_2 and H_2O	The end products are alcohol & CO_2 or lactic acid.
4.	The oxidation of one molecules of glucose produces 38 ATP molecules.	The number of ATP molecules produced is only 2 ATP.
5.	All the reactions except the reactions of glycolysis take place inside mitochondria.	All the reactions take place in cytoplasm.
6.	Organic compounds are completely oxidized and high amount of energy is released.	Organic compounds are incompletely oxidized and very small amount of energy.
7.	Non toxic to higher organisms.	Toxic to higher organisms.

➢ **Process of Respiration :**

I. External respiration: Exchange of gases between an organism and its environment.

II. Internal respiration: Exchange of gases between tissue cells and extracellular environment.

III. Cellular respiration: Involves oxidation of food along with release of energy, inside cell.

8. RESPIRATION IN HUMANS

8.1 Breathing

- Exchange of gases or taking in O_2 and giving out CO_2 with the help of respiratory organs is called breathing.
- The taking in of air rich in oxygen is called **inhalation** and giving out CO_2 rich air is called **exhalation**.
- It is a continuous process which goes on all the time and throughout the life of an organism.
- The number of times a person breathes in a minute is called the **breathing rate**.
- Normal breathing of adult human beings at rest is about **15-18 per min**. But it can change according to requirement of O_2 by the body.
- Thus, whenever a person needs extra energy breathing rate increases.
- So, during heavy exercise, the breathing rate can increase upto 25 times per minute and also we take deep breaths to inhale more oxygen.
- As a result more oxygen is supplied to our cells.
- So speeds up the breakdown of food and more energy is released.
- That is the cause we feel hungry after a physical activity.

Difference between breathing and respiration

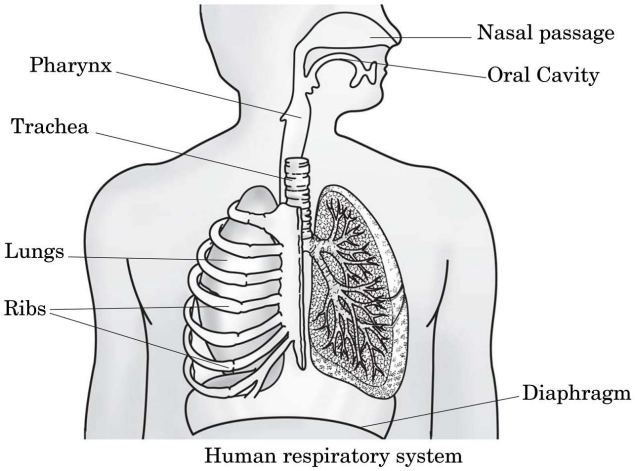
S. No.	Breathing	Cellular respiration
1.	It is a physical phenomenon where exchange of oxygen and carbon dioxide takes place.	It is a biochemical process where glucose is oxidized to produce carbon dioxide and water.
2.	Energy is not released.	Energy is released.
3.	Enzymes are not involved.	A series of respiratory enzymes are involved to bring about the oxidation.
4.	It is extra cellular.	It is intracellular.

8.2 Human Respiratory System

In humans, several organs take part in the process of respiration. These different organs together form the **respiratory system**.

➢ **Organs of the Respiratory System**

- Nostrils
- Nasal cavity or passage
- Windpipe (trachea)
- Bronchi (singular bronchus)
- Lungs
- Alveoli



Human respiratory system

I. **External Nostrils :** First part of respiratory system.
It opens into nasal cavity and is meant for inhalation of air from outside.

II. **Nasal Cavity :** This cavity is separated from oral cavity by means of a hard and bony palate. It is lined by ciliated columnar epithelial cells that are rich in mucus, it brings about warming, moistening and sterilization of air. It contains hair and mucus which entrap the dust particles.

Nasal septum is a cartilage which divides nasal cavity into two nasal chamber.

III. **Internal nares :** Nasal cavity opens into it and it leads to pharynx.

IV. **Pharynx :** It is a common part between both alimentary canal and respiratory system.

V. **Laryngopharynx :** It is the lower part of pharynx and has a slit like aperture called **glottis**, which can be closed by a leaf like bi-lobed cartilage **epiglottis**, during swallowing of food bolus. Epiglottis prevents the entry of food into the trachea.

VI. **Larynx :** It is an enlarged part of trachea which is also called as 'voice box'. It produces voice by passage of air between vocal cords. It contains four different types of cartilage among them a 'c' shaped thyroid cartilage protruding out in neck region is called Adam's apple.

Vocal cord : In larynx, 2 pairs of vocal cord is found outer pair is false vocal cord where as, inner pair is true vocal cord when air is forced through the larynx it cause vibration of true vocal cords and sound is produced.

VII. **Trachea (Wind pipe) :** It is 10-12 cm long tube. It's walls are supported by 16 – 20 'C' shaped cartilaginous rings which prevent them to collapse when air is absent in them.

VIII. **Bronchi :** Trachea is branched into two bronchi left and right each of which enters into the lungs.

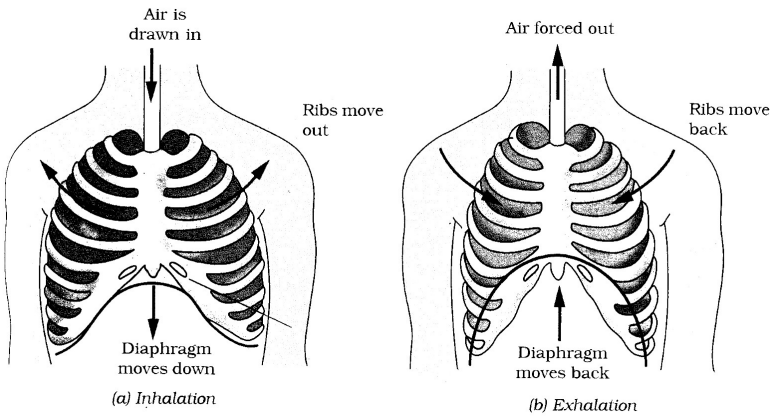
IX. **Lungs :** These are two light weight spongy pouches covered by a membrane called Pleura. Bronchi are further branched into several bronchioles, at the end of bronchioles alveolar sacs or alveoli are present which are rich in blood capillaries and thin walled.

X. **Diaphragm :** It is a sheet of muscles that lies below the lungs and separates thoracic cavity from abdominal cavity.

9. MECHANISM OF BREATHING IN HUMANS BEINGS

Normally we take in air through our nostrils. When we inhale air, it passes through our nostrils into the nasal cavity. From the nasal cavity, the air reaches our lungs through the windpipe. Lungs are present in the chest cavity. This cavity is surrounded by ribs on the sides. A large, muscular sheet called **diaphragm** forms the floor of the chest cavity. Breathing involves the movement of the diaphragm and the rib cage.

- **During inhalation-**
  Ribs move up and outwards and diaphragm moves down. Its movement increases space in our chest cavity and air rushes into the lungs. The lungs get filled with air and exchange of gases take place by the process of difference in alveoli.
- **During exhalation -**
  Ribs move down and inwards, while diaphragm moves up to its former position. This reduces the size of the chest cavity and air is pushed out of the lungs.



Mechanism of breathing in human beings

Let's know

Smoking damages lungs and also causes cancer. When we inhale, unwanted particles like smoke, dust, pollens etc. present in air gets trapped by hairs of nasal cavity. But sometimes these particles may get passed the hair in nasal cavity and causes sneezing to expel out the foreign particles. So, clean air reaches our lungs

Activity :

To show that exhaled air contains water vapour.

Stand in front of a clean mirror. Breathe out some air from your mouth on the mirror. The mirror becomes cloudy. Sometimes even water droplets may be seen on the mirror. This activity shows that exhaled air contains water vapour.

10. WHAT DO WE BREATHE OUT?

Air is a mixture of gases such as nitrogen, oxygen, carbon dioxide, and water vapour. When we breathe in, our body uses oxygen for respiration to release energy from food. During this process, carbon dioxide is produced as a waste gas. This carbon dioxide is removed from the body when we breathe out. Hence, exhaled air contains less oxygen and more carbon dioxide compared to inhaled air. The presence of carbon dioxide in exhaled air can be demonstrated by passing it through lime water, which turns milky.

Important Points

- Air is a mixture of gases like nitrogen, oxygen, carbon dioxide, and water vapour.
- Inhaled air contains **more oxygen** and **less carbon dioxide**.
- Exhaled air contains **less oxygen** and **more carbon dioxide**.
- Oxygen is used by the body for respiration.
- Carbon dioxide is produced as a waste product during respiration.
- Carbon dioxide is removed from the body through breathing out.
- When exhaled air is passed through lime water, it turns **milky**.
- Lime water turns milky due to the presence of carbon dioxide.

Activity :

Gas Present in Air We Breathe Out

Aim: To identify the gas present in the air we breathe out.

Materials Required:

Two clean test tubes, freshly prepared lime water, straw/syringe (pichkari).

Method (Brief):

⇒ Take fresh lime water in test tubes A and B.

⇒ Pass normal air into test tube A using a syringe.

⇒ Blow air from your mouth into test tube B using a straw.

⇒ Observe the change in both test tubes.

Observation:

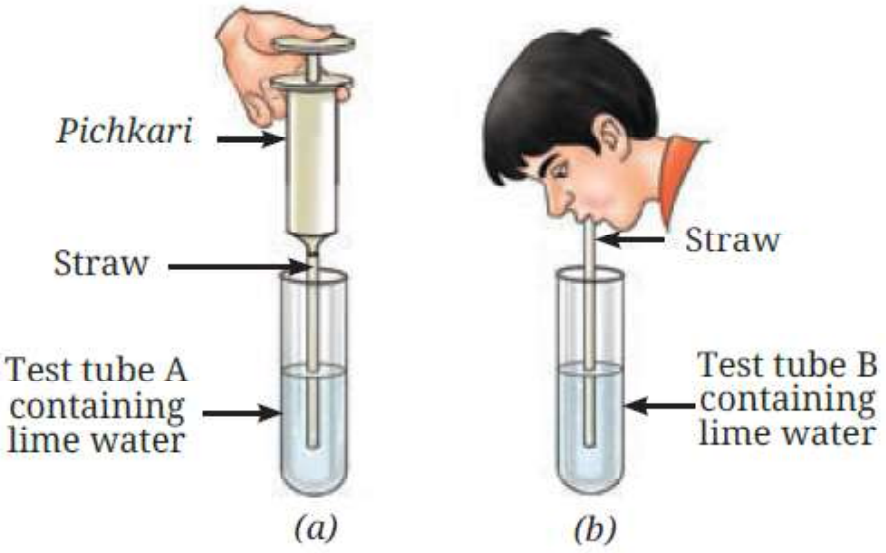
Lime water in test tube B turns milky.

Lime water in test tube A shows no change.

Conclusion:

The air we breathe out contains carbon dioxide.

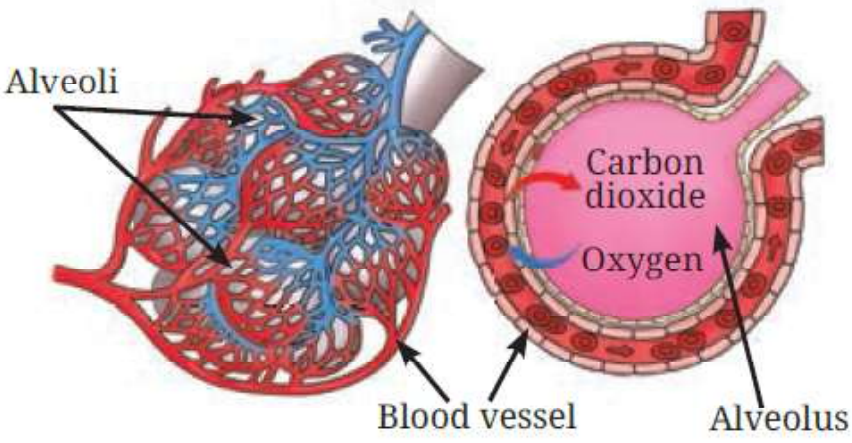
Carbon dioxide turns lime water milky due to the formation of calcium carbonate. Hence, this is a standard test for carbon dioxide.



(a) Air is passed into lime water with a pichkari/syringe (b) Air is exhaled into lime water

11. HOW DOES THE EXCHANGE OF GASES HAPPEN?

During breathing, fresh air from the environment enters the lungs and reaches the tiny air sacs called alveoli. The alveoli have very thin walls and are surrounded by a dense network of fine blood capillaries. Because of this close contact between air and blood, gases can easily pass through the walls. Oxygen from the air moves into the blood, while carbon dioxide from the blood moves into the alveoli. This exchange of gases takes place by diffusion and helps supply oxygen to the body and remove carbon dioxide.



Gas exchange through alveoli

Important Points

- Fresh air enters the lungs during inhalation.
- Air reaches tiny air sacs called **alveoli**.
- Alveoli have **very thin walls**.
- Alveoli are surrounded by a **network of blood capillaries**.
- Oxygen from alveoli diffuses into the blood.
- Carbon dioxide diffuses from the blood into the alveoli.
- This exchange occurs due to **difference in concentration of gases**.
- Oxygen is carried by blood to all body cells.
- Carbon dioxide is expelled out during exhalation.

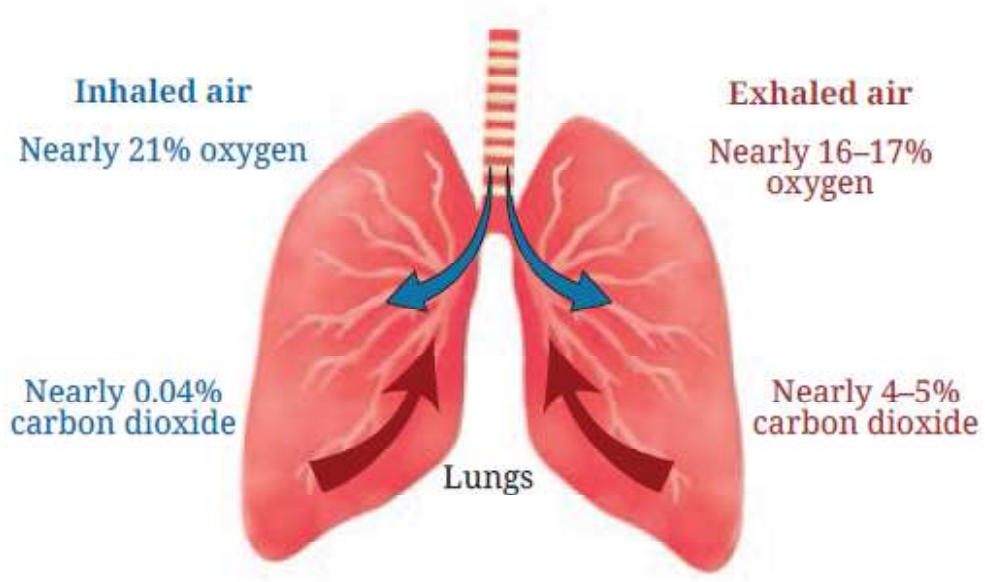
The blood vessels surrounding the alveoli carry carbon dioxide from different parts of the body to the lungs, where it is released into the alveoli and exhaled out. At the same time, oxygen from the inhaled air diffuses through the thin walls of the alveoli into the blood vessels. This oxygen-rich blood is then transported to all parts of the body. Oxygen is used by body cells to break down glucose during respiration, a process that releases energy required for various life activities. The waste product carbon dioxide produced during respiration is carried back to the lungs and removed from the body during exhalation.

Important Points

- Blood vessels bring carbon dioxide from the body to the alveoli.
- Carbon dioxide diffuses into the alveoli and is exhaled out.
- Oxygen from inhaled air passes through alveolar walls into the blood.
- Oxygen is carried by blood to all body cells.
- Respiration releases energy needed for growth, movement, and repair.
- Word equation of respiration:

Glucose + Oxygen '! Carbon dioxide + Water + Energy

- Inhaled air contains about **21% oxygen** and **0.04% carbon dioxide**.
- Exhaled air contains about **16–17% oxygen** and **4–5% carbon dioxide**.
- Not all inhaled oxygen is used; some is exhaled back.



The percentage of oxygen and carbon dioxide in inhaled and exhaled air

Breathing vs Respiration

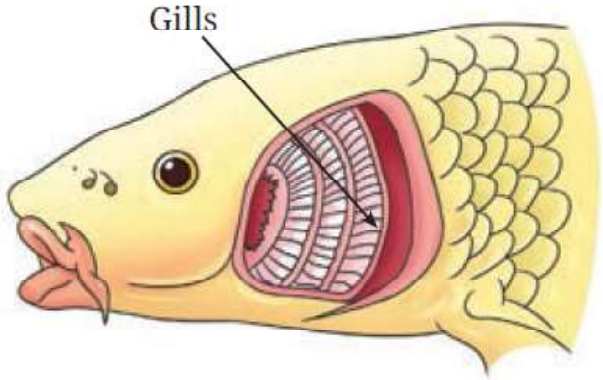
- **Breathing** is a physical process of inhaling oxygen and exhaling carbon dioxide.
- **Respiration** is a chemical process that uses oxygen to release energy from food.
- Energy released during respiration supports all life activities like walking, running, and thinking.

12. DO OTHER ANIMALS BREATHE THE SAME WAY AS HUMANS?

Like humans, all animals need oxygen for respiration and release carbon dioxide as a waste gas, but they do not all breathe in the same way. The method of breathing in animals depends on their habitat, body structure, and needs. Animals living on land, in water, or in both environments have developed different respiratory organs such as lungs or gills to obtain oxygen efficiently from their surroundings.

Important Points

- **Animals with lungs:** Animals such as birds, elephants, lions, cows, goats, lizards, and snakes breathe through lungs.
- Although all these animals have lungs, their **structure and efficiency differ** according to their lifestyle.
- **Birds** have highly efficient lungs with air sacs that supply extra oxygen, especially during flight.
- **Mammals** like elephants and lions have large, spongy lungs suitable for breathing on land.
- **Animals with gills:** Most aquatic animals such as fishes breathe through **gills**, which are specialized organs for exchanging gases in water.
- Dissolved oxygen in water enters the fish's body through the gills, which have thin, skin-like projections rich in blood vessels.
- These blood vessels absorb oxygen and release carbon dioxide into the surrounding water.
- Oxygen is carried by blood to all parts of the fish's body for respiration, while carbon dioxide is brought back to the gills and expelled.



Breathing body parts in a fi sh

13. CIRCULATION IN HUMANS

The human body has a well-organised transport system that supplies essential substances like oxygen and nutrients to every cell and removes waste materials. This transport system is known as the **circulatory system**. It consists mainly of the heart, blood, and blood vessels. The heart works like a strong pump that continuously pushes blood throughout the body. Blood carries oxygen from the lungs and nutrients from digested food to different organs and tissues. At the same time, it collects waste substances such as carbon dioxide and transports them to organs like the lungs, kidneys, and skin for removal. In this way, circulation helps maintain life by ensuring that all body parts receive what they need to function properly.

Key Points

- The **circulatory system** is responsible for transporting oxygen, nutrients, hormones, and other useful substances to body cells.
- The **heart** acts as a pumping organ that keeps blood flowing continuously.
- **Blood vessels** form an extensive network throughout the body and include:
  - **Arteries** – carry blood away from the heart
  - **Veins** – carry blood back to the heart
  - **Capillaries** – thin vessels that allow exchange of materials between blood and cells
- Blood also carries **waste materials**, such as carbon dioxide, from cells to excretory organs for removal.
- All body systems, including the digestive, respiratory, and circulatory systems, **work together** to maintain coordination and sustain life.

EXERCISE-I NCERT Essentials

Q.1 Complete the journey of food through the alimentary canal by filling up the boxes with appropriate parts—

Food → Mouth → ____ → Stomach → ____ → ____ → Anus

Q.2 Sahil placed some pieces of *chapati* in test tube A. Neha placed chewed *chapati* in test tube B, and Santushti took boiled and mashed potato in test tube C. All of them added a few drops of iodine solution to their test tubes—A, B, and C, respectively.
What would be their observations? Give reasons.

Q.3 What is the role of the diaphragm in breathing?
(i) To filter the air
(ii) To produce sound
(iii) To help in inhalation and exhalation
(iv) To absorb oxygen

Q.4 Match the following

Name of the part		Functions	
(i)	Nostrils	(a)	fresh air from outside enters
(ii)	Nasal passages	(b)	exchange of gases occurs
(iii)	Windpipe	(c)	protects lungs
(iv)	Alveoli	(d)	tiny hair and mucus help to trap dust and dirt from the air we breathe
(v)	Ribcage	(e)	air reaches our lungs through this part

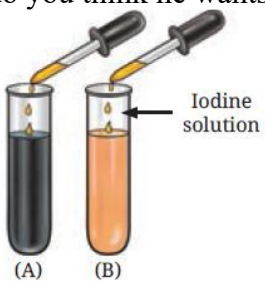
Q.5 Anil claims to his friend Sanvi that respiration and breathing are the same process. What question(s) can Sanvi ask him to make him understand that he is not correct?

Q.6 Which of the following statements is correct and why?
Anu: We inhale air.
Shanu: We inhale oxygen.
Tanu: We inhale air rich in oxygen.

Q.7 We often sneeze when we inhale a lot of dust-laden air. What can be possible explanations for this?

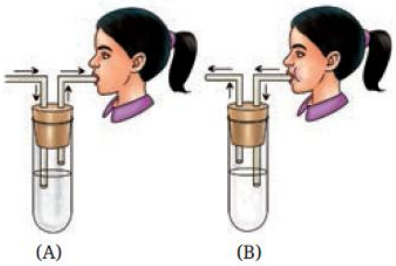
Q.8 Paridhi and Anusha of Grade 7 started running for their morning workout. After they completed their running, they counted their breaths per minute. Anusha was breathing faster than Paridhi. Provide at least two possible explanations for why Anusha was breathing faster than Paridhi.

Q.9 Yadu conducted an experiment to test his idea. He took two test tubes, A and B, and added a pinch of rice flour to the test tubes, half-filled with water and stirred them properly. To test tube B, he added a few drops of saliva. He left the two test tubes for 35–45 min. After that, he added iodine solution into both the test tubes. Experimental results are as shown in Fig. What do you think he wants to test?



Experimental results

Q.10 Rakshita designed an experiment taking two clean test tubes, A and B and filled them with lime water as shown in the figure. In test tube A, the surrounding air that we inhale was passed on by sucking air from the pipe, and in test tube B, the exhaled air was blown through the pipe (Fig.). What do you think she is trying to investigate? How can she confirm her findings?



Experimental set-up

EXERCISE-II Brain Booster MCQs

MCQ BASED QUESTIONS :

Q.1 The site of cellular respiration is
(A) chloroplast (B) nucleus
(C) mitochondria (D) cell membrane

Q.2 What is the raw material for the cellular respiration?
(A) Glucose (B) Sucrose
(C) Fructose (D) Starch

Q.3 Which of the following organisms can do anaerobic respiration?
(A) Euglena (B) Yeast
(C) Paramecium (D) Amoeba

Q.4 What are the end products of aerobic respiration?
(A) Carbon dioxide, water and energy
(B) Alcohol, carbon dioxide and energy
(C) Lactic acid and energy
(D) None of the above

Q.5 Which are the gases involved in breathing?
(A) O_2 and NO_2 (B) O_2 and SO_2
(C) O_2 and O_3 (D) O_2 and CO_2

Q.6 Name the organ of the body in which the blood is oxygenated.
(A) Heart (B) Lungs
(C) Lever (D) Pancreas

Q.7 After heavy exercise, due to the accumulation of which substance we get muscle cramps?
(A) Malaic acid (B) Fumaric acid
(C) Lipoic acid (D) Lactic acid

Q.8 Yeasts are used in
(A) wine and beer industry
(B) bakery
(C) in both (D) none of these

Q.9 In the following figure of respiratory system organs labelled by 1 and 2 are respectively:

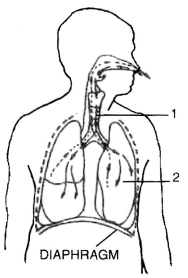


Fig. Respiratory system

(A) Tracheae, Lungs
(B) Lungs, Tracheae
(C) Nasal cavity, Lungs
(D) Lungs, Nasal cavity

Q.10 Breathing rate in human beings in normal condition is
(A) 12-15 times in a minutes
(B) 15-18 times in a minutes
(C) 18-22 times in a minutes
(D) 22-25 times in a minutes

Q.11 Digestion within a digestive tract is
(A) incomplete
(B) extracellular
(C) the same as absorption
(D) an irreversible process

Q.12 Where is bile stored in the human body ?
(A) Liver (B) Gall bladder
(C) Spleen (D) Blood

Q.13 Which of the following regions of the alimentary canal of man does not secrete a digestive enzyme ?
(A) Oesophagus (B) Stomach
(C) Duodenum (D) Mouth

Q.14 A digestive enzyme, salivary amylase, in the saliva begin digestion of
(A) protein (B) nucleic acids
(C) facts (D) carbohydrates

Q.15 Which one of the following enzyme acts efficiently at pH 2.0?
(A) Pepsin (B) Trypsin
(C) Chymotrypsin (D) All the above

Q.16 If you chew on a piece of bread long enough, it will begin to taste sweet because
(A) maltase is breaking down maltose
(B) lipases are forming fatty acids
(C) amylase is breaking down starches to disaccharides
(D) disaccharides are forming glucose

Q.17 Humans are unable to digest the cellulose of the food because
(A) their stomach is not divided into compartments.
(B) the lumen of the small intestine is narrow.
(C) they are unable to chew cellulose.
(D) certain bacteria that are present in ruminants are not present in humans.

Q.18 Saliva has the enzyme
(A) pepsin (B) ptyalin
(C) trypsin (D) rennin

Q.19 Number of permanent teeth in humans is
(A) 28 (B) 30
(C) 32 (D) 34

Q.20 Pepsin digests
(A) proteins in stomach
(B) carbohydrates in duodenum
(C) proteins in duodenum
(D) fats in ileum

Q.21 Digestion of starch starts from
(A) stomach (B) intestine
(C) oesophagus (D) mouth

Q.22 Chief function of HCl is
(A) to maintain a low pH to prevent growth of micro-organisms
(B) to facilitate absorption
(C) to maintain low pH to activate pepsinogen to form pepsin
(D) to dissolve enzyme secreted in stomach

Q.23 In human being number of stomach is
(A) 1 (B) 2
(C) 3 (D) 4

Q.24 If the stomach did not produce any hydrochloric acid, which enzyme will not function?
(A) Ptyalin (B) Trypsin
(C) Pepsin (D) Collagenase

Q.25 Total number of canines in permanent dental set of human is
(A) 4 (B) 6
(C) 2 (D) 12

Q.26 Chief function of bile is
(A) to digest fat by enzymatic action
(B) to emulsify fat for digestion
(C) to eliminate waste product
(D) to regulate process of digestion

Q.27 What is common among gastric amylase, rennin and pepsin
(A) all these are protein
(B) all these are protein digesting enzymes
(C) all these are not produced in stomach
(D) all these act at lower pH

Q.28 Where is bile produced ?
(A) In gall bladder (B) In blood
(C) In liver (D) In spleen

Q.29 Digestion is completed in
(A) duodenum (B) ileum
(C) stomach (D) large Intestine

Q.30 Ileum is
(A) first part of the small intestine
(B) middle part of the small intestine
(C) last part of the small intestine
(D) not a part of the small intestine

Q.31 The alimentary canal starts from:
(A) Stomach (B) Mouth
(C) Oesophagus (D) Small intestine

Q.32 Which enzyme in saliva helps break down starch?
(A) Pepsin (B) Amylase
(C) Lipase (D) Trypsin

Q.33 The longest part of the alimentary canal is:
(A) Large intestine (B) Small intestine
(C) Oesophagus (D) Stomach

Q.34 Which part of the respiratory system filters dust and dirt?
(A) Lungs (B) Windpipe
(C) Nasal passages (D) Alveoli

Q.35 Gas exchange in lungs occurs in:
(A) Bronchi (B) Alveoli
(C) Windpipe (D) Diaphragm

Q.36 The dome-shaped muscle below the lungs is called:
(A) Ribcage (B) Diaphragm
(C) Intercostal muscle (D) Chest muscle

Q.37 Which organ stores bile?
(A) Liver (B) Pancreas
(C) Gall bladder (D) Stomach

Q.38 The waste material expelled from the anus is called:
(A) Urea (B) Stool
(C) Bile (D) Mucus

Q.39 Amphibians like frogs breathe through:
(A) Only lungs (B) Only gills
(C) Only skin
(D) Lungs, gills, and skin

Q.40 The circulatory system includes:
(A) Heart only
(B) Blood vessels only
(C) Blood only
(D) Heart, blood vessels, and blood

EXERCISE-III Concept Check

TRUE AND FALSE :

Q.1 All living organisms respire to get energy from food.

Q.2 Cellular respiration takes place in the cells of all organisms.

Q.3 Muscles can also respire anaerobically.

Q.4 During heavy exercise the breathing rate declines.

Q.5 Breathing involves the upward movement of the diaphragm.

Q.6 The percentage of carbon dioxide is higher in exhaled air in comparison to inhaled air.

Q.7 Roots take up air from the air spaces present between the soil particles.

Q.8 Digestion of starch starts in the stomach.

Q.9 The tongue helps in mixing food with saliva.

Q.10 The gall bladder temporarily stores bile.

Q.11 The ruminants bring back swallowed grass into their mouth and chew it for some time.

FILL IN THE BLANKS :

Q.1 In higher animals, respiration occurs through _____ .

Q.2 The food has _____ which is released during _____ .

Q.3 Yeasts can survive in the absence of air. They are called _____ .

Q.4 The accumulation of _____ causes muscle cramps.

Q.5 The taking in of air rich in oxygen into body is called _____ .

Q.6 Breathing involves the movement of the _____ and the _____ .

Q.7 The main steps of nutrition in humans are _____ , _____ , _____, _____ and _____.

Q.8 The largest gland in the human body is _____.

Q.9 The stomach releases hydrochloric acid and _____juices which act on food.

Q.104. The inner wall of the small intestine has many finger-like outgrowth called _____.

Q.11 Amoeba digests its food in the _____.

ASSERTION & REASON :

Instructions: Each question contains an Assertion (A) and a Reason (R). Choose the correct option:

(A) Both A and R are true, and R is the correct explanation of A

(B) Both A and R are true, but R is not the correct explanation of A

(C) A is true, but R is false

(D) A is false, but R is true

Q.1 **Assertion (A):** Ruminants chew their food twice.
Reason (R): Ruminants have a complex stomach with four chambers.

Q.2 **Assertion (A):** Fish can survive underwater.
Reason (R): Fish have gills to extract oxygen from water.

Q.3 **Assertion (A):** Villi increase the surface area of the small intestine.
Reason (R): Increased surface area helps in better absorption.

Q.4 **Assertion (A):** The stomach produces acid.
Reason (R): Acid helps in killing harmful bacteria.

Q.5 **Assertion (A):** Smoking is harmful.
Reason (R): Smoking damages the lungs and causes diseases.

CASE STUDY :

Case Study 1: Breathing Mechanism

Priya made a model using a plastic bottle, balloons, and rubber sheet to demonstrate breathing.

Q.1 When the rubber sheet is pulled down, the balloons:
(A) Deflate (B) Inflate
(C) Remain same (D) Burst

Q.2 The rubber sheet represents:
(A) Lungs (B) Ribs
(C) Diaphragm (D) Windpipe

Q.3 This model demonstrates:
(A) Gas exchange
(B) Breathing mechanism
(C) Circulation
(D) Digestion

Q.4 When we inhale, the diaphragm:
(A) Moves up
(B) Moves down
(C) Stays flat
(D) Moves sideways

Case Study 2: Respiratory Health

During COVID-19, respiratory health became very important.

Q.5 Which organ is primarily affected by respiratory diseases?
(A) Heart
(B) Liver
(C) Lungs
(D) Kidneys

Q.6 Why is wearing masks important?
(A) Fashion
(B) Prevents dust
(C) Prevents infectious particles
(D) Keeps face warm

Q.7 Which breathing exercise is beneficial for health?
(A) Rapid breathing
(B) Pranayama
(C) Mouth breathing
(D) Shallow breathing

Q.8 What happens to breathing rate during fever?
(A) Decreases (B) Increases
(C) Remains same (D) Stops

MATCH THE COLUMN :

[A] [ONE TO ONE]:

Column-I and **column-II** contain **four** entries each. One entry of column-I is to be matched with one entry of column-II.

Q.1 Match the column

Column I
(a) Unicellular organisms
(b) Plants
(c) Earthworm, Leech
(d) Insects
(e) Frog
(f) Mammals
(g) Fish

Column II
(p) Skin
(q) Spiracles
(r) Cell membrane
(s) Lungs, skin
(t) Stomata
(u) Gills
(v) Lungs

(A) (a)-(r); (b)-(t); (c)-(p); (d)-(q); (e)-(s); (f)-(v); (g)-(u)
(B) (a)-(q), (b)-(s), (c)-(p), (d)-(r); (e)-(u); (f)-(t); (g)-(v)
(C) (a)-(p), (b)-(s), (c)-(q), (d)-(r); (e)-(t); (f)-(v); (g)-(u)
(D) (a)-(p), (b)-(r), (c)-(s), (d)-(q); (e)-(v); (f)-(u); (g)-(t)

Q.2 Match the column

Column I
(a) Salivary gland
(b) Stomach
(c) Liver
(d) Rectum
(e) Small intestine
(f) Large intestine

Column II
(p) Bile juice secretion
(q) Storage of undigested food
(r) Saliva secretion
(s) Acid release
(t) Digestion is completed
(u) Absorption of water
(v) Release of faeces

(A) (a)-(r); (b)-(s); (c)-(p); (d)-(v); (e)-(t); (f)-(q)
(B) (a)-(q), (b)-(s), (c)-(p), (d)-(r); (e)-(u); (f)-(t)
(C) (a)-(p), (b)-(s), (c)-(q), (d)-(w); (e)-(t); (f)-(v)
(D) (a)-(p), (b)-(r), (c)-(s), (d)-(q); (e)-(v); (f)-(w)

EXERCISE-IV Subjective Assessment

VERY SHORT TYPE QUESTIONS :

Q.1 What is a cell?

Q.2 Why do all animals respire?

Q.3 Define aerobic respiration and anaerobic respiration.

Q.4 How do unicellular organisms exchange gases with the environment?

Q.5 Why do body cells require oxygen?

Q.6 What brings oxygen to all parts of our body?

Q.7 Name the process by which energy is released from the digested food.

Q.8 Name the respiratory organs of human's respiratory system.

Q.9 Name one bad habit which can cause lung cancer.

Q.10 What is the importance of nostrils during breathing?

Q.1 Write the importance of saliva in our mouth.

Q.2 What is cud?

Q.3 What is rumination?

Q.4 What are ruminants?

Q.5 Mention the various steps involved in the process of nutrition.

Q.6 Which type of carbohydrate cannot be digested by humans ?

Q.7 Why do we call animals heterotrophs ?

Q.8 Name the type of nutrition in amoeba.

Q.9 Which organs help to sense the different taste ?

Q.10 What is the function of villi ?

SHORT TYPE QUESTIONS :

Q.11 Explain only by equations :
(i) Aerobic respiration
(ii) Anaerobic respiration in yeast
(iii) Anaerobic respiration in muscle cells.

Q.12 Why do we get muscle cramps after heavy exercise?

Q.13 What are yeasts? Why are they used to make wine and beer?

Q.14 What could be the difference in the chest size of an adult during inhalation and exhalation?

Q.15 Write one difference between breathing and respiration.

Q.11 What is tongue? Write its function.

Q.12 What is tooth decay?

Q.13 How do we feel when food particles enter the windpipe? Give the reason.

Q.14 What do you know about the liver as an organ?

Q.15 What is assimilation?

Q.16 What is the function of large intestine?

Q.17 Name the organs that make the alimentary canal.

Q.18 What is the role of hydrochloric acid in the stomach ?

Q.19 Differentiate between ingestion and egestion.

Q.20 Which is the largest chamber of the ruminant stomach ? What is its role ?

LONG TYPE QUESTIONS :

Q.16 Explain, why we get relief from cramps after a hot water bath or a massage?

Q.17 Why do we sometime yawn when we are sleepy or drowsy?

Q.18 Explain the mechanism of breathing with the help of diagram.

Q.19 What is the difference between respiration and breathing?

Q.20 Show the respiratory organs of the following
(a) amoeba (b) earthworm
(c) frog (d) cockroach
(e) fish

Q.21 Define intracellular digestion. Give two examples of animals where this type of digestion take places.

Q.22 Draw a diagram of the tongue to show the location of various taste buds.

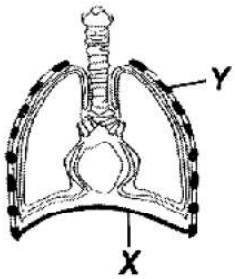
Q.23 Which digestive juice is secreted in the mouth ? What enzyme does it contain and what is its function ?

Q.24 What are digestive glands ? Name three such glands that are present in the human body. What are their secretions called ?

Q.25 What is the role of stomach in the digestion process ?

EXERCISE-V Competition Edge

Q.1 Which of the following best describes what happens to the parts X and Y during inhalation and exhalation? **(NSO-2015)**

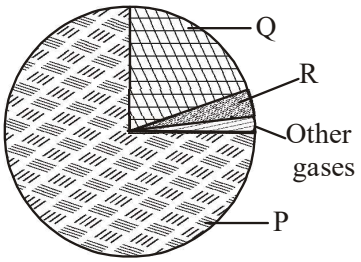


(A) X-Contracts, Y-Moves down, X-Relaxes, Y-Moves up
(B) X-Relaxes, Y-Moves down, X-Contracts, Y-Moves up
(C) X-Contracts, Y-Moves up, X-Relaxes, Y-Moves down
(D) X-Relaxes, Y-Moves up, X-Contracts, Y-Moves down

Q.2 Read the given passage. **(NSO-2015)**
Sometimes during heavy physical exercise, you body cannot get enough P to produce the required energy. To get the additional energy, Q respiration occurs in you R, during which partial breakdown of glucose occurs and S is produced. Find out incorrect statement.
(A) P represents oxygen.
(B) Q is the type of respiration that occurs in the presence of oxygen.
(C) R-represents muscle cells of our body.
(D) Accumulation of S in muscles causes muscular cramps.

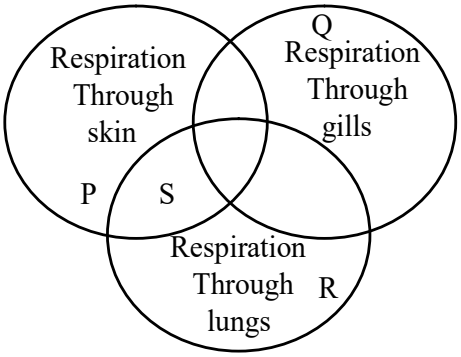
Q.3 Farheen soaked some bean seeds in water overnight. Next morning, she drained the water and kept the seeds moist till they started germinating. She boiled half of the seeds and then kept the germinating seeds in one thermos flask X and the boiled seeds in another thermos flask Y. She covered the mouth of both flasks with moist cotton wool. Then she inserted thermometers in both flasks and left them. What would be her observation after four hours? **(NSO-2016)**
(A) Temperature of flask X increases because it has photosynthesising seeds.
(B) Temperature of flask X increases because it has respiring seeds.
(C) Temperature of flask Y increases because it has boiled seeds.
(D) Both B and C

Q.4 The given diagram shows percentage composition of gases P, Q, R and other gases present in air. **(NSO-2016)**



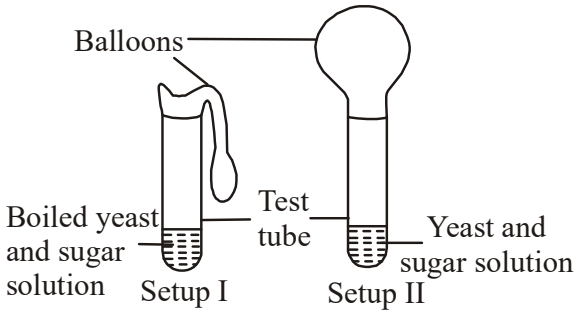
Which of the following statements is/are correct regarding gases P, Q and R?
(i) P can be fixed in soil by certain bacteria present in roots of leguminous plants.
(ii) P supports combustion whereas Q and R help in extinguishing fire.
(iii) Plants and animals release R in respiration whereas plants use Q in Photosynthesis.
(iv) R entraps sun's heat and makes earthworm and hospitable.
(A) (i) and (iv) only
(B) (ii) and (iii) only
(C) (i), (ii) and (iv) only
(D) (iii) only

Q.5 Refer to the given Venn diagram and identify P, Q, R and S. **(NSO-2016)**



(A) P - Paramecium, Q - Scoliodon, R - Spiny ant eater, S - Lung fish
(B) P-Lion tailed macaque, Q -Salmon, R-Dolphin, S - Platypus
(C) P-Earthworm, Q -Rohu, R- Blue whale, S - Frog
(D) P - Amoeba, Q - Tadpole, R - Trout, S - Snake

Q.6 Siddhi set up an experiment as shown here to investigate fermentative activity in yeast. **(NSO-2017)**



Which of the following holds incorrect regarding the given experiment?

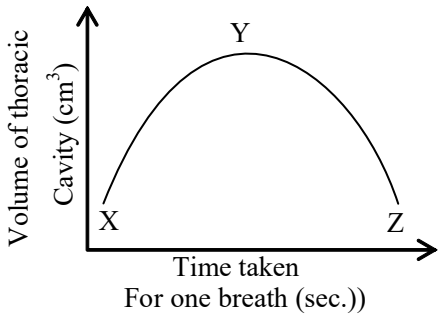
(A) The balloon of setup II got inflated due to accumulation of a gas which gives white precipitate when bubbled through calcium hydroxide solution.

(B) The balloon in setup I does not inflate as boiled yeast cannot respire.

(C) Most of the sugar solution is converted to ethyl alcohol in setup II due to anaerobic respiration of yeast.

(D) In setup I, yeast respires only aerobically whereas in setup II yeast undergoes both aerobic and anaerobic respiration

Q.7 The given graph shows changes in the volume of thoracic cavity in a normal human being while breathing. **(NSO-2017)**



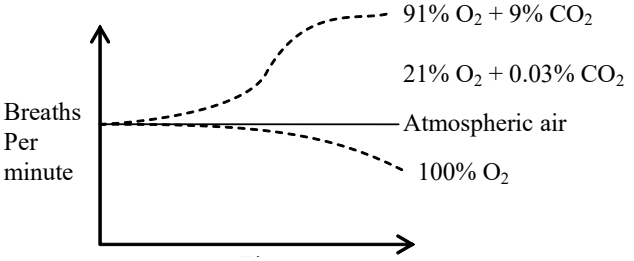
(A) From X to Y , pressure in lungs increases whereas from Y to Z pressure in lungs decreases.

(B) From X to Y, ribs move upward and outward whereas from Y to Z ribs move downward and inward.

(C) At point Y diaphragm is dome shaped whereas at points X and Z it is flat.

(D) X to Y represents exhalation and Y to Z represents inhalation.

Q.8 The given graph shows how the rate of breathing of a person changes under different conditions. At the beginning of each experiment, the person is breathing in atmospheric air. **(NSO-2017)**



What conclusion may be derived from the graph?

(A) High level of oxygen in the air causes breathing rate to drop, regardless of carbon dioxide level.

(B) Increase in carbon dioxide level in air causes breathing rate to increase unto a limit.

(C) Breathing rate is controlled only by oxygen content of air and is independent of carbon dioxide concentration.

(D) None of these

Q.9 Consider the following statements and select the option which correctly identifies true (T) and false (F) ones. **(NSO-2019)**

(i) In cockroaches, air enters the body through spiracles.

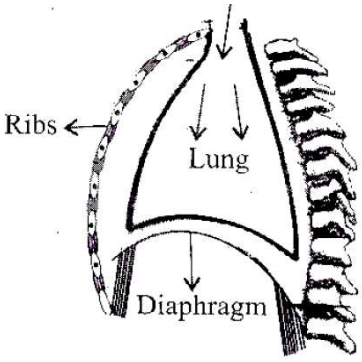
(ii) During heavy exercise, we get cramps in the legs due to accumulation of carbon dioxide.

(iii) Normal range of breathing rate per minute in an average adult person at rest is 12-18.

(iv) During exhalation, the ribs move upwards.

	(i)	(ii)	(iii)	(iv)
(A)	F	T	F	T
(B)	T	T	F	T
(C)	T	F	T	F
(D)	T	T	T	F

Q.10 Observe the given figure. **(NSO-2019)**



What will be the condition of the given structures when we breath in air?

	Rib	Cage	Diaphram	Lungs	pressure
(1)	Down	and	In	Contracts	High
(2)	Up	and	out	Relaxes	High
(3)	Up	and	out	Contracts	Low
(4)	Down	and	in	Relaxes	Low

Q.11 Match the following correctly:**(CSO 2021-22)**

Organisms	How they Breathe/ respire
1. Cockroach	a. Gills
2. Earthworm	b. Spiracles
3. Fish	c. Stomata
4. Green plants	d. Skin

(A) 1 - b, 2 - d, 3 - a, 4 - c
(B) 1 - a, 2 - b, 3 - d, 4 - c
(C) 1 - b, 2 - a, 3 - c, 4 - d
(D) 1 - b, 2 - a, 3 - d, 4 - c

Q.12 Which of the following organs are parts of the human respiratory system? **(CSO 2021-22)**

I. Pharynx II. Nostrils
III. Gullet IV. Windpipe
V. Lungs

(A) II and V only
(B) II, IV and V only
(C) I, II, IV and V only
(D) I, II, III, IV and V

Q.13 Read the given statements and select the correct option.

(NSO-2015)

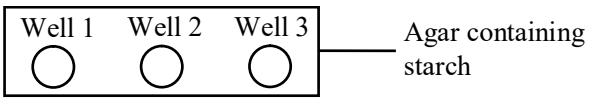
Statement 1 : Chemical digestion of food involves breaking down of food by chewing and churning.

Statement 2 : Mechanical digestion of food involves coversion of complex substances such as carbohydrates into their simpler forms such as glucose by enzymatic action.

(A) Both statements 1 and 2 are true and statement 2 is the correct explanation of statement 1.
(B) Both statements 1 and 2 are true but statement 2 is not the correct explanation of statement 1.
(C) Statement 1 is true but statement 2 is false.
(D Both statements 1 and 2 are false.

Q.14 Digestive juices were collected from three different regions of the alimentary canal. Drops of these juices were added to wells made in an agar of starch as shown below.

(NSO-2016)



After an hour, the wells were rinsed with distilled water and flooded with iodine solution. "The results are shown below.

Well	1	2	3
Colour of iodine solution	Blue - black	Yellow - brown	Yellow - brown

Which of the following correctly identifies the regions of the alimentary canal from which the three digestive juices were obtained?

(A) Well-1 Mouth cavity, Well-2 Small intestine, Well-3 Stomach
(B) Well-1 Mouth cavity, Well-2 Stomach, Well-3 Small intestine
(C) Well-1 Small intestine, Well-2 Mouth cavity, Well-3 Stomach
(D Well-1 Stomach, Well-2 Mouth cavity, Well-3 Small intestine

Q.15 Read the given paragraph where few words have been italicised. **(NSO-2016)**

Buccal cavity of humans contains two pairs of salivary glands which secrete digestive juices that help in digestion of proteins present in food. From here food enters stomach where digestion of mainly *fats* takes place. As this semi-digested food enters small intestine complete digestion of food occurs. Small intestine receives bile juice from pancreas which *digests* fats. Most absorption of water occurs in *large intestine.*

Select the correct option regarding this.

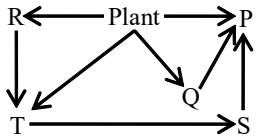
(A) Two should be replaced by four whereas proteins should not be replaced as it is correctly mentioned.
(B) Fats should be replaced by carbohydrates and pancreas should be replaced by liver.
(C) Digests should be replaced by emulsifies.
(D Large should be replaced by small.

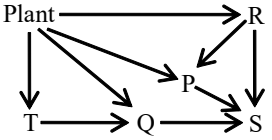
Q.16 The given table classifies five animals P, Q, R, S and T according to their feeding habits. These animals live in the same habitat.

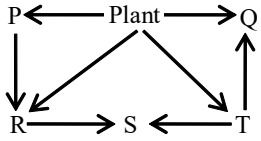
(NSO 2016)

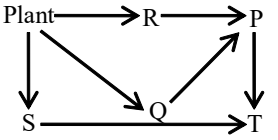
Carnivore	Harbivore	Ornnivore
S	R	P
	T	Q

Which of the following shows their correct interlinking with respect to their feeding habits?

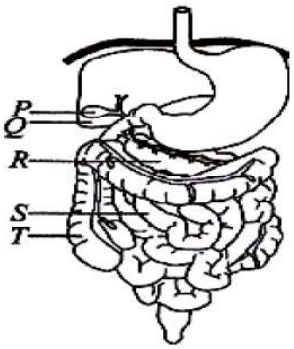
(A)


(B)


(C)


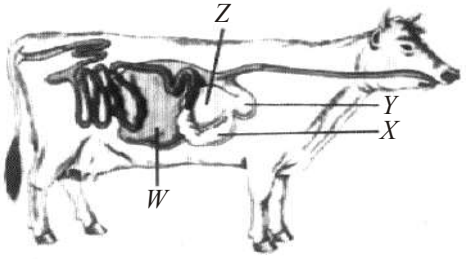
(D


Q.17 Refer to the given diagram of human digestive system and select the correct option regarding its labelled parts P, Q, R, S and T. **(NSO 2018)**



(A) R secretes digestive enzymes via. amylase, lipase, pepsin, trypsin, etc.
(B) P secretes bile juice whereas T secretes hydrochloric acid.
(C) S is longer in herbivores as compared to carnivores to aid the digestion of cellulose rich food.
(D Q is the largest digestive gland which secretes different enzymes for digestion of fats, proteins and carbohydrates.

Q.18 Refer to the given diagram of stomach of ruminant mammal with its parts labelled as "W, X, Y and Z and select the incorrect statement regarding them. **(NSO-2019)**



(A) The parts labelled W, X, Y and Z are called rumen, abomasum, reticulum and omasum respectively.
(B) The part labelled X is true stomach.
(C) Food is completely digested in chambers W and Y.
(D None of these

Q.19 Which of the following is/are wrongly classified? **(CSO 2021-22)**
P: Ingestion- The process of taking food into the body.
Q: Absorption- Process by which absorbed nutrients became part of the body.
R: Assimilation- Process by which absorbed nutrients become part of the body.
S: Egestion- Process by which faecal matter is removed through the anus.
(A) Q and R (B) P and Q
(C) R and S (D P and S

Q.20 Choose the correct option which completes the following passage: **(CSO 2021-22)**
A herbivore quickly swallows the grass and stores it in a part of the stomach calledrumen. It is likely to be having a large sac-like structure called ____. Which is between the small intestine and large intestine.
(A) Rumen (B) Ileum
(C) Duodenum (D Caecum

Q.21 Pam wrote two statements. They are as follows: **(CSO 2021-22)**
1. In the starch test using iodine, the leaf turns blue-black in colour.
2. The structures in the leaves, which contain chlorophyll are called chloroplasts.
Which of the above statement(s) is/are true?
(A) Statement 1 only
(B) Statement 2 only
(C) Both the statements are true
(D Both the statements are false

Q.22 Study the table given below and identify X, Y and Z correctly from the given options: **(CSO 2021-22)**

Parasites	Saprotrophs	Insectivorous plants
Orchid	Fungi	Venus flytrap
X	Y	Z

(A) X-Pitcher plant, Y-Pistia, Z-China rose
(B) X-Pistia, Y-Algae, Z-China rose
(C) X-Pitcher plant, Y-Mushroom, Z-Cuscuta
(D X-Cuscuta, Y-Bacteria, Z-Pitcher plant

Q.23 In the following question, an assertion and a reason are given. Choose the correct option: **(CSO 2021-22)**

Assertion: Food stays in the stomach from a few minutes to few hours depending onthe type of food eaten.

Reason: Digestion of starch begins in the stomach and digestion of proteins completes in the stomach.

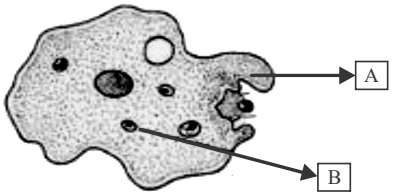
(A) Both assertion and reason are true and reason is the correct explanation of assertion

(B) Both assertion and reason are true and reason is not the correct explanation of assertion

(C) Assertion is true but reason is false

(D Assertion is false but reason is true

Q.24 Maya drew the picture of the single-celled organism named amoeba below. Help her to identify parts named A and B and also the function of part A correctly: **(CSO 2021-22)**



(A) Part A - Pseudopodia, Part B - Food vacuole, Function of part A - To move and capture food

(B) Part A-Mitochondria, Part B- Cytoplasm, Function of part A - To digest food.

(C) Part A -Cytoplasm, Part B- Mitochondria, Function of part A - To sense food outside.

(D Part A -Food vacuole, Part B- Pseudopodia, Function of part A- To digest food

Q.25 Read the clues given below and identify the organism: **(CSO 2021-22)**

Clue 1: I am an alga.

Clue 2: I live together with fungus.

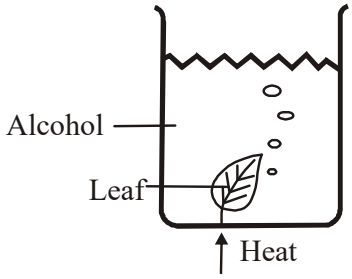
Clue 3: I show a symbiotic relationship with the fungus.

Who am I?

(A) Lichens (B) Parasites

(C) Mushroom (D Rhizobium

Q.26 The diagram below shows a step carried out before aniodine test to determine if plants make food. **(NSTSE -22)**



Which of the following correctly shows the reasons for carrying out the step shown?

(A) To remove the chlorophyll

(B) To keep the chlorophyll

(C) To harden the leaf

(D To soften the leaf

Q.27 While a student was eating a piece of bread, a sweet taste developed in her mouth when she chewed on it for some time. What makes bread taste sweet? **(NSTSE -22)**

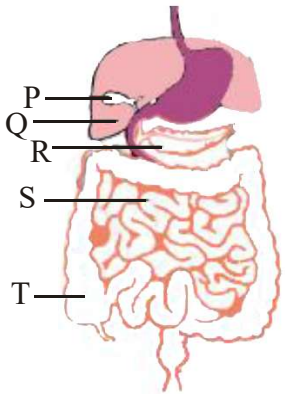
(A) Bacteria in the mouth fed on starch and produced sugar.

(B) Enzymes in the saliva breakes down the starch.

(C) Sugars in the bread diffused into her mouth.

(D There was a greater secretion of sugar in saliva.

Q.28 Refer to the diagram of the human digestive system. **(NSTSE -22)**



Which of the following are produced by R?

(i) Amylase (ii) Insulin

(iii) Lipase (iv) Pepsin

(A) (i), (ii) and (iii) only

(B) (i), (iii) and (iv) only

(C) (ii), (iii) and (iv) only

(D (i), (ii), (iii) and (iv)

ANSWER KEY

EXERCISE-II

MULTIPLE CHOICE QUESTIONS :

Q.1	C	**Q.2**	A	**Q.3**	B	**Q.4**	A	**Q.5**	D	**Q.6**	B	**Q.7**	D
Q.8	A	**Q.9**	A	**Q.10**	B	**Q.11**	B	**Q.12**	B	**Q.13**	A	**Q.14**	D
Q.15	A	**Q.16**	C	**Q.17**	D	**Q.18**	B	**Q.19**	C	**Q.20**	A	**Q.21**	D
Q.22	C	**Q.23**	A	**Q.24**	C	**Q.25**	A	**Q.26**	B	**Q.27**	D	**Q.28**	C
Q.29	B	**Q.30**	C	**Q.31**	B	**Q.32**	B	**Q.33**	B	**Q.34**	C	**Q.35**	B
Q.36	B	**Q.37**	C	**Q.38**	B	**Q.39**	D	**Q.40**	D				

EXERCISE-III

TRUE AND FALSE :

Q.1	True	**Q.2**	True	**Q.3**	True	**Q.4**	False
Q.5	False	**Q.6**	True	**Q.7**	True	**Q.8**	True
Q.9	True	**Q.10**	True	**Q.11**	True		

FILL IN THE BLANKS :

Q.1	lungs	**Q.2**	stored energy, respiration	**Q.3**	anaerobes	**Q.4**	lactic acid
Q.5	inhalation	**Q.6**	diaphragm, rib-cage				
Q.7	ingestion, digestion, absorption, assimilation, egestion			**Q.8**	liver	**Q.9**	gastric
Q.10	villi	**Q.11**	food vacuole				

ASSERTION & REASON

Q.1	A	**Q.2**	A	**Q.3**	A	**Q.4**	A	**Q.5**	A

CASE STUDY

Q.1	B	**Q.2**	C	**Q.3**	B	**Q.4**	B	**Q.5**	C
Q.6	C	**Q.7**	B	**Q.8**	B				

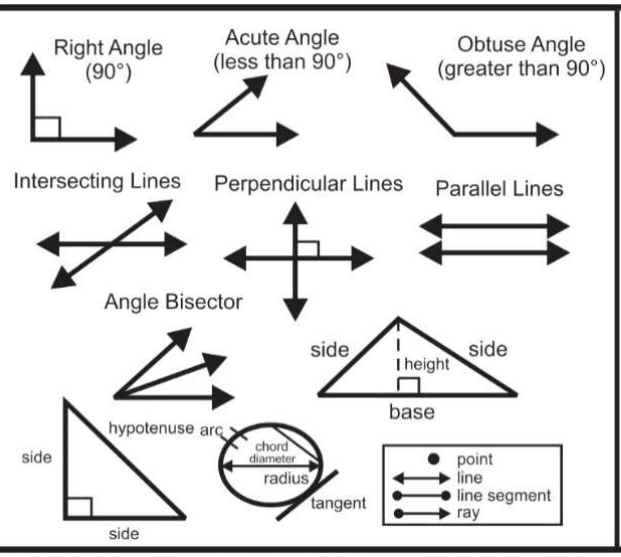
MATCH THE COLUMN :

Q.1	A	**Q.2**	A

EXERCISE-V

Q.1	C	**Q.2**	B	**Q.3**	B	**Q.4**	A	**Q.5**	C	**Q.6**	B	**Q.7**	B
Q.8	B	**Q.9**	C	**Q.10**	C	**Q.11**	A	**Q.12**	C	**Q.13**	D	**Q.14**	D
Q.15	C	**Q.16**	B	**Q.17**	A	**Q.18**	C	**Q.19**	A	**Q.20**	D	**Q.21**	C
Q.20	D	**Q.23**	C	**Q.24**	A	**Q.25**	A	**Q.26**	A	**Q.27**	B	**Q.28**	A

5. Parallel & Intersecting Lines



Geometry is all about lines, dots and angles. Thus when drawing sketches or architectural plans, we often use geometry to figure out the actual details of the plans. In this chapter, we will study the properties of the angles formed when two lines intersect each other and also the properties of the angles formed when a line intersect two or more parallel lines at distinct points.

1. INTRODUCTION

In this chapter apart from point, line, line segment, we will deal with types of angles such as complementary angles, supplementary angles, adjacent angles, linear pair angles, vertically opposite angles. Also about angles formed when transversal cut two parallel lines and their appears corresponding angles, alternate interior angles, alternate exterior angles and co-interior angles.

2. DEFINITION

2.1 Point:

A fine dot made by a sharp pencil or a geometrical figure having no length, breadth and height as called a point.

2.2 Line segment

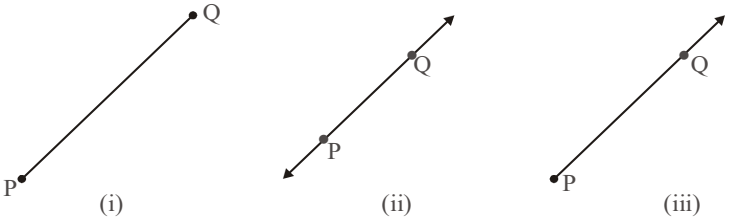
If we join two fixed points then the figure formed is called line segment.

2.3 Line

If we extend the two end points of a line segment in either direction endlessly then it is called a line. It has no definite length.

2.4 Ray

If we extend one end point of a line segment endlessly then it is called a ray.

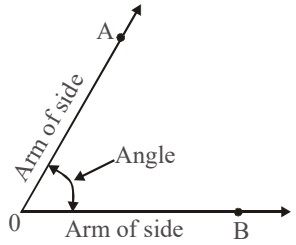


In figure (i) It shows a line segment and it is represented as $\overline{PQ}$. Fig (ii) shows a line which is represented as $\overleftrightarrow{PQ}$. Fig (iii) shows a ray and it is represented as $\overrightarrow{PQ}$.

2.5 Angle

An angle is formed by intersecting two rays. The intersection point is the common initial point of these two rays which is called as vertex of the angle. We use the **symbol '** $\angle$ **'** to denote the measure of the angle

- An angle is an inclination between two rays with the same initial point.



In this fig. the angles are $\angle AOB$ or $\angle$BOA.

3. DIFFERENT TYPES OF ANGLES

3.1 Acute angle: An acute angle is an angle whose measure lies between 0^0 and 90^0.

3.2 Right angle: A right angle is an angle whose measure is exactly 90^0. Symbol '**L**' is used to represent a right angle.

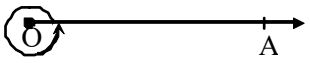
3.3 Obtuse angle: It is an angle whose measure is greater than 90^0 but less then 180°.

3.4 Straight angle: It is an angle which is exactly 180^0.

3.5 Reflex angle: A reflex angle is greater than 180^0 but less than 360^0.

3.6 Complete angle

An angle of 360° is called a complete angle.



4. SPECIAL PAIRS OF ANGLES

4.1 Adjacent angle :

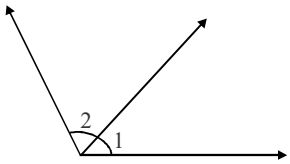
If a pair of angles have :

a. a common vertex

b. a common arm

c. and their non-common arms are on either side of the common arm. Such pairs of angles are called adjacent angles. Adjacent angles have no common interior points.

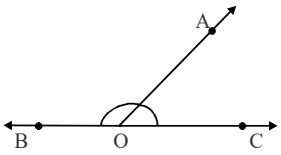
For example,



$\angle 1$ and $\angle 2$ are called the adjacent angles.

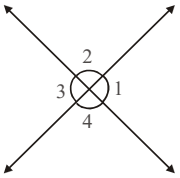
4.2 Linear pair: A pair of adjacent angles whose non-common sides are opposite rays. The angles in a linear pair are supplementary.

For example,



Here OA is common arm and OB and OC form opposite rays. $\angle AOB + \angle AOC = 180°$
By seeing this fig. we can say that if a ray stand on a line, then the sum of the two adjacent angles so formed is 180°.

4.3 Vertically opposite angles



In this fig. two lines intersect and the angles formed are $\angle 1, \angle 2, \angle 3$ and $\angle 4$. $\angle 1$ **and** $\angle 3$ **are vertically opposite angles.** Similary $\angle 2$ **and** $\angle 4$ **are vertically opposite angles.** When two lines intersect then the **vertically opposite angles are equal.**
We can see from fig. that

$\angle 1 + \angle 2 = 180^0$ (Because $\angle 1, \angle 2$ form a linear pair) — (i)

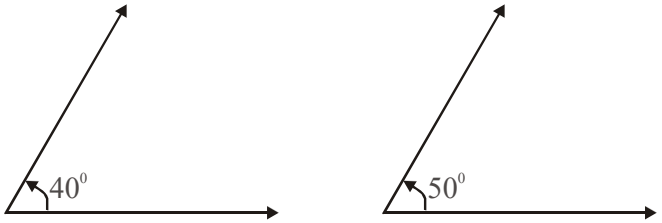
and $\angle 2 + \angle 3 = 180^0$ (Similarly $\angle 2, \angle 3$ form a linear pair) — (ii)

from these 2 equations $\angle 1 = \angle 3$

Similarly we can prove that $\angle 2 = \angle 4$

4.4 Complementary angles: If the sum of the measures of two angles is 90^0 then the angles are complementary angles and each angle is complement of the other angle.

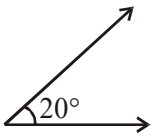
For example,

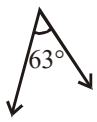


(i) (ii)

These two angles are complementary angles.

Ex. Find the complement of the following angels.

(i) 

(ii) 

(i) 90° - 20° = 70° **(ii) 90° - 63° = 27°**

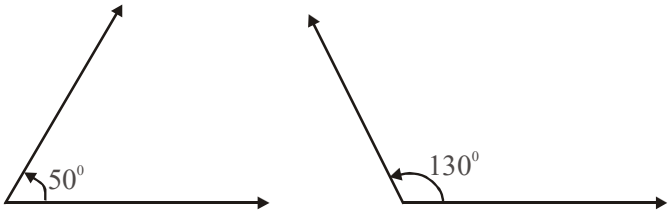
Let's know

(i) If two angles are complement of each other, then each is an acute angle except the pair (90°, 0°). But any two acute angles need not be complementary. For example, angles of measure 30° and 50° are not complement of each other.

(ii) Two obtuse angles cannot be complement of each other.

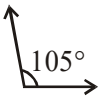
(iii) Two right angles cannot be complement of each other.

4.5 Supplementary angles: If the sum of the measures of two angles is 180^0 then the angles are called supplementary angles and each angle is said to be the supplement of the other.



(i) (ii)

Ex. Find the supplement of each of the following angles.

(i) 

(ii) 

(i) $180° - 105° = 75°$ (ii) $180° - 154° = 26°$

EXAMPLES

Example 1 : Find the measure of an angle which is complement of itself.

Solution : Let the measure of the angle be x^o. Then, the measure of its complement is given to be x^o.

Since, the sum of the measures of an angle and its complement is 90^o.

$\therefore \quad x^o + x^o = 90^o$

$\Rightarrow \quad 2x^o = 90^o \quad \Rightarrow \quad x^o = 45$

Hence, the measure of the angle is 45^o.

Example 2 : Two supplementary angles differ by 34^o. Find the angles.

Solution : Let one angle be x^o. Then, the other angle is $(x + 34)^o$.

Now, x^o and $(x + 34)^o$ are supplementary angles.

$\therefore \quad x^o + (x + 34)^o = 180^o$

$\Rightarrow \quad 2x^o + 34^o = 180^o$

$\Rightarrow \quad 2x^o = 180^o - 34^o$

$\Rightarrow \quad 2x^o = 146^o$

$\Rightarrow \quad x^o = 73^o$.

Hence, the measures of two angles are 73^o and $73^o + 34^o = 107^o$.

Let's know

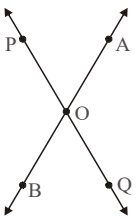
(i) Two acute angles cannot be supplement of each other.

(ii) Two right angles are always supplementary.

(iii) Two obtuse angles cannot be supplement of each other.

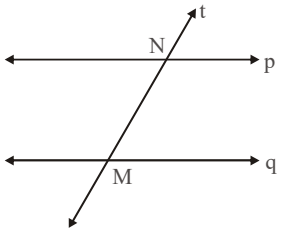
5. PAIR OF LINES

5.1 **Intersecting lines :** Two lines are called intersecting lines if they have a common point. This common point is called the point of intersection.



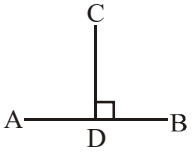
AB and PQ is called the intersecting lines and O is called a point of intersection.

5.2 Transversal : A line that intersects two or more lines at distinct points is called a transversal.



In this fig. t is the transversal which cut two lines p and q at distinct points, 'N' and 'M' respectively.

5.3 Perpendicular lines:

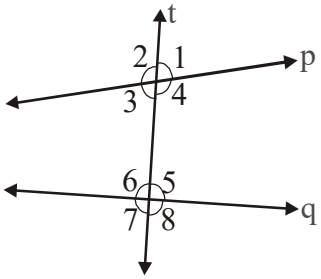


CD is perpendicular to AB

CD $\perp$ AB

6. ANGLES MADE BY A TRANSVERSAL

Two lines p and q cut by a transversal t. It form angles that have some special names as :



(i) Exterior angles : The angles whose arms do not contain the segment on the transversal cut by the given lines are called exterior angles. Such as $\angle 1$, $\angle 2$ and $\angle 7$ and $\angle 8$

(ii) Interior angles : The angles whose one of the arms contains the segment on the transversal cut by the given lines are called interior angles. Such as $\angle 3$, $\angle 4$, $\angle 5$ and $\angle 6$

(iii) Corresponding angles : A pair of angles in which one arm of both the angles of the pair is on the same side of the transversal and the other arms are directed in the same sense is called a pair of corresponding angles. Such as $\angle 1$ and $\angle 5$, $\angle 4$ and $\angle 8$, $\angle 2$ and $\angle 6$ and $\angle 3$ and $\angle 7$ are corresponding angles.

(iv) Alternate interior angles : A pair of angles in which one arm of each of the angles is on opposite sides of the transversal and whose other arm contains the segment on the transversal cut by the given lines is called a pair of alternate interior angles.

(v) Alternate exterior angles : A pair of angles in which one arm of each of the angles is on opposite sides of the transversal and whose other arm is directed in opposite sense doesnot contains the segment on the transversal cut by the given lines is called a pair of alternate exterior angles.

(a) Interior angles $\rightarrow \angle 3, \angle 4, \angle 5, \angle 6$

(b) Exterior angles $\rightarrow \angle 1, \angle 2, \angle 7, \angle 8$

(c) Pairs of corresponding angles $\rightarrow \angle 1$ and $\angle 5, \angle 2$ and $\angle 6, \angle 3$ and $\angle 7, \angle 4$ and $\angle 8$

(d) Pairs of alternate interior angles $\rightarrow \angle 3$ and $\angle 5$, $\angle 4$ and $\angle 6$

(e) Pairs of alternate exterior angles $\rightarrow \angle 1$ and $\angle 7$, $\angle 2$ and $\angle 8$

(f) Pairs of interior angles on the same side of the transversal $\rightarrow \angle 3$ and $\angle 6$, $\angle 4$ and $\angle 5$

7. PARALLEL LINES

Two lines ℓ and m in the same plane are said to be parallel lines if they do not intersect when produced indefinitely in either direction and we write $\ell \parallel$ m which is read as ℓ is parallel to m. Clearly, when $\ell \parallel$ m, we have m $\parallel \ell$.

Let's know

(i) If two or more parallel lines are cut by a transversal, then each pair of the corresponding angles have equal measure.

(ii) If two parallel lines are cut by a transversal, the pair of alternate (interior as well as exterior) angles are equal.

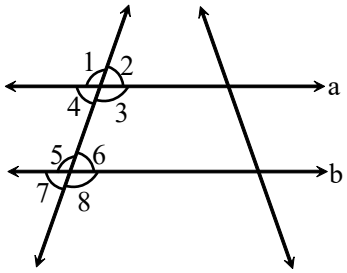
(iii) If two parallel lines are cut by a transversal, then each pair of interior angles as well as exterior angles on the same side of the transversal are supplementary.

Example 3 : State the property that is used in each of the following statements :

(i) -If a || b, then $\angle 1 = \angle 5$

(ii) -If $\angle 4 = \angle 6$, then a || b

(iii) If $\angle 4 + \angle 5 = 180°$, then a || b



Solution. (i) If a || b, then $\angle 1 = \angle 5$.

if lines are parallel then corresponding angles are equal or corresponding angle property)

(ii) If $\angle 4 = \angle 6$, then a || b (if alternate interior angles are equal the lines are parallel or alternate interior angle property)

(iii) If $\angle 4 + \angle 5 = 180°$, then a || b

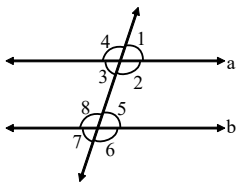
[as interior angles on the same side (co-interior angles) of the transversal are supplementary].

Example 4 : In the adjoining figure, identify

(i) the pairs of corresponding angles

(ii) the pairs of alternate interior angles

(iii) the pairs of interior angles on the same side of the transversal



(iv) the vertically opposite angles

Solution. (i) The pairs of corresponding angles are :

($\angle 1$, $\angle 5$), ($\angle 2$, $\angle 6$), ($\angle 4$, $\angle 8$) and ($\angle 3$, $\angle 7$).

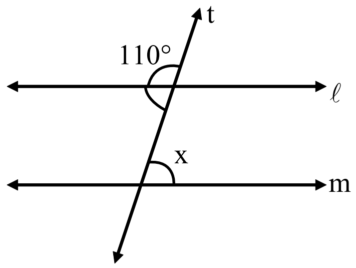
(ii) The pairs of alternate interior angles are :

($\angle 2$, $\angle 8$) and ($\angle 3$, $\angle 5$).

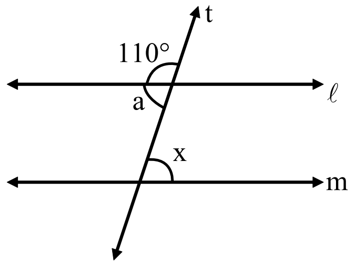
(iii) The pairs of interior angles on the same side of the transversal are ($\angle 3$, $\angle 8$) and ($\angle 2$, $\angle 5$).

(iv) The pairs of vertically opposite angles are ($\angle 1$, $\angle 3$), ($\angle 4$, $\angle 2$), ($\angle 5$, $\angle 7$) and ($\angle 6$, $\angle 8$).

Example 5 : Find the value of x, if ℓ || m.



Solution : ∵ ℓ || m and t is transversal



So,

$\angle a + 110° = 180°$ (linear pair angles)

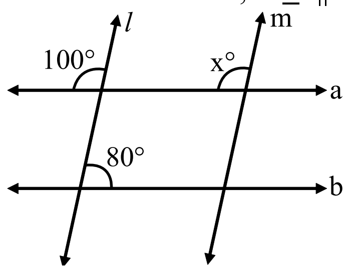
$\angle a = 180° - 110°$

$\angle a = 70°$

$\angle x = \angle a$ (alternate interior angles)

$\angle x = 70°$ (∵ $\angle a = 70°$)

Example :6 Find the value of x, if l || m.



Solution : ∵ l || m

So, $\angle x = 100°$. (corresponding angles)

Example 7: Find the value of x, if l || m.

Solution :

∵ l || m

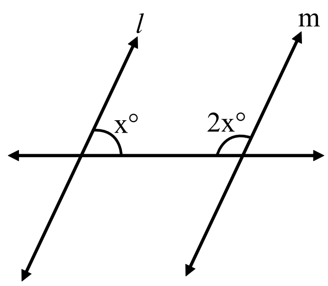
$x + 2x = 180°$ (co-interior angles on the same side of transversal are supplementary)

$\Rightarrow 3x = 180°$

$\Rightarrow x = \frac{180}{3}$

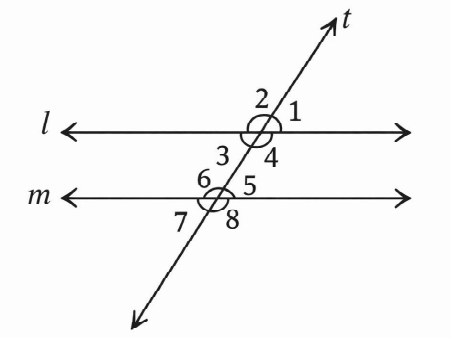
$\Rightarrow x = 60°$

Hence, x = 60°.



8. ANGLES FORMED WHEN A TRANSVERSAL CUTS TWO PARALLEL LINES

When a straight line, called a **transversal**, intersects two parallel lines, several angles are formed at the points of intersection. These angles show special relationships with one another. By observing their positions, we can identify different types of angles and understand how they are related. These relationships help us compare angles, find unknown angles, and even check whether two given lines are parallel.



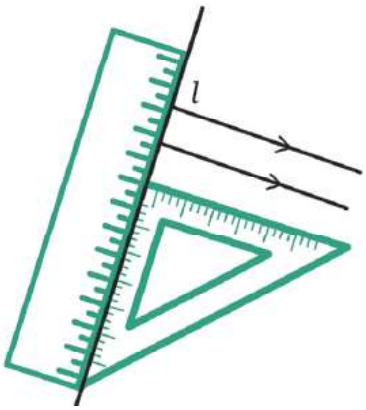
Types of angles formed

- **Corresponding angles**
  These angles lie in the same relative position on each intersection.
  When a transversal cuts two parallel lines, corresponding angles are **equal**.
- **Alternate interior angles**
  These angles lie between the two parallel lines and on opposite sides of the transversal.
  Alternate interior angles are **equal**.
- **Alternate exterior angles**
  These angles lie outside the two parallel lines and on opposite sides of the transversal.
  Alternate exterior angles are also **equal**.
- **Co-interior (consecutive interior) angles**
  These angles lie between the parallel lines and on the same side of the transversal.
  Co-interior angles are **supplementary**, meaning their sum is **180°**.

9. DRAWING PARALLEL LINES

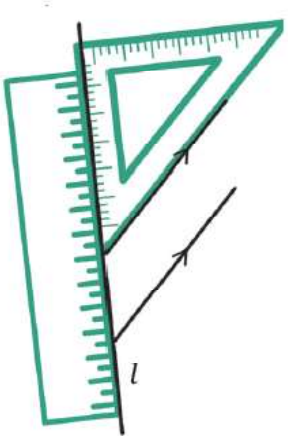
Parallel lines are lines that never meet and always remain the same distance apart. We can draw a pair of parallel lines accurately using a **ruler** and a **set square**. This method ensures that both lines make the same angle with a common line, which confirms that they are parallel.

Step 1: Draw the base line



First, draw a straight line using a ruler.
This line is taken as the **reference line** or **base line** (usually named line *l*). All other constructions will be done with respect to this line.

Step 2: Draw a perpendicular line



Place the set square so that one of its sides lies exactly on the base line *l*.
Adjust it so that the other side of the set square forms a **right angle (90°)** with line *l*.
Now, draw a straight line along this edge of the set square.
This new line is **perpendicular** to the base line.

Step 3: Slide the set square to draw another perpendicular

Keep the ruler fixed in its position.
Carefully slide the set square **upwards or downwards** along the ruler, without changing its orientation.
Draw another line along the same edge of the set square as before.
This second line is also **perpendicular** to the base line *l*.

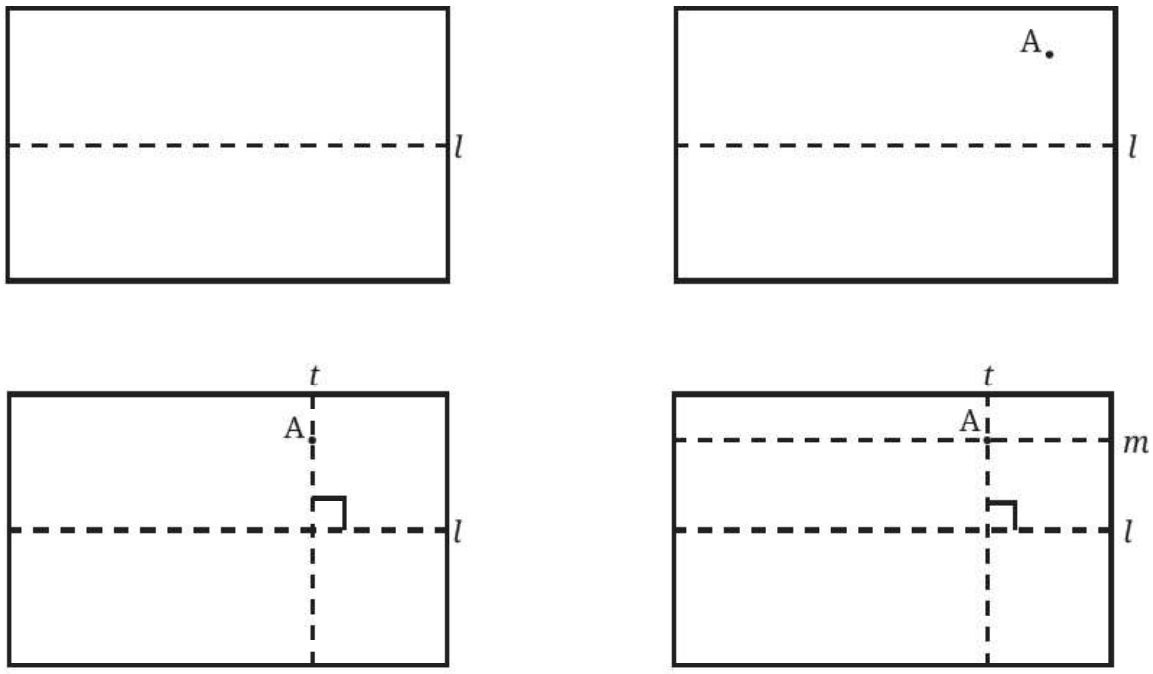
Conclusion

Since both newly drawn lines are **perpendicular to the same line**, they are **parallel to each other**.
This is based on the property that **if two lines are perpendicular to the same line, then they are parallel**.
Thus, we have successfully drawn a pair of parallel lines using a ruler and a set square.

10. MAKING PARALLEL LINES THROUGH PAPER FOLDING

Parallel lines can be drawn even **without using a ruler or compass**, simply by folding a sheet of paper. In this method, we are given a paper with a crease line –! and a point **A** that does not lie on this line. Our aim is to draw a line through point **A** that is **parallel to line –!**, using only

folds. This works because of the geometric property that **lines perpendicular to the same line are parallel to each other**.

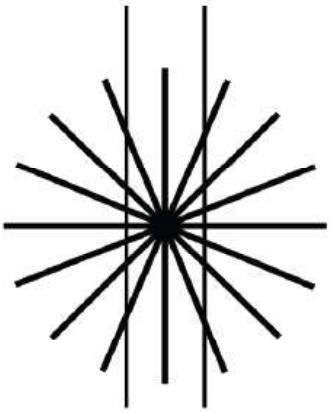


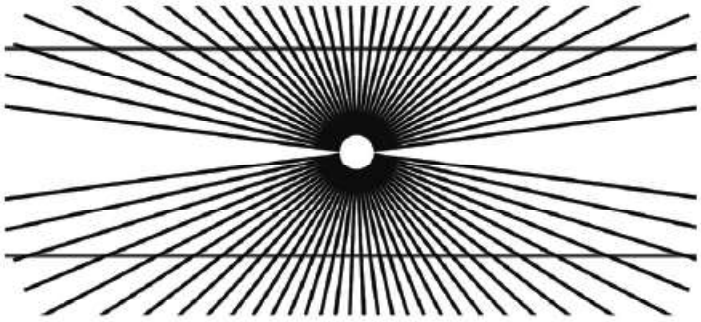
Steps involved

- **First fold:**
  Fold the paper so that the crease formed is **perpendicular to line –!** and **passes through point A**.
  Name this new crease as line **t**.
- **Second fold:**
  Fold the paper again such that the new crease is **perpendicular to line t** and **passes through point A**.
  Name this crease as line **m**.
- **Conclusion:**
  Since line **t** is perpendicular to line –!, and line **m** is perpendicular to line t, the new line **m** is **parallel to line –!**. Thus, a line parallel to –! through point A has been constructed using only paper folding.

11. PARALLEL ILLUSIONS

Sometimes, our eyes and brain can be **tricked by visual patterns**, making parallel lines appear as if they are not parallel. This effect is called a **parallel illusion**. Even though the lines are actually parallel, surrounding shapes, angles, or patterns can distort our perception.





Key points

- Parallel illusions occur due to **visual interference** from nearby lines or shapes.
- In the given figures, the lines **look tilted or curved**, but they are actually straight and parallel.
- Careful observation shows that the spacing between the lines remains the same, proving they are parallel.

12. UNDERSTANDING PARALLEL ILLUSIONS

At first glance, the given designs give the impression that none of the lines are parallel. Our eyes quickly form this conclusion because the arrangement of lines looks complex and confusing. However, when we observe the designs carefully, we realize that our first impression is misleading. The way the lines are arranged affects how our brain interprets them, even though the actual geometry may be simple and regular.

Key observations

- The design looks like a burst of lines spreading out from a central point.
- At a quick glance, the brain assumes the lines are going in different directions and are not parallel.
- On closer inspection, **some pairs of lines are actually straight, parallel, and equally spaced**.
- The **radial pattern** (lines appearing to come from the centre) forces our eyes to focus inward, making it harder to judge straightness or equal distance.
- Although the lines may appear curved or tilted, they are not actually so.
- Such designs are often created deliberately to **trick our sense of depth**, making lines seem as if they are converging toward a centre.
- In reality, the illusion lies in our perception, not in the lines themselves.

TRY YOURSELF

Q.1 In the given figure, the sum of ∠1, ∠2, and ∠3 is :

(A) 360° (B) 270° (C) 120° (D) 300°

Q.2 Which one of the following is not correct :

(A) If two lines are intersected by a transversal, then alternate angles are equal.

(B) If two lines are intersected by a transversal then sum of the interior angles on the same side of transversal is 1800°.

(C) If two lines intersected by a transversal then corresponding angles are equal.

(D) All of these.

Q.3 In the given figure, if EC || AB ∠ECD =70° and ∠BDO = 20°, then ∠OBD is :

(A) 20° (B) 50° (C) 60° (D) 70°

Q.4 In the given figure, AB || CD. The value of x is :

(A) 20° (B) 30° (C) 45° (D) 60°

Q.5 AB || CD || PQ and O is a point between AB and CD such that ∠BAO = 105° and ∠OCD = 125°, find the measure of ∠AOC.

(A) 50° (B) 105° (C) 125° (D) 130°

Q.6 In the figure, ℓ parallel to m and AX and AY are transversals. Then the value of the angle (x + y – z) is :

(A) 110° (B) 80° (C) 40° (D) 30°

Q.7 In the given figure, if AB and CD are straight lines and ∠COE = 90°, then the value of the angles x, y and z are :

(A) 16°, 50°, 130° (B) 18°, 45°, 135°

(C) 20°, 40°, 140° (D) 30°, 15°, 165°

Q.8 In the given figure lines p and q are parallel. Find value of x so that lines l and m be parallel.

(A) 45° (B) 100° (C) 135° (D) 60°

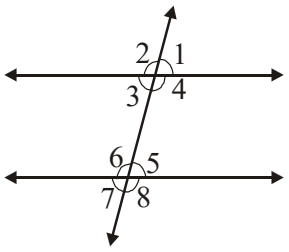
ANSWER KEY

Q.1 D **Q.2** D **Q.3** B **Q.4** B **Q.5** D **Q.6** C **Q.7** D

Q.8 C

8. TRANSVERAL OF PARALLEL LINES

Parallel lines are those lines on a plane that do not intersect anywhere.



➢ **If two parallel lines are cut by a transversal, then**

- Each pair of corresponding angles are equal
- Each pair of alternate interior angles are equal
- Each pair of interior angles on the same side of the transversal are supplementary.

So $\angle 1 = \angle 5, \angle 2 = \angle 6$

$\angle 3 = \angle 7, \angle 4 = \angle 8$ (Pair of corresponding angles)

$\angle 3 = \angle 5, \angle 4 = \angle 6$ (Pair of alternate interior angles)

$\angle 4 + \angle 5 = 180°$

$\angle 3 + \angle 6 = 180°$ (Pair of interior angles on the same side of the transversal)

- If two lines are cut by a transversal and it is given that the pair of corresponding angles are equal or the pair of alternate interior angles or the pair of interior angles are supplementary then the lines have to be parallel.

Example 8 : An angle is 1/4th of its supplement. Find the angles.

Solution : Let one angle be x^0. Then other angle is $\frac{x^0}{4}$.

Now x^0 and $\frac{x^0}{4}$ are supplementary angles.

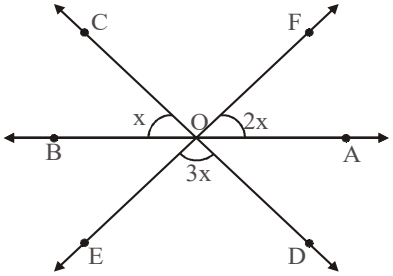
$\therefore \quad x + \frac{x}{4} = 180^0 \Rightarrow \frac{4x + x}{4} = 180° \Rightarrow \frac{5x}{4} = 180°$

$x = \frac{180 \times 4}{5}$

$x = 144°, \quad \frac{x}{4} = \frac{144}{4} = 36°$

Hence the angles are $144^0, 36^0$

Example 9 :



Determine the value of x

Solution Since $\angle BOC$ and $\angle DOA$ are vertically opposite angles.

$\therefore \quad \angle BOC = \angle DOA$

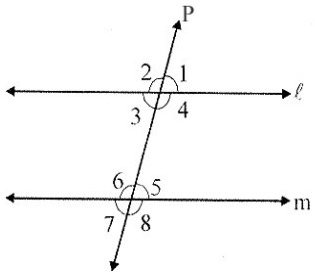
$\angle DOA = x^0$

Now OE and OF are opposite rays

$\therefore \quad \angle EOD + \angle DOA + \angle AOF = 180^0$

$\Rightarrow \quad 3x + x + 2x = 180 \quad \Rightarrow \quad 6x = 180^0 \quad \Rightarrow \quad x = 30^0$

Example 10 :



In fig. $l \parallel$ m and p is a transversal to the lines l and m.

(i) If $\angle 1 = 35^0$, find the remaining angles.

(ii) If $\angle 2 + \angle 4 = 210^0$, find $\angle 1, \angle 2 \ldots\ldots\ldots\ldots \angle 8$

(iii) If $\angle 1 : \angle 2 = 2 : 3$, find all the angles.

Solution

(i) $\angle 1 + \angle 2 = 180^0$ [Linear pair axiom]

$\Rightarrow \angle 2 = 180^0 - \angle 1$

$\Rightarrow \angle 2 = 180 - 35^0 = 145^0$

Now : $\angle 3 = \angle 1 = 35^0$ [vertically opposite angles]

and $\angle 4 = \angle 2 = 145^0$

By the corresponding angles axiom :

$\angle 5 = \angle 1 = 35^0$

$\angle 6 = \angle 2 = 145^0$

$\angle 7 = \angle 3 = 35^0$

and $\angle 8 = \angle 4 = 145^0$

(ii) Since : $\angle 2 = \angle 4$ [vertically opposite angles]

and $\angle 2 + \angle 4 = 210^0$

we get $\angle 2 + \angle 2 = 210^0 \Rightarrow 2\angle 2 = 210^0$

$\Rightarrow \angle 2 = 105^0$

$\Rightarrow \angle 4 = \angle 2 = 105^0$

$\Rightarrow \angle 1 = 180^0 - \angle 2$

$= 180^0 - 105^0 = 75^0$

$\angle 3 = \angle 1 = 75^0$ [vertically opposite angles]

By the corresponding angles axion.

$\angle 5 = \angle 1 = 75^0$, $\angle 6 = \angle 2 = 105^0$

$\angle 7 = \angle 3 = 75^0$ and $\angle 8 = \angle 4 = 105^0$

(iii) Let $\angle 1 = 2x$ and $\angle 2 = 3x$

we have, $\angle 1 + \angle 2 = 180^0$ [Linear pair axiom]

$\Rightarrow$ $2x + 3x = 180^0$

$\Rightarrow$ $5x = 180^0$

$\Rightarrow$ $x = 36^0$

$\therefore$ $\angle 1 = 2x = 2(36^0) = 72^0$

$\angle 2 = 3x = 3(36^0) = 108^0$

Now $\angle 3 = \angle 1 = 72^0$

and $\angle 4 = \angle 2 = 180^0$ [vertically opposite angles]

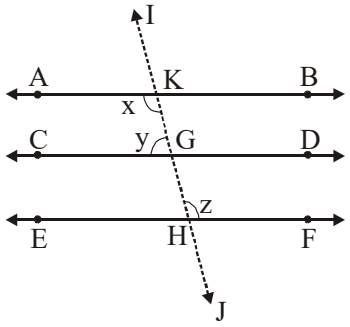
By the corresponding angles axiom :

$\angle 5 = \angle 1 = 72^0$, $\angle 6 = \angle 2 = 108^0$

$\angle 7 = \angle 3 = 72^0$, $\angle 8 = \angle 4 = 108^0$

Example 11 :

In fig. AB || CD, CD || EF and y : z = 3 : 7, find x.



Solution $\angle CGH = \angle GHF = z$ (Alternate angles)

$\angle AKG = \angle CGH$ (corresponding angles)

or $x = z$

Also, $\angle CGK + \angle CGH = 180^0$ [linear pair]

$y + z = 180°$

Let $y = 3m, z = 7m$

$3m + 7m = 180^0$

or $10m = 180^0$

$\Rightarrow$ $m = 18^0$

$y = 3 \times 18^0 = 54^0$

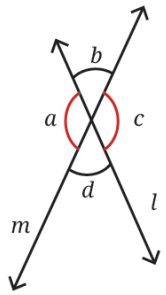
$z = 7 \times 18^0 = 126^0$

$\Rightarrow$ $x = z = 126^0$

EXERCISE-I NCERT Essentials

Figure it Out (Page No. 108)

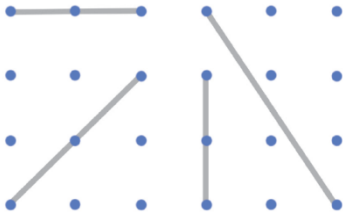
List all the linear pairs and vertically opposite angles you observe in Fig.:



Linear Pairs	$\angle a$ and $\angle b$, …
Pairs of Vertically Opposite Angles	$\angle b$ and $\angle d$, …

Figure it Out (Page No. 113-114)

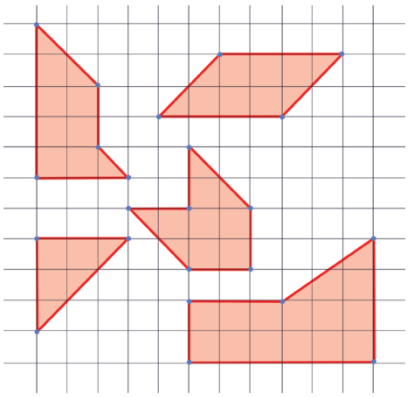
Q.1 Draw some lines perpendicular to the lines given on the dot paper in Fig.



Q.2 In Fig., mark the parallel lines using the notation given above (single arrow, double arrow etc.). Mark the angle between perpendicular lines with a square symbol.

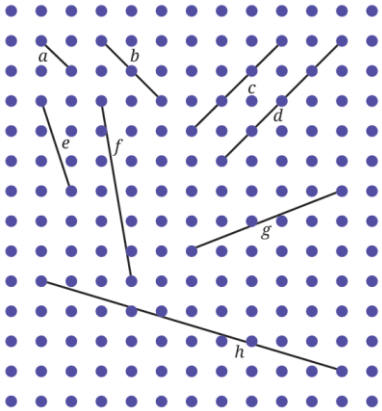
(a) How did you spot the perpendicular lines?

(b) How did you spot the parallel lines?



Q.3 In the dot paper following, draw different sets of parallel lines. The line segments can be of different lengths but should have dots as endpoints.

Q.4 Using your sense of how parallel lines look, try to draw lines parallel to the line segments on this dot paper.



(a) Did you find it challenging to draw some of them?

(b) Which ones?

(c) How did you do it?

Q.5 In Fig., which line is parallel to line a —— line b or line c? How do you decide this?

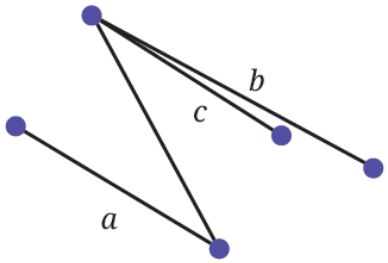


Figure it Out (Page No. 119)

Can you draw a line parallel to l, that goes through point A? How will you do it with the tools from your geometry box? Describe your method.

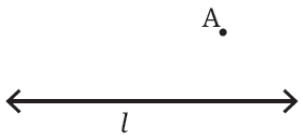
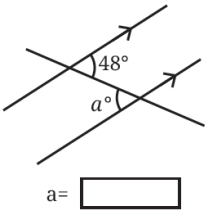
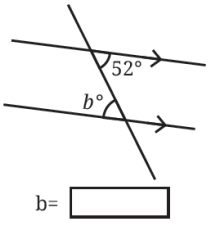
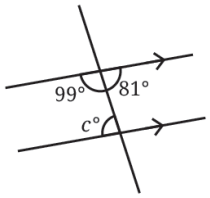


Figure it Out (Page No. 121-123)

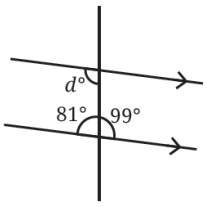
Q.1 Find the angles marked below.



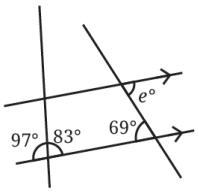




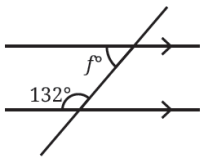
c= ☐



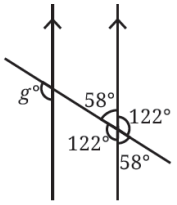
d= ☐



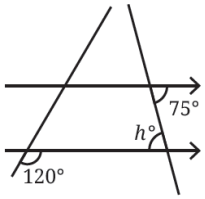
e= ☐



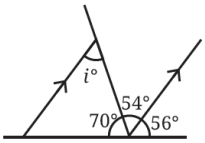
f= ☐



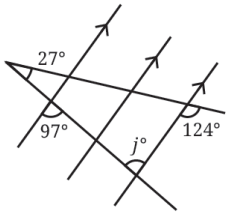
g= ☐



h= ☐

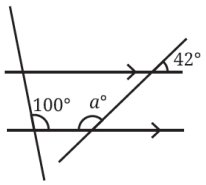


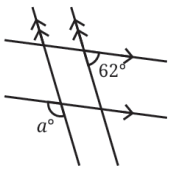
i= ☐



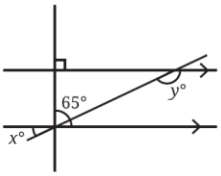
j= ☐

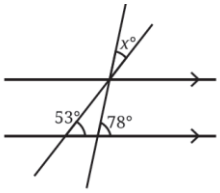
Q.2 Find the angle represented by *a*.



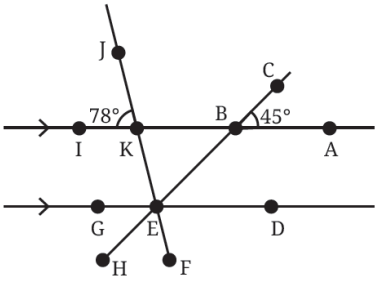


Q.3 In the figures below, what angles do *x* and *y* stand for?

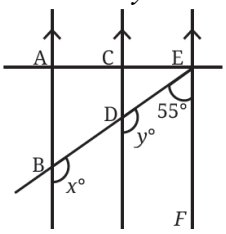




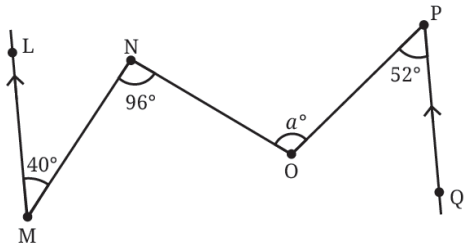
Q.4 In Fig., ∠ABC = 45° and ∠IKJ = 78°. Find angles ∠GEH, ∠HEF, ∠FED



Q.5 In Fig., AB is parallel to CD and CD is parallel to EF. Also, EA is perpendicular to AB. If ∠BEF = 55°, find the values of *x* and *y*.



Q.6 What is the measure of angle ∠NOP in Fig.?



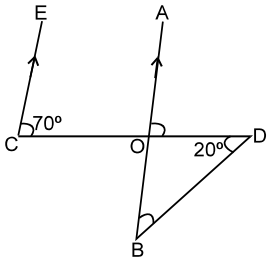
[**Hint:** Draw lines parallel to LM and PQ through points N and O.]

EXERCISE-II Brain Booster MCQs

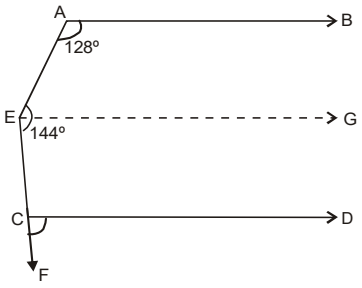
MCQ BASED QUESTIONS:

Q.1 Which one of the following is not correct :
(A) If two lines are intersected by a transversal, then alternate angles are equal.
(B) If two lines are intersected by a transversal then sum of the interior angles on the same side of transversal is 180^0.
(C) If two lines intersected by a transversal then corresponding angles are equal.
(D) All of these.

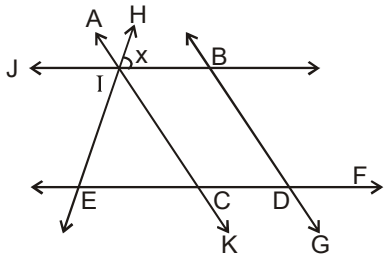
Q.2 In the given figure, if EC || AB $\angle ECD = 70^o$ and $BDO = 20^o$, then $\angle OBD$ is :
(A) 20^o
(B) 50^o
(C) 60^o
(D) 70^o



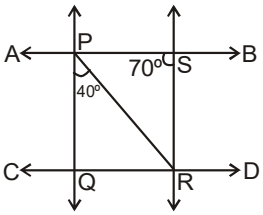
Q.3 In the given figure, AB || CD, $\angle A = 128^o$, $\angle E = 144^o$.
Then $\angle FCD$ is equal to :
(A) 72^o
(B) 64^o
(C) 136^o
(D) 92^o



Q.4 In the given Figure, IB || CD and AC || BD. If $\angle EIC = 40^o$, $\angle FDG = 55^o$, $\angle HIB = x^o$, then the value of x is :
(A) 95^o
(B) 85^o
(C) 165^o
(D) 50^o

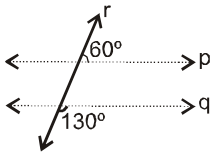


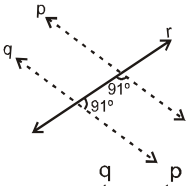
Q.5 In the given Figure, AB || CD and PQ || SR. Then, $\angle SPR$ is :
(A) 55^o
(B) 60^o
(C) 70^o
(D) 40^o

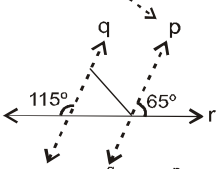


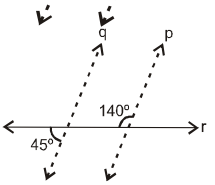
Q.6 If $(3x + 20)^o$ and $(2x + 25)^o$ are supplementary angles then the value of x , is :
(A) 27^o (B) 34^o (C) 63^o (D) 80^o

Q.7 Observe the diagram carefully and decide in which option, the pair of dotted lines is parallel.

(A)


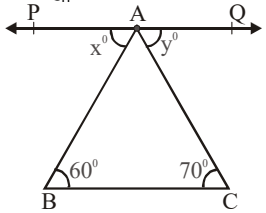
(B)


(C)


(D)


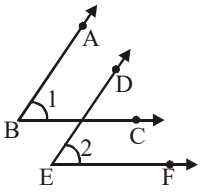
Q.8 Of all the line segments that can be drawn to a given line from a given point out side it , which angle of inclination among the following alternatives has the shortest length ?
(A) 55^o (B) 60^o (C) 70^o (D) 65^o

Q.9 In fig. if PQ||BC then find x and y



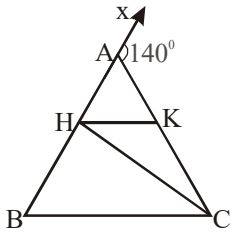
(A) 70°, 60° (B) 60°, 70°
(C) 30°, 20° (D) 120°, 110°

Q.10 In fig., the arms of two angles are parallel. If $\angle 1 = 50°$, find $\angle 2$



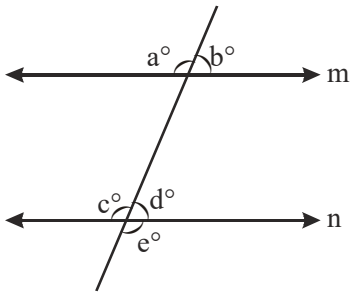
(A) 40° (B) 50°
(C) can not say (D) None of these

Q.11 In fig. AB = AC, CH = CB and HK||BC. If the exterior angle CAX is 140° then the angle HCK is



(A) 45° (B) 30°
(C) 50° (D) 40°

Q.12 In the given figure, lines m and n are not parallel and will intersect at some point to the right of the page. Which of the following statements is/are true?



(A) c = e (B) b > d
(C) a < c (D) a > c

Q.13 Two parallel lines have :
(A) a common point
(B) two common point
(C) no common point
(D) infinite common points

Q.14 Which one of the following statements is not false :
(A) If two angles forming a linear pair, then each of these angles is of measure 900.
(B) Angles forming a linear pair can both be acute angles.
(C) One of the angles forming a linear pair can be obtuse angle.
(D) Bisectors of the adjacent angles form a right angle.

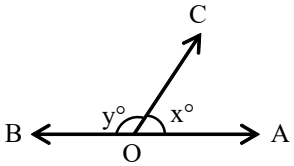
Q.15 Linear pair angles are also
(A) Complementary angles
(B) Supplementary angles
(C) Equal angles
(D) None of these

Q.16 An angle is 140° more than its complementary angle then angle is :
(A) 38° (B) 52°
(C) 30° (D) None

Q.17 Two complementary angles differ by 16° find the angles.
(A) 53°, 37° (B) 56°, 40°
(C) 62°, 28° (D) 59°, 31°

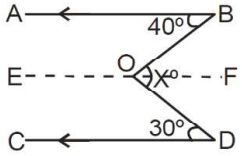
Q.18 If the supplement of an angle is three times its complement, then angle is :
(A) 40° (B) 35° (C) 50° (D) 45°

Q.19 In the given figure, x is greater then one fifth of a right angle then :
(A) y > 162° (B) y ≥162°
(C) y ≤ 162° (D) y < 162°



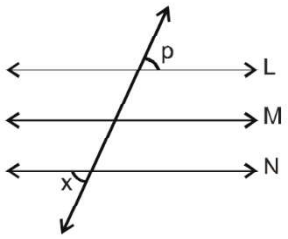
Q.20 The co-interior angles are supplementary than lines are
(A) Parallel (B) Intersecting
(C) Perpendicular (D) None of these

Q.21 In the given figure, AB || CD, ∠ABO = 40° and ∠CDO = 30°. If ∠DOB = x°, then the value of x is



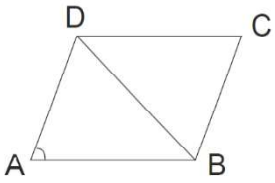
(A) 35° (B) 110° (C) 70° (D) 140°

Q.22 In the below figure L || M, M || N and ∠p = 65°, the value of ∠x is =



(A) 65° (B) 115° (C) 25° (D) 45°

Q.23 Diagonal DB of a rhombus ABCD is equal to one of its sides. The values of ∠A is :



(A) 30° (B) 60° (C) 120° (D) 90°

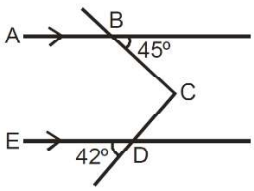
Q.24 Find the measure of an angle, if six times its complement is 12° less than twice its supplement.

(A) 48° (B) 30° (C) 87° (D) 49°

Q.25 The complementary and supplementary angles of an angle are in the ratio 2 : 5 respectively. Find the measure of that angle.

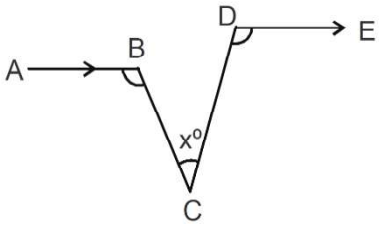
(A) 60° (B) 30° (C) 90° (D) 45°

Q.26 In the given figure AB || ED, then the value of ∠ABC + ∠BCD + ∠CDE is :



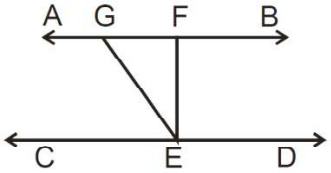
(A) 180° (B) 273°
(C) 360° (D) 110°

Q.27 In the adjoining figure, ∠ABC = 100°, ∠EDC = 120° and AB || DE. Then, find ∠BCD.



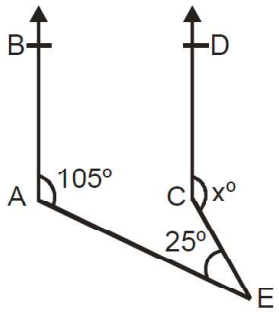
(A) 40° (B) 100° (C) 75° (D) 60°

Q.28 In given figure if AB || CD, EF ⊥ CD and ∠GED = 1260, then ∠AGE is :



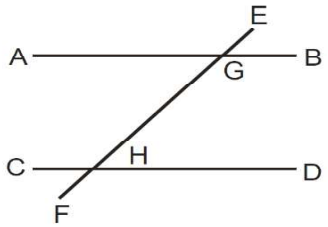
(A) 126° (B) 132°
(C) 146° (D) None

Q.29 In the given figure, AB || CD. Find the value of x.



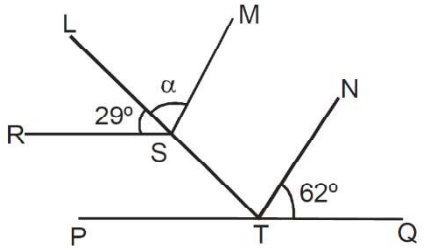
(A) 126° (B) 132°
(C) 146° (D) None

Q.30 Given that AB || CD. False statement from the following is :



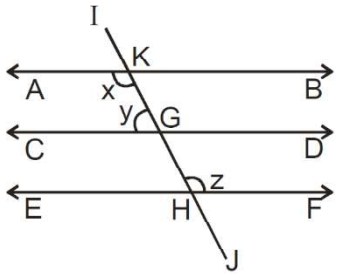
(A) ∠AGH + ∠DHF = ∠EGB + ∠GHC
(B) ∠AGE + ∠GHC = ∠AGH + ∠GHD
(C) ∠AGE + ∠CHF = ∠EGB + ∠DHF
(D) ∠AGH + ∠GHC = ∠EGB + ∠DHF

Q.31 In the figure shown PQ || RS and SM || TN. Then measure of angle α is :



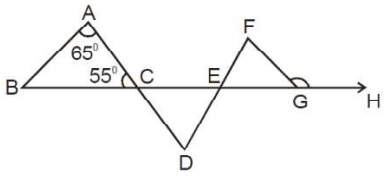
(A) 58° (B) 118° (C) 89° (D) 91°

Q.32 In figure, if AB || CD || EF and y : z = 3 : 7 find x.



(A) 40° (B) 120°
(C) 126° (D) 150°

Q.33 In the given figure if AB || DF, AD || FG, ∠BAC = 65°, ∠ACB = 55°. Find ∠FGH.



(A) 125° (B) 100°
(C) 120° (D) 110°

Q.34 Alternate angles are equal when:

(A) Two lines intersect

(B) Two parallel lines are cut by a transversal

(C) Two perpendicular lines are cut by a transversal

(D) Any two lines are cut by a transversal

Q.35 If "A and "B are vertically opposite angles and "A = 45°, then "B = ?

(A) 45° (B) 135°
(C) 90° (D) 35°

Q.36 The sum of interior angles on the same side of a transversal cutting two parallel lines is:

(A) 90° (B) 180°
(C) 270° (D) 360

Q.37 In the figure, if line l || line m and "1 = 70°, then "5 = ?

(A) 70° (B) 110°
(C) 20° (D) 140°

Q.38 Two lines are said to be perpendicular if they intersect at:

(A) Acute angle (B) Obtuse angle
(C) Right angle (D) Straight angle

Q.39 If "P and "Q form a linear pair and "P = 60°, then "Q = ?

(A) 60° (B) 30°
(C) 120° (D) 90°

Q.40 Co-interior angles (same side interior angles) are:

(A) Equal

(B) Supplementary

(C) Complementary

(D) Vertically opposite

Q.41 The angle between a horizontal line and a vertical line is:

(A) 45° (B) 60°
(C) 90° (D) 180°

Q.42 If two lines are perpendicular to the same line, then they are:

(A) Perpendicular to each other

(B) Parallel to each other

(C) Intersecting

(D) None of these

Q.43 If "A = 65° and "B = 115°, and they are co-interior angles, then the lines are:

(A) Parallel (B) Perpendicular
(C) Intersecting (D) Concurrent

Q.44 When drawing parallel lines using set square, the angle formed with the base line is:

(A) 45° (B) 60°
(C) 90° (D) 30°

Q.45 If two angles are complementary to the same angle, then they are:

(A) Equal

(B) Supplementary

(C) Unequal

(D) None of these

Q.46 The number of degrees in a straight angle is:

(A) 90° (B) 180°
(C) 270° (D) 360°

EXERCISE-III Concept Check

TRUE AND FALSE

Q.1 Interior angles on the same side of the transversal are supplementary if the lines are parallel.

Q.2 Complementary angle of 45 is 45.

Q.3 A vertex of angle ABC is A.

Q.4 The distance between two parallel lines is nt always same.

Q.5 Two obtuse angles cannot be complement of each other.

Q.6 If two lines in a plane do not intersect then line are parallel.

Q.7 If two parallel lines are intersected by transversal then sum of cointerior angle is 180°

Q.8 If tw parallel line are intersected by transversal then alternate interior angle are equal.

FILL IN THE BLANKS

Q.1 If the sum of the measures of two angles is 90º, then the angles are called _____

Q.2 A ray has _____ end point.

Q.3 A figure formed by two rays having the same initial point is called an _____

Q.4 Three or more lines in a plane passing through the same point are called _____

Q.5 A line segment has _____ end points.

Q.6 Three or more points which lie on the same line are called _____

ASSERTION & REASON

Instructions: Choose the correct option:

(A) Both assertion and reason are true, and reason is the correct explanation of assertion

(B) Both assertion and reason are true, but reason is not the correct explanation

(C) Assertion is true but reason is false

(D) Assertion is false but reason is true

Q.1 **Assertion:** Two lines perpendicular to the same line are parallel.

Reason: Perpendicular lines form 90° angles.

Q.2 **Assertion:** Alternate interior angles are equal when lines are parallel.

Reason: Alternate interior angles are vertically opposite to corresponding angles.

Q.3 **Assertion:** Co-interior angles sum to 180° when lines are parallel.

Reason: Co-interior angles are supplementary to corresponding angles

Q.4 **Assertion:** Alternate exterior angles are equal when lines are parallel.

Reason: They follow the same principle as alternate interior angles.

Q.5 **Assertion:** A straight angle measures 180°.

Reason: A straight angle forms a straight line.

MATCH THE COLUME

Q.1 **Match the column**

Column A	Column B
(a) Complement of 53	**(p)** Linear pair
(b) Supplement of 87	**(q)** 45°
(c) Two adjacent supplementry angles	**(r)** 93°
(d) Angle which is equal to its complement	**(s)** 120°
(e) Angle which is 2/3 of its supplement	**(t)** 37°

(A) (a)-(r), (b)-(p), (c)-(s), (d)-(t),(e)-(q)
(B) (a)-(q), (b)-(p), (c)-(t), (d)-(s),(e)-(r)
(C) (a)-(s), (b)-(r), (c)-(q), (d)-(t),(e)-(p)
(D) (a)-(t), (b)-(r), (c)-(p), (d)-(q),(e)-(s)

Q.2 Match the column

Column A	Column B
(a) 90°	**(p)** Obtuse
(b) 45°	**(q)** Right
(c)120°	**(r)** Acute
(d)180°	**(s)** Straight

Options:

(A) (a)–(q), (b)–(p), (c)–(r), (d)–(s)
(B) (a)–(r), (b)–(q), (c)–(p), (d)–(s)
(C) (a)–(q), (b)–(r), (c)–(p), (d)–(s)
(D) (a)–(s), (b)–(r), (c)–(p), (d)–(q)

Q.3 Match the column

Column A	Column B
(a) Set square	**(p)** Measure angles
(b) Compass	**(q)** Draw perpendicular
(c) Protractor	**(r)** Draw circles
(d) Ruler	**(s)** Draw straight lines

Options:

(A) (a)–(q), (b)–(r), (c)–(p), (d)–(s)
(B) (a)–(p), (b)–(r), (c)–(q), (d)–(s)
(C) (a)–(q), (b)–(p), (c)–(r), (d)–(s)
(D) (a)–(s), (b)–(r), (c)–(p), (d)–(q)

Q.4 Match the column

Column A	Column B
(a) If corresponding angles equal	**(p)** Lines are parallel
(b) If alternate angles equal	**(q)** Lines are parallel
(c) If co-interior angles sum 180°	**(r)** Lines are parallel
(d) If lines are parallel	**(s)** All above relationships hold

Options:

(A) (a)–(p), (b)–(q), (c)–(r), (d)–(s)
(B) (a)–(q), (b)–(p), (c)–(s), (d)–(r)
(C) (a)–(s), (b)–(r), (c)–(q), (d)–(i)
(D) (a)–(r), (b)–(s), (c)–(p), (d)–(q)

Q.5 Match the column

Column A	Column B
(a) Two lines intersect	**(p)** 8 angles
(b) Transversal cuts two lines	**(q)** 4 angles
(c) Three lines meet at point	**(r)** 6 angles
(d) Two perpendicular lines	**(s)** 4 right angles

Options:

(A) (a)–(q), (b)–(p), (c)–(r), (d)–(s)
(B) (a)–(p), (b)–(q), (c)–(s), (d)–(r)
(C) (a)–(r), (b)–(p), (c)–(q), (d)–(s)
(D) (a)–(s), (b)–(r), (c)–(p), (d)–(q)

EXERCISE-IV

Subjective Assessment

VERY SHORT ANSWER TYPE QUESTIONS:

Q.1 If (2x – 10) and (x – 5) are complementary angles, find x.

Q.2 If (3x + 40°) and (x – 20°) are supplementary angles, find x.

Q.3 Two supplementary angles are in ratio 3 : 7. Find the angles.

Q.4 Two complementary angles are in ratio 2 : 3. Find the angles.

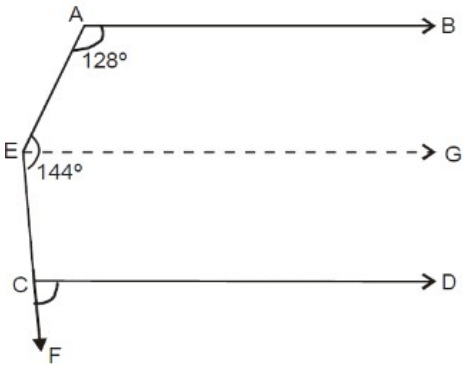
Q.5 X lies in the interior of ∠BAC. If ∠BAC = 70° and ∠BAX = 42°, then ∠XAC = ?

SHORT ANSWER TYPE QUESTIONS :

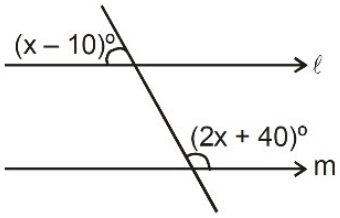
Q.1 If (3x + 20)° and (2x + 25)° are supplementary angles then find the value f x.

Q.2 If one angle of triangle is equal to the sum of the ther two then prove that it is right triangle

Q.3 In the given figure, AB || CD, ∠A = 128°, ∠E = 144° . Then find the ∠FCD.



Q.4 For what value of x will line ? be parallel to line m ?



Q.5 In figure ℓ || m and n is the transversal cutting ℓ and m at P and Q respectively. If ℓ1 = 3x and ∠2 = x, find the value f o

Q.6 If "P and "Q are co-interior angles and "P = 110°, find "Q when lines are parallel.

Q.7 Explain the difference between intersecting and parallel lines.

Q.8 What is the measure of each angle when two perpendicular lines intersect?

Q.9 If two parallel lines are cut by a transversal, what can you say about alternate angles?

Q.10 In triangle ABC, if AB || DE, what can you conclude about corresponding angles?

Q.11 Explain the paper folding method to create parallel lines.

Q.12 What is the maximum number of distinct angle measures when a transversal cuts twolines?

Q.13 If "1, "2, "3, "4 are four angles at intersection point O, what is "1 + "2 + "3 + "4?

Q.14 How do you identify parallel lines in real-world situations?

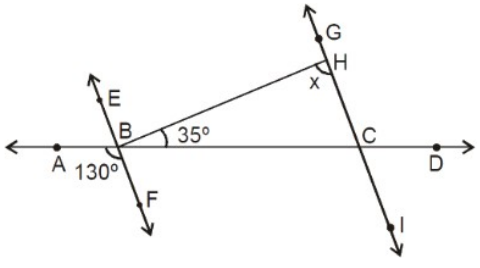
Q.15 What is the relationship between the angles formed when two parallel lines are cut by two transversals?

LONG ANSWER TYPE QUESTIONS:

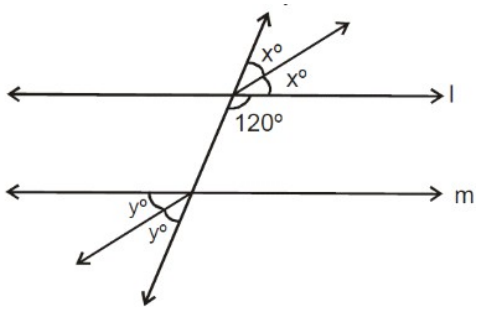
Q.1 The supplement of an angle is one third of itself. Determine the angle and its supplement.

Q.2 In figure, EF is a line thrught A and parallel to the side BC of triangle ABC. Find the value of x and
use that to find ∠EAB and ∠FAC.

Q.3 In the given fig. $\overleftrightarrow{EF} \| \overleftrightarrow{GI}$. Find the value of x.



Q.4 In the given fig. I | | m. Find measure of x and y.



Q.5 Two parallel lines AB and CD are intersected by a transversal EF at points P and Q respectively. If "APE = 65°, find all the remaining seven angles. Draw a figure and show all calculations.

Q.6 In a quadrilateral ABCD, AB || DC and AD || BC. If "A = 110°, find all other angles. Explain the relationship between opposite angles in this figure.

Q.7 In the given figure, AB || CD, "BAC = 35°, and "ACD = 65°. Find "CAD. Explain your reasoning step by step with reference to parallel line properties.

Q.8 In triangle PQR, a line ST is drawn parallel to QR. If "P = 50°, "Q = 60°, and "R = 70°, find all angles formed by the parallel line ST with sides PQ and PR. Explain using parallel line theorems.

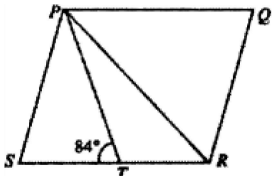
Q.9 Two roads intersect at point O making angles of 50° and 130°. A third road crosses both at point P on one road and point Q on the other. If the roads are parallel, find all angles at P and Q. Draw the complete figure.

Q.10 Three parallel lines l , l, , and l*f* are cut by two transversals m and m, . If one of the angles formed is 40°, find all possible angle measures at all intersection points. Create a systematic approach to solve this.

Q.11 Two parallel mirror strips are placed such that a light ray hits one mirror at 30° angle. Trace the path of light ray as it reflects between the mirrors. Calculate all angles of incidence and reflection. What geometric principles apply here?

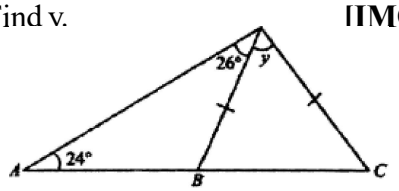
EXERCISE-V Competition Edge

Q.1 In the given figure, PQ||RS, PS||QR and ∠RPT is $\frac{1}{4}$ as much as ∠PTS. What is the value of ∠RPQ? **[IMO-2013]**



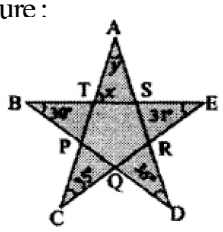
(A) 84° (B) 63° (C) 42° (D) 52°

Q.2 In the given figure, ABC is a straight line. Find v. **[IMO-2013]**



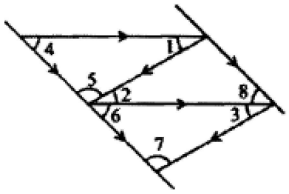
(A) 50° (B) 80° (C) 100° (D) 130°

Q.3 Find the angles x and y respectively in the given figure : **[IMO-2013]**



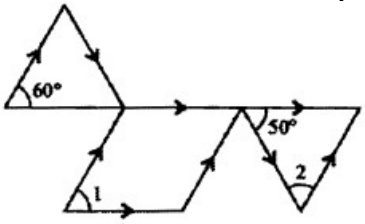
(A) 66° and 84° (B) 60° and 40°
(C) 66° and 48° (D) 60° and 48°

Q.4 Which of the following options is INCORRECT ? **[IMO-2014]**



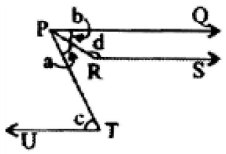
(A) ∠ 1 = ∠ 3
(B) ∠1 + ∠4 + ∠5 = 180°
(C) ∠ 8 = ∠ 6
(D) ∠ 1 + ∠ 3 = 180°

Q.5 Find the value of ∠1 + ∠2 **[IMO-2014]**



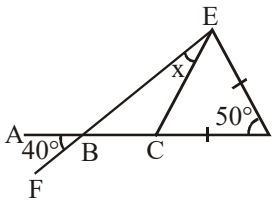
(A) 150° (B) 60° (C) 130° (D) 110°

Q.6 In the given figure, PQ, RS and UT are parallel lines. If c = 75° and a = (2/5)c, find b + d/2 **[IMO-2014]**



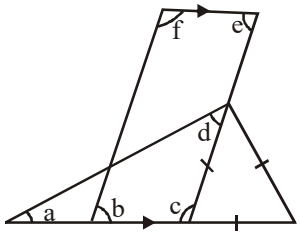
(A) 92° (B) 115°
(C) 112.5°C (D) 135.5°

Q.7 In the figure given below, ABCD is a straight line. Find x. **[IMO-2015]**



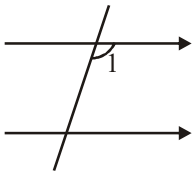
(A) 25° (B) 35° (C) 45° (D) 55°

Q.8 The given figure is not drawn to scale. Which one of the following option is true ? **[IMO-2015]**



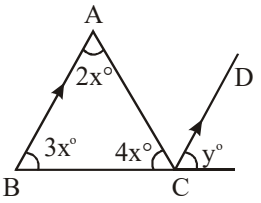
(A) ∠a + ∠d = 60° (B) ∠c + ∠e = 160°
(C) ∠c + ∠f = 240° (D) ∠e + ∠f = 180°

Q.9 For two parallel lines and transversal, ∠1 = 74°. For which pair of angle measures is the sum of the least ? **[IMO2016]**



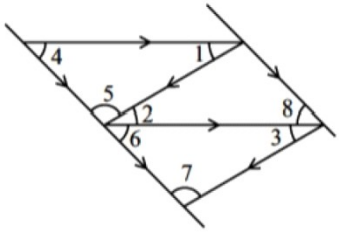
(A) ∠1 and a corresponding angle
(B) ∠1 and the corresponding co-interior angle
(C) ∠1 and its supplement
(D) ∠1 and its complement

Q.10 In the fugure CD is parallel to AB. Then angle Y is equal to:



(A) 40° (B) 60° (C) 80° (D) 120°

Q.11 Which of the following options is INCRRECT ? **[IMO-2017]**



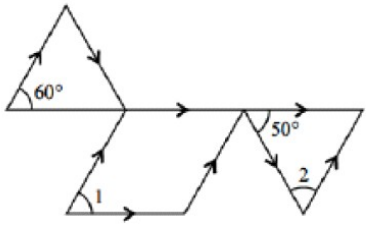
(A) $\angle 1 = \angle 3$

(B) $\angle 1 + \angle 4 + \angle 5 = 180°$

(C) $\angle 8 = \angle 6$

(D) $\angle 1 + \angle 3 = 180°$

Q.12 Find the value of $\angle 1 + \angle 2$ **[IMO-2017]**



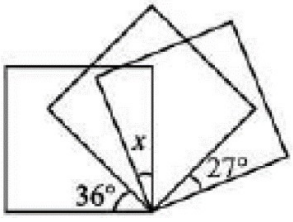
(A) 150° (B) 60° (C) 130° (D) 110°

Q.13 Fill in the blanks. **[IMO-2018]**

P is perfectly straight and extends forever in both directions. Q is perfectly flat surface that extends forever in all directions. R is the part of a line between two points.

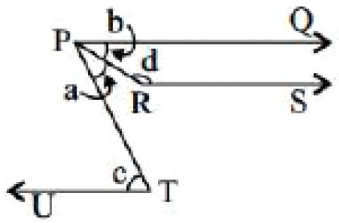
	P	Q	R
(A)	Line	Plane	Ray
(B)	Line	Plane	Segment
(C)	Line	Ray	Plane
(D)	Ray	Segment	Plane

Q.14 The given figure shows three identical squares. Find x. **[IMO-2018]**



(A) 30° (B) 27° (C) 36° (D) 16°

Q.15 In the given figure, PQ, RS and UT are parallel lines. If c =75° and a = (2/5) c, find b + d/2. **[IMO-2019]**

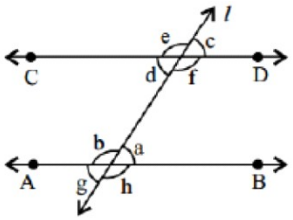


(A) 92° (B) 115°
(C) 112.5° (D) 135.5

Q.16 Study the given statements. **[IMO-2020]**

Statement-I : e and h are supplementary angles.

Statement-II : c and g are equal angles.



(A) Both statement-I and statement-II are true.

(B) Statement-I is true and statement-II is false.

(C) Statement-I is false and statement-II is true.

(D) Both statement-I and statement-II are false.

Q.17 A lamp post has half of its length in mud, 1/3 of its length in water and 31/3m above the water. Find the total length of the post : **[CMO-2022]**

(A) 20 m (B) 15 m (C) 25 m (D) 30 m

Q.18 In the figure given below, AD and CF are straight lines. Find the value of $\angle EBF$: **[CMO-2022]**

(A) 93° (B) 140° (C) 47° (D) 107°

Q.19 In the given figure, LM and PQ are parallel to each other and AB is the transversal. if $\angle MCD = (3x)°$ and $\angle QDC = (2x + 50)°$, then find the value of x : **[CMO-2022]**

(A) 26° (B) 36° (C) 40° (D) 50°

ANSWER KEY

EXERCISE-II

MULTIPLE CHOICE QUESTIONS :

Q.1	D	**Q.2**	B	**Q.3**	D	**Q.4**	B	**Q.5**	C	**Q.6**	A	**Q.7**	C
Q.8	C	**Q.9**	B	**Q.10**	B	**Q.11**	B	**Q.12**	A	**Q.13**	C	**Q.14**	C
Q.15	B	**Q.16**	B	**Q.17**	A	**Q.18**	D	**Q.19**	D	**Q.20**	A	**Q.21**	C
Q.22	A	**Q.23**	B	**Q.24**	A	**Q.25**	B	**Q.26**	C	**Q.27**	A	**Q.28**	A
Q.29	D	**Q.30**	B	**Q.31**	C	**Q.32**	C	**Q.33**	A	**Q.34**	B	**Q.35**	A
Q.36	B	**Q.37**	A	**Q.38**	C	**Q.39**	C	**Q.40**	B	**Q.41**	C	**Q.42**	B
Q.43	A	**Q.44**	A	**Q.45**	A	**Q.46**	B						

EXERCISE-III

TRUE FALSE :

Q.1	True	**Q.2**	True	**Q.3**	False	**Q.4**	False	**Q.5**	True
Q.6	True	**Q.7**	True	**Q.8**	True				

FILL IN THE BLANKS

Q.1	complementary	**Q.2**	one	**Q.3**	angle	**Q.4**	concurrent lines
Q.5	2	**Q.6**	Collinear				

ASSERTION & REASON :

Q.1	**(A)**	**Q.2**	**(C)**	**Q.3**	**(C)**	**Q.4**	**(A)**	**Q.5**	**(A)**

MATCH THE COLUME :

Q.1	(D)	**Q.2**	(C)	**Q.3**	(A)	**Q.4**	(B)	**Q.5**	(A)

EXERCISE-V

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

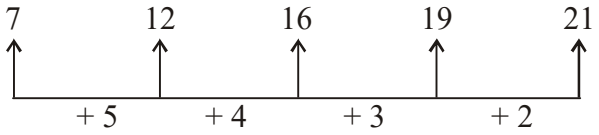
1. Series Completion

NUMBER SERIES

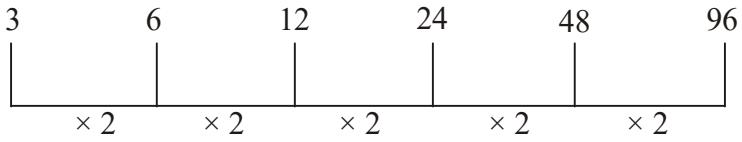
A number series is a collection of numbers which follow a particular pattern or rule. The pattern followed by the number in the series remains the same throughout. Each number in a number series is called a term.

TYPES OF SERIES

1. **Difference series** : The difference series can be further, classified as follows:
   (a) Number series with a constant difference ; Here the difference between two consecutive numbers is always constant. For example, the numbers of the series 1, 4, 7, 10, 13 ..... are such that the difference between two consecutive terms is constant. Here this difference is 3.
   (b) Number series with increasing /decreasing difference : Here the difference between consecutive terms is not constant. It either decreases or increases, e.g. the series 7, 12, 16, 19, 21 ....

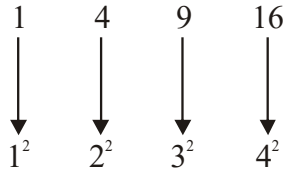


2. **Product series :** Consider the series 3, 6, 12, 24, 48, 96.



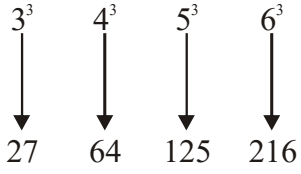
3. **Squares/Cubes series :**

Ex.1 Squares series :



Here the term that follows 16 will be square of 5, i.e. 25.

Ex.2 Cubes series :



4. **Combination series :** This is a type of series where more than one arithmetic operation is performed. Let us take an example. 2, 1, 4, 4, 6, 9, 8, 16
Here two series are being followed alternatively first is even number series (2, 4, 6, 8) and the second is square series (1, 4, 9, 16)

5. **Triangular Pattern Series :** Sometimes, the differences between the consecutive terms of a series, again form a series. The differences between the consecutive terms of the new series so formed, again form a series. This pattern continues till we attain a uniform difference between the consecutive terms of the series.

Illustration 1: Find the missing numbers :
1, 1, 4, 8, 9, ? ,16, 64
(A) 21 (B) 27 (C) 25 (D) 28

Solution : (B)
(i) 1, 4, 9, 16 [1^2, 1^3, 2^2, 2^3, 3^2, 3^3.....]
(ii) 1, 8, __, 64
mixed combination

Illustration 2: Find the missing numbers :
2, 8, 18, 32, ___
(A) 62 (B) 60 (C) 50 (D) 46

Solution : (C)
The pattern is + 6, + 10, + 14, + 18, ...
$\therefore$ missing number = 32 + 18 = 50

Illustration 3: Find the missing numbers
7,19, 55, 163, ___
(A) 387 (B) 329 (C) 527 (D) 487

Solution : (D)
Series : $(7 \times 3) - 2$, $(19 \times 3) - 2$, $(55 \times 3) - 2$, $(163 \times 3) - 2 \Rightarrow 487$.
No. is miltiplied by 3 and subtracted by 2.

Illustration 4: Find the missing numbers:
2, 3, 6, 9, 10, 27, 14, ___
(A) 81 (B) 82 (C) 84 (D) 28

Solution : (A)
I : 2, 6, 10, 14 [4 is added to each no.]
II : 3, 9, 27, ... [series 3^1, 3^2, 3^3, 3^4, ...] $\Rightarrow$ 81 (A).

FINDING THE WRONG TERMS IN THE GIVEN SERIES (NUMBER ODD MAN OUT)

Let us consider some examples to understand the concept of odd man.

1 4 9 16 25 36 63 81

(a) On observing the terms of the above number series carefully, we notice that all the terms except 63 are perfect squares of natural numbers. 63 is not a square of a natural number. Hence, 63 is the odd man.

(b) 235 354 424 541 613
This problem is somewhat tricky. The sum of digits of each term except 354 si 10. The sum of digits of 354 is 3 + 5 + 4 = 12. Hence 354 is the odd man.

Illustration 1 : Find the wrong term of the series :
2, 12, 24, 34, 68, 78, 158, 166
(A) 68 (B) 78 (C) 158 (D) 166

Solution : (C)
The sequence in the given series is :
+ 10, × 2, + 10, × 2, + 10, × 2, + 10, × 2, ...
So, 158 is wrong and must be replaced by 156.

Illustration 2 : Find the wrong term of the series :
7, 9, 16, 25, 41, 68, 107, 173
(A) 16 (B) 41 (C) 68 (D) 107

Solution : (C)
No. is the sum of its previous two numbers.
7 + 9 = 16, 9 +16 = 25, 16 + 25 = 41,
25 + 41 = 66, 41 + 66 = 107, 66 +107 = 173.
Hence, the wrong number is = 68.

ALPHABET SERIES

In this type of questions, a series of single, pairs or groups of letters or combinations of letters and numerals is given. The terms of the series form a certain pattern as regards the position of the letters in the English alphabet. Identity this pattern and accordingly find the missing term or the wrong term in the given series.

Illustration 1 : Find the missing term :

Q, N, K, ?, E

(A) H (B) I (C) J (D) G

Solution : (A)

In the given series, every letter is moved three steps backward to obtain the corresponding letters of the next term. So, the missing term is H.

Illustration 2 : Find the missing term :

DFK, FEL, HDM, JCN, ?

(A) KBN (B) KBO (C) LBO (D) LBN

Solution : (C)

The first letter of each term is moved two steps forward, the second letter is moved one step backward and the third letter is moved one steps forward to obtain the corresponding letters of the next term.

ALPHA NUMERIC SERIES

This type of question is just a jumbled form of questions of Type 1 and Type 2, which you have just read. Here, the terms of the given series are a combination of letters and numerals, which move according to a set pattern. Study the following illustrations.

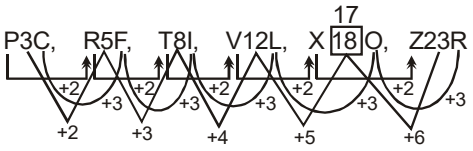
Illustration 1 : Find the wrong term(s)

P 3 C, R 5 F, T 8 I, V 12 L, X 18 O, Z 23 R

(A) V 12 L (B) X 18 O (C) Z 23 R (D) R 5 F

Solution : (B)

Given series is :



CONTINUOUS PATTERN SERIES

This type of questions usually consists of a series of small letters which follow a certain pattern. However, some letters are missing from the series. These missing letters are then given in a proper sequence as one of the alternatives. Choose this alternative as the answer.

Illustration 1 : Which sequence of letters when placed at the blanks one after the other will complete the given letter series?

– b c c – ac – a a b b – a b – c c

(A) aabca (B) abaca (C) bacab (D) bcaca

Solution : (C)

The series is bbccaa / ccaabb / aabbcc.

MISSING CHARACTER

In such type of question, a figure, a set of figures, an arrangement or a matrix is given, each of which bears certain characters, be it numbers, letters or a group/combination of letters/numbers, following a certain pattern. The candidate is required to decipher this pattern and accordingly find the missing character in the figure.

EXERCISE

Directions: Find the missing numbers:

Q.1 4, 8, 16, ? , 64
(A) 30 (B) 33
(C) 32 (D) 35

Q.2 1, 2, 4, 4, 9, 6, ?
(A) 16 (B) 9
(C) 12 (D) 15

Q.3 1, 8, 27, 64, _
(A) 81 (B) 125
(C) 100 (D) 128

Q.4 7, 13, 25, 49, _
(A) 97 (B) 96
(C) 95 (D) 94

Q.5 512, 64, 16, 8, 8, 16, ?
(A) 16 (B) 32
(C) 40 (D) 64

Q.6 3, 6, 24, 30, 63, 72, ?, 132
(A) 58 (B) 42
(C) 90 (D) 120

Q.7 1 4 13 40 —
(A) 125 (B) 94
(C) 108 (D) 121

Q.8 0.5, 1.5, 3, 5, 7.5, 10.5,.....
(A) 21 (B) 13.5
(C) 14 (D) 15

Q.9 5, 3, 6, 2, 7, 1, ?
(A) 0 (B) 2
(C) 8 (D) 4

Q.10 3, 6, 15, ?, 123, 366
(A) 34 (B) 59
(C) 42 (D) 60

Q.11 6, 11, 18, 27, 38, ?, 66
(A) 58 (B) 54
(C) 51 (D) 59

Q.12 2, 5, 7, 12, 19, 31, ?
(A) 41 (B) 50
(C) 60 (D) 71

Q.13 2, 6, 14, 26 .....
(A) 92 (B) 54
(C) 44 (D) 42

Q.14 990, 720, 504, ?, 210
(A) 316 (B) 330
(C) 336 (D) 356

Q.15 5, 8, 14, 26, 50, ?
(A) 60 (B) 98
(C) 68 (D) 78

Q.16 9, 12, 8, 11, 7, 10, ?
(A) 5 (B) 6
(C) 7 (D) 8

Q.17 11, 10, ?, 100, 1001, 1000, 10001
(A) 100 (B) 101
(C) 110 (D) 111

Q.18 1,4,2,8,6,24,22,88, ?
(A) 86 (B) 90
(C) 154 (D) 352

Q.19 8, 12, 21, 46, 95, ?
(A) 188 (B) 214
(C) 148 (D) 216

Q.20 100, 91, 83, 76, 70, ?
(A) 65 (B) 60
(C) 62 (D) 63

Q.21 0, 0, ?, 3, 7, 15, 8, 26, 80
(A) 0 (B) 1
(C) 2 (D) 3

Q.22 101, 100, ?, 87, 71, 46.
(A) 92 (B) 88
(C) 89 (D) 96

Q.23 – 4, – 3, 0, 5, 12, ? , 32.
(A) 21 (B) 20
(C) 22 (D) 19

Q.24 96, 90, 78, ?, 36, 6
(A) 60 (B) 54
(C) 72 (D) 48

Q.25 29, 34, 32, 37, 35, ?
(A) 40 (B) 39
(C) 36 (D) 42

Q.26 3, 6, 18, 72, 360,.....
(A) 720 (B) 1080
(C) 1600 (D) 2160

Directions : Find the missing term:

Q.27 V, T, R, ?, N, ?
(A) P, M (B) O, L
(C) P, L (D) O, M

Q.28 CG, DI, ?, IP, MU
(A) FM (B) EL
(C) EM (D) FL

Q.29 FLP, INS, LPV, ?
(A) ORX (B) PRY
(C) ORY (D) OSY

Q.30 D-4, F-6, H-8, J-10, ?
(A) L - 14 (B) L -12
(C) L - 13 (D) N - 12

Q.31 B2E, D5H, F12K, H27N, ?
(A) J58Q (B) J56Q
(C) J57Q (D) J56P

Q.32 CYD, FTH, IOL, LJP, ?
(A) PET (B) OET
(C) OEY (D) PEV

Q.33 2B, 4C, 8E, 14H, ?
(A) 22L (B) 24L
(C) 22K (D) 22M

Q.34 AG, LR, WC, HN, ?
(A) SX (B) RY
(C) SY (D) TX

Q.35 Z, L, X, J, V, H, T, F, ?, ?
(A) R, D (B) R, E
(C) S, E (D) Q, D

Directions : Which sequence of letters when placed at the blanks one after the other will complete the given letter series?

Q.36 _ bca _ ca _ c _ b _
(A) aabbc (B) abbbc
(C) aabcc (D) abbac

Q.37 a _ abb _ aa _ ba _ a _ b
(A) ababa (B) aabba
(C) aabab (D) aaabb

Q.38 a – – b – a – a b – a a
(A) a b a a b (B) b b a b a
(C) b b a b b (D) b a a b a

Q.39 – b c – – b b – a a b c
(A) acac (B) babc
(C) abab (D) aacc

Q.40 – b a a – b a – a a b –
(A) b a b a (B) b b a a
(C) a b b b (D) b b a b

Q.41 ab__bc__c__ba__c
(A) bbca (B) bcbc
(C) caba (D) caab

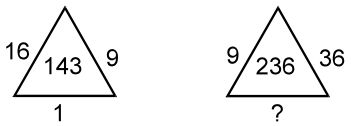
Q.42 _bcdbc_dcabd_bcdbc_dc_bd
(A) aaaaa (B) ccccc
(C) bbbbb (D) ddddd

Q.43 ab _ ab _ a _ ab _ b
(A) abba (B) abab
(C) baab (D) baba

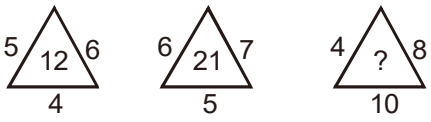
Q.44 ac __ cab __ baca __ aba __ acac
(A) aacb (B) acbc
(C) babb (D) bcbb

Q.45 ab _ cb _ c _ c _ _ b
(A) bcaaa (B) aabbc
(C) abcab (D) acbca

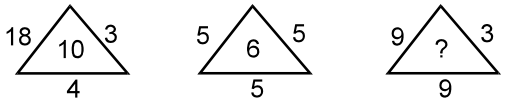
Directions : Find the missing character :

Q.46 

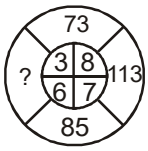
(A) 38 (B) 64
(C) 4 (D) 16

Q.47 

(A) 14 (B) 22
(C) 32 (D) 320

Q.48 

(A) 20 (B) 22
(C) 24 (D) 12

Q.49 

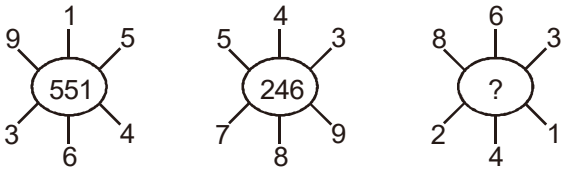
(A) 42 (B) 48
(C) 54 (D) 45

Q.50 

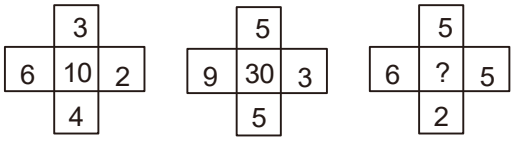
(A) Z (B) C
(C) E (D) F

Q.51 

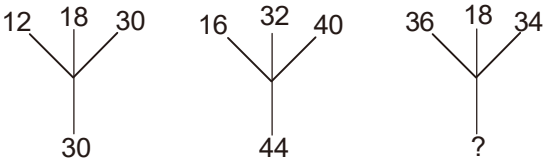
(A) 117 (B) 36
(C) 32 (D) 26

Q.52 

(A) 262 (B) 622
(C) 631 (D) 631

Q.53 

(A) 15 (B) 20
(C) 25 (D) 40

Q.54 

(A) 48 (B) 9
(C) 44 (D) 64

Q.55

25	4	57
9	71	6
52	?	23

(A) 21 (B) 11
(C) 31 (D) 15

Q.56

P	T	?
O	Q	S
M	N	R

(A) I (B) L
(C) O (D) U

Q.57

3C	27D	9E
7I	21K	3M
4D	?	7J

(A) 11E (B) 28G
(C) 35I (D) 48F

Q.58

5	11	96
9	13	88
8	17	?

(A) 225 (B) 165
(C) 185 (D) 250

Q.59

17	11	19
12	13	16
25	4	?

(A) 36 (B) 9
(C) 25 (D) 64

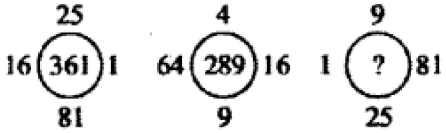
Q.60 Which of the following options will complete the series ? **[IMO]**
3, 2, 11, 4, 35, 8, 107, 16 ?
(A) 321 (B) 323
(C) 32 (D) 120

Q.61 Which number will replace the question mark, if the matrix follows a certain rule row-wise or column-wise ? **[IMO]**

4	7	5
33	78	46
8	?	9

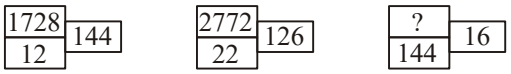
(A) 12 (B) 13
(C) 11 (D) 10

Q.62 Find the missing character in the number pattern given below. **[IMO]**



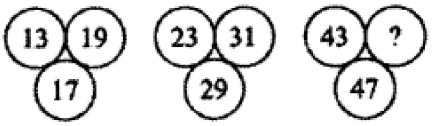
(A) 260 (B) 269
(C) 324 (D) 429

Q.63 If the figures having some characters given below follow the same rule, then find the missing number from the options. **[IMO]**



(A) 1304 (B) 2304
(C) 2034 (D) 1034

Q.64 The given set of figures carry certain characters. Assuming that the characters in each set follow a similar rule, identify the rule and find the missing character. **[IMO]**



(A) 51 (B) 53
(C) 49 (D) 41

Q.65 Replace the question mark with the correct number. **[IOM]**

15	225	30
7	70	20
3	?	8

(A) 12 (B) 16
(C) 24 (D) 70
(E) None of these

ANSWERS

Q.1	C	Q.2	A	Q.3	B	Q.4	A	Q.5	D	Q.6	D	Q.7	D
Q.8	C	Q.9	C	Q.10	C	Q.11	C	Q.12	B	Q.13	D	Q.14	C
Q.15	B	Q.16	B	Q.17	B	Q.18	A	Q.19	D	Q.20	A	Q.21	A
Q.22	D	Q.23	A	Q.24	A	Q.25	A	Q.26	D	Q.27	C	Q.28	D
Q.29	C	Q.30	B	Q.31	A	Q.32	B	Q.33	A	Q.34	C	Q.35	A
Q.36	D	Q.37	C	Q.38	A	Q.39	A	Q.40	C	Q.41	D	Q.42	A
Q.43	B	Q.44	A	Q.45	A	Q.46	C	Q.47	C	Q.48	D	Q.49	D
Q.50	C	Q.51	B	Q.52	B	Q.53	B	Q.54	C	Q.55	B	Q.56	D
Q.57	B	Q.58	A	Q.59	B	Q.60	B	Q.61	C	Q.62	C	Q.63	B
Q.64	B	Q.65	A										