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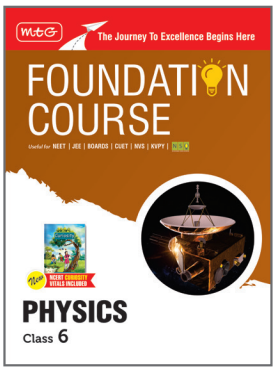
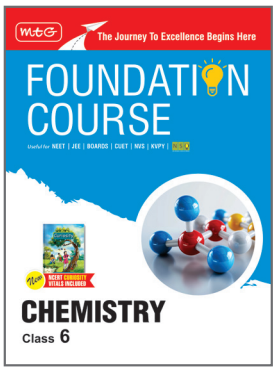
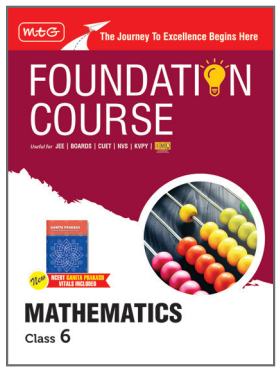


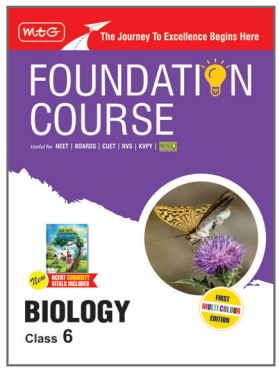
PHYSICS
- Exploring Magnets
- Measurement of Length and Motion
- Temperature and its Measurement
- Beyond Earth
- Light, Shadows and Reflections
- Electricity and Circuits



CHEMISTRY
- Materials Around Us
- A Journey through States of Water
- Methods of Separation in Everyday Life
- Changes Around Us

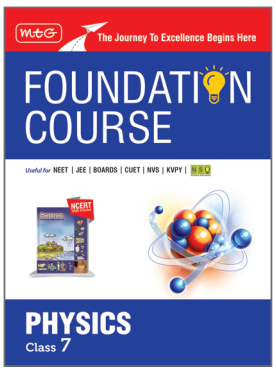


MATHEMATICS
- Patterns in Mathematics
- Lines and Angles
- Number Play
- Data Handling and Presentation
- Prime Time
- Perimeter and Area
- Fractions
- Playing with Constructions
- Symmetry
- The Other Side of Zero

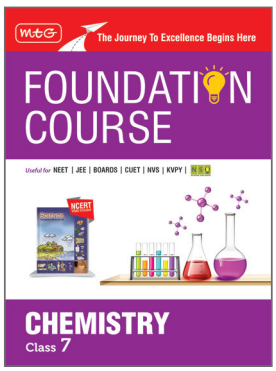


BIOLOGY
- The Wonderful World of Science
- Diversity in the Living World
- Mindful Eating: A Path to a Healthy Body
- Living Creatures: Exploring their Characteristics
- Nature's Treasures

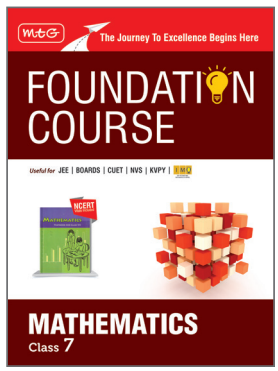
FOUNDATION COURSE CLASS 7



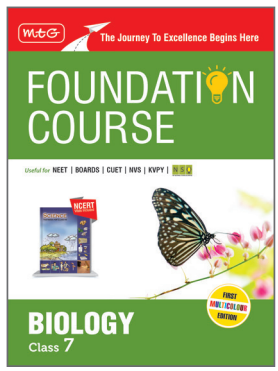
PHYSICS
- Heat
- Motion and Time
- Electric Current and Its Effects
- Light



CHEMISTRY
- Acids, Bases and Salts
- Physical and Chemical Changes



MATHEMATICS
- Integers
- Fractions and Decimals
- Data Handling
- Simple Equations
- Lines and Angles
- The Triangle and Its Properties
- Comparing Quantities
- Rational Numbers
- Perimeter and Area
- Algebraic Expressions
- Exponents and Powers
- Symmetry
- Visualising Solid Shapes



BIOLOGY
- Nutrition in Plants
- Nutrition in Animals
- Respiration in Organisms
- Transportation in Animals and Plants
- Reproduction in Plants
- Forests : Our Lifeline
- Wastewater Story

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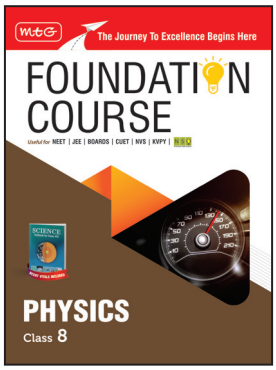
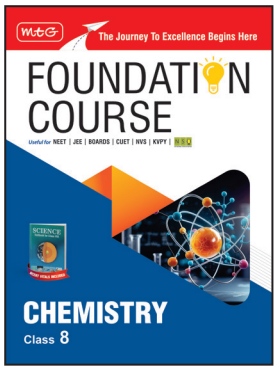
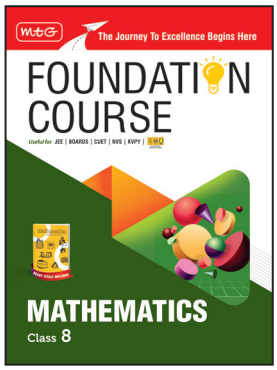
FOUNDATION COURSE CLASS 8



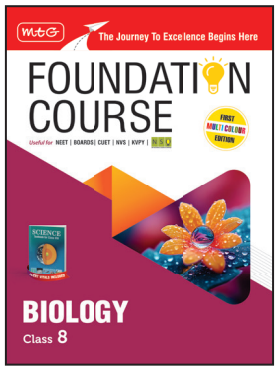
PHYSICS
- Force and Pressure
- Friction • Sound
- Chemical Effects of Electric Current
- Some Natural Phenomena
- Light • Planets
- Measurements and Motion
- Temperature and Heat
- Magnetic Effects of Electric Current



CHEMISTRY
- Coal and Petroleum
- Combustion and Flame
- Materials : Metals and Non-metals
- Matter : Elements, Compounds and Mixtures
- Atoms, Molecules and Atomic Structure

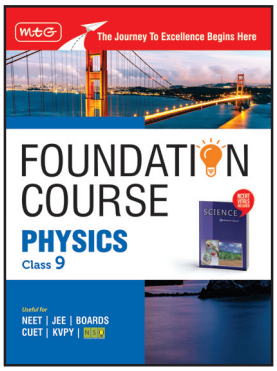


MATHEMATICS
- Rational Numbers
- Linear Equations in One Variable
- Understanding Quadrilaterals
- Data Handling
- Squares and Square Roots
- Cubes and Cube Roots
- Comparing Quantities
- Algebraic Expressions and Identities
- Mensuration
- Exponents and Powers
- Direct and Inverse Proportions
- Factorisation
- Introduction to Graphs

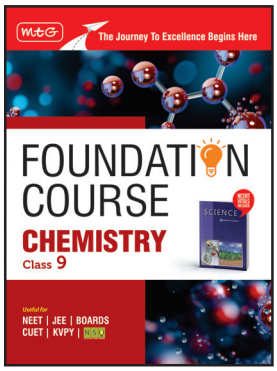


BIOLOGY
- Crop Production and Management
- Microorganisms : Friend and Foe
- Conservation of Plants and Animals
- Reproduction in Animals
- Reaching the Age of Adolescence
- Cell - Structure and Functions

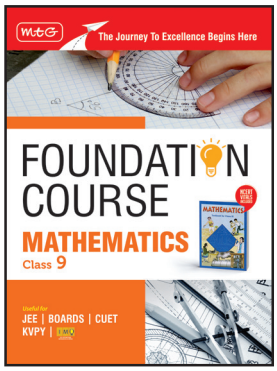
FOUNDATION COURSE CLASS 9



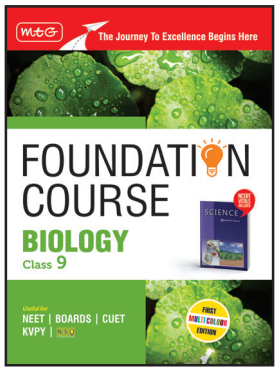
PHYSICS
- Motion
- Force and Laws of Motion
- Gravitation
- Thrust and Pressure
- Work and Energy
- Sound



CHEMISTRY
- Matter in Our Surroundings
- Is Matter Around Us Pure ?
- Atoms and Molecules
- Structure of the Atom

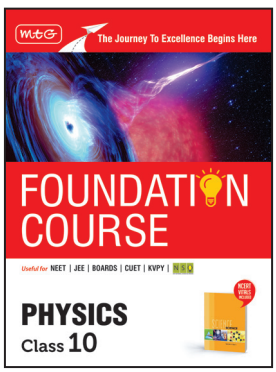


MATHEMATICS
- Number Systems
- Polynomials
- Coordinate Geometry
- Linear Equations in Two Variables
- Introduction to Euclid's Geometry
- Lines and Angles
- Triangles
- Quadrilaterals
- Circles
- Heron's Formula
- Surface Areas and Volumes
- Statistics

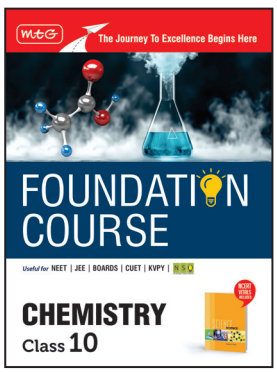


BIOLOGY
- Cell - The Fundamental Unit of Life
- Tissues
- Improvement in Food Resources
- Diversity in Living Organisms
- Why Do We Fall Ill
- Natural Resources

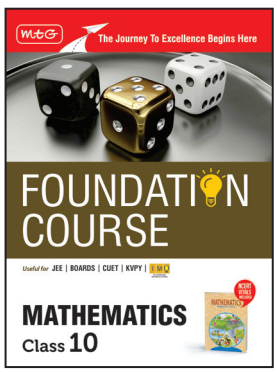
FOUNDATION COURSE CLASS 10



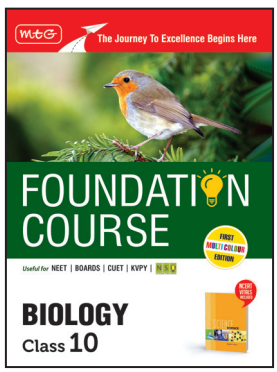
PHYSICS
- Light – Reflection and Refraction
- The Human Eye and the Colourful World
- Electricity
- Magnetic Effects of Electric Current
- Nuclear Energy



CHEMISTRY
- Chemical Reactions and Equations
- Acids, Bases and Salts
- Metals and Non-metals
- Carbon and its Compounds
- Periodic Classification of Elements
- Mole Concept and Stoichiometry
- Atomic Structure
- Chemical Bonding
- Chemical Equilibrium
- Practical Chemistry

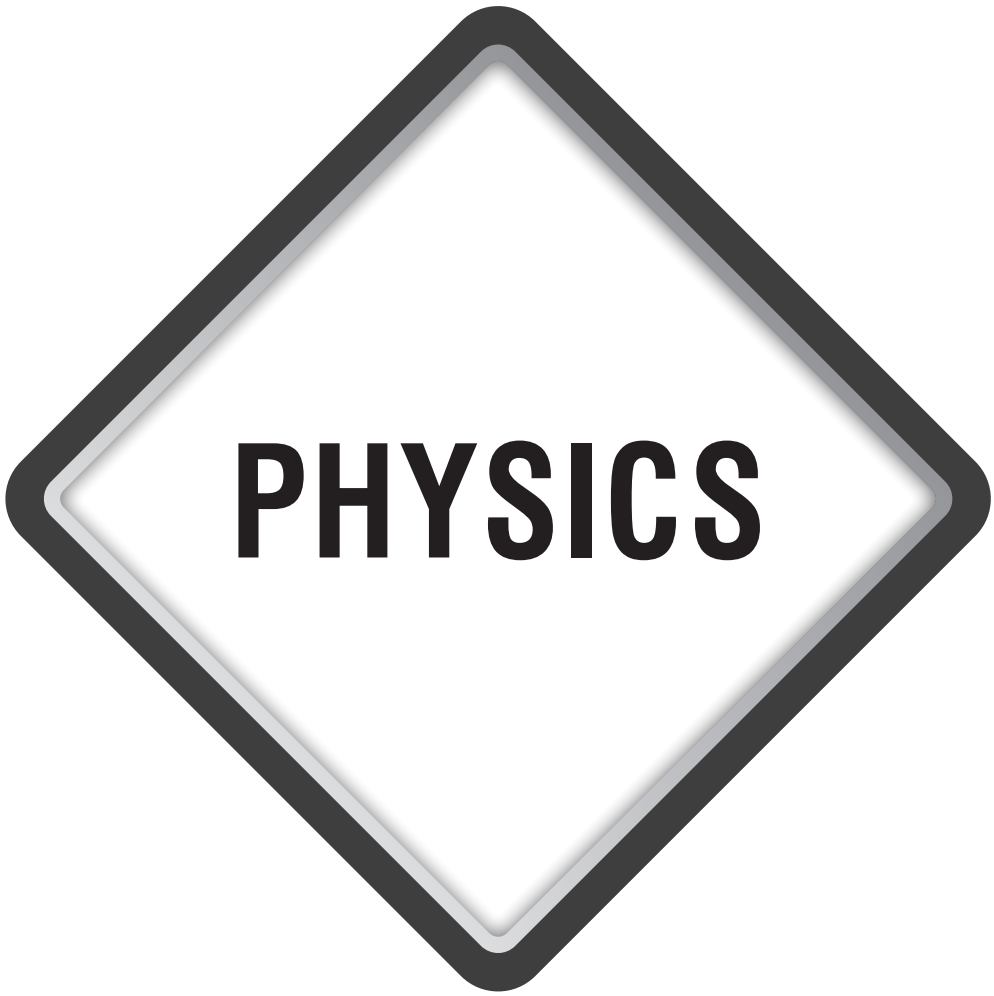


MATHEMATICS
- Real Numbers
- Polynomials
- Pair of Linear Equations in Two Variables
- Quadratic Equations
- Arithmetic Progressions
- Triangles
- Coordinate Geometry
- Introduction to Trigonometry
- Some Applications of Trigonometry
- Circles
- Areas Related to Circles
- Surface Areas and Volumes
- Statistics
- Probability



BIOLOGY
- Life Processes
- Control and Coordination
- How Do Organisms Reproduce?
- Heredity
- Our Environment
- Evolution
- Sustainable Management of Natural Resources

SAMPLE CHAPTERS


PHYSICS

CHAPTER 03

Temperature and its Measurement

Learning Outcomes...

- Hot or Cold
- Heat
- Temperature and its Measurement
- Thermometer and its types
- Air Temperature
- Heat Transfer

Introduction

We can have a rough idea if someone is having fever by merely touching her forehead, but this is not reliable. Human perception of temperature can be subjective and influenced by factors like the temperature of the environment or person's own body temperature. For example, a person might feel warm when touched due to being in a warm environment, but her actual body temperature could be normal. So it is not always correct to judge that a person has fever only by touching the person.

Using a thermometer is essential for accurate measurement of temperature. Incorrect measurements can lead to incorrect diagnosis and wrong treatment of the condition.

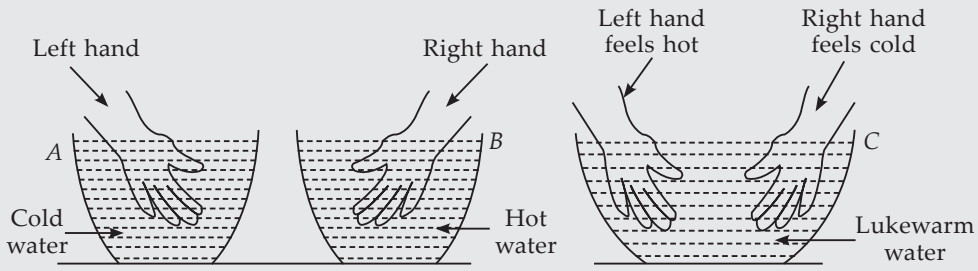
Hot or Cold

We see that some objects around us are cold while some others are hot. How do we say whether a body is hotter or colder? We often try to know the same by touching them. But is it possible to use the same method always? Then how do we find out how hot an object really is?

ACTIVITY CORNER

Feeling hotness or coldness of water by dipping hands.

- Take three small tubs/containers. Label them as *A*, *B* and *C*. Put cold water in container *A* and hot water in container *B*. (Make sure that the water is not so hot that you burn your hand)
- Mix some cold and hot water in container *C*.
- Now dip your left hand in container *A* and the right hand in container *B*.
- After keeping the hands in the two containers for 2-3 minutes, put both hands simultaneously in container *C*. Do both the hands get the same feeling?



Here, we will notice that the water in tub *C* does not feel equally warm to both the hands. Since, to the left hand, this lukewarm water appears to be hot while to the right hand, this lukewarm water appears to be cold.

So it is true to say that we cannot depend on our sense of touch for estimating the hotness or coldness of an object.

Temperature

Temperature is a reliable measure of the hotness or coldness of an object. The object is how much hot or cold is decided based on its temperature.

The temperature of an object is an only property that indicates which object is hot and which one is cold. A high temperature of a body indicates that it is very hot whereas a low temperature of the object indicates that it is quite cold, e.g., the temperature of boiling water is quite high, so boiling water appears to be very hot. On the other side, the temperature of melting ice is quite low. So, ice appears to be very cold on touch.

DO YOU KNOW?

- Younger children typically have higher body temperature than adults
- Physical activity can increase body temperature due to increased metabolic rate.
- Body temperature can vary throughout the day, usually being lower in the morning and higher in the later afternoon and evening.

Heat

Heat is a form of energy. It makes a substance hotter. Heat cannot be seen by us. We can feel the heat by the 'temperature effect' it produces. When heat is given to a substance, its temperature increase and it becomes hotter. For example, when a utensil is kept on a gas burner, it gets heat, its temperature increases and it becomes hot. On the other hand, when heat is removed from a substance then its temperature decreases and it becomes cold. For example, when water is kept in a refrigerator, then heat gets removed from water, its temperature decreases and it becomes cold.

When two bodies of different temperatures are in contact, what is the direction of flow of heat? Heat always flows from body of higher temperature to one of lower temperature.

DO YOU KNOW?

As heat is a form of energy. So its unit is same as energy *i.e.*, Joule or Calorie. There are 4.2 joules in one calorie.

ILLUSTRATIONS

1 How can temperature measurement impact daily life and various industries?

Ans.: Accurate measurement of temperature is essential in various industries such as food processing, medicine and manufacturing. It also impacts daily life by helping us to dress appropriately for the weather, adjust heating and cooling systems and monitor health conditions.

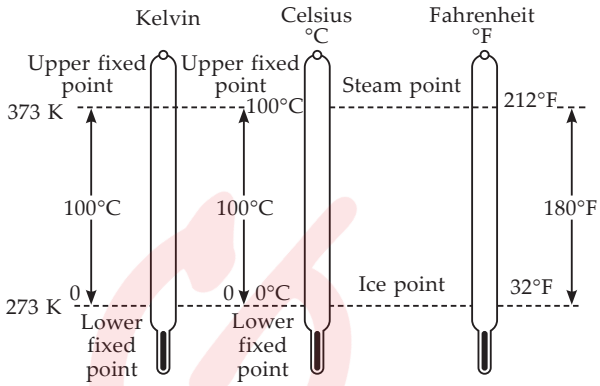
2 Why is it important to measure temperature accurately in scientific experiments?

Ans.: To ensure reproducibility and reliability of results, it is important to measure temperature accurately in scientific experiments.

Measuring Temperature

Temperature is measured by a device called thermometer. The property of the expansion and contraction of substances due to heating and cooling is used in thermometers. Generally, mercury is used in the thermometer. It provides a quantitative value of how hot or cold the object or substance is.

The SI unit of temperature is Kelvin (K). Other units of temperature are Fahrenheit (°F), Rankine (°R).



- **Construction of thermometer:** A thermometer is made of a glass tube, with a capillary tube inside it. To the end of this, there is a cylindrical bulb filled with mercury or alcohol.
- **Calibration of thermometer:** The lower marking on thermometer is the melting point of pure water while the upper marking is the boiling point of pure water.
- **Celsius scale:** The gap between the lower fixed point (LFP) and upper fixed point (UFP) on a thermometer is, divided into hundred units and each unit is 1°C. The LFP is 0°C while the UFP is 100°C.
- **Kelvin scale of temperature:** 0°C is equal to 273 K. To convert Celsius scale into Kelvin scale, just add 273 to the value in degree Celsius.
  Example: 17°C = 273 + 17 = 290 K
- **Fahrenheit scale of temperature:** The LFP is 32°F and UFP is 212°F.
  This scale is used mostly on clinical thermometers since the same gap between LFP and UFP is divided into 180 divisions whereas the same gap is divided into 100 divisions in Celsius and Kelvin scales. In converting the temperature from Celsius to Fahrenheit, the formula is $F = (9/5)C + 32$.

Reasons Why Mercury is Used in Thermometer

(a) It is opaque and shiny. It can be easily seen through the glass to note the reading.

(b) It does not stick to the glass.

(c) It is a good conductor of heat.

(d) Used over a wide range of temperatures since it has low freezing point (–39°C) and a high boiling point (357°C).

DO YOU KNOW?

The constant temperature at which, the solid substance changes into liquid is called its melting point. The constant temperature at which, a liquid changes into gaseous state is called boiling point.

Relation between Temperature Measuing Scales

- A branch of physics which deals with the measurement of temperature, (temperature of a substance) is known as the thermometry.
- Temperature Measuring Scales (Thermometer) :
  (a) Celsius Scale (°C) → Ice Point = 0°C, Steam Point = 100°C
  (b) Fahrenheit scale (°F) → Ice Point = 32°F, Steam Point = 212°F
  (c) Kelvin scale (K) → Ice point = 273.15 K, Steam point = 373.15 K
- Conversion method of temperature scale

$$\frac{C}{5}=\frac{F-32}{9}=\frac{K-273}{5}=\frac{R}{4}$$

where, C = Celsius, F = Fahrenheit, K = Kelvin, R = Reaumur

COMPETITION WINDOW

ILLUSTRATIONS

3 Aishwarya is suffering from fever and her temperature was 39°C. What is her temperature in Fahrenheit and Kelvin scale of temperature?

Ans.: (i) K = °C + 273 = 39 + 273 = 312 K

(ii) $\frac{°C}{5}=\frac{F-32}{9}$

$$\Rightarrow F\left(\frac{°C\times 9}{5}\right)+32=\left(\frac{39\times 9}{5}\right)+32=102.2°F$$

4 Ethyl alcohol boils at 78.5°C and freezes at 117°C under a pressure of 1 atm. convert these temperatures to the
(A) Kelvin scale
(B) Fahrenheit scale

Ans.: (A) 351.5 K, 156 K (B) 173.3°F, – 178.6 °F

Type of Thermometers

Digital Thermometer

Most of the common thermometers are mercury thermometers which use a liquid metal called mercury for their working. Mercury is a toxic substance (poisonous substance) and hence it is very difficult to dispose of safely if a thermometer breaks. So, there is a lot of concern over the use of mercury in thermometers. These days, digital thermometers are available which do not use mercury.

A digital thermometer

ACTIVITY CORNER

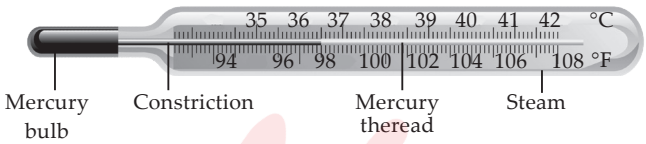
How to use a digital thermometer to measure body temperature?

- Wash you hand and tip of the digital thermometer with soap and water.
- Turn on the thermometer and click till the number zero appears on the display.
- Place the tip of the thermometer under the tongue and close you mouth.
- Wait for a few seconds before you hear the beepin sound from the thermometer.
- Remove the thermometer and check for the temperature on the display.
- Record the temperature in table given below.
- After use, clean the tip of the thermometer with soap and water and dry it.
- Repeat the above steps fro measuring the temperatures of your friends, and second the observations in the table given below.

S. No.	Name	Temperature (°C)
1.		
2.		
3.		
4.		
5.		

Clinical Thermometer

Clinical thermometer is used for the measurement of body temperature. The body temperature varies slightly. Therefore the range of clinical thermometer is between 35°C to 42°C. Clinical thermometer has graduated scale, on which scale is mentioned in degree celsius and in fahrenheit. Small division on the body of the clinical thermometer represents the temperature of 0.1 °C or $\frac{1}{10}$ degree C. The range in terms of fahrenheit on the body of the thermometer is between 94°F to 108°F. Human body temperature on the fahrenheit scale is 98.4°F and in the celsius scale it is 37°C. Clinical thermometer is made up of glass tube and a liquid **(mercury or alcohol or hydrocarbon based fluid)** is filled inside it. As the temperature increases, volume of the mercury expands. Division on the body of the thermometer shows the increase in temperature.

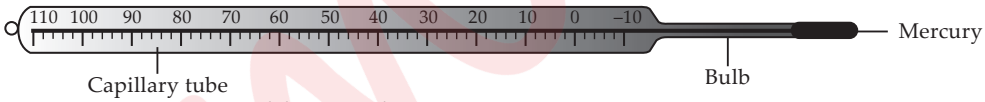


Precautions to be followed while using a clinical thermometer

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

Laboratory Thermometer

A laboratory thermometer is used for measuring temperatures, it ranges from –10°C to 110°C which is other than the human body temperature. Laboratory thermometers are used for lab purposes such as checking freezing point, boiling point, or temperature of other substances.



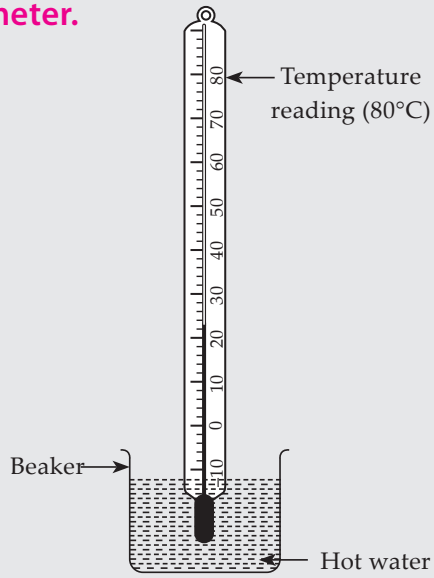
A laboratory thermometer

ACTIVITY CORNER

To take reading of a laboratory thermometer.

There are following steps to read the temperature on a laboratory thermometer.

- First of all, take some hot water in a beaker
- Now, try to hold the laboratory thermometer from its glass tube and immerse the bulb of the thermometer in hot water taken in the beaker. Notice that the bulb of the thermometer should not touch the sides or the bottom of the beaker as shown in figure.
- Here, we will observe the shining thread of mercury moving up in the thermometer tube. After sometime, the mercury will stop rising and stand at one place.
- Now, read the temperature on thermometer tube which corresponds to the top of mercury thread. This will give us the temperature of hot water taken in the beaker.



Measuring temperature of hot water with a laboratory thermometer

Precaution in Using a Laboratory Thermometer

- The laboratory thermometer should be held vertically (or upright) while measuring temperature. It should not be tilted.
- The thermometer bulb should be surrounded from all sides by the substance whose temperature is to be measured.
- The thermometer bulb should not touch the sides or bottom of the container in which the substance is taken.
- Read the thermometer while its bulb is still in touch with the substance whose temperature is being measured.
- Read the thermometer by keeping the level of mercury along the line of sight.
- Do not hold the thermometer by the bulb.
- Handle the thermometer with care. It can break it hit against any hard object.

DO YOU KNOW?

These are the special thermometers which automatically record the maximum and minimum temperature of the day. The maximum and minimum temperature of the last day reported in weather reports in TV and newspapers are measured by the maximum-minimum thermometers.

Pyrometer

The laboratory thermometer cannot be used to measure the temperature of a furnace as its temperature is above 1000°C. The thermometer which is used for this purpose is called pyrometer. This thermometer is made by joining together two wires of different metals. Different metals are used on the basis of the temperature to be measured. An electric current passes through this device when one end of it is held in the furnace. The magnitude of electric current gives the measure of temperature.

Comparison Between Clinical Thermometer and Laboratory Thermometer

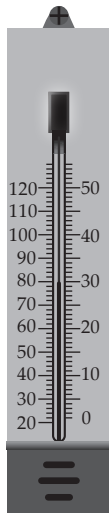
A similarity between clinical thermometer and laboratory thermometer is the both are mercury in glass thermometers. The differences between a clinical thermometer and a laboratory thermometer are as follows :

(i) The clinical thermometer has a very short temperature range (35°C to 42°C) whereas a laboratory thermometer has a large temperature range (usually from, – 10°C to 110°C).

(ii) The clinical thermometer has a kink (or constriction) in its tube to prevent the back flow of mercury into the bulb whereas a laboratory thermometer has no kink.

(iii) The clinical thermometer measures temperature more accurately (up to 0.1°C) than a laboratory thermometer (which usually measures up to 1°C).

Air Temperature



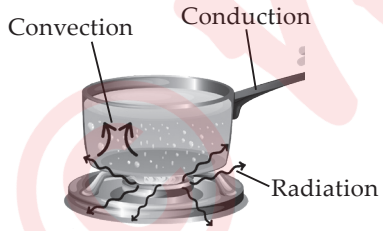
Air temperature is the measure of the warmth or coolness of the air. It is the degree of heat or cold in the air, usually measured in degrees Celsius (°C), Fahrenheit (°F), or Kelvin (K). It gives us an approximate idea of room temperature.

You might have seen thermometers, such as the one shown in figure, hung on walls of you school laboratory, doctor's clinic, and hospitals. These give an approximate idea of the room temperature

Because weather depends on several factors, these temperatures usually vary every day. Generally, as we approach the summer season, the temperature rises and during the winter season, it falls. There are many techniques for measuring air temperature. Air temperature is an important weather parameter and is monitored at weather stations all over the world. The data gathered on air temperature along with various other parameters are used for making weather forecasts.

Heat Transfer

- You might have observed that food prepared cools down when kept for a long time. The heat is transferred from the food to the surroundings. So, heat is always transmitted from a hot substance to cold substance. The transmission of heat takes place in three following ways :
  1. Conduction
  2. Convection
  3. Radiation

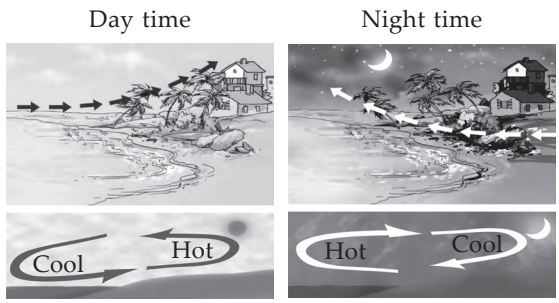


- **Conduction :** It is a mode of heat transfer from particle to particle without any actual movement of the particles. E.g., if we heat one end of a metal rod the other end of the rod also becomes hot. Here the heat has travelled from the hot end to the cold end by the process of conduction. All solids generally get heated by conduction.
- Touching a hot object being burnt, cooling down of your hand on holding ice are also examples of conduction of heat.

COMPETITION WINDOW

Convection

- Convection is the process of heat transfer by the bulk movement of molecules within fluids such as gases and liquids. For example, sea breeze and land breeze
- Sea breeze : Land gets heated faster as compared to water. The air over the land becomes hotter and rises up. The cooler air from the sea rushes in towards the land to take its place. The warm air from the land moves towards the sea to complete the cycle and phenomenon is called sea breeze. It happens in day time.
- Land breeze : The water cools down more slowly than the land. The cool air from the land moves towards the sea and phenomenon is called the land breeze. It happens in night time.

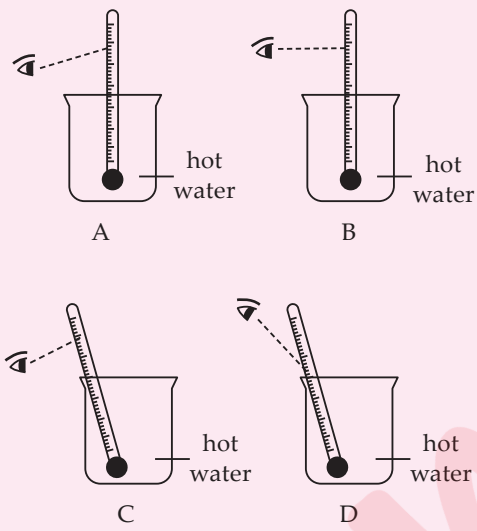


Sea breeze and Land breeze

- **Radiation :** Radiation is a mode of heat transfer from the source to the receiver without any actual movement of the source or the receiver and also without heating the intervening medium. Transfer of heat through radiation does not require any medium. We feel warm when we receive heat from the sun. This heat is transferred to us by the mode of radiation. Heat from fire is also an example of radiation. The greenhouse works on radiation. Heating up of a room through an electric heater happens because of radiation.

ILLUSTRATIONS

5 Which figure shows the correct way of redding the temperature on thermometer?



Ans.: Image B is correct position of thermometer in water and is properly aligned to eyes also.

6 Which process causes the air above the hot tea to the get heated?


A cup of hot tea

(a) Conduction (b) Evaporation
(c) Convection (b) Radiation

Ans.: Radiation

7 Why digital thermometers are preferred over clinical thermometer?

Ans.: Mercury is a toxic substance and is very difficult to dispose of if a thermometer breaks hence, digital thermometers are better than the clinical thermometers.

8 During winter season why does hot water kept in a bucket, in open becomes cold after sometime.

Ans.: When there is a temperature difference between two bodies, the heat flows from a body at a higher temperature to a body at a lower temperature.

CONCEPT MAP

Temperature and its Measurement

Measure of degree of hotness or coldness of a body is called temperature.
Temperature is measured in celsius, fahrenheit or kelvin.

Scales of temperature

Celsius Scale

- On this scale, ice point (L.F.P is taken as 0°C and steam point is taken as 100°C).
- The fundamental interval (interval between L.F.P and U.F.P) is divided into 100 equal parts (division).
- Each division corresponds to a difference of temperature of 1°C.

Fahrenheit Scale

- Here ice point (L.F.P) is taken as 32°F and steam point (U.F.P) is taken as 212°F.
- The fundamental interval is divided into 180 equal parts.
- Each part corresponds to a difference of temperature of 1°F.

Kelvin Scale

- Here, ice point (L.F.P) is taken as 273 K and steam point. Steam point (U.F.P) is taken as 373 K.
- The fundamental interval is divided into 100 equal parts.
- Each division corresponds to 1 K.

Conversion of one Scale to another Scale

$$\frac{C-0}{100-0} = \frac{F-32}{212-32} = \frac{K-273}{273-173}$$

Measurement of temperature

Thermometer

- Thermometer is a device used to measure temperature.
- Generally, mercury is used in thermometers.

Air Temperature

- Measure of the warmth or coolness of the air.
- It gives idea about room temperature.

Effects of temperature

Heat

- Heat is a form of energy which causes the sensation of hotness or coldness.
- Heat always flows from a body of higher temperature to a body of lower temperature.
- It is measured in joule or calorie.

Transmission of Heat

- **Conduction (solid) :** Transfer of heat from one substance to another due to direct contact. There is no movement of the heated particles of the medium.
- **Convection (liquid, gases) :** Transfer of heat through a fluid caused by the molecular motion. There is actual movement of the heated particles of the medium.
  The phenomenon of land breeze and sea breeze are based on natural convection.
- **Radiation vacuum :** Energy is radiated or transmitted in the form of rays of waves of particle

Type of thermometers

Clinical Thermometer

- It is used for measurement of body temperature.
- Range of clinical thermometer is between 35°C to 42°C.

Laboratory Thermometer

- It is used in the laboratory for measurement of the temperature of chemicals and for other purposes.
- Range of laboratory thermometers is –10°C to 110°C.

Digital Thermometer

- It is used for measuring temperature with the help of an electronic circuit.
- It is widely used because of their accuracy.

Pyrometer

It is used to measure very high temperature.

Solved Examples

1. Express the following temperatures in the Celsius scale: 131°F

Ans.: Given, temperature = 131°F,
To find C = ?

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

$= \frac{5}{9}(131 - 32) = \frac{5}{9} \times 99 = 55°C$

2. A faulty thermometer has its fixed points marked 5 and 95. When this thermometer reads 68, find the correct temperature in Celsius scale.

Ans.: 70°C

3. Ethyl alcohol boils at 78.5°C and freezes at – 117°C under a pressure of 1 atm. Convert these temperatures to the

(A) Kelvin scale

(B) Fahrenheit scale.

Ans.: (A) 351.5 K, 156 K, (B) l73.3°F – 178.6°F

4. According to the weather report the temperature of Dimapur today is 86°F .Convert it into °C.

Ans.: Given, temperature of Dimapur = 86°F,
To find C = ?

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

$= \frac{5}{9}(86 - 32) = \frac{5}{9} \times 54 = 30°C$

Therefore, temperature of Dimapur = 30°C

5. The temperature during a hot day in delhi was 45°C. Express this temperature in degree Fahrenheit.

Ans.: Given, temperature in delhi = 45°C
To find, F = ?

We know, $F = \left(C \times \frac{9}{5}\right) + 32$

$= \left(45 \times \frac{9}{5}\right) + 32 = (81 + 32) = 113°F$

6. If you are given the choice in winter of using either an old blanket or a new blanket what would you choose and why?

Ans.:

We know, air is a bad conductor of heat so, the air which is trapped in between the air spacing of cotton in a blanket act as an insulator and prevents the flow of heat from our body to the cold surroundings however, the trapping of air is more in new blanket as compared to the old blanket because when the quilt gets older, the air spacing of the cotton gets compressed which makes it less good insulator. Hence, I will choose the new blanket over the old one.

7. Thermometer '*A*' of length 20 cm has the temperature range 32°A – 212°A and thermometer '*B*' of the same length has the temperature range 37°B–157°B. Choose the one which can measure an accurate temperature of the body.

Ans.: Thermometer '*A*' has the number of divisions (212 -32) = 180 and thermometer '*B*' has (157 – 37) = 120 divisions. So, the single division value on scale *A* is smaller than '*B*' scale.
So, thermometer '*A*' measures the temperature more accurately than '*B*'.

8. Express the following temperatures in the Celsius scale: 77°F

Ans: Given, temperature = 77°F
To find C = ?

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

$= \frac{5}{9}(77 - 32) = \frac{5}{9} \times 45 = 25°C$

9. Explain why a clinical thermometer is exclusively used to measure the human body temperature and a laboratory thermometer is used to measure the temperatures of different substances but not to measure the human body temperature.

Ans.: The clinical thermometer is designed to measure the temperature of the human body only. The temperature of human body normally does not go below 35°C and 42°C. It means that the range is from 35°C to 42°C. So, it is not used in measuring the temperature of any object other than human body.

Normal thermometer or laboratory thermometer is generally from –10°C to 110°C and value of each small division is 1°C. Thus, small variations in body temperature cannot be measured accurately by using a laboratory thermometer. So, we cannot use this thermometer to find out the temperature of the human body.

10. A new thermometer calibrated as X°U to (X + 100)°U, then find the reading on this scale which is equal to 300 K temperature on the absolute scale.

Ans.: New thermometer LFP = X°U and
UFP = (X + 100)°U
Reading on kelvin scale is 300 K that means
C = K – 273 = 300– 273 = 27°C
Let '*R*' be the reading on the new thermometer

$$\left(\frac{R-\text{LFP}}{\text{UFP}-\text{LFP}}\right)_{\text{new scale}} = \left(\frac{\text{C}-0}{100-0}\right)_{^\circ\text{C}}$$

$$\frac{R-X}{(X+100)-X} = \frac{\text{C}}{100} \Rightarrow \frac{R-X}{100} = \frac{27}{100}$$

$$R - X = 27 \Rightarrow R = (27 + X)^\circ\text{U}$$

NCERT Section

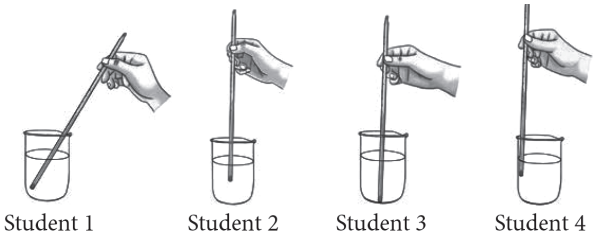
1. The normal temperature of a healthy human being is close to
(a) 98.6°C (b) 37.0°C (c) 32.0°C (d) 27.0°C

2. 37°C is the same temperature as
(a) 97.4°F (b) 97.6°F (c) 98.4°F (d) 98.6°F

3. Fill in the blanks:
(i) The hotness or coldness of a system is determined by its ____ .
(ii) The temperature of ice-cold water cannot be measured by a ____ thermometer.
(iii) The unit of temperature is degree ____ .

4. The range of a laboratory thermometer is usually
(a) 10°C to 100°C (b) –10°C to 110°C
(c) 32°C to 45°C (d) 35°C to 42°C

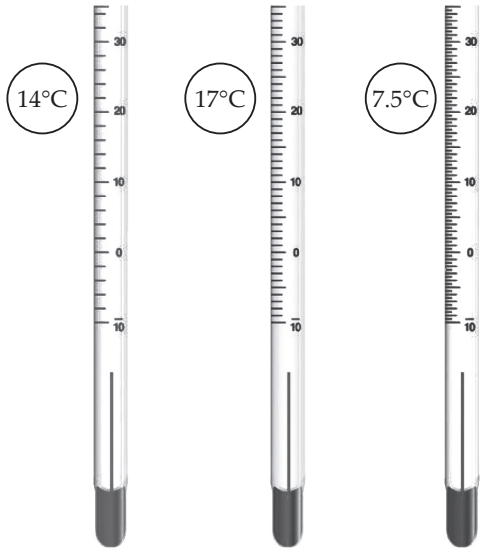
5. Four students used a laboratory thermometer to measure the temperature of water as shown in figures below.



Student 1 Student 2 Student 3 Student 4

Who do you think followed the correct way for measuring temperature?
(a) Student 1 (b) Student 2
(c) Student 3 (d) Student 4

6. Colour to show the red column on the drawings of thermometers (figures below) as per the temperatures written below:



7. Observe the part of thermometer shown in figure and answer the following questions:

(i) What type of thermometer is it?
(ii) What is the reading of the thermometer?
(iii) What is the smallest value that this thermometer can measure?

8. A laboratory thermometer is not used to measure our body temperature. Give a reason.

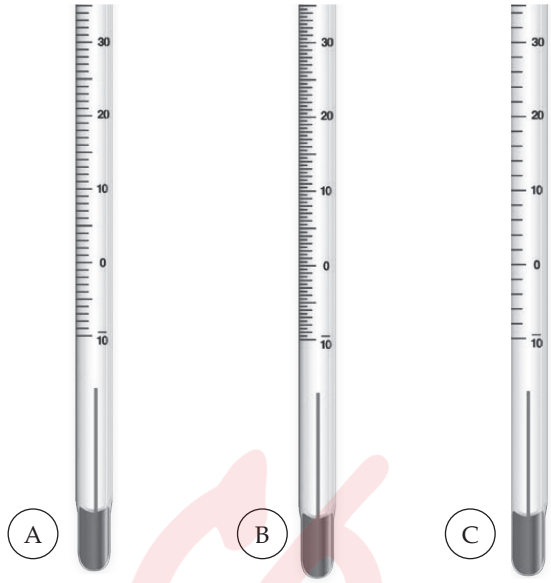
9. Vaishnavi has not gone to school as she is ill. Her mother has kept a record of her body temperature for three days as shown in Table below.

	Temperature (in °C) at					
Day	**7 am**	**10 am**	**1 pm**	**4 pm**	**7 pm**	**10 pm**
One	38.0	37.8	38.0	38.0	40.0	39.0
Two	38.6	38.8	39.0	39.0	39.0	38.0
Three	37.6	37.4	37.2	37.0	36.8	36.6

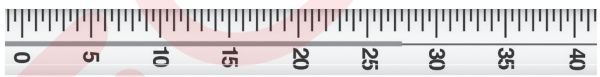
Table: Body temperature record of Vaishnavi

(i) What was Vaishnavi's highest recorded temperature?
(ii) On which day and at what time was Vaishnavi's highest temperature recorded?
(iii) On which day did Vaishnavi's temperature return to normal?

10. If you have to measure the temperature 22.5°C, which of the following three thermometers will you use (figure)? Explain.



11. The temperature shown by the thermometer in figure is



(a) 28.0°C (b) 27.5°C (c) 26.5°C (d) 25.3°C

12. A laboratory thermometer has 50 divisions between 0°C and 100°C. What does each division of this thermometer measure?

13. Draw the scale of a thermometer in which the smallest dimension reads 0.5°C. You may draw only the portion between 10°C and 20°C.

14. Someone tells you that she has a fever of 101 degrees. Does she mean it on the Celsius scale or Fahrenheit scale?

Exercise

Multiple Choice Questions

LEVEL - 1

1. Pyrometer is an instrument used to measure
(a) high temperature
(b) low temperature
(c) specific heat
(d) latent heat

R

2. The constant temperature at which a solid substance changes into liquid state is called
(a) Melting point of the substance.
(b) Boiling point of the substance.

(c) Saturation temperature.
(d) Evaporation temperature. R

3. Temperature is measured in ____ .
(a) Degree celsius
(b) Kelvin
(c) Degree fahrenheit
(d) All the above R

4. The reliable measure of hotness of an object is
(a) its heat content
(b) its temperature
(c) its contact with other objects
(d) None of these U

5. The direction of flow of heat is
(a) always from hotter body to a cooler body
(b) always from cooler body to a hotter body
(c) always from a body at a lower temperature to a body at higher temperature
(d) All the above are correct U

6. Which of the following devices is used for measurement of temperature of human body?
(a) Thermometer
(b) Clinical thermometer
(c) Laboratory thermometer
(d) None of these R

7. At low temperatures ____ types of thermometer is used.
(a) mercury thermometer
(b) water thermometer
(c) alcohol thermometer
(d) thermometers cannot be used R

8. The difference between lower fixed point and upper fixed point is divided into ____ parts on a Celsius scale
(a) 100 (b) 273
(c) 180 (d) 50 U

9. Normal temperature of the human body is ____ .
(a) 87 K (b) 273 K
(c) 37°C (d) 82°F R

10. Clinical thermometer is calibrated in ____ .
(a) Celsius scale (b) Fahrenheit scale
(c) Absolute scale (d) Both (a) and (b) R

11. For a clinical thermometer we use a solid and a liquid. The liquid use in a clinical thermometer is
(a) a metal
(b) a non-metal
(c) neither a metal nor a non-metal
(d) None of the above is correct R

12. Convert 95°F to °C.
(a) 49°C (d) 35°C
(c) 28°C (d) 42°C R

13. The glass tube used for construction of a thermometer should be
(a) long (b) narrow
(c) uniform (d) All of these U

14. Cooling in a motor car is done by
(a) Conduction
(b) Convection
(c) Radiation
(d) All of the above

15. In solids, generally the heat is transferred by
(a) Conduction (b) Convection
(c) Radiation (d) All of the above U

16. Which of the following thermometers does not use mercury?
(a) Clinical thermometers
(b) Laboratory thermometers
(c) Digital thermometers
(d) All of these use mercury R

17. In the process of flow of heat by conduction
(a) there is no movement of the substance
(b) the heat transfer takes place from higher temperature part of body to lower temperature part of body
(c) occurs when one end of an iron rod is heated on a burner
(d) All the above are correct U

18. The heat from the sun reaches us on the earth by the process of :
(a) conduction (b) radiation
(c) convection (d) none of these R

19. The process which can transfer heat through the vacuum as well as air is :
(a) conduction (b) convection
(c) irradiation (d) radiation R

20. The mode of transfer of heat in the absence medium is called ____ .
(a) Convection (b) Conduction
(c) Radiation (d) All of the above R

21. The scale in clinical thermometer is marked from ____ °C to ____ °C
(a) 35°C to 43°C (b) 36°C to 44°C
(c) 37°C to 45°C (d) 38°C to 46°C R

22. The device used for measuring temperature is called :
(a) tachometer (b) odometer
(c) thermometer (d) barometer R

23. Which of the following features are that of a clinical thermometer?
A. Short temperature range
B. Wide temperature range
C. Alcohol filled glass bulb
D. Constriction in glass tube
(a) A and B (b) B and C
(c) A and D (d) B and D R

24. Digital thermometers available these days for measuring temperature use :
(a) alcohol (b) water
(c) mercury (d) none of these R

25. Which of the following is a poor conductor of heat?
(a) Plastic (b) Aluminium
(c) Silver (d) Copper

26. Which of the following is true in case of mode of transmission of the of heat?
(a) Convection is possible only in case of liquids and gases.
(b) Radiation is the fastest mode of heat transfer.
(c) Conduction is possible only in case of solids.
(d) All of the above R

27. Sea breeze and land breeze are formed due to ____ .
(a) Conduction
(b) Convection
(c) Radiation
(d) All of the above

28. Which of the following is a poor conductor of heat?
(a) Wood (b) Water
(c) Air (d) All of the above U

29. Mercury is widely used in clinical thermometers because
(a) mercury is cheap
(b) mercury is clearly visible
(c) it is fashionable to use mercury
(d) mercury has a constant coefficient of expansion.

30. The equatorial and polar regions of the earth receive unequal solar heat. The convection current arising due to this is called
(a) land breeze (b) sea breeze
(c) trade wind (d) tornado R

LEVEL - 2

31. Mercury has a _____ boiling point and a _____ melting point.
(a) high, low (b) low, high
(c) high, high (d) low, low U

32. Conduction is the primary mode of heat transfer in which of the following?
(a) Water (b) Solid
(c) Liquid (d) gases Ap

33. Two laboratory thermometers are marked as '*A*' and '*B*'. The bulb of thermometer '*A*' is wrapped in a white cloth and that of thermometer '*B*' in black cloth. Both the thermometers are placed in-sunlight for an hour. After one hour:
(a) Both the thermometers will read the same temperature.
(b) Thermometer '*A*' will show higher temperature than '*B*'
(c) Thermometer '*B*' will show higher temperature than '*A*'
(d) None of the above is correct. An

34. The convection currents in air transfer heat:
(a) downwards
(b) upwards
(c) downwards as well as upwards
(d) sideways U

35. Which of the following conditions lead to the blowing of sea-breeze in coastal areas.
A. Land cool and sea warm
B. Land hot and sea cool
C. Day time
D. Night time
(a) A and B (b) A and C
(c) B and C (d) B and D Ap

36. 40°C in Fahrenheit scale is equal to
(a) 104°F (b) 110°F
(c) 119°F (d) 100°F An

37. On heating a substance which of the following physical quantities change(s)?
(a) Density (b) Mass
(c) Volume (d) Both (a) and (c) U

38. The physical state of a substance can be changed by
(a) Maintaining its temperature.
(b) Removing heat energy from the substance.
(c) Giving heat energy to the substance.
(d) Both (b) and (c)

39. The temperature of an object is 60°C. Its value in Fahrenheit scale is
(a) 120°F (b) 130°F
(c) 140°F (d) 110°F An

40. The temperature on a Fahrenheit scale is 98.6°F? What is the corresponding temperature on a Kelvin scale?
(a) 310.2 K (b) 280.3 K
(c) 420.5 K (d) 370.6 K An

41. Two temperature scales A and B are related by $\frac{A-42}{110}=\frac{B-72}{220}$. At which temperature two scales have the same reading?
(a) –42° (b) –72°
(c) +12° (d) – 40°

42. By heating, _____ of substances can be changed.
(a) Size (b) Temperature
(c) State (d) All of the above
U

43. An iron ball at 40°C is dropped in a mug containing oil at 40°C. Then
(a) Heat flows from iron ball to oil.
(b) Heat flows from oil to iron ball.
(c) Heat does not flow between oil and iron.
(d) Temperature of oil increases and temperature of iron ball decreases.
Ap

44. In a thermos flask, the loss of heat energy due to the following method is minimized.
(a) Conduction (b) Convection
(c) Radiation (d) All of the above
Ap

45. Heat energy brings about _____ .
(a) Chemical changes in matter
(b) Change in dimensions
(c) Change in temperature
(d) All of the above

LEVEL - 3 (HOTS)

Competency Focused Questions (CFQs)

46. What does temperature measure?
(a) Degree of hotness of a body
(b) degree of coldness of a body
(c) Volume of a body
(d) both (a) and (b)
An

47. What are the commonly used reference temperatures for constructing temperature scales?
(a) Melting point of wax and boiling point of alcohol
(b) Melting point of wax and boiling point of water
(c) Melting point of ice and boiling point-of wax
(d) Melting point of ice and boiling point of water.
An

48. Which of the following statements is true?
(a) Copper has a higher rate of conduction than iron.
(b) Iron has a higher rate of conduction than copper
(c) Aluminium has a higher rate of conduction than iron
(d) Both (b) and (c)
An

49. Which of the following is the reason for sea breeze and land breeze to blow?
(a) Water heats up faster than land
(b) Land heats up much faster than water
(c) Water and land gets heated up equally fast
(d) None of these
Ap

50. Why does an electric heater have a mirror fitted behind its heating coil?
(a) Mirror is a good conductor of heat
(b) Mirror is a bad conductor of heat
(c) To improve convection of heat
(d) Mirrors reflect heat radiation to the front of the heater
Ap

51. Arrange the following steps in sequential order to construct a celsius thermometer.
(A) Lower fixing point is marked by placing the bulb of the thermometer in pure melting ice.

(B) A thin capillary tube, covered with a thick glass stem and providing a funnel is taken.

(C) The distance between upper fixing point and lower fixing point is divided into 100 equal parts and calibrated.

(D) Upper fixing point is marked by placing the bulb of the thermometer in boiling water.

(E) While pouring the mercury in the tube, place the mercury bulb in hot water both to remove air bubbles.

(F) Lat the funnel and seal that end

(a) BEFADC (b) BEADCE

(c) BFECAD (d) BEFCAD Cr

52. Convection is the primary mode of heat transfer in which of the following?

(a) Solids and liquids

(b) Liquids and gases

(c) Gases and solids

(d) only liquids Ap

53. Express the following temperatures in the Fahrenheit scale.

110°C

(a) 210°C (b) 220°C

(c) 230°C (d) 240°C

54. Find the temperature at which Fahrenheit and Kelvin scales give the same reading.

(a) 544°C (b) 554°C

(c) 564°C (d) 574°C Ev

55. The temperature of liquid hydrogen is 20 K. What is this temperature on the Fahrenheit scale?

(a) 393°F (b) 403°F

(c) 413°F (d) 423°F Ev

56. Two thermometers *A* and *B* have fundamental interval of 45° and 100°. The lower points of *A* and *B* are 0° and 50° respectively. If Breads 110°, then find the reading of *A*.

(a) 18°C (b) 27°C

(c) 36°C (d) 55°C Ev

57. At what temperature a fahrenheit thermometer be double that of a centigrade thermometer?

(a) 140°C (b) 160°C

(c) 180°C (d) 200°C Ev

58. When a liquid in a beaker is heated on a gas burner

(a) heated molecules becomes less dense and rise

(b) colder molecules from above move down and get heated

(c) the heat is transferred by convection

(d) All of these are correct An

59. Which one of the following will not help to cool down a cup of hot tea?

(a) Stirring the contents of cup continuously

(b) Adding a piece of ice to the cup of hot tea

(c) Pouring the hot tea in a saucer

(d) Adding more sugar to the cup of tea.

60. An iron ball at 60°C is dropped in a mug containing water at 60°C. The heat will

(a) flow from iron ball to water

(b) not flow from iron ball to water or from water to iron ball

(c) flow from water to iron ball

(d) increase the temperature of both

61. When one end of an iron rod is heated, its other end also becomes hot soon. Name the process by which heat flows in the iron rod.

(a) Radiation (b) Conduction

(c) Convection (d) All of these

Ap

62. Name the process by which a frying pan transfers heat from the gas stove through its bottom to the food kept inside it.
(a) Convection (b) Radiation
(c) Conduction (d) None of above

63. A hot utensil (filled with hot water) kept away from flame cools down by transferring heat to surroundings. Name the process of heat transfer involved.
(a) Conduction (b) Convection
(c) Radiation (d) None of these.

Ap

64. In case of an incense stick or an agarbati, the smoke at the lighted end of stick moves in upward direction, it is because
(a) The cool air below the lighted end moves to take the place of hot air above the lighted end.
(b) The air at the hot end is more dense.
(c) It is natural for the smoke to move up.
(d) The smoke is repelled by the gravity of earth.

Ap

65. Arrange the following steps in sequential order to show that the conduction of heat is different in different conductors.
(A) Take two identical rods one is copper and the other is iron.
(B) The ends of the two rods are heated with the same spirit lamp.
(C) Fix some nails on the rods with the help of wax at equal distances.
(D) The nails near to the flame falls first from the copper rod and then from the iron rod.
(a) ACDB (b) ABCD
(c) ACBD (d) ADBC

Cr

Fill in the Blanks

1. A cold steel spoon is dipped in a cup of hot milk. It transfers heat to its other end by the process of ____ .
2. The hotness of an object is determined by its ____ .
3. Temperature is measured in degree ____ .
4. Temperature of boiling water cannot be measured by a ____ thermometer.
5. In liquids and gases, heat is transferred by the process of ____ .
6. If heat energy is given to a substance and its temperature remains constant, then the substance undergoes a change in ____ .
7. ____ is the SI unit of heat.
8. If temperature of a substance increases, the average kinetic energy of molecules of the substance ____ .
9. Fastest mode of transmission of heat is ____ .
10. The highest and lowest temperatures of the day are measured by a thermometer called the ____ .

True or False

1. In a clinical thermometer the mercury level immediately falls when taken out of the mouth.
2. Heat energy is invisible.
3. The heat required to raise the temperature of 1 kg of water by 1 °C is called one calorie.

4. The heat absorbed by a substance decreases with increase in temperature.

5. The maximum and minimum temperature of the day is measured by doctor's thermometer.

6. The thermometer has a shining thread of water.

7. The temperature of boiling water can be measured by a clinical thermometer.

8. No medium is required for transfer of heat by the process of convection.

9. Marking on clinical thermometer is from 0°C to 100°C.

10. The maximum and minimum temperature of the day is measured by a laboratory thermometer.

Match the Following

In this section, each question has two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (a), (b), (c) and (d) out of which one is correct.

1.

	List-I		**List-II**
(P)	Clinical thermometer	(1)	Kink
(Q)	Laboratory thermometer	(2)	Scale marked in °C
(R)	Steel	(3)	Good conductor
(S)	Plastic	(4)	Bad conductor

(a) (P)-(4), (Q)-(3), (R)-(2), (S)-(1)
(b) (P)-(1), (Q)-(2), (R)-(3), (S)-(4)
(c) (P)-(2), (Q)-(1), (R)-(3), (S)-(4)
(d) (P)-(3), (Q)-(4), (R)-(1), (S)-(2)

2.

	List-I		**List-II**
(P)	Range of clinical thermometer	(1)	35°C to 42°C
(Q)	Range of Laboratory thermometer	(2)	–10°C to 110°C
(R)	Normal body temperature	(3)	37°C
(S)	A liquid metal	(4)	Mercury

(a) (P)-(2), (Q)-(1), (R)-(3), (S)-(4)
(b) (P)-(3), (Q)-(4), (R)-(1), (S)-(2)
(c) (P)-(4), (Q)-(3), (R)-(2), (S)-(1)
(d) (P)-(1), (Q)-(2), (R)-(3), (S)-(4)

3.

	List-I		**List-II**
(P)	Water	(1)	Convection currents
(Q)	Temperature	(2)	Bad absorber of heat
(R)	White	(3)	Bad conductor of heat
(S)	Sea breeze	(4)	Liquid state
(T)	Mercury	(5)	Degree Celsius

(a) (P)-(3), (Q)-(5), (R)-(2), (S)-(1), (T)-(4)
(b) (P)-(1), (Q)-(2), (R)-(3), (S)-(4), (T)-(5)
(c) (P)-(3), (Q)-(4), (R)-(1), (S)-(2), (T)-(5)
(d) (P)-(5), (Q)-(4), (R)-(3), (S)-(2), (T)-(1)

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If assertion is false but reason is true.

1. **Assertion :** The body temperature of every person is not 37°C.
   Reason : It is an average temperature of human body.

2. **Assertion :** Radiation is a method of transfer of heat.
   Reason : The process of heat transfer that does not require any medium is called convection.

3. **Assertion :** To check the body temperature, a thermometer is usually placed in mouth or in armpit.
   Reason : The normal body temperature of a healthy person is 37°C or 98.6 F.

4. **Assertion :** The most common scales used to measure the temperature are celsius scale and fahrenheit scale.
   Reason : The interval between upper fixed point and lower fixed point of these scales is divided into 100 equal parts.

5. **Assertion :** Temperature is a measure of degree of hotness of our body.
   Reason : We use a clinical thermometer to measure the degree of hotness of our body.

6. **Assertion :** When a body *A* at temperature 50°C is brought in contact with a body *B* at temperature 30°C, heat flows from the body *A* to the body *B*.
   Reason : Heat always flows from a body at a low temperature to a body at a high temperature.

7. **Assertion :** The temperature of a body is 10°C. Its temperature in Fahrenheit scale is 50°F.
   Reason : Celcius (C) and Fahrenheit (F) are related as $F = \frac{9}{5}C + 32$.

8. **Assertion :** All materials conduct the heat.
   Reason : Conductors are the materials which allow heat to pass through them easily.

9. **Assertion :** A vacuum flask keeps hot liquids hot and cold liquids cold.
   Reason : A thermos flask is silvered to minimise the heat transfer by convection.

10. **Assertion :** Sea breeze refers to the movement of cold air from sea towards land during day time.
    Reason : Land breeze refers to the movement of cold air from land towards sea during night time.

Comprehension Type

PASSAGE-I : Vinay with a group of adventurous friends, went to river rafting in Manali in winters. There the tented accommodations on the river bank. He noticed that at every camping site the basic element of all the tents was a long, narrow strip of heavy black cotton. Every tent had a room heater, the travellers were advised to place room heaters at the ground level for effective heating. At night it was chilling so, bonfire was arranged by the camp owner for the travellers to provide warmth in open cool spaces. When Vinay was sitting beside a campfire, his body facing the fire got hot while the side facing away from the fire stays cold.

1. Which of the following is a method of heat transfer?
   (a) Convection
   (b) Radiation

(c) Conduction
(d) All of the mentioned

2. Why Vinay's body facing the fire got hot while the side facing away from the fire stays cold because of
(a) The transfer of heat by convection
(b) The transfer of heat by radiation
(c) The transfer of heat by conduction
(d) All of the above

3. If heater is placed at a height then
(a) cold air above this height will not be heated by heater
(b) the hot air comes down to get heat from heater
(c) cold air below this height will not be heated by heater
(d) cold air rises up in the room to get heated.

4. Why all the tents are black in colours at the campus?
(a) The black colour is good absorber of heat.
(b) The black colour is bad absorber of heat
(c) The black colour is visible clearly at night.
(d) None of the above

5. Why white colour fabric tent is preferred on in a hot weather place?
(a) The white colour is good absorber of heat.
(b) The white colour is bad absorber of heat.
(c) It looks good as a white canopy.
(d) None of the these.

PASSAGE-II : A clinical thermometer is used to measure the body temperature of human beings. It consists of a long, narrow, uniform glass tube. It has a bulb at one end. The bulb contains mercury. This thermometer reads temperatures from 35°C to 42°C.

1. A clinical thermometer can be used to measure the body temperature of human beings. A person suffering with fever is likely to show which of the following readings on this thermometer?
(a) 35°C (b) 36°C (c) 37°C (d) 39°C

2. What for is a clinical thermometer provided with a kink?
(a) To keep the mercury within the range of 35°C – 42°C.
(b) To allow the temperature reading to remain unchanged after the use of temperature until a jerk is given.
(c) To make the thermometer size smaller.
(d) All of the above are correct

3. Which of the following precautions should be used while using a clinical thermometer?
(a) It should be washed before use.
(b) It should be washed after use.
(c) It should be washed preferably with some antiseptic.
(d) All the above.

Subjective Problems

Very Short Answer Type

1. What are Celsius and Fahrenheit?
2. In which thermometer is a kink added?
3. Heat is a form of what?
4. The scale in which the melting point of ice and the boiling point of water is taken as 0 and 100, respectively.
5. The silvery grey liquid used in clinical thermometers.

6. The breeze that flows from the land to the sea during night time.
7. The type of waves via which heat and light energy travel.
8. A unit for measuring heat energy.
9. Express the following temperatures in the Fahrenheit scale.
   85°C
10. What do you mean by the transfer of heat?

Short Answer Type

1. State two disadvantages of clinical thermometer.
2. Under what conditions does heat flows from a hot body to a cold body by conduction?
3. Give one advantage of using alcohol thermometer as compared to using mercury.
4. Explain, how convection current in air help as to fly a kite.
5. List two characteristic features of a mercury thermometer.
6. Why bottom of cooking utensils is often blackened?
7. What is the physical quantity that decides the flow of heat energy?
8. Why wool is a bad conductor of heat?
9. What is the thermometer used to measure the temperature of a furnace?
10. Express the following temperature in the Celsius scale.
    0°C
11. Why boiling water is not used to sterilize a clinical thermometer?
12. What is the range of temperatures, that can be measured using clinical thermometer in Fahrenheit scale?
13. What prevents the mercury level in the glass tube of a clinical thermometer from falling on its own when its bulb is removed from the mouth of a patient?
14. What is maximum and minimum thermometers?
15. What are the precautions needed while reading a laboratory thermometer?

Long Answer Type

1. Describe a simple experiment which can demonstrate that the terms hot and cold as we feel them are only relative.
2. Explain the occurrence of the sea breeze near coastal regions with the help of a diagram.
3. Distinguish between heat and temperature.
4. What are temperature scales? Explain how Celsius and Fahrenheit are defined.
5. With the help of diagram, explain the working of thermoflask.

Integer/Numerical Value Type

1. What is the boiling point of water on the Fahrenheit scale?
2. At what temperature does the Celsius scale mark the boiling point of water?
3. The Kelvin scale is related to the Celsius scale by the formula:
   Temperature in Kelvin = Temperature in Celsius + x. What is the value of x ?

4. If we convert 287 K to celsius scale, we will get _____ °C.

5. A rise in temperature of 50°C on celsius scale is equal to rise in the temperature of _____ K.

Case Based Questions

Case I : Take a rod or flat strip of a metal such as iron or aluminium. Fix a few small wax pieces on the rod. Fix these pieces at equal distances and clamp the rod to stand in a horizontal position. Now, heat the farther end (away from clamped position) of the rod with the help of a burner. Observe the changes in wax pieces.

CFQs

1. The wax piece that melts first is one
   (a) that is farthest away from the clamped end of the rod.
   (b) that is nearest to the clamped end of the rod.
   (c) that is in the middle of the rod.
   (d) any one of the wax pieces may melt first.

2. In this activity the heat travels from one end of the rod to the other end of the rod by
   (a) Conduction (b) Convection
   (c) radiation (d) All of these

3. In this activity heat travels from
   (a) higher temperature to lower temperature.
   (b) lower temperature to higher temperature.
   (c) Both ends to the middle of rod.
   (d) None of these is correct.

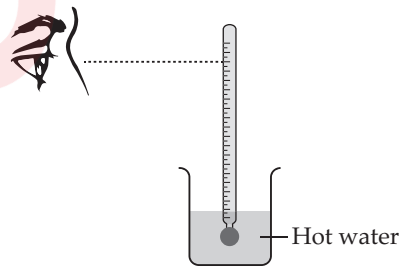
Case II : Light a candle, Keep one hand above the candle flame and one hand on the side of the flame. Do you feel any difference in degree of hotness felt by two hands?

1. Which hand feels more hot?
   (a) The hand that was kept above the flame.
   (b) The hand that was kept on the side of the flame.
   (c) Both hands feel equally hot.
   (d) None of those is correct.

2. In this activity the mode of transfer of heat is
   (a) conduction (b) convection
   (c) radiation (d) None of these

3. How does the heat travel in air?
   (a) The air near the heat source gets hot and rises
   (b) The air from sides come to take its place.
   (c) In this way air gets heated.
   (d) All the above are correct.

Case III : Look at the figure given below.



1. Which thermometer is being used in the above figure to measure the temperature?

2. What is the range of this thermometer?

3. What two precautions are to be taken while reading this thermometer?

Case IV : Substances that conduct heat very well are called good conductors of heat or thermal conductors. All the metals such as silver, copper, aluminium, iron, mercury and metal alloys such as brass, steel and stainless steel are good conductors of heat. Though all the metals are good conductors of heat, some metals are better conductors of heat than the

others. Among metals, silver metal is the best conductor of heat, next is copper and lowest is lead.

Substances that do not conduct heat very well are called bad conductors or poor conductors or insulators of heat. Some of the examples of heat or thermal insulators are plastic, wood, paper, cloth, thermocol, rubber, etc. Liquids like water are poor conductors and gases are very poor conductors of heat. Thus, air is a very good insulator of heat.

CFQs

1. It is observed that when glass heated it cracks while metal does not. Which is of the following statements explain this phenomenon?
   (a) Metal is a poor conductor of heat.
   (b) The expansion of the glass after heating is uniform and therefore it cracks.
   (c) In case of glass the heat is transmitted quickly when heated.
   (d) Glass is a poor conductor of heat.

2. Which of the following is the best insulator of heat?
   (a) air (b) silver
   (c) iron (d) water

3. When we touch a steel rod and a paper simultaneously, we feel that the rod is colder because
   (a) iron being a good conductor conducts more heat from our body.
   (b) paper being a good conductor conducts more heat from out body.
   (c) more heat flows from the iron to our body.
   (d) more heat flows from the paper to our body.

ANSWER KEY

Multiple Choice Questions

1.	(a)	2.	(a)	3.	(d)	4.	(b)	5.	(a)
6.	(b)	7.	(c)	8.	(a)	9.	(c)	10.	(d)
11.	(a)	12.	(b)	13.	(d)	14.	(b)	15.	(a)
16.	(c)	17.	(d)	18.	(b)	19.	(d)	20.	(c)
21.	(a)	22.	(c)	23.	(c)	24.	(d)	25.	(a)
26.	(b)	27.	(b)	28.	(d)	29.	(d)	30.	(c)
31.	(a)	32.	(b)	33.	(c)	34.	(b)	35.	(c)
36.	(a)	37.	(d)	38.	(d)	39.	(c)	40.	(a)
41.	(c)	42.	(d)	43.	(c)	44.	(d)	45.	(d)
46.	(d)	47.	(d)	48.	(a)	49.	(b)	50.	(d)
51.	(a)	52.	(b)	53.	(c)	54.	(d)	55.	(d)
56.	(b)	57.	(d)	58.	(d)	59.	(d)	60.	(b)
61.	(b)	62.	(c)	63.	(c)	64.	(a)	65.	(c)

Match the Following

1.	(b)	2.	(d)	3.	(a)

Assertion & Reason Type

1.	(a)	2.	(c)	3.	(b)	4.	(c)	5.	(b)
6.	(c)	7.	(a)	8.	(d)	9.	(c)	10.	(b)

Comprehension Type

Passage-I

1.	(d)	2.	(b)	3.	(c)	4.	(a)	5.	(b)

Passage-II

1.	(d)	2.	(b)	3.	(d)

Integer/Numerical Value Type

1.	(212°F)	2.	(100°C)
3.	(273.15)	4.	(14°C)
5.	(323 K)		

Case Based Questions

Case I

1.	(a)	2.	(a)	3.	(a)

Case II

1.	(a)	2.	(b)	3.	(d)

Case IV

1.	(d)	2.	(a)	3.	(a)

CHAPTER 03

Temperature and its Measurement

NCERT Section

1. **(b) :** 37.0°C

2. **(d) :** 98.6°F

3. **(a) :** (i) temperature; (ii) clinical; (iii) Celsius

4. **(b) :** –10°C to 110°C

5. **(b) :** Student 2

6. For 14°C, color up to two small lines above the 10°C mark (each line represents 2 degrees Celsius).
For 17°C, color up to seven small lines above the 10°C mark (each line represents 1 degree Celsius).
For 15°C, color up to fifteen small lines above the 0°C mark (each line represents 0.5 degree Celsius). Red lines are indicated alongside the respective thermometers for clarity.

7. (i) This is a laboratory thermometer, as it has a measuring range from –10°C to 110°C.
(ii) The thermometer reading is 26°C.
(iii) The smallest value this thermometer can measure is –10°C, with 10 small lines representing each degree between any 10-degree intervals.

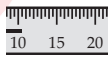
8. A laboratory thermometer is not used to measure human body temperature for two reasons:
A laboratory thermometer is not suitable for measuring body temperature because:
(i) It is designed for a wider temperature range and requires direct observation, which is inconvenient for use inside the mouth or under the armpit.
(ii) The calibration and scale are not as precise for the narrow range of human body temperature compared to clinical thermometers.

9. (i) 40.0°C
(ii) Day one 7 pm
(iii) Day three

10. You should use a thermometer
(b) Thermometer (a) can measure temperatures with a precision of 1°C, and thermometer
(c) can measure with a precision of 2°C, based on their small line markings. Thermometer (b) is the only one with markings that allow for a precision of 0.5°C, which is needed to accurately measure 22.5°C.

11. **(b) :** 27.5°C

12. **(c) :** 2°C

13. 

14. She means the temperature on the Fahrenheit scale. Human body temperature does not normally go below 35°C or above 42°C. In the Fahrenheit scale this range is between 95 degrees to 107.8 degrees.

Multiple Choice Questions

1. **(a) :** Pyrometer is an instrument used to measure high temperature.

2. **(a) :** The temperature at which a solid substance changes into a liquid is called the melting point of the substance.

3. **(d) :** Temperature is measured in degree celsius, kelvin or degree fahrenheit.

4. **(b) :** The reliable measure of hotness of an object is its temperature.

5. (a)

6. (b) : The measure temperature of human body we use clinical thermometer or doctor's thermometer

7. (c) : Alcohol has a freezing point much lower than other substances given here.

8. (a)

9. (c) : Normal temperature of the human body is 37°C.

10. (d) : In a clinical thermometer, both Celsius scale and Fahrenheit scale readings are marked.

11. (a) : Mercury (liquid) used in clinical thermometer is a metal.

12. (b) : $T(°C) = \frac{5}{9} \times [T(°F) - 32]$

$= \frac{5}{9} \times 95 - 32 = 35°C$

13. (d)

14. (b) : Cooling in a motor car is done by convection.

15. (a) : In solids generally the heat is transferred by conduction.

16. (c) : Digital thermometer do not use mercury.

17. (d)

18. (b) : Radiation is the process by which heat from Sun reaches the earth.

19. (d) : By the process of radiation heat can transfer through Vacuum as well as air.

20. (c) : The mode of transfer of heat in the absence of a medium is called radiation.

21. (a) : The scale in clinical thermometer is marked from 35°C to 43°C.

22. (c) : Thermometer is the device which is used to measure temperature.

23. (c)

24. (d) : A digital thermometer.

25. (a) : The materials which do not allow heat to pass through them easily are called poor conductors of heat. Poor conductors are also known as 'insulators'.
Examples: Plastic, wood, etc.

26. (b) : The molecules of a solid are held strongly due to strong intermolecular forces. As these molecules cannot travel to the source of heat energy, therefore, convection is not possible in case of solids, but transformation of heat takes place from one molecule to another molecule which is side by it, *i.e.*, conduction takes place. Radiation is the fastest mode of heat transfer from hot body to cold body.

27. (b) : Sea breeze and land breeze are formed due to convection.

28. (d) : Among the given options, all are poor conductors of heat.

29. (d) : Mercury expands uniformly at all temperatures, hence it can help us to measure accurately.

30. (c)

31. (a) : Mercury has a high boiling point and a low melting point.

32. (b) : Solid

33. (c)

34. (b) : The convection current in air transfers heat in upward direction.

35. (c)

36. (a) : The temperature in Centigrade and Fahrenheit is related as

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

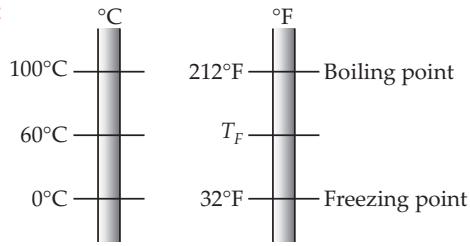
Given, T_C = 40°C

$$\therefore \quad \frac{40}{100} = \frac{T_F - 32}{180} \text{ or } T_F = 104°F$$

37. (d) : On heating, substances either expand or contract, *i.e.*, their volume (either change in length or change in area) changes, and hence, density changes. But mass remains the same.

38. (d) : Change of state of a substance is due to the change in heat energy.

39. (c) :



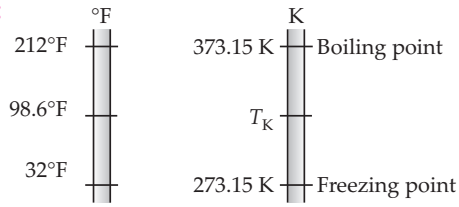
Let T_F be temperature on Fahrenheit scale corresponding to 60°C on Celsius scale. Then

$$\frac{60-0}{100-0}=\frac{T_F-32}{212-32} \quad \text{or} \quad \frac{3}{5}=\frac{T_F-32}{180}$$

or $5T_F - 160 = 540$

or $5T_F = 700$ or $T_F = \frac{700}{5}$ °F = 140°F

40. (a) :



Let T_K be temperature on Kelvin scale corresponding to 98.6°F on Fahrenheit scale. Then

$$\frac{98.6-32}{212-32}=\frac{T_K-273.15}{373.15-273.15}$$

or $$\frac{66.6}{180}=\frac{T_K-273.15}{100}$$

or $$T_K=\frac{66.6}{180}\times 100+273.15=310.2\ \text{K}$$

41. (c) : Let at temperature T both the scales A and B have the same reading.

$$\therefore \quad \frac{T-42}{110}=\frac{T-72}{220} \quad \text{or} \quad 2T - 84 = T - 72$$

or $T = +12°$

42. (d) : On heating substances will undergo change in size, temperature and state.

43. (c) : There is no net heat flow, because temperature is same.

44. (d) : In a thermos flask, the loss of heat energy is minimized due to conduction, convection and radiation.

45. (d) : Heat energy brings about change in the dimensions of a substance (object), chemical composition of substance and also change in its temperature.

46. (d) : both (a) and (b)

47. (d) : Melting point of ice and boiling point of water

48. (a) : Copper has a higher rate of conduction than iron.

49. (b) : Land heats up much faster than water.

50. (d) : Mirrors reflect heat radiation to the front of the heater.

51. (a) : Take a thin capillary tube which is covered with a thick glass stem. Fill the bulb of thermometer with mercury, while filling with mercury, air bubble may trapped. To remove the air bubbles, place the thermometer bulb in hot water bath. Then cut the funnel and that end is sealed. Now, mark the lower fixing point, by placing bulb in pure melting ice. Mark the upper fixing point by placing the bulb in boiling water. The distance between the two fixed points is divided into 100 equal parts and calibrated.

52. (b) : Liquids and gases

53. (c) : Given, temperature = 110°C

To find, F = ?

We know, $F=\left(C\times\frac{9}{5}\right)+32=\left(110\times\frac{9}{5}\right)+32$

= (198 + 32) = 230°F

54. (d) : We have, $\frac{F-32}{180}=\frac{K-273}{100}$

$$F-32=\frac{9}{5}(K-273)$$

Given, $T_F = T_k = T$

Therefore, $$T-32=\frac{9}{5}(T-273)$$

$5T - 160 = 9T - 2457$

$4T = 2297$

$T = 574.25$ K or 574 K

55. (d) : Given, temperature of liquid hydrogen, $T_K = 20$ K

To Find, F = ?

We know that, $\frac{F-32}{180}=\frac{K-273}{100}$

$\frac{F-32}{180}=\frac{20-273}{100}$

$F-32=\frac{9}{5}(-253)$

F = 423.4°F or 423°F

56. (b) : Given, for thermometer *A*,

$(UFP - LFP)_A = 45$

for thermometer *B*, $(UFP - LFP)_B = 100$

Lower point of *A*, $T_A = 0°$

Lower point of *B*, $T_B = 50$

Let thermometer A reads temperature, = T_1

$\therefore \frac{T_1-0°}{(UFP-LFP)_A}=\frac{T_2-50}{(UFP-LFP)_B}$

$\Rightarrow \frac{T_1}{45}=\frac{100-50}{100}$

$T_1=\frac{60\times 45}{100}$

T_1 = 24°C

Hence, thermometer *A* reads 27°C

57. (d) : Given, temperature of centigrade = 2 × temperature of fahrenheit thermometer

∴ temperature of centigrade thermometer = *T*

temperature of fahrenheit thermometer = 2*T*

We know that, $\frac{C}{100}=\frac{F-32}{80}$

$\Rightarrow \frac{T}{100}=\frac{2T-32}{180}$

$9T = 10T - 160$

T = 160°C

58. (d)

59. (d)

60. (b) : Since the temperature are equal there will be no flow of heat.

61. (b) : Conduction

62. (c) : Conduction

63. (c) : Radiation

64. (a) : In case of an incense stick, the air at the lighted end is hot, and hence, volume increases and density decreases, so, it rises up (moves up).

(or)

The air at the hot end is at a higher temperature, so, its density is less and this lesser dense air rises up and more dense air occupies this place, so, it is due to convection of gases.

65. (c) : *ACBD*

Fill in the Blanks

1. conduction **2.** temperature

3. Celsius **4.** clinical

5. convection

6. state; The temperature of a body remains constant if the substance undergoes a change in state.

7. Joule; joule is the SI unit of heat.

8. Temperature is directly proportional to the average kinetic energy of molecules. As temperature increases, average kinetic energy also increases.

9. Radiation is the fastest mode of transmission of heat.

10. maximum-minimum thermometer

This thermometer was invented by James six in 1780.

This thermometer is also know as six's thermometer.

True or False

1. **False :** A clinical thermometer has a slight bend or kink that prevents the mercury level from falling down, by itself.

2. **True :** Heat is an invisible form of energy.

3. **False :** The heat required to raise the temperature of 1 kg of water by 1°C is called one kilocalorie.

4. Heat absorbed by a substance increases with the increase in temperature.

5. **False**

6. **False :** It has a shining thread of mercury.

7. The maximum temperature that can be measured by using a clinical thermometer is less than the boiling point of water.

8. **False :** A medium is required for the transfer of heat by the process of convection.

9. **False :** It is marked from 35°C to 43°C

10. **False**

Match the Following

1. **(b) :** (P)-(1), (Q)-(2), (R)-(3), (S)-(4)
Clinical thermometer is kink to prevent the dropping of mercury level, when it is removed from body. Laboratory thermometer has a range – 10°C to 110°C.

2. **(d) :** (P)-(1), (Q)-(2), (R)-(3), (S)-(4)

3. **(a) :** (P)-(3), (Q)-(5), (R)-(2), (S)-(1), (T)-(4)
Mercury is only metal that is in liquid state at room temperature.

Assertion & Reason Type

1. **(a) :** 37°C is considered as the normal human body temperature. It is the average body temperature of a large number of healthy persons however, it could be slightly higher or slightly lower.

2. **(c) :** Convection requires medium to transfer heat.

3. **(b)**

4. **(c) :** The interval between the upper fixed point and lower fixed point of celsius scale is divided into 100 equal parts while that of fahrenheit scale is divided into 180 equal parts.

5. **(b)**

6. **(c) :** Heat always flows from hot to cold bodies.

7. **(a) :** Put the given value increase on,

$$F = \frac{9}{5} \times 10 + 32 = 18 + 32 = 50°C$$

8. **(d) :** All materials do not conduct the heat. Based on ability to conduct the heat materials are classified as: Conductors and Insulators.
Conductors are the materials which allow heat to pass through them easily. For examples, aluminium, iron and copper.
Insulators are materials which do not allow heat to pass through them easily. They are poor conductors of heat. For example, plastic and wood etc.

9. **(c) :** Radiation is reduced by silvering both the walls of the thermos flask on vacuum side.

10. **(b)**

Comprehension Type

PASSAGE-I

1. **(d) :** There are three ways in which heat can flow from one object to another. These are conduction, convection and radiation.

2. **(b) :** When Vinay sits near a bonfire, the heat gets radiated. The transfer of heat by radiation does not require any medium, heat transmission by radiation can occur between two bodies this is the reason why Vinay's body facing the fire got hot.

3. **(c) :** A heater makes a room warmer by convection currents this allows the hot air near the heater to rise up and warm the entire room and the cold air comes down to get heat from heater. If heater is placed at a height, then cold air below this height will not be heated by heater therefore, the entire room will not warm up.

4. **(a) :** Black colour is a is good absorber of heat. As the weather in Manali is cold so, to absorb maximum sunlight to keep the ten hot, the tents are the made up of black fabric.

5. **(b) :** White fabric is preferred in a hot weather place because light colours are bad absorber of heat as they reflect most of the heat (sunlight) that falls on them therefore, this helps to keep the tent cool.

PASSAGE-II

1. (d) : Normal body temperature is 37°C. A person having fever will show higher temperature than 37°C.

2. (b) : The kink is a constriction in the glass tube just above the bulb. It breaks the connection between the bulb and the narrow (capillary) tube and preventing the drop of mercury.

3. (d)

Subjective Problems

Very Short Answer Type

1. Temperature scales

2. Clinical thermometer

3. Energy

4. Celsius scale

5. Mercury

6. Land breeze

7. Electromagnetic waves

8. Joule

9. Given,Temperature = 85°C
To find, F = ?
We know, $F = \left(C \times \frac{9}{5}\right) + 32 = \left(85 \times \frac{9}{5}\right) + 32$
= (153 + 32)
= 185°F

10. The heat flows from a hotter object to a colder object. This process is called transfer of heat or it is also called transfer of energy.

Short Answer Type

1. (i) The clinical thermometer cannot be used for measuring the temperature of any object other than the human body because its maximum range is 42°C.
(ii) If it is kept in the sun or near a flame, then this clinical thermometer can be break.

2. Heat flows from a hot body to a cold body when the particles starts vibrating and collide with each other.

3. It is cheaper and less harmful than mercury thermometer.

4. During the day time hot air rises up because it is less dense than the cold air. This causes convectional current in the air so; a kite starts moving along this convectional current which helps us to fly it higher.

5. (i) It is relatively easy to see because of its silvery grey colour.
(ii) It does not stick to glass.

6. The black objects are very good absorber of radiant energy and so when the bottoms black painted bottom of cooking utensils are exposed to flame, they absorb the heat quickly thus, this speeds up the cooking process.

7. Temperature decides the direction of flow of heat energy. Always heat energy flows from high temperature body to low temperature body.

8. Wool is a bad conductor of heat as it consists of wool fibres which has a series of curls called crimps that can hold and trap air.

9. The thermometer used to measure the temperature of a furnace above 1000°C is called pyrometer.

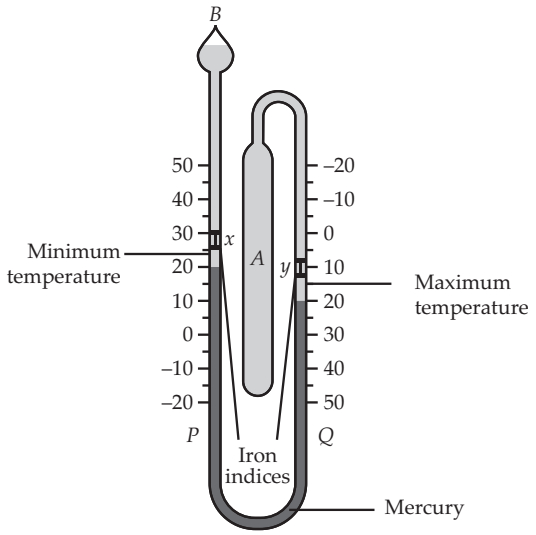
10. Given, Temperature = 0°C
To find, F = ?
We know, $F = \left(C \times \frac{9}{5}\right) + 32 = \left(0 \times \frac{9}{5}\right) + 32$
= (0 + 32)
= 32°F

11. The temperature of boiling water is 100°C, but the maximum temperature that can be measured by using clinical thermometer is 43°C. It will break at 100°C.

12. The range of temperatures that can be measured using thermometer is 95°F to 110°F (or) 35°C to 43°C.

13. Kink (or Constriction)

14. A thermometer used to measure the maximum and minimum temperature of previous day is called Maximum-Minimum thermometer. It is used by the weather department to report/ predict the weather.



Maximum and Minimum Theromometer

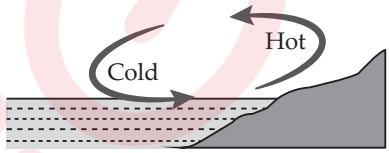
15. (i) The thermometer should be kept upright not tilted.
(ii) Bulb should be surrounded from all the substance of which the temperature is to be measured.
(iii) The bulb should not touch the surface of the container.

Long Answer Type

1. To show that the terms hot and cold as we feel them are only relative:
Materials required: 3 glasses, hot water (as hot as you can bear to dip your finger in), ice cold water and water at room temperature.
Method:
(i) Pour hot water, water at room temperature and ice cold water into 3 separate glasses.
(ii) Dip the index finger of one hand in the ice, cold water and the other hand in the hot water for a minute.
(iii) Then dip both the index finger into the water at room temperature.

In conclusion you will find that the water feels hot in one finger and to the other finger it feels cold because the finger that was in ice cold water has become cold and when it was placed in the water at room temperature, it felt that the water was warm, relative to the earlier temperature.

2. Sea breeze:
(i) During day time, as land gets heated faster as compared to water, the air over the land becomes hotter and rises up.
(ii) The cooler air from the sea rushes in towards the land to take its place.
(iii) The warm air from the land moves towards the, sea to complete the cycle.



Sea breeze

3.

	Heat	Temperature
1.	Heat is a form of energy, which causes the sensation of hotness or coldness.	The degree of hotness or coldness of a body is measured in temperature.
2.	Heat energy is the cause.	Temperature is the effect.
3.	It is measured in joule or calorie.	It is measured in kelvin or celsius or fahrenheit.
4.	Calorimeter is used to measure heat energy.	Thermometer is used to measure temperature.
5.	Heat energy always flows from body at high temperature to body at low temperature.	Temperature depends on the average kinetic energy of the molecules.

4. Temperature scales are units that is used to measure temperature quantitatively. The two commonly used of temperature scales are :

Celsius and Fahrenheit

(i) Celsius: This scale is indicated by degree C in honour of Anders Celsius. The melting point of pure ice is 0°C and boiling point of water is 100°C.

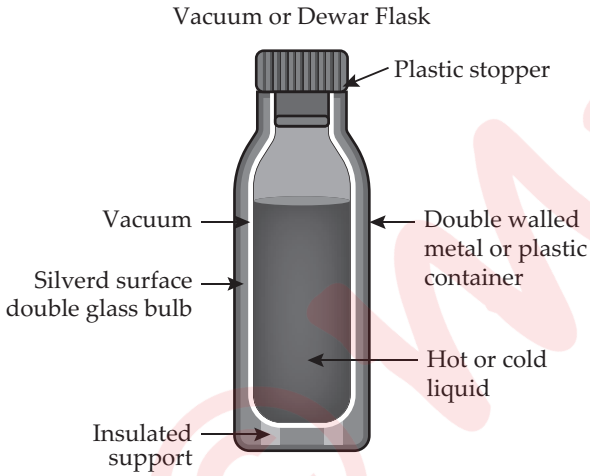
(ii) Fahrenheit: This scale is indicated by °F in honour of Gabriel Fahrenheit. On this scale the melting point of ice is 32°F and boiling point of water is 212°F.

5. Working of a thermo flask:

(i) The outer casing and the cap of the thermo flask is made up of plastic to reduce heat loss due to conduction.

(ii) The inner jar consist of double walled bottle made of glass or stainless steel ,the space between the two walls consist of vacuum so that heat loss due to convection is minimized.

(iii) The surface of the jar is made reflective so that heat loss due to radiation is minimized.



Integer/Numerical Value Type

1. 212°F **2.** 100°C

3. 273.15 **4.** 14°C

5. 323 K

Case Based Questions

Case I

1. (a) : The end that is heated is farthest away from the clamp stand end of the rod.

2. (a)

3. (a) : The end that is heated is at a higher temperature.

Case II

1. (a) : Towards top the air gets heated by convection but there is no convection on sides.

2. (b) : Conduction

3. (d)

Case III

1. The given thermometer is the laboratory thermometer.

2. The range of a laboratory thermometer is generally from –10°C to 110°C

3. (i) It should be kept upright not tilted.

(ii) The bulb should be surrounded from all sides by the substance of which the temperature is to be measured moreover, the bulb should not touch the surface of the container.

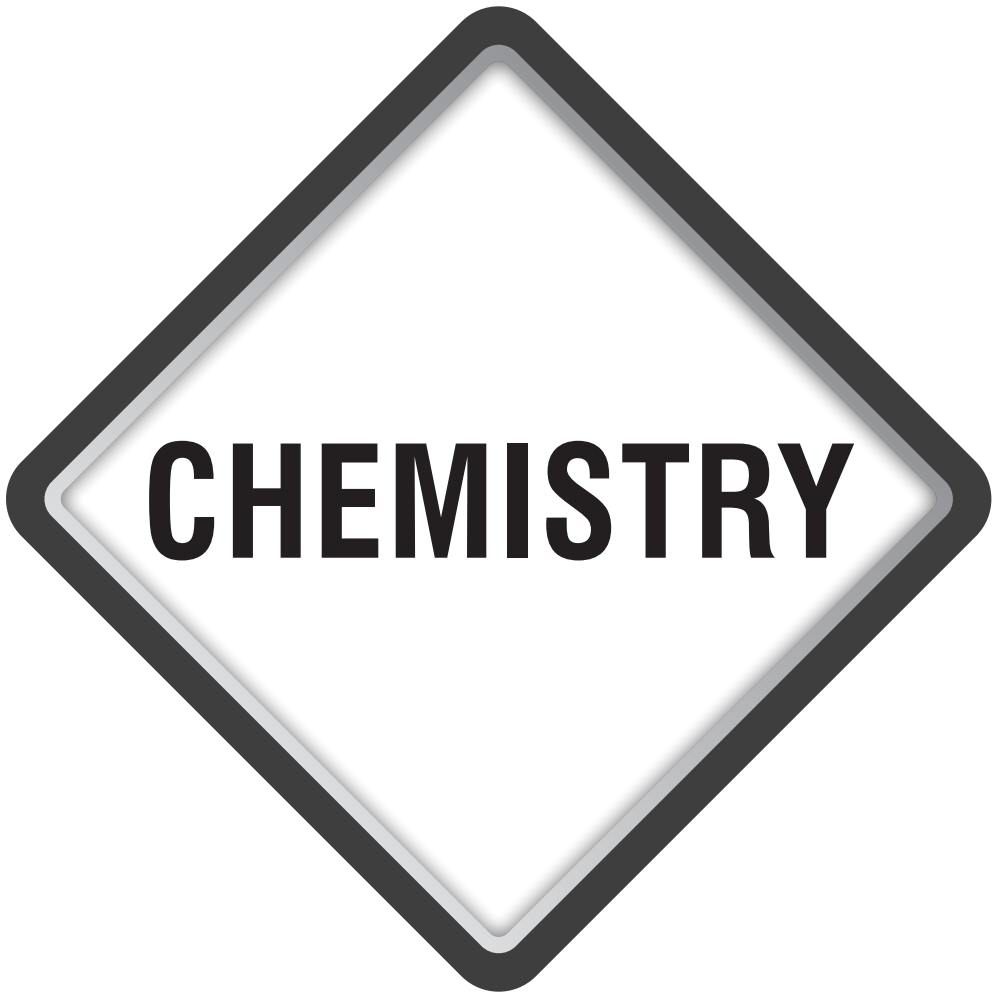
Case IV

1. (d) : Glass is poor conductor of heat.

2. (a) : Air is the best insulator of heat.

3. (a) : Heat always flows from a hotter region to a colder one. Since, iron is a good conductor of heat, more heat will flow from out body into it and we will feel it as cold. As paper is a bad conductor less heat will flow from our body.

☺☺☺


CHEMISTRY

CHAPTER 02

Physical and Chemical Changes

Learning Outcomes...

- Physical and Chemical Changes : Characteristics and Differences
- Rusting of Iron
- Chemical Reactions : Characteristics and Types
- Reactivity Series of Metals
- Redox Reactions, Oxidising and Reducing Agent
- Crystallisation

Introduction

Changes take place around us all the time. The changes can be divided into different types depending upon the nature of the change taking place. The changes differ in terms of appearance, colour, composition, formation of new products or any other change. Changes can be slow or fast, desirable or undesirable, periodic or non-periodic. Broadly, these changes are of two types – physical and chemical.

Physical Change

Those changes in which a substance undergoes a change in its physical properties are called a **physical change**. Properties such as shape, size, colour and state of a substance are called **physical properties.**

Reversible and Irreversible Physical Changes

A reversible change can be easily reversed by removing the cause of change while an irreversible change cannot be reverted back.

Melting of ice, dissolution of sugar/salt in water, drying of clothes, sublimation of camphor, etc., are reversible physical changes.

Tearing of paper, breaking of a glass tumbler, growth of plants, weathering of rocks, etc. are irreversible physical changes.

Characteristics of Physical Changes

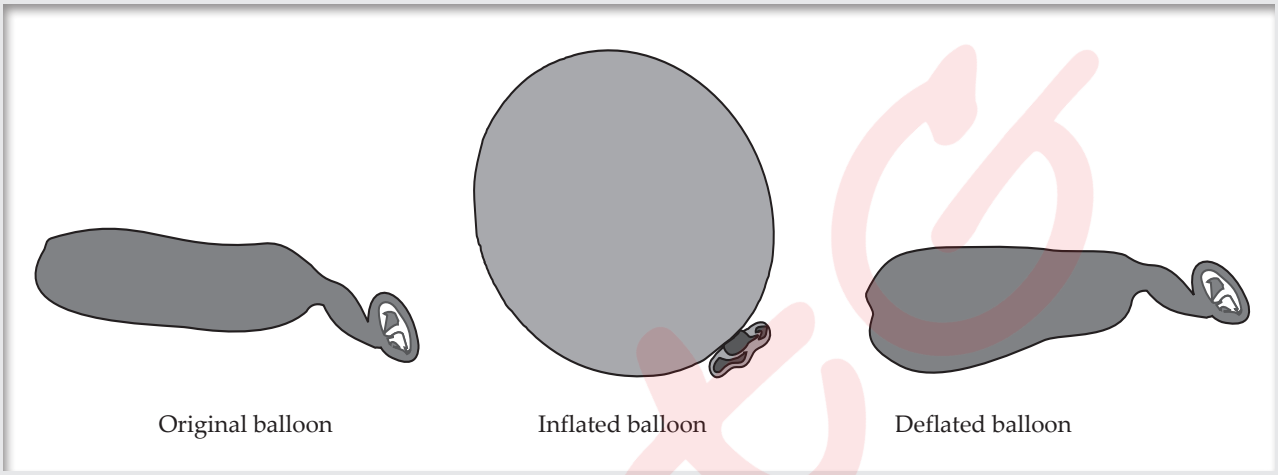
- No new substances are formed.
- The properties of the substance remains same even if the physical state changes.
- There may or may not be evolution of heat.

- Properties like appearance, texture, colour, smell, etc. may change.
- Chemical properties of the substance do not change.
- A physical change is generally reversible and the things can get back to their original form after the change.

ACTIVITY CORNER

To show that the physical change involves change in size and shape

- **Materials required :** Balloon
- **Procedure :** Take a balloon and inflate it. Observe the change in size and shape. Now deflate the balloon and again observe the change in size and shape.

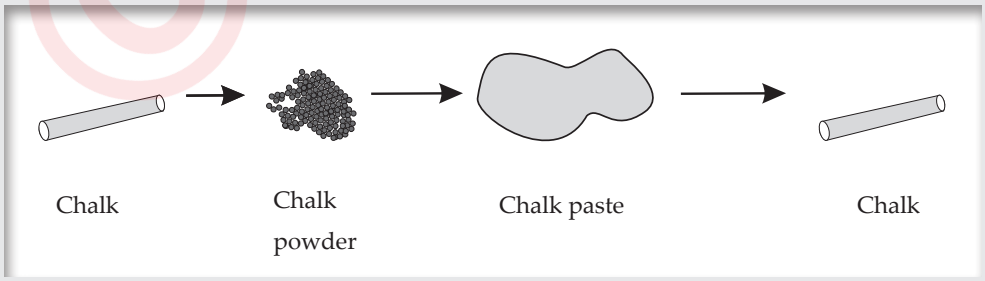


- **Observations :** The balloon becomes big and round when air is filled in it. When it is deflated, the air comes out and balloon comes back to its original shape.
- **Conclusion :** There is no change in the structure of the balloon. Only its shape and size change. Hence, it is a physical and reversible change.

ACTIVITY CORNER

To study a physical change using a chalk

- **Materials required :** Chalk, water
- **Procedure :** Crush a chalk piece into powder. Add a little water to the chalk powder and make a paste. Roll it into the shape of the chalk again.



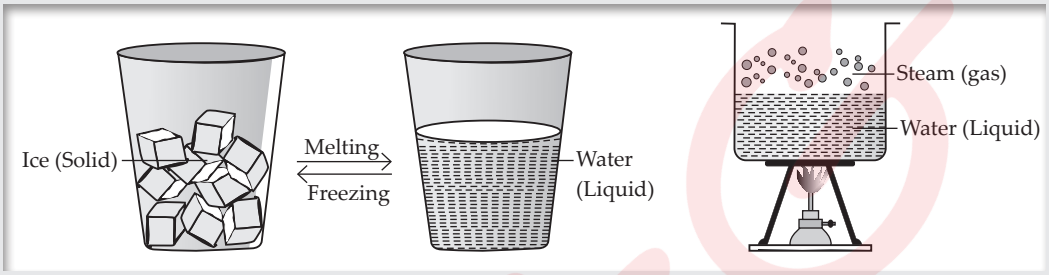
- **Observations :** On crushing, the chalk is converted into powder but the powder is again rolled back to chalk by adding small amount of water.
  The chalk can be used again.
- **Conclusion :** There is no change in the properties of a substance during a physical change.

- Physical change can lead to change in the physical state of the substance, *e.g.*, water can be changed from liquid to gaseous state or to solid state but there is no change in the chemical structure of ice, water and steam.

ACTIVITY CORNER

To observe the change in physical state of water

- **Materials required :** Water, ice, container, beaker, burner
- **Procedure :**
  - Take some ice in a container and keep it outside the fridge for some time. Once the ice melts, keep it again in the freezer and record your observations.
  - Take some water in a beaker and boil it. Cover the beaker with a metallic plate and record your observations.



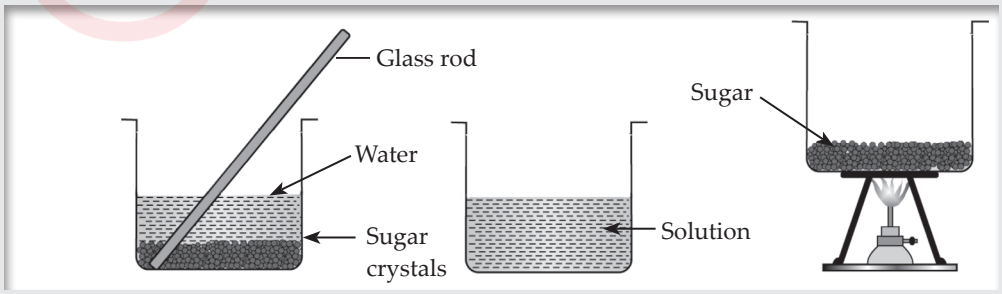
- **Observations :**
  - On melting, ice is converted to water which can be frozen back to ice.
  - When water is boiled it is converted to steam. If we cover the beaker with a lid, steam condenses back to water.
- **Conclusion :** Freezing, melting, boiling and condensation are physical changes since only the physical state of water changes. Chemically all the three states (solid, liquid and gas) are same.

- During a physical change sometimes a substance disappears but can be recovered after the change.

ACTIVITY CORNER

To show that dissolution of sugar in water is a physical change

- **Materials required :** Water, sugar, beaker, burner, glass rod
- **Procedure :** Take some water in a beaker and add sugar to it. Stir the solution and observe the change. Now heat the sugar solution in the beaker till the water is evaporated. Record your observation after evaporation of water.



- **Observations :** When sugar is dissolved in water it disappears. If you taste the solution, the sugar is still present in dissolved form. If water is evaporated, we get back the sugar.
- **Conclusion :** Dissolution of sugar in water is a physical and reversible change.

ILLUSTRATIONS

1 Formation of clouds is a physical change. Explain.

Ans.: Formation of clouds is a physical change as it is phase of transformation of natural water from liquid to gas during water cycle and then, gas to liquid. Hence, the property of water never changes in clouds form.

2 Are ice and steam different substances?

Ans.: No, ice and steam are two different states of water. On freezing, water is converted into solid state which is ice. On heating, water is converted into gaseous state which is steam. Chemically ice, steam and water are different forms of same substance.

3 Which of the following are physical and reversible changes?

(i) Crushing a chalk into powder

(ii) Breaking of an egg

(iii) Tearing of a piece of paper into small pieces

(iv) Melting of ice into water

Ans.: (i) and (iv) are physical but reversible changes. Chalk powder can be again converted into chalk. Molten ice or water can again be converted into ice.

(ii) and (iii) are physical but irreversible changes. A broken egg cannot be converted back into an egg and small pieces of paper cannot be converted back into original paper.

4 State any four properties which can change during a physical change.

Ans.: Colour, shape, size and state of a substance can change during a physical change.

5 Give an example of a physical change in which the colour of the substance changes.

Ans.: Heat a piece of iron wire on fire. After some time, it turns red in colour. On cooling, it is again converted into its original colour.

Chemical Change

Those changes in which a new substance is formed which has totally different properties than the original substance are called a **chemical change**.

Characteristics of Chemical Changes

- Chemical changes are usually irreversible. The original substance cannot be recovered in most of the cases.
- One or more new substances are formed during the change.
- New substances have different properties from the original substance.
- Heat or light or both may be produced during the change.
- A chemical change is also called a chemical reaction.
- Rusting of iron, burning of substances, cooking of food, etc. are the examples of chemical change.
- Browning of surface of few fruits and vegetables when cut and exposed to air is a chemical change.
- Few natural processes like digestion and photosynthesis are also chemical changes.

Difference Between Physical and Chemical Changes

	Physical change	Chemical change
1.	No new substance is formed in a physical change.	A new substance is formed in a chemical change.

2.	A physical change is a temporary change.	A chemical change is a permanent change.
3.	A physical change is usually reversible.	A chemical change is usually irreversible.
4.	Very little energy (in the form of heat, etc.) is absorbed or given out in a physical change.	A lot of energy (in the form of heat, light, sound, etc.) is absorbed or given out in a chemical change.

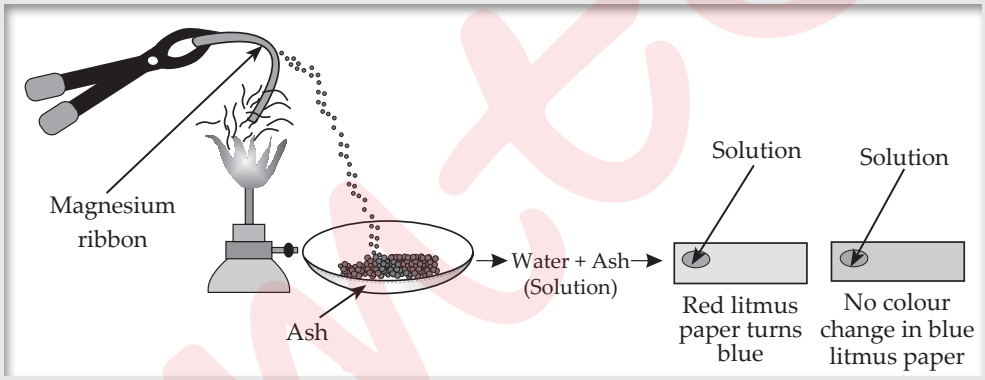
DO YOU KNOW?

- Some fruits and vegetables like apples, bananas, brinjals and potatoes develop a brown layer when they are cut and kept in open. Certain compounds present in them react with oxygen present in air and get oxidised as a result of a chemical reaction.

ACTIVITY CORNER

To show that burning of magnesium ribbon is a chemical change

- **Materials required :** Magnesium ribbon, sand paper, pair of tongs, burner, water, blue and red litmus papers
- **Procedure :** Take a small piece of magnesium ribbon and clean it with a sand paper. Hold it with a pair of tongs and heat it on the burner. Let the magnesium ribbon burn completely. Collect the ash and dissolve it in water. Test the solution with blue and red litmus papers.



- **Observations :**
  - When magnesium ribbon is burnt in air, it burns with a dazzling white flame. It forms a powdery ash when it is burnt completely. A new substance is formed after burning magnesium. This powdery ash is known as magnesium oxide.

    $\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen}}{O_2} \rightarrow \underset{\text{Magnesium oxide}}{2MgO}$
  - When magnesium oxide is dissolved in water, a new substance called magnesium hydroxide is formed.

    $\underset{\text{Magnesium oxide}}{MgO} + \underset{\text{Water}}{H_2O} \rightarrow \underset{\text{Magnesium hydroxide}}{Mg(OH)_2}$
  - When a drop of this solution is kept over litmus paper, it is observed that it turns red litmus blue and blue litmus does not turn to red.
- **Conclusion :**
  - Burning of magnesium in air is a chemical change due to formation of a new compound magnesium oxide.
  - On reaction with water it forms a new compound magnesium hydroxide which is basic in nature.

Rusting of Iron

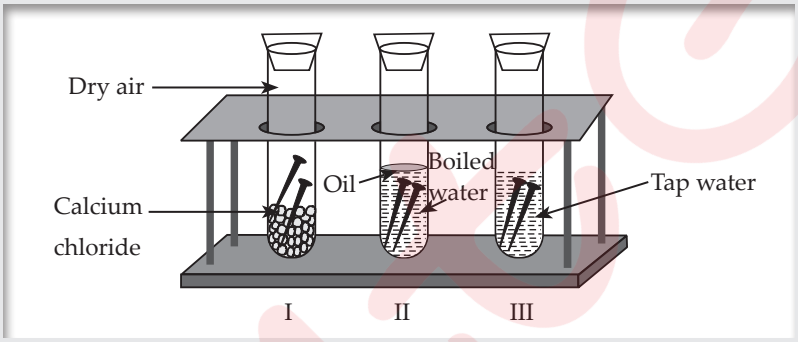
Rusting is a chemical change which takes place in presence of air and moisture only. It is a reddish brown powder which is formed on the surface of iron and goes into the deeper layers.

$$\underset{\text{Iron}}{Fe} + \underset{\text{Oxygen}}{O_2} + \underset{\text{Water}}{H_2O} \rightarrow \underset{\text{Hydrated iron oxide (Rust)}}{Fe_2O_3 \cdot xH_2O}$$

ACTIVITY CORNER

To show that rusting of iron is a chemical change which requires presence of both air and water

- **Materials required :** Iron nails, three test tubes, water, calcium chloride, oil, corks
- **Procedure :** Take three test tubes and put two iron nails in each test tube. Put some calcium chloride in test tube marked as (I) and put cork on the test tube. Put some boiled water in test tube marked as (II) and cover the surface of water with oil and cork the test tube. In test tube (III) put some tap water and put the cork. Keep the test tubes for a few days and note down the observations.



- **Observations :** It is observed that in test tube (I) the nails are not rusted because there is no moisture due to calcium chloride. There is no rusting in test tube (II) because the layer of oil on water prevents air to come in contact with nails. The nails in test tube (III) get rusted because they are exposed to both water and air.
- **Conclusion :** Rusting of iron requires both air and water.

Rusting is very harmful since the objects made of iron like gates, pillars, chains, bridges, etc. get rusted which results in eating away the metal and slowly destroys them, the monetary loss due to rusting is huge.

Prevention of Rusting

The most important methods to prevent rusting are :

- By painting the surface of iron objects
- By greasing or oiling the surface of iron objects
- By galvanisation : Galvanisation is a process of coating the surface of iron with zinc to prevent rusting of iron.
- By alloying : Alloying is a process in which two or more metals or a metal and a non-metal are mixed in a molten state to improve the properties of metals. Iron gets rusted in moist air, iron is mixed with a small amount of carbon and metals like chromium or manganese to make stainless steel. Stainless steel does not get rusted.

DO YOU KNOW?

- The iron pillar near Qutub Minar in New Delhi is said to be more than 1600 years old. Despite remaining exposed to the atmosphere for so long, the pillar has not rusted, which is a demonstration of the high degree of accomplishment in the art of iron making in ancient India.

Chemical Reactions

The process by which chemical change takes place, *i.e.,* by which one or more substances react to form new substances having different composition and different properties is called **a chemical reaction**. The substances which take part in a chemical reaction are called **reactants** and the substances formed in a chemical reaction are called **products**.

Characteristics of Chemical Reactions

When a chemical reaction takes place, it is accompanied by one or more of the following characteristics :

Change in state

Some chemical reactions are accompanied by change in state. For example, petrol, which is a liquid, burns to form water vapour and carbon dioxide which are gaseous.

Change in colour

Some chemical reactions are characterised by a change in colour.

$$\underset{\text{(Green)}\\\text{Copper carbonate}}{CuCO_3} \xrightarrow{\text{Heat}} \underset{\text{(Black)}\\\text{Copper oxide}}{CuO} + \underset{\text{Carbon dioxide}}{CO_2\uparrow}$$

Formation of a precipitate

Some chemical reactions are characterised by the formation of a precipitate. A precipitate is a solid product which separates out from the solution during a chemical reaction and is shown by an arrow pointing downwards (↓).

$$\underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Silver nitrate}}{AgNO_3} \longrightarrow \underset{\text{Silver chloride (white ppt.)}}{AgCl\downarrow} + \underset{\text{Sodium nitrate}}{NaNO_3}$$

Evolution of a gas

A gas may evolve during a chemical reaction if one of the reactants is a liquid or in solution form. Evolution of a gas is confirmed by appearance of efflorescence (bubbling) and is shown by an arrow pointing upwards(↑).

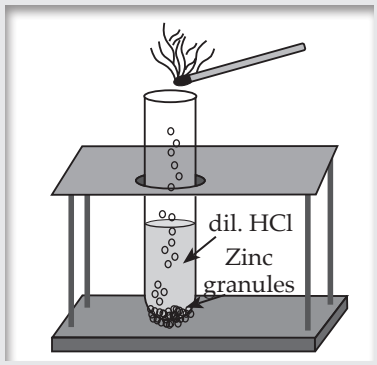
$$\underset{\text{Zinc}}{Zn} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + \underset{\text{Hydrogen}}{H_2\uparrow}$$

ACTIVITY CORNER

To produce hydrogen gas from zinc granules

- **Materials required :** Zinc granules, dilute hydrochloric acid, test tube, matchstick
- **Procedure :** Take clean pieces of zinc granules in a test tube and add dilute hydrochloric acid to it. Take a burning matchstick near the mouth of the test tube and record the observations.

- **Observations :** When zinc granules react with dilute hydrochloric acid, hydrogen gas comes out which burns with a pop sound when a burning splinter is brought near the mouth of the test tube.
- **Conclusion :** Hydrogen gas is evolved during the reaction which burns with a pop sound.



Change in temperature

- Some chemical reactions are accompanied by change in temperature, *i.e.*, rise or fall in temperature. Such reactions can be classified into two types : Exothermic and endothermic reactions.
  - **Exothermic reactions :** Reactions which are accompanied by rise in temperature are those in which heat is evolved, such reactions are called exothermic reactions. Release of heat is shown by writing + 'heat' on right hand side of the reaction.

    $C + O_2 \longrightarrow CO_2 + \text{Heat}$

    Carbon Oxygen Carbon dioxide
  - **Endothermic reactions :** Reactions which are accompanied by fall in temperature are those in which heat is absorbed, such reactions are called endothermic reactions. Absorption of heat is shown by writing + 'heat' on the left hand side of the equation.

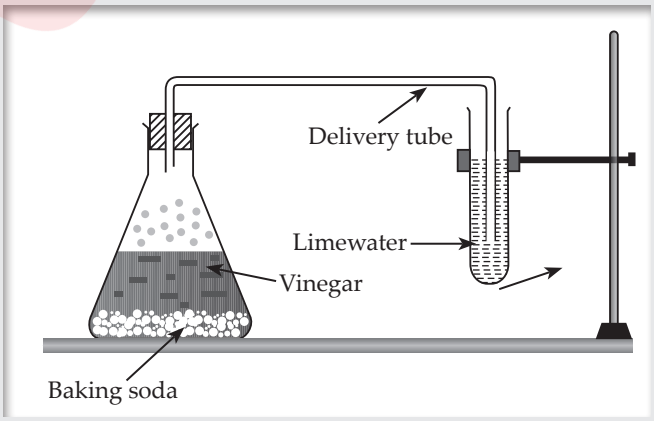
    $C + 2S + \text{Heat} \longrightarrow CS_2$

    Carbon Sulphur Carbon disulphide

ACTIVITY CORNER

To study reaction between vinegar and baking soda

- **Materials required :** Vinegar, baking soda, test tube, conical flask, gas delivery tube, limewater



- **Procedure :** Take some baking soda in a conical flask. Add vinegar to it and put the cork with delivery tube. Pass the gas coming out from the tube into limewater taken in a test tube and record your observations.
- **Observations :** When vinegar is added to baking soda brisk effervescence takes place and bubbles of a gas are given off. The gas evolved is passed through limewater which turns milky.
- **Conclusion :** When vinegar reacts with baking soda, carbon dioxide gas is given out which turns limewater milky due to formation of calcium carbonate.

Vinegar (Acetic acid) + Baking soda (Sodium hydrogencarbonate) → Carbon dioxide + Other products

$\text{Carbon dioxide } (CO_2) + \text{Limewater } (Ca(OH)_2) \rightarrow \text{Calcium carbonate } (CaCO_3) + \text{Water } (H_2O)$

COMPETITION WINDOW

Chemical Equations

- A chemical equation links together the substances which react (reactants) with the new substances that are formed (products).
- The chemical equations can be written in two ways : (i) Word equations (ii) Symbol equations

Balanced Chemical Equations

- A balanced chemical equation is the equation which contains an equal number of atoms of each element on both the sides of the equation.

  For example, balanced chemical equation for burning of magnesium in oxygen to form magnesium oxide is written as :

  $2Mg + O_2 \longrightarrow 2MgO$

  A balanced chemical equation must obey the **law of conservation of mass.** This means that the total mass of the reactants and products participating in an equation must be the same.

Unbalanced Chemical Equations

- An unbalanced chemical equation is the equation in which the number of atoms of the elements on the two sides of the equation is not the same.

  For example, formation of water by the reaction between hydrogen and oxygen.

  $H_2 + O_2 \longrightarrow H_2O$ (Unbalanced)

  $2H_2 + O_2 \longrightarrow 2H_2O$ (Balanced)

Balancing of Chemical Equations

- The number of atoms of each element should be equal on both sides of the equation. The equation can be balanced by hit and trial method.

Types of Chemical Reactions

Chemical reactions can be grouped into various types on the basis of their nature. Some common types of chemical reactions are :

Combination reactions

A combination reaction may be defined as, "The reaction in which two or more substances combine to form a single substance under suitable conditions."

For example, when vapours of dry chlorine gas are passed through iron in the form of a fine wool, a chemical reaction takes place. A brown mass of ferric chloride is formed on iron wool as a result of the combination reaction.

$$\underset{\text{Iron}}{2Fe_{(s)}} + \underset{\text{Dry chlorine gas}}{3Cl_{2(g)}} \longrightarrow \underset{\text{Ferric chloride}}{2FeCl_{3(s)}}$$

Displacement reactions

A displacement reaction may be defined as, "The chemical reaction in which one element takes the position or place of another element present in a compound". These reactions occur mostly in solution form and a more active metal displaces or removes another less active element or metal to form a compound.

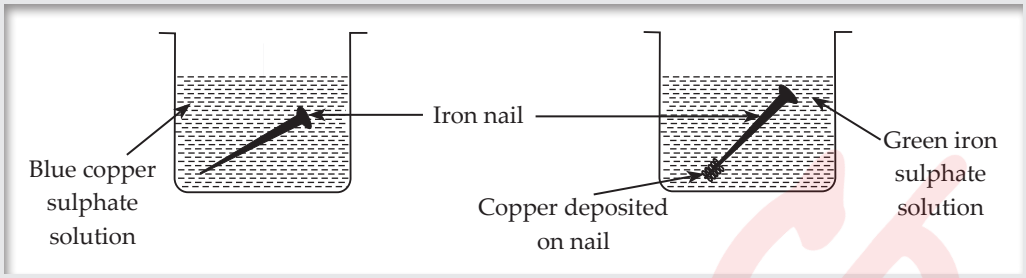
For example,

$$\underset{\text{Zinc}}{Zn_{(s)}} + \underset{\text{Dil. sulphuric acid}}{H_2SO_{4(aq)}} \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_{4(aq)}} + \underset{\text{Hydrogen gas}}{H_{2(g)}}$$

ACTIVITY CORNER

To show the deposition of copper on iron nails

- **Materials required :** Iron nail, copper sulphate solution, beaker, glass rod, water, dilute sulphuric acid
- **Procedure :** Dissolve copper sulphate in a beaker by adding water and stirring it with a glass rod. Add few drops of dilute sulphuric acid to retain blue colour of copper sulphate solution. Drop the iron nail into the solution. After some time observe the change which has taken place.



- **Observations :** The colour of the solution changes from blue to green. The colour of iron nail changes to reddish brown.
- **Conclusion :**
  - Copper from copper sulphate solution deposits on the iron nail giving it a reddish brown copper colour. The solution turns green due to the formation of a new substance—ferrous sulphate.

    $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$
  - This reaction is an example of displacement reaction.

COMPETITION WINDOW

Reactivity Series of Metals or Activity Series

- The arrangement of metals in the decreasing order of their reactivities is called reactivity series or activity series of metals.
- In the activity series, the most reactive metal is placed at the top whereas the least reactive metal is placed at the bottom. A more reactive metal (placed higher in the activity series) can displace any less reactive metal from its aqueous salt solution. For example, zinc displaces copper (less reactive) from its solution as

  $Zn_{(s)} + CuSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$

  But copper is less reactive than zinc and cannot displace it from $ZnSO_4$ solution.

  $Cu_{(s)} + ZnSO_{4(aq)} \longrightarrow$ No reaction

Activity Series	Reactivity
K	Most reactive
Na	↑
Ca	
Mg	Metals more reactive than hydrogen
Al	
Zn	
Fe	↓
Pb	
H	
Cu	↑
Hg	Metals less reactive than hydrogen
Ag	↓
Au	Least reactive

Decreasing chemical reactivity ↓

Double displacement reactions

A double displacement reaction may be defined as, "The chemical reaction in which two reactants exchange ions to form two new compounds."

These reactions are also known as partner exchange reactions.

For example, $\underset{\text{Silver nitrate}}{AgNO_3} + \underset{\text{Sodium chloride}}{NaCl} \longrightarrow \underset{\text{Silver chloride}}{AgCl} + \underset{\text{Sodium nitrate}}{NaNO_3}$

Decomposition reactions

A decomposition reaction may be defined as, "The reaction in which a single substance splits into two or more simple substances under suitable conditions." Decomposition reactions are mainly endothermic in nature.

For example, decomposition of sugar on strong heating into black mass of charcoal.

$$C_{12}H_{22}O_{11} \xrightarrow{\text{Heat}} 12C + 11H_2O$$

Precipitation reactions

When the aqueous solution of two ionic compounds react by exchanging their ions/radicals, to form two or more new compounds, such that one of the products formed is an insoluble salt, and hence, forms precipitate then it is called a precipitation reaction.

For example, when lead nitrate solution is mixed with potassium iodide solution, a yellow precipitate is formed. This reaction is a precipitation reaction and can be expressed as follows :

$$\underset{\substack{\text{Lead nitrate solution}\\\text{(colourless)}}}{Pb(NO_3)_{2\,(aq)}} + \underset{\substack{\text{Potassium iodide}\\\text{solution (colourless)}}}{2KI_{\,(aq)}} \longrightarrow \underset{\substack{\text{Lead iodide}\\\text{(yellow ppt.)}}}{PbI_2\downarrow} + \underset{\substack{\text{Potassium nitrate}\\\text{solution}}}{2KNO_{3(aq)}}$$

Neutralisation reactions

When an aqueous solution of an acid reacts with a base (alkali) by exchanging their ions/radicals to form salt and water as the only products then it is called a neutralisation reaction.

For example, $\underset{\substack{\text{Sulphuric acid}\\\text{(Acid)}}}{H_2SO_{4(dil)}} + \underset{\substack{\text{Sodium hydroxide}\\\text{(Base/Alkali)}}}{2NaOH_{(aq)}} \longrightarrow \underset{\substack{\text{Sodium sulphate}\\\text{(Salt)}}}{Na_2SO_{4(aq)}} + \underset{\substack{\text{Water}\\\text{(Water)}}}{2H_2O_{(l)}}$

Oxidation and reduction reactions

- **Oxidation** involves addition of oxygen or removal of hydrogen from a substance.
  For example, $\underset{\text{Carbon}}{C} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Carbon dioxide}}{CO_2}$
- **Reduction** involves addition of hydrogen or removal of oxygen from a substance.
  For example, $\underset{\text{Hydrogen}}{H_2} + \underset{\text{Copper oxide}}{CuO} \longrightarrow \underset{\text{Copper}}{Cu} + \underset{\text{Water}}{H_2O}$

COMPETITION WINDOW

Redox reactions, Oxidising agent and Reduction agent

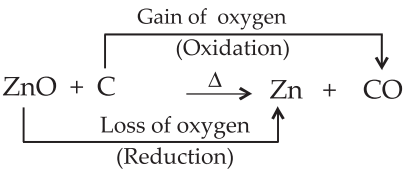
- The oxidation and reduction reactions are also called **redox reactions** (in the name 'redox', the term 'red' stands for 'reduction' and 'ox' stand for oxidation).
- For memory aid, oxidation and reduction together are written as 'OILRIG' which means
  OIL → Oxidation is loss
  RIG → Reduction is gain (of electrons)

Oxidising agent

- The substance which either gives oxygen or removes hydrogen in an oxidation reaction, is known as an **oxidising agent.**

Reducing agent

- The substance which either gives hydrogen or removes oxygen in a reduction reaction, is known as a **reducing agent.**

For example, 

Therefore, ZnO is oxidising agent and C is reducing agent.

ILLUSTRATIONS

6 What is galvanisation?
Ans.: It is a process in which a layer of zinc is deposited on iron. Iron water pipes are generally galvanised so that iron does not get rusted since it does not come in contact with water.

7 What will happen if iron nails are kept in a moist cloth for two days?
Ans.: Since air and water are in contact with iron nails, all the conditions for rusting are there. Hence, iron nails get rusted in the wet cloth.

8 What are the simple methods to prevent rusting of iron?
Ans.: Coating with oil, grease or paint are simplest methods of preventing rusting. It can also be prevented by galvanisation, *i.e.*, depositing a layer of zinc on it or alloying to steel.

9 Why does limewater turn milky when carbon dioxide gas is passed through it?
Ans.: When carbon dioxide is passed through limewater, carbon dioxide reacts with it to form a compound calcium carbonate which is in the form of precipitate, hence limewater turns milky.

Limewater + Carbon dioxide → Calcium carbonate + Water

$Ca(OH)_2 + CO_2 \rightarrow \underset{\text{(Milky)}}{CaCO_3} + H_2O$

10 What are the changes which take place during a chemical change or a chemical reaction?
Ans.: There can be change in colour, smell, properties, chemical composition, etc. during a chemical change. A new substance is formed during the change. It can be accompanied by evolution of light, evolution or absorption of heat or sound.

11 A silver spoon is kept immersed in an aqueous copper sulphate solution. What change will take place?
Ans.: No change will take place and the silver spoon will remain unaffected. Moreover, blue colour of copper sulphate will also not fade. This is because no chemical reaction takes place between silver and copper sulphate solution as silver is placed below copper in the activity series, *i.e.*, silver is less reactive than copper.

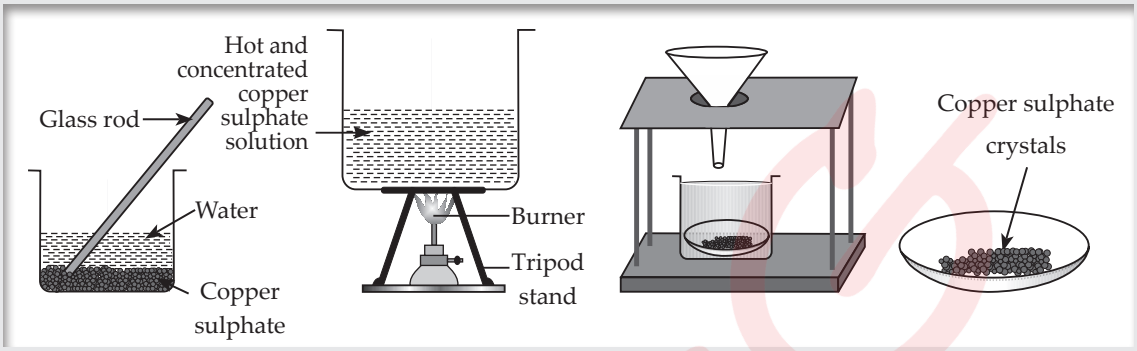
Crystallisation

- It is a process of separation of pure crystals of a substance from its solution.
- Crystallisation is an example of a physical change.
- This method is used to prepare pure crystals of many compounds like sugar, copper sulphate, alum (*phitkari*).
- This method is also used to prepare pure salt from sea water.
- A large crystals of alum can be prepared by adding a small crystal of alum in its saturated solution.

ACTIVITY CORNER

To prepare crystals of copper sulphate

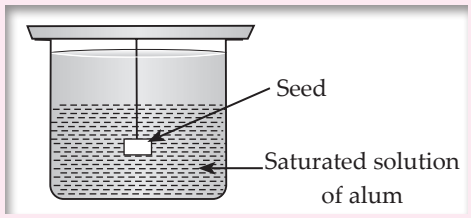
- **Materials required :** Copper sulphate, water, dilute sulphuric acid, beaker, funnel, filter paper, china dish, burner
- **Procedure :** Dissolve copper sulphate in half a beaker of water. Add a few drops of dilute sulphuric acid. Heat the solution and keep adding more copper sulphate till a saturated solution is formed and no more copper sulphate can be added to it. Filter the solution in a china dish and keep the filtrate undisturbed for some time. As the solution cools it becomes a supersaturated solution. Record your observations once the solution is cooled.



- **Observations :** Blue crystals of copper sulphate separate out at the bottom of china dish.
- **Conclusion :** Pure crystals of copper sulphate can be prepared from its supersaturated solution.

DO YOU KNOW?

- During crystallisation, the small crystal which is added to start crystallisation is called seed crystal or seed. To prepare a big crystal of alum, seed is tied with a thread and suspended in saturated solution of alum. The crystal grows in size and becomes big.
- After removing the crystals from the solution the remaining solution is called mother liquor.



ILLUSTRATIONS

12 What are crystalline substance?

Ans.: Those substance which are hard and possess definite geometrical shape are known as crystalline substances. For example, sodium chloride, crystals of copper sulphate, etc.

13 Is crystallisation a physical change or a chemical change?

Ans.: It is a physical change, as no new substance is formed.

14 Give one example where crystallisation is involved in getting an important ingredient of our food.

Ans.: Crystallisation is used to obtain salt from sea water.

15 Name the method used for the separation of hydrated copper sulphate from its aqueous solution.

Ans.: Crystallisation

CONCEPT MAP

Physical and Chemical Changes

Physical Change

A physical change is a change in shape, size, colour or state of a substance without changing its chemical composition.

Characteristics

- No new substances are formed.
- These are temporary changes.
- These can generally be reversed.
- There is no change in weight.
- Only a little heat is absorbed or given off.

Examples :
Melting of ice, boiling of water, freezing of water, condensation, crystallisation, etc.

Crystallisation

Crystallisation is the process of formation of solid crystals from a saturated solution.

Chemical Change

A chemical change results in the formation of new substances when the composition of the original substance is changed.

Characteristics

- A new substance with new properties is formed.
- These are permanent changes.
- These cannot be easily reversed.
- There is a change in weight.
- Heat is absorbed or given off.

Examples :
Burning of magnesium ribbon, rusting of iron, digestion of food, photosynthesis, etc.

Rusting

Corrosion of iron is called rusting. When iron is exposed to moist air for a long time, its surface acquires a coating of a brown, flaky substance called rust. Rust is mainly hydrated iron(III) oxide, $Fe_2O_3 \cdot xH_2O$. Both air and moisture are needed for rusting.

Chemical Reaction

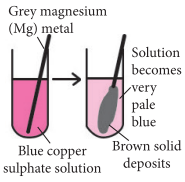
In a chemical reaction, formation of new products takes place.

Types of Chemical Reactions

Single displacement reactions

The chemical reactions in which one element takes the place of another element in a compound, *e.g.*,

$$\underset{\text{Magnesium}}{Mg_{(s)}} + \underset{\text{Copper sulphate}}{CuSO_{4(aq)}} \rightarrow \underset{\text{Magnesium sulphate}}{MgSO_{4(aq)}} + \underset{\text{Copper}}{Cu_{(s)}}$$



Combination reactions

Two or more substances combine to form a single substance.

e.g., $\underset{\text{Magnesium}}{2Mg_{(s)}} + \underset{\text{Oxygen}}{O_{2(g)}} \rightarrow \underset{\text{Magnesium oxide}}{2MgO_{(s)}}$

Decomposition reactions

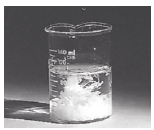
Single substance splits up into two or more substances, *e.g.*,

$$\underset{\text{Calcium carbonate}}{CaCO_{3(s)}} \xrightarrow{\text{Heat}} \underset{\text{Calcium oxide}}{CaO_{(s)}} + \underset{\text{Carbon dioxide}}{CO_{2(g)}}$$

Double displacement reactions

Two compounds react by exchange of ions to form two new compounds, *e.g.*,

$$\underset{\text{Sodium chloride}}{NaCl_{(aq)}} + \underset{\text{Silver nitrate}}{AgNO_{3(aq)}} \rightarrow \underset{\text{Silver chloride}}{AgCl_{(s)}} + \underset{\text{Sodium nitrate}}{NaNO_{3(aq)}}$$



Neutralisation reactions

When an aqueous solution of an acid reacts with a base by exchange of their ions/radicals to form salt and water, *e.g.*,

$$\underset{\text{Sulphuric acid}}{H_2SO_{4(aq)}} + \underset{\text{Sodium hydroxide}}{2NaOH_{(aq)}} \rightarrow \underset{\text{Sodium sulphate}}{Na_2SO_{4(aq)}} + \underset{\text{Water}}{2H_2O_{(l)}}$$

Solved Examples

1. Write any four characteristics of a physical change.

Ans.: (i) No new substance is formed.
(ii) There is a change in shape, size or state.
(iii) Physical change is generally temporary.
(iv) Properties of the substance remain same even after the change.

2. Breaking of an egg is a physical change while boiling of an egg is a chemical change. Why?

Ans.: When an egg is broken, no new substance is formed hence it is a physical change but when egg is boiled, chemical nature of the egg changes. The properties of a boiled egg are totally different from the raw egg. Hence, boiling of an egg is a chemical change.

3. Is conversion of milk into ice-cream a chemical change? Justify your answer.

Ans.: Yes, conversion of milk into ice-cream is a chemical change since properties of ice-cream are different from the milk.

4. Why does the colour of copper sulphate change from blue to green if an iron nail is placed in the solution of copper sulphate?

Ans.: When an iron nail is placed in the copper sulphate solution, iron being more reactive than copper displaces copper from copper sulphate solution. Displacement reaction takes place and ferrous sulphate is formed which is green in colour. Brown copper is deposited on the nail.

$$CuSO_4 + Fe \rightarrow FeSO_4 + Cu$$

5. What is a reversible change? Give few examples.

Ans.: A change in which original substance can be recovered by removing the factor responsible for change or by using simple methods is known as reversible change.
Examples : Conversion of ice into water, inflating of a balloon, stretching of a rubber band, mixing of salt in water, etc.

6. Explain the reasons for the following :
(i) Cooking of rice is a chemical change.
(ii) Adding sugar to milk is a physical change.
(iii) Burning of coal is a chemical change.

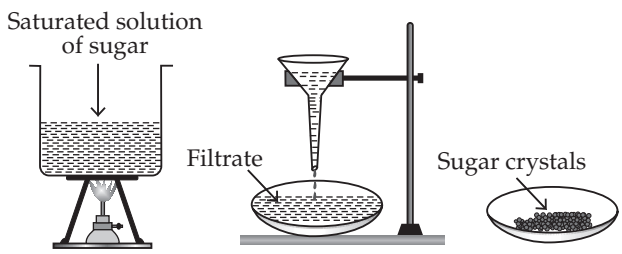
Ans.: (i) Rice, when cooked cannot be reverted to its raw form again. There is difference in the properties of rice after cooking.
(ii) There is no difference in the properties of milk or sugar after it is dissolved.
(iii) When coal is burnt, ash is left behind. Ash cannot be converted to coal again. Coal and ash have different properties.

7. What are the main factors which are responsible for rusting of iron?

Ans.: There are two main factors which are responsible for rusting of iron :
(i) Presence of air or oxygen.
(ii) Presence of water or moisture.
Both these factors have to be present for iron to get rusted. If any of these *i.e.*, either air or water are absent, rusting will not take place.

8. What is crystallisation? How can you get crystals of pure sugar from its solution?

Ans.: Crystallisation is the process in which pure crystals of a substance are separated from its saturated solution. To get crystals of pure sugar, the sugar is dissolved in minimum amount of water and heated to get its saturated solution. Solution is filtered to remove any impurities present in the sugar. Crystals of pure sugar separate out from the filtrate on cooling the solution.



9. What is alloying? Name an important alloy of iron.

Ans.: Alloying is a method in which a metal is mixed with another metal or a non-metal in molten state to improve the properties of the metal. Iron gets rusted very easily and to make it rust free, iron is combined with carbon and some other metals like chromium or manganese to make an important alloy called stainless steel. Stainless steel does not get rusted.

10. State two points of differences between formation of rust and formation of ice.

Ans.: (i) Rusting is a chemical process while formation of ice is a physical process.

(ii) Rusting is irreversible while formation of ice is a reversible process.

11. Give two examples for each of the following cases:

(a) Physical changes which are reversible.

(b) Physical changes which are not reversible.

(c) Chemical changes. *(NCERT Exemplar)*

Ans.: (a) (i) Folding of paper

(ii) Melting of ice

(b) (i) Cutting of paper

(ii) Breaking of glass

(c) (i) Burning of paper

(ii) Curdling of milk

12. Explain the following:

(a) Lime water turns milky on passing carbon dioxide gas into it.

(b) Bubbles are produced when acetic acid is added to a solution of sodium hydrogencarbonate. *(NCERT Exemplar)*

Ans.: (a) When carbon dioxide gas is passed through lime water, it turns milky because a white precipitate of calcium carbonate is formed.

Calcium hydroxide + Carbon dioxide → Calcium carbonate + Water

(b) When acetic acid is added to a solution of sodium hydrogencarbonate, carbon dioxide gas is formed which comes out in the form of bubbles.

Sodium hydrogencarbonate + Acetic acid → Sodium carbonate + Water + Carbon dioxide

13. A student took a solution of copper sulphate in a beaker and put a clean iron nail into it and left it for about an hour.

(a) What changes do you expect?

(b) Are these changes chemical in nature?

(c) Write a word equation for the chemical change, if any. *(NCERT Exemplar)*

Ans.: (a) Copper sulphate solution is blue in colour. When an iron nail is left in it for some time the blue colour of copper sulphate solution changes to green and the surface of iron nail gets a brown coloured deposit.

(b) Yes, the changes are chemical changes because new substances iron sulphate (green) and copper (brown) are formed in the reaction.

(c) Copper sulphate (Blue) + Iron (Shining grey) → Iron sulphate (Green) + Copper (Brown)

14. If you leave a piece of iron in the open for a few days, it acquires a film of brownish substance, called rust.

(a) Do you think rust is different from iron?

(b) Can you change rust back into iron by some simple method?

(c) Do you think formation of rust from iron is a chemical change?

(d) Give two other examples of a similar type of change. *(NCERT Exemplar)*

Ans.: (a) Yes, rust is different from iron. It is a brown powder of iron oxide.

(b) No rusting is a chemical change and cannot be reversed.

(c) Yes, rusting is a chemical change since a new substance is formed.

(d) (i) Burning of magnesium ribbon to give magnesium oxide.

(ii) Burning of wood to give coal and ash.

15. Give an example of a chemical reaction for each of the following situations :

(a) A change in colour is observed.

(b) A gas is evolved.

(c) Sound is produced. *(NCERT Exemplar)*

Ans.: (a) Reaction between copper sulphate and iron metal - blue solution of copper sulphate changes to green solution of ferrous sulphate.

(b) Reaction between sodium hydrogen carbonate and acetic acid - carbon dioxide gas is evolved.

(c) Burning of crackers produces a loud sound.

NCERT Section

1. Classify the changes involved in the following processes as physical or chemical changes:
   (a) Photosynthesis
   (b) Dissolving sugar in water
   (c) Burning of coal
   (d) Melting of wax
   (e) Beating aluminium to make aluminium foil
   (f) Digestion of food

2. State whether the following statements are true or false. In case a statement is false, write the correct statement in your notebook.
   (a) Cutting a log of wood into pieces is a chemical change. (True/False)
   (b) Formation of manure from leaves is a physical change. (True/False)
   (c) Iron pipes coated with zinc do not get rusted easily. (True/False)
   (d) Iron and rust are the same substances. (True/False)
   (e) Condensation of steam is not a chemical change. (True/False)

3. Fill in the blanks in the following statements:
   (a) When carbon dioxide is passed through lime water, it turns milky due to the formation of _____.
   (b) The chemical name of baking soda is _____.
   (c) Two methods by which rusting of iron can be prevented are _____and _____.
   (d) Changes in which only _____ properties of a substance change are called physical changes.
   (e) Changes in which new substances are formed are called _____ changes.

4. When baking soda is mixed with lemon juice, bubbles are formed with the evolution of a gas. What type of change is it? Explain.

5. When a candle burns, both physical and chemical changes take place. Identify these changes. Give another example of a familiar process in which both the chemical and physical changes take place.

6. How would you show that setting of curd is a chemical change?

7. Explain why burning of wood and cutting it into small pieces are considered as two different types of changes.

8. Describe how crystals of copper sulphate are prepared.

9. Explain how painting of an iron gate prevents it from rusting.

10. Explain why rusting of iron objects is faster in coastal areas than in deserts.

11. The gas we use in the kitchen is called liquefied petroleum gas (LPG). In the cylinder it exists as a liquid. When it comes out from the cylinder it becomes a gas (Change - A) then it burns (Change - B).

    The following statements pertain to these changes. Choose the correct one.
    (i) Process - A is a chemical change.
    (ii) Process - B is a chemical change.
    (iii) Both processes A and B are chemical changes.
    (iv) None of these processes is a chemical change.

12. Anaerobic bacteria digest animal waste and produce biogas (Change - A). The biogas is then burnt as fuel (Change - B). The following statements pertain to these changes. Choose the correct one.
    (i) Process - A is a chemical change.
    (ii) Process - B is a chemical change.
    (iii) Both processes A and B are chemical changes.
    (iv) None of these processes is a chemical change.

Exercise

Multiple Choice Questions

LEVEL - 1

1. Which of the following is not a physical change?
(a) Breaking of a glass tumbler
(b) Melting of butter
(c) Dissolving of sugar in water
(d) Ripening of a fruit U

2. Which gas is produced when vinegar reacts with baking soda?
(a) Hydrogen (b) Carbon dioxide
(c) Carbon monoxide (d) Oxygen An

3. Rusting of iron is
(a) an irreversible chemical change
(b) a reversible chemical change
(c) an irreversible physical change
(d) a reversible physical change. U

4. Galvanisation is a process in which
(a) iron is coated on zinc metal
(b) zinc and iron are mixed in molten state
(c) zinc is coated as a layer on iron
(d) carbon is mixed with iron and heated.

5. Which of the following is a chemical change?
(a) Cutting of a cloth (b) Ironing of a cloth
(c) Drying of a cloth (d) Burning of a cloth U

6. Which of the following methods cannot be used to prevent rusting?
(a) Painting
(b) Alloying
(c) Galvanisation
(d) Mixing with sulphur

7. When an iron nail is dipped in copper sulphate solution, the colour of copper sulphate changes to
(a) green (b) blue
(c) pink (d) colourless U

8. Which of the following metals burns with a dazzling white flame?
(a) Zinc (b) Copper
(c) Iron (d) Magnesium R

9. A reversible change is a change which
(a) cannot be reversed
(b) is a chemical change
(c) takes place during a displacement reaction
(d) can be reversed. R

10. Which of the following gases burns with a pop sound?
(a) Hydrogen (b) Oxygen
(c) Nitrogen (d) Carbon dioxide

11. Carbon dioxide gas turns limewater milky. This change is a
(a) physical change
(b) chemical change
(c) displacement reaction
(d) neutralisation reaction. U

12. Choose the incorrect statement.
(a) Chemical reactions are characterised by change in colour and smell.
(b) Change in chemical compositions of reactants takes place during a chemical change.
(c) Physical changes are always reversible.
(d) Change in physical state is a physical change.

13. Identify the physical change among the following.
(a) Burning of magnesium ribbon
(b) Formation of solution by dissolving a soluble substance in water
(c) Photosynthesis
(d) Digestion of food

14. Which type of the chemical reaction is the following reaction?
$AB + C \rightarrow AC + B$
(a) Decomposition reaction
(b) Neutralisation reaction
(c) Displacement reaction
(d) Combination reaction U

15. Crystallisation is the process in which
(a) crystals of pure substance are obtained
(b) crystals of impure substance are obtained
(c) colourless crystals of a coloured substance are obtained
(d) coloured crystals of a colourless substance are obtained. Ap

16. Which of the following compounds is formed when the ash formed by burning of magnesium in air is dissolved in water?
(a) Magnesium oxide
(b) Magnesium hydroxide
(c) Magnesium carbonate
(d) Magnesium chloride An

17. A cut piece of apple turns brown when exposed to air for some time. It is an example of a
(a) reversible change
(b) physical change
(c) chemical change
(d) physical and reversible change.

18. Which of the following is not a chemical change?
(i) Magnesium burning
(ii) Cake baking
(iii) Cooking of food
(iv) Crystal formation
(v) Melting of ice-cream
(a) (i) and (iii) (b) (ii) and (iv)
(c) (ii) and (v) (d) (iv) and (v) An

19. Pure salt from the sea water can be obtained by
(a) neutralisation
(b) boiling
(c) sublimation
(d) evaporation and crystallisation. Ap

20. When magnesium oxide is dissolved in water, the solution formed
(a) turns red litmus blue
(b) turns blue litmus red
(c) gives no colour with phenolphthalein
(d) gives back the magnesium ribbon on standing.

21. Which of the following will result in a chemical change?
(a) Mixing of milk and sugar
(b) Mixing of milk and curd
(c) Mixing of milk and water
(d) Mixing of water and salad An

22. Beating an egg to make a cake is a
(a) physical change
(b) chemical change
(c) reversible change
(d) change in state. U

23. Which of the following is not the correct combination?
(a) Melting of butter – Physical change
(b) Shaping of glass by heating – Physical change
(c) Burning of magnesium in air – Physical change
(d) Glowing of an electric bulb – Physical change An

24. Which of the following statements is correct regarding formation of rust and formation of ice?
(a) Rust is formed by a chemical change while ice is formed by a physical change.
(b) Both rust and ice are formed by physical change.
(c) Both rust and ice are formed by chemical change.
(d) Rust is formed by a physical change while ice is formed by a chemical change.

25. Keeping a stone in sunlight for few hours is
(a) a physical change
(b) a chemical change
(c) neither physical nor a chemical change
(d) combination of physical and chemical changes. U

26. In which type of change we observe change in specific property of matter but not in chemical composition?
(a) Physical change
(b) Chemical change
(c) Both physical and chemical changes
(d) Neither physical nor chemical change
U

27. Which of the following is not the correct combination?
(a) Preparing sugar solution by heating – Physical change
(b) Evaporation of salt solution to get salt – Chemical change
(c) Formation of magnesium oxide on burning – Chemical change
(d) Formation of paneer from milk – Chemical change
An

28. Mark the incorrect statement.
(a) A crystal is a solid in its pure form.
(b) Galvanisation is zinc coating on iron.
(c) Rusting is a chemical reversible change.
(d) Reaction of iron and copper sulphate is a displacement reaction.
U

29. Cut vegetables turn brown when exposed to air. This is due to
(a) evaporation (b) oxidation
(c) neutralisation (d) displacement

30. A chemical reaction in which magnesium ribbon burns can be represented as
(a) Magnesium + Oxygen → Magnesium oxide
(b) Magnesium + Oxygen → Magnesium hydroxide
(c) Magnesium + Water → Magnesium hydroxide
(d) Magnesium + Oxygen + Water → Magnesium hydroxide

LEVEL - 2

31. In a displacement reaction
(a) the colour of the original solution does not change
(b) a more reactive element displaces a less reactive element from its solution
(c) a less reactive element displaces a more reactive element from its solution
(d) the elements with same reactivity displace each other in salt solution.
U

32. Identify the type of change in the following reaction.

$$\text{Ice} \xrightarrow{\text{heat}} \text{Water} \xrightarrow{\text{heat}} \text{Steam}$$

(a) Physical change (b) Chemical change
(c) Both physical and chemical changes
(d) None of the above

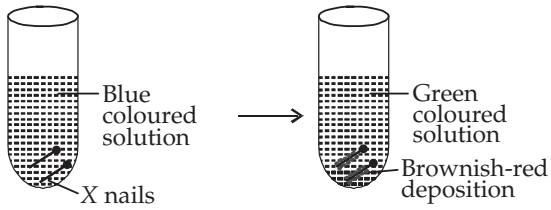
33. Mark the correct statement.
(a) Hydrogen gas is evolved when vinegar is added to baking soda.
(b) Heat energy is always given out during a chemical change.
(c) New product is always formed during a chemical change.
(d) Combining two substances by heating is a physical change.
U

34. Identify the correct statement.
(a) Rusting and burning are reversible changes.
(b) Physical change is always an irreversible change.
(c) Oxygen gas turns limewater milky.
(d) Cutting of an apple is an irreversible chemical change.

35. Which of the following changes is wrongly identified?
(a) Eating of *dosa* in breakfast – Chemical change
(b) Cutting of wood to make furniture – Chemical change
(c) Making fruit custard from milk – Chemical change
(d) Baking a cake – Chemical change
An

36. For crystallisation to take place a solution must be
(a) saturated
(b) supersaturated
(c) unsaturated
(d) dilute. U

37. Study the given figure carefully.



Which of the following reactions explains the above change most appropriately?
(a) $ZnSO_4 + Cu \rightarrow CuSO_4 + Zn$
(b) $CuSO_4 + Fe \rightarrow FeSO_4 + Cu$
(c) $FeSO_4 + Cu \rightarrow CuSO_4 + Fe$
(d) $CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$ Cr

38. Dissolve some common salt in water and leave the solution in an open and sunny place for a day. What do you observe?
(a) The whole of the solution evaporates
(b) Water evaporates leaving behind salt
(c) Salt evaporates leaving behind water
(d) No change of any form in the salt solution U

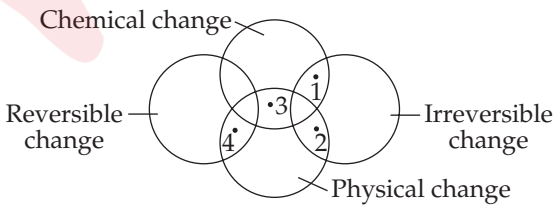
39. When an iron spade is left open in a moist atmosphere it
(a) develops brown powdery layer of iron oxide
(b) develops green layer of iron oxide
(c) develops brown layer of oxygen
(d) does not undergo any change.

40. When carbon dioxide is passed through limewater
(a) it turns blue due to formation of calcium oxide
(b) it turns green due to formation of iron sulphate
(c) it turns white due to formation of calcium hydroxide
(d) it turns milky due to formation of calcium carbonate.

41. The example for exothermic reaction is
(a) melting of ice cubes
(b) decomposition of vegetable matter into compost
(c) cooking an egg (d) baking bread.

42. The given reaction is an example of
$Fe + CuSO_4 \rightarrow Cu + FeSO_4$
(a) Redox reaction
(b) Double displacement reaction
(c) Neutralization reaction
(d) Precipitation reaction

43. Study the given Venn diagram :



Points 1, 2, 3 and 4 represent

	1	2	3	4
(a)	Folding a paper to make boat	Burning of a cracker	A spinning top	Germination of seeds
(b)	Growth of a plant	Cutting of a tree	Burning of cooking gas	Melting of ice
(c)	Setting of milk to form curd	Melting of ice	Inflation of tyre	Tearing a paper into pieces
(d)	Change of seasons	Rising and setting of sun	Bursting of a balloon	Burning of a candle

Cr

44. Rajni has classified a few changes around us as shown in the table.

S. No.	Change	Type of change
1.	Browning of sliced brinjal	Physical, irreversible
2.	Getting pure crystals of copper sulphate from saturated solution of copper sulphate	Physical, reversible
3.	Baking of a cake	Chemical, reversible
4.	Respiration	Chemical, irreversible
5.	Making sugar solution	Physical, reversible

The changes classified correctly are
(a) 3 and 5 only (b) 2, 4 and 5 only
(c) 1 and 5 only (d) 2 and 4 only

45. Observe the given experimental set-up.

Which of the following represents the correct observation?
(a) Vapours of chlorine are evolved.
(b) Ammonium chloride melts after some time.
(c) White solid gets deposited on the upper cooler part of test tube.
(d) Violet coloured vapours are produced as ammonium chloride undergoes sublimation. An

46. Which of the following statements is incorrect?
(a) Carbon dioxide turns lime water milky.
(b) Breaking down of ozone is a chemical change.
(c) Production of biogas from animal waste is a physical change.
(d) For rusting, the presence of both oxygen and water is essential.

47. Which of the following statements is/are correct?
I. Manure formation from leaves is a chemical change.
II. Chemically iron and rust are same.
III. Breakdown of ozone to oxygen is a chemical change.
IV. Zinc coated iron pipes rust easily.
(a) II only (b) I and III only
(c) II and III only (d) I and IV only

48. When silver bromide is exposed to light, it forms silver metal and bromine vapours. This reaction comes under which of the following category?
(a) Decomposition reaction
(b) Single displacement reaction
(c) Double displacement reaction
(d) Combination reaction

49. Process of respiration is
(a) an oxidation reaction which is endothermic
(b) a reduction reaction which is exothermic
(c) a combination reaction which is endothermic
(d) an oxidation reaction which is exothermic. U

50. Chemical reaction between quick lime and water is characterised by
(a) evolution of hydrogen gas
(b) formation of slaked lime precipitate
(c) change in temperature of mixture
(d) change in colour of the product. An

LEVEL - 3 (HOTS)

Competency Focused Questions (CFQs)

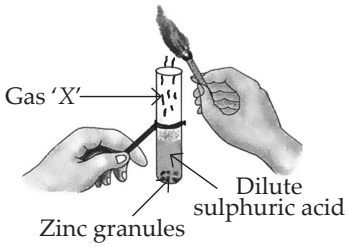
51. All of the following processes involve a separation of either a mixture into its components, or a compound into elements. For each, decide whether a physical process or a chemical reaction is required.
(i) Sodium metal is obtained from the substance sodium chloride.
(ii) Iron filings are separated from sand by using a magnet.
(iii) Sugar crystals are separated from sugar syrup by evaporation of water.

(iv) Fine crystals of silver chloride are separated from a suspension of the crystals in water.
(v) Copper is produced when zinc metal is placed in a solution of copper (II) sulphate, a compound.

	Physical Processes	Chemical Processes
(a)	i, ii, iii	iv, v
(b)	i, iv	ii, iii, v
(c)	ii, iii, iv	i, v
(d)	v	i, ii, iii, iv

U

52. Observe the given figure carefully.



Read the given passage and fill in the blanks by selecting an appropriate option.
In the given figure, (i) reaction takes place which is a chemical change. (ii) being more reactive than (iii), produces gas '*X*' which is (iv) and it burns with a (v).

	(i)	(ii)	(iii)	(iv)	(v)
(a)	oxidation	Zn	H	SO_2	dazzling light
(b)	displacement	H	Zn	H_2	pop sound
(c)	displacement	Zn	H	H_2	pop sound
(d)	reduction	Zn	S	SO_2	rotten egg smell

An

53. The equation,
$Mg_{(s)} + CuO_{(s)} \rightarrow MgO_{(s)} + Cu_{(s)}$
represents
i. decomposition reaction
ii. displacement reaction
iii. combination reaction
iv. double displacement reaction
v. redox reaction
(a) i and ii
(b) iii and iv
(c) ii and v
(d) iv and v

U

54. Read the given statements and select the correct option.
Statement 1 : Electrolysis of water is a displacement reaction.
Statement 2 : Water gets broken down to form hydrogen and oxygen.
(a) Both statements 1 and 2 are true.
(b) Both statements 1 and 2 are false.
(c) Statement 1 is false and statement 2 is true.
(d) Statement 1 is true but statement 2 is false.

55. Classify each of the following reactions :
1. $Zn_{(s)} + 2AgNO_{3(aq)} \longrightarrow Zn(NO_3)_{2(aq)} + 2Ag_{(s)}$
2. $Ca(OH)_{2(s)} \xrightarrow{\text{Heating}} CaO_{(s)} + H_2O_{(g)}$
3. $Cu(NO_3)_{2(aq)} + Na_2S_{(aq)} \longrightarrow 2NaNO_{3(aq)} + CuS_{(s)}\downarrow$
4. $H_2SO_{3(aq)} + 2KOH_{(aq)} \longrightarrow K_2SO_{3(aq)} + 2H_2O_{(l)}$

	1	2	3	4
(a)	Precipitation	Neutralization	Decomposition	Redox reaction
(b)	Neutralization	Precipitation	Redox reaction	Decomposition
(c)	Redox reaction	Decomposition	Precipitation	Neutralization
(d)	Decomposition	Redox reaction	Neutralization	Precipitation

56. While discussing the topic 'Rusting', Mr. Ankit, a class 7 teacher wrote the following statements on the blackboard. He asked his students to find the incorrect statements.

I. Depositing a layer of tin on iron is called galvanisation.

II. Stainless steel rusts more quickly as it contains carbon and metals like chromium, nickel and manganese.

III. Salty water fastens the process of rust formation.

Select the incorrect statement(s).

(a) III only (b) I only

(c) I and II only (d) I, II and III

57. A few changes are given below :

A. Making almirah from wood

B. Galvanisation of an iron pot

C. Making an aeroplane from a paper

D. Formation of acid rain from air pollutants

E. Photosynthesis

F. Breaking of vase

Classify these changes into

I. Irreversible-physical change

II. Chemical change

III. Reversible-physical change.

(a)	I - A, F	II - B, D, E	III - C
(b)	I - A, B, E	II - D, F	III - C
(c)	I - A	II - B, D	III - C, E, F
(d)	I - F	II - C, E	III - A, B, D

58. Observe the given figures carefully.

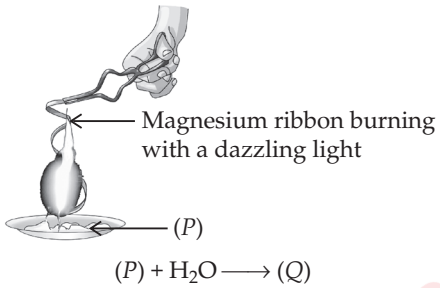


Figure 1

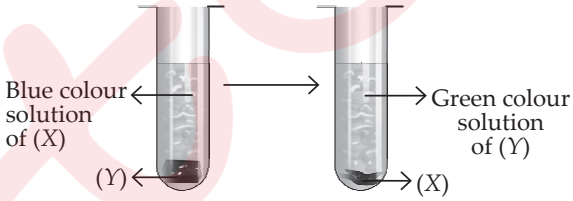


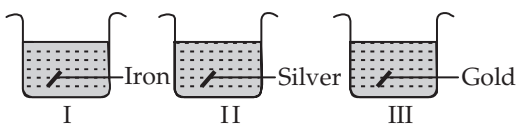
Figure 2

Read the given passage and fill in the blanks by selecting an appropriate option.

Figures 1 and 2 both represent a (i) change. In figure 1, *P* is (ii) and *Q* is (iii). In figure 2, *X* and *Y* can be (iv) and (v) respectively.

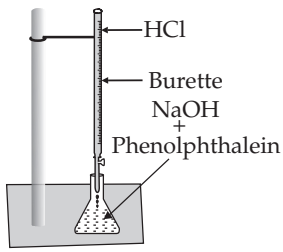
	(i)	(ii)	(iii)	(iv)	(v)
(a)	Physical	Mg	$MgO.2H_2O$	Cu	Ag
(b)	Chemical	MgO	$Mg(OH)_2$	Cu	Fe
(c)	Chemical	$Mg(OH)_2$	MgO	Fe	Cu
(d)	Physical	$Mg(NO_3)_2$	MgO	Zn	Al

59. Vishakha took few wire pieces made up of different metals and placed them in blue coloured solution of copper sulphate. What will be the colour of the solutions present in beakers I, II and III after half an hour?



	I	II	III
(a)	Green	Blue	Green
(b)	Blue	Green	Green
(c)	Green	Blue	Blue
(d)	Blue	Blue	Blue

60. Observe the given figure carefully and select the correct statements.



I. Heat is evolved in this reaction.

II. The colour of the mixture in the conical flask is pink in the beginning.

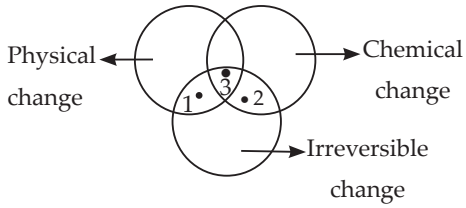
III. It represents a neutralisation reaction.

IV. No new substance is formed in the reaction.

(a) I, II and III only (b) II and III only

(c) III and IV only (d) I, II, III and IV

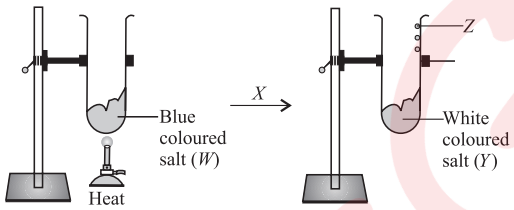
61. Study the given Venn diagram and identify points 1, 2 and 3.



	1	2	3
(a)	Melting of ice	Boiling of rice	Burning of a candle
(b)	Burning of paper	Rusting of iron	Cutting of fruits
(c)	Breaking of a glass	Baking LPG in kitchen	Burning of a cake
(d)	Tearing of paper	Evaporation of water	Making lemonade

U

62. Observe the given change carefully and identify *W*, *X*, *Y* and *Z*.



	W	*X*	*Y*	*Z*
(a)	$CuSO_4.5H_2O$	Physical change	$CuSO_4$	H_2O vapours
(b)	$MgSO_4.7H_2O$	Physical change	$MgSO_4$	H_2O vapours
(c)	$FeSO_4.7H_2O$	Chemical change	$FeSO_4$	H_2O droplets
(d)	$CuSO_4.5H_2O$	Chemical change	$CuSO_4$	H_2O droplets

Ap

63. Match the given chemical reactions with the products listed and select the correct option from the given codes.

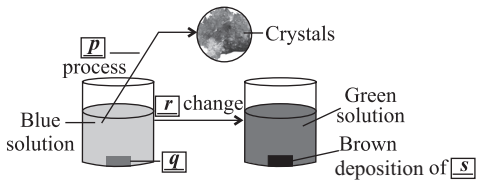
(i) CaO (ii) $Mg(OH)_2$ (iii) NO_2 (iv) Cu
(v) $MgCl_2$ (vi) O_2 (vii) Fe_2O_3 (viii) $CaCO_3$

P. Mixing magnesium oxide with water
Q. Brown deposit on iron nail kept in copper sulphate solution
R. Carbon dioxide is passed through lime water
S. Absorption of ultraviolet radiations by ozone.

(a) P-(v), Q-(vii), R-(i), S-(vi)
(b) P-(iv), Q-(ii), R-(i), S-(iii)
(c) P-(ii), Q-(iii), R-(viii), S-(vii)
(d) P-(ii), Q-(iv), R-(viii), S-(vi)

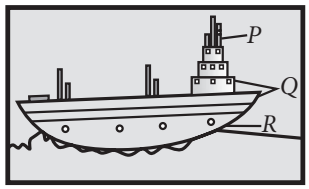
An

64. Observe the given figure carefully and fill in the blanks by choosing an appropriate option.



	p	*q*	*r*	*s*
(a)	Crystallisation	Iron	Chemical, reversible	Iron oxide
(b)	Sublimation	Zinc	Physical, irreversible	Zinc oxide
(c)	Melting	Copper	Physical, reversible	Copper oxide
(d)	Crystallisation	Iron	Chemical, irreversible	Copper

65. Which portion of the ship will rust the fastest?



(a) *P*
(b) *Q*
(c) *R*
(d) *P*, *Q* and *R* will rust equally. U

Fill in the Blanks

1. When _____ gas is passed through limewater it turns milky.
2. The process of mixing a non-metal or metal to a molten metal is known as _____ .
3. Physical changes are generally _____ in nature.
4. Exposed cut surfaces of fruits and vegetables turn brown due to _____ .
5. Chemical changes are permanent and usually _____ in nature.
6. Salt is obtained from sea water by the process of _____ .
7. With the combination of water and oxygen on iron, a new product _____ is formed.
8. The chemical formula of rust is _____ .
9. The process of depositing zinc on iron to prevent rusting is called _____ .
10. Heat may be evolved or absorbed during a _____ change.
11. _____ gas is given out when vinegar is added to baking soda.
12. Copper sulphate solution is _____ in colour and it turns _____ when an iron nail is added to it.
13. When magnesium is burnt in air, a new substance is formed which is _____ .
14. A _____ reactive element displaces _____ reactive element from its salt solution.
15. The change in which a substance in a different state but having similar chemical properties is formed is a _____ change.

True or False

1. The iron gate if not painted gets rusted due to presence of air and moisture.
2. The process of separation of crystals from a saturated solution on cooling is called evaporation.
3. Burning of candle is a chemical change, while melting of wax is a physical change.
4. When exposed to air a cut brinjal turns black at the surface. This is an example of a chemical change.
5. Rusting of iron is a reversible chemical change.
6. Crystallisation is an irreversible physical change.
7. A physical change can be reversible as well as irreversible.
8. Oxygen gas is evolved when baking soda and vinegar react.
9. Nitrogen gas turns limewater milky.
10. Rusting can be prevented by applying a coat of paint or grease.
11. The green colour of copper sulphate turns blue when iron nail is added to it.
12. Salt dissolved in sea water can be obtained by evaporation.
13. Vinegar is common name for acetic acid.
14. Photosynthesis is an irreversible chemical change.
15. Burning of fuel, cooking of food and digestion of food are all chemical changes.

Match the Following

In this section, each question has two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (a), (b), (c) and (d) out of which one is correct.

1.

List-I	List-II
(P) Folding of paper	1. Crystallisation
(Q) Zinc coating	2. Cut apples
(R) Solid in pure form	3. Can be reversed
(S) Oxidation	4. Galvanisation

(a) P-3, Q-4, R-2, S-1 (b) P-3, Q-4, R-1, S-2
(c) P-4, Q-3, R-2, S-1 (d) P-1, Q-2, R-4, S-3

2.

List-I	List-II
(P) Iron nail + Copper sulphate	1. Carbon dioxide
(Q) Vinegar + Baking soda	2. Calcium carbonate
(R) Iron + Moisture + Air	3. Displacement reaction
(S) Lime water + Carbon dioxide	4. Rust

(a) P-3, Q-1, R-4, S-2 (b) P-3, Q-1, R-2, S-4
(c) P-2, Q-3, R-1, S-4 (d) P-1, Q-2, R-4, S-3

3.

List-I	List-II
(P) Chemical change	1. Evolution of a gas
(Q) Physical change	2. Pure solid
(R) Crystallisation	3. Change in state
(S) Alloying	4. Mixing of molten solids

(a) P-3, Q-4, R-2, S-1 (b) P-2, Q-3, R-1, S-4
(c) P-1, Q-3, R-2, S-4 (d) P-4, Q-2, R-3, S-1

4.

List-I	List-II
(P) Burning of coal	1. Rusting
(Q) Painting of a surface	2. Evaporation
(R) Dipping iron in water	3. Chemical change
(S) Salt from sea water	4. Prevention of rusting

(a) P-1, Q-4, R-2, S-3 (b) P-3, Q-1, R-2, S-4
(c) P-4, Q-3, R-2, S-1 (d) P-3, Q-4, R-1, S-2

5.

List-I	List-II
(P) Change in temperature	1. Magnesium reacting with dilute sulphuric acid
(Q) Evolution of a gas	2. Potassium iodide reacting with lead nitrate
(R) Formation of a precipitate	3. Sulphur dioxide gas reacting with acidified potassium dichromate solution
(S) Change in colour	4. Zinc granules reacting with dilute sulphuric acid

(a) P-3, Q-4, R-1, S-2 (b) P-4, Q-1, R-2, S-3
(c) P-1, Q-4, R-3, S-2 (d) P-4, Q-2, R-3, S-1

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

1. **Assertion :** Rusting can be prevented by applying a coat of paint on the surface.
Reason : Coat of paint cuts off contact of iron with water and air.

2. **Assertion :** Cutting of paper into very small pieces is an irreversible change.
Reason : Physical changes are always reversible.

3. **Assertion :** Carbon dioxide is evolved when vinegar is added to baking soda.
Reason : Carbon dioxide turns a solution of limewater milky.

4. **Assertion :** Freezing of water to ice is a physical change.
Reason : A physical change involves the change in state.

5. **Assertion :** Burning of a candle is considered a physical as well as chemical change.
   Reason : Melting of wax is a physical change, melted wax turns into vapours and then burns which is a chemical change.

6. **Assertion :** The ash produced by burning of magnesium when dissolved in water, turns red litmus blue.
   Reason : On dissolving in water, magnesium oxide forms magnesium hydroxide which is acidic in nature.

7. **Assertion :** No new substance is formed when water is heated to get steam.
   Reason : Conversion of water into steam is a physical change.

8. **Assertion :** Corrosion of iron is commonly known as rusting.
   Reason : Corrosion of iron occurs in presence of water and air.

9. **Assertion :** Following reaction describes the rusting of iron and is a redox reaction,
   $4Fe + 3O_2 \rightarrow 4Fe^{3+} + 6O^{2-}$.
   Reason : The metallic iron is oxidised to Fe^{3+}.

10. **Assertion :** The reaction in which a substance is decomposed into two or more simple substances is known as decomposition reaction.
    Reason : The decomposition can be carried out by giving energy in the form of heat, light, electricity, etc.

Comprehension Type

PASSAGE-I : Matter exists in three states – solid, liquid and gas. Water can exist in all the three states. Water exists as ice in solid state while as steam in vapour state. No new substance is formed when water, steam and ice are interconverted.

$$\text{Ice} \overset{\text{Heat}}{\rightleftharpoons} \text{Water} \overset{\text{Heat}}{\rightleftharpoons} \text{Steam}$$

1. Conversion of ice into water on heating or keeping the ice at room temperature is an example of
   (a) physical and reversible change
   (b) physical and irreversible change
   (c) chemical and reversible change
   (d) chemical and irreversible change.

2. When water is heated it is converted into steam. What makes it a physical and reversible change?
   (a) Water and steam are two different compounds and are interconvertible.
   (b) Water and steam have same chemical composition and on cooling steam can be condensed back to water.
   (c) Water and steam have same physical properties but different chemical properties.
   (d) Water can be converted to steam but steam cannot be converted back to water.

3. A physical change may involve
   (a) change in state (b) change in shape
   (c) change in size (d) all of these.

PASSAGE-II : A change in which a new substance is formed with different properties is called a chemical change. In a chemical change heat is either evolved or absorbed. The original substances cannot be recovered easily. The change may be accompanied by evolution of light and sound also. Chemical reactions are examples of chemical change. When a matchstick is burnt, it changes forever and it cannot be lighted again. Hence, we say that matchstick has undergone a chemical change.

1. Which of the following is not a chemical change?
   (a) Cooking of rice and dal
   (b) Burning of coal to give ash
   (c) Cutting of wood into very small pieces
   (d) Burning of small pieces of wood

2. Which of the following statements is not true?
   (a) Adding sugar in milk is a physical change.
   (b) Ice and steam are two different substances.
   (c) Rusting of iron is a chemical reaction.
   (d) Chemical changes are generally irreversible.

3. Which of the following is involved in a chemical change?
   (a) Change in colour
   (b) Evolution of a gas
   (c) Absorption or release of heat
   (d) All of the above

PASSAGE-III : Substances made up of iron if left open in air develop a reddish-brown layer. With time the layers fall off in the form of powder and fresh iron is exposed and ultimately complete iron is eaten away. This process is known as rusting of iron. It takes place only in the presence of air and moisture. If any one of these conditions is absent, the rusting can be prevented. Rusting is an example of a chemical change since a new product, rust is formed.

1. Why is rusting an irreversible chemical change?
   (a) The original iron cannot be obtained from rust.
   (b) A new substance called rust (iron oxide) is formed from iron.
   (c) Both (a) and (b).
   (d) None of the above.
2. The conditions necessary for rusting are
   (a) carbon dioxide, oxygen and hydrogen
   (b) oxygen and water
   (c) carbon dioxide and water
   (d) hydrogen and water.
3. Rusting can be prevented by
   (a) removing brown layer of rust from the surface of iron
   (b) cutting the contact of iron from air and water
   (c) keeping iron covered with paper
   (d) keeping on pouring water on the surface of iron.

Subjective Problems

Very Short Answer Type

1. What is the process of depositing a layer of zinc on iron called?
2. Why does stainless steel not rust?
3. Which gas turns limewater milky?
4. Can rusting take place in dry air?
5. What type of a change is digestion of food?
6. Name one alloy of iron which does not get rusted.
7. Burning of magnesium wire is which type of a change?
8. What is the name given to the reaction in which blue colour of copper sulphate turns green when iron is added to it?
9. What is chemical reaction?
10. Name the change in which no new substance is formed.
11. Name the process through which solid crystals of pure substances are obtained from their saturated solutions.
12. Name the change in which a new substance is formed.
13. Is crystallisation an irreversible reaction?
14. Give an example in which both physical and chemical changes are taking place.
15. Write the composition of the alloy called bronze.

Short Answer Type

1. (a) Define an irreversible physical change.
   (b) What happens when a saturated solution is left for cooling?
2. What is evaporation? How is evaporation useful in getting salt from sea water?
3. Which type of changes is represented by the following examples?
   (i) When an iron piece is left in a moist atmosphere, a brown layer of rust is formed on it.
   (ii) Carbon dioxide is evolved when vinegar is added to sodium bicarbonate.
4. (a) Give an example to justify the statement that physical changes can be reversible as well as irreversible.
   (b) Write the equation of the reaction taking place between baking soda and vinegar.

5. (a) Give an example of a chemical change in which a change of colour takes place.
   (b) Why do cut vegetables and fruits turn brown when exposed to air?

6. Define combustion. What type of change is it? Demonstrate with an activity.

7. Define chemical equation. Write the steps for balancing it. Explain by giving an example.

8. What type of chemical reactions take place when
   (a) a magnesium wire is burn in air
   (b) limestone is heated
   (c) silver bromide is exposed to sunlight
   (d) zinc strip is dipped into a copper sulphate solution.

9. Which gas is evolved when dil. hydrochloric acid is added to calcium carbonate? How will you test the gas? Write the chemical equations involved.

10. (a) Give two examples of chemical changes that are harmful.
    (b) Explain why you consider them harmful.
    (c) How can you prevent them?

Long Answer Type

1. With a diagram explain what happens when an iron nail is exposed to
   (i) dry air (ii) only moisture
   (iii) both moisture and air.

2. (a) What is crystallisation? How will you obtain crystals of alum from an impure sample?
   (b) What is a displacement reaction? Why is it a chemical reaction? Explain with an example.

3. State five differences between a physical and a chemical change.

4. Define the following chemical reactions and give an example of each.
   (a) Exothermic reaction
   (b) Oxidation reaction
   (c) Combination reaction
   (d) Reduction reaction
   (e) Decomposition reaction

5. With an activity explain burning of magnesium in air. What is the compound formed after burning of magnesium? What happens when this compound is dissolved in water?

Integer/Numerical Value Type

1. Out of the following, the number of properties which change during a physical change is _____.
   Shape, size, state, chemical composition.

2. Among the following, the total number of methods that can be used to prevent rusting is _____.
   Dipping in water, painting the surface, greasing the surface, galvanisation, alloying, heating the iron.

3. Number of states shown by water is _____.

4. Among the following, the total number of chemical changes is _____.
   Melting of ice, crushing of paper, rusting of iron, burning of magnesium, ironing of clothes, cooking of rice, burning of LPG, photosynthesis, digestion of food.

5. Number of changes from the given list cannot be reversed are _____.
   (i) Breaking of an earthen pitcher
   (ii) Freezing of ice-cream
   (iii) Falling of trees during storm
   (iv) Filling of bucket with water
   (v) Rusting of a bicycle
   (vi) Digestion of food

Case Based Questions

Case I : Properties such as shape, size, colour and state of a substance are called its physical properties. A change in which a substance undergoes a change in its physical properties is called a physical change. In a physical change, no new substance is formed.

1. Ripening of fruit is a
   (a) slow and desirable change
   (b) undesirable and fast change
   (c) slow and undesirable change
   (d) fast and desirable change.

2. Which of the following is a physical change?
   (a) Rusting of iron
   (b) Dissolving common salt in water
   (c) Growing of tree
   (d) Ripening of fruit

3. Which of the following is reversible change?
   (a) Rusting of iron nail (b) Boiling of water
   (c) Cutting of wood (d) Growing of kid

4. The reason for a physical change to be named as such because
   (a) change occurs only in physical properties
   (b) transfer of energy takes place
   (c) it is a reversible change
   (d) all of these.

Case II : A change in which one or more new substances are formed is called a chemical change. We observe various kinds of chemical changes in our dialy life. In a chemical change, heat, light or any other radiation may be given off. Sound, smell, colour change may occur in a chemical change.

1. Which of the following is a chemical change?
   (a) Melting of ice (b) Boiling of water
   (c) Growing of plant (d) Freezing of water

2. Which of the following statements is correct?
   (a) When coal is burnt, no new substance is produced.
   (b) Rust is not formed in the absence of air or oxygen.
   (c) The fizz that comes out when a soda bottle is opened is due to a chemical change.
   (d) Respiration is a physical process.

3. Change of milk to curd is a
   (a) physical change (b) chemical change
   (c) both physical and chemical change
   (d) neither physical nor chemical change.

4. Chemical change that is accompanied by evolution of heat energy is
   (a) physical chemical change
   (b) exothermic chemical change
   (c) endothermic chemical change
   (d) none of these.

Case III : In a chemical reaction, new products are formed. Burning of coal or burning of any substance is a chemical change. Burning is always accompanied by production of heat. Digestion and photosynthesis are also chemical changes.

1. When magnesium is burnt, heat and light are produced. The burning of magnesium is a
   (a) reversible change
   (b) physical change
   (c) chemical and exothermic change
   (d) chemical and endothermic change.

2. In which of the following situations chemical reaction does not occur?
   (a) Common salt is exposed to air.
   (b) Coal is burnt in air.
   (c) Sodium is placed in water.
   (d) Iron is kept in moist air.

3. What happens to lime water when CO_2 gas is passed through it?
   (a) It turns blue.
   (b) It turns green.
   (c) It turns milky.
   (d) Milkiness disappears.

4. Choose the correct option.
   (a) Cutting a log of wood into pieces is a chemical change.
   (b) Condensation of vapours is not a chemical change.
   (c) Formation of manure from leaves is a physical change.
   (d) Iron pipes coated with zinc get easily rusted.

Case IV : When iron is left outside open, it acquires a film of brownish substance. This substance is called rust and this process is called rusting. Rusting is a chemical change. This is one change that affects iron articles and slowly destroys them.

1. Rusting of iron is a slow change and burning of petrol is a
   (a) physical change
   (b) momentary change
   (c) fast change
   (d) slow change.

2. Rusting of iron requires
   (a) air and sunlight (b) water and soil
   (c) only air (d) moisture and air.

3. Which of the given methods is used to prevent rusting?
   (a) Painting (b) Greasing
   (c) Galvanisation (d) All of these

4. Stainless steel is an alloy and it does not rust. Stainless steel is a mixture of
   (a) iron and carbon only
   (b) carbon and nickel only
   (c) iron, carbon, chromium, nickel and manganese
   (d) carbon, magnesium and nickel.

5. Galvanisation is a process of depositing a layer of which metal over iron sheets?
   (a) Copper (b) Zinc
   (c) Manganese (d) Lead

Case V : Large crystals of pure substances are formed by the process called crystallisation. It is an example of physical change. For crystallisation, first impure substance is dissolved in a selective liquid by heating and kept undisturbed for sometime, then pure crystals are formed.

1. The process of obtaining salt by the evaporation of sea water is called
   (a) crystallisation (b) neutralisation
   (c) galvanisation (d) amalgamation.

2. Crystals of copper sulphate are prepared by the method of
   (a) fractional distillation
   (b) crystallisation
   (c) distillation
   (d) solidification.

3. Which of the following statements is correct about crystallisation?
   (a) The solution used for crystallisation should be unsaturated.
   (b) Impure crystals are formed.
   (c) The solution used for crystallisation should be saturated.
   (d) It is chemical change.

ANSWER KEY

Multiple Choice Questions

1.	(d)	2.	(b)	3.	(a)	4.	(c)	5.	(d)
6.	(d)	7.	(a)	8.	(d)	9.	(d)	10.	(a)
11.	(b)	12.	(c)	13.	(b)	14.	(c)	15.	(a)
16.	(b)	17.	(c)	18.	(d)	19.	(d)	20.	(a)
21.	(b)	22.	(b)	23.	(c)	24.	(a)	25.	(c)
26.	(a)	27.	(b)	28.	(c)	29.	(b)	30.	(a)
31.	(b)	32.	(a)	33.	(c)	34.	(d)	35.	(b)
36.	(b)	37.	(b)	38.	(b)	39.	(a)	40.	(d)
41.	(b)	42.	(a)	43.	(b)	44.	(b)	45.	(c)
46.	(c)	47.	(b)	48.	(a)	49.	(d)	50.	(c)
51.	(c)	52.	(c)	53.	(c)	54.	(c)	55.	(c)
56.	(c)	57.	(a)	58.	(b)	59.	(c)	60.	(a)
61.	(c)	62.	(d)	63.	(d)	64.	(d)	65.	(c)

Match the Following

1.	(b)	2.	(a)	3.	(c)	4.	(d)	5.	(b)

Assertion & Reason Type

1.	(a)	2.	(c)	3.	(b)	4.	(a)	5.	(a)
6.	(c)	7.	(a)	8.	(b)	9.	(a)	10.	(b)

Comprehension Type

Passage I

1.	(a)	2.	(b)	3.	(d)

Passage II

1.	(c)	2.	(b)	3.	(d)

Passage III

1.	(c)	2.	(b)	3.	(b)

Integer/Numerical Value Type

1.	(3)	2.	(4)	3.	(3)	4.	(6)	5.	(4)

Case Based Questions

Case I

1.	(a)	2.	(b)	3.	(b)	4.	(a)

Case II

1.	(c)	2.	(b)	3.	(b)	4.	(b)

Case III

1.	(c)	2.	(a)	3.	(c)	4.	(b)

Case IV

1.	(c)	2.	(d)	3.	(d)	4.	(c)	5.	(b)

Case V

1.	(a)	2.	(b)	3.	(c)

CHAPTER 02

Physical and Chemical Changes

NCERT Section

1. (a) Chemical (b) Physical
(c) Chemical (d) Physical
(e) Physical (f) Chemical

2. (a)False – Cutting a log of wood into pieces is a physical change.
(b) False – Formation of manure from leaves is a chemical change.
(c) True
(d) False – Rust is iron oxide (hydrated).
(e) True – Condensation of steam is a physical change.

3. (a) calcium carbonate
(b) sodium bicarbonate
(c) painting, oiling
(d) physical
(e) chemical

4. It is a chemical change. When baking soda is mixed with lemon juice, a gas carbon dioxide comes out.

5. When a candle burns, first it melts which is a physical change. When the liquid is converted into vapours and mixed with air during burning, a chemical change takes place. Another example of a change in which both physical and chemical changes occur is burning of LPG gas. Liquefied petroleum gas is filled in the cylinder in the form of a liquid. When these liquids come out of the cylinder in the form of vapours, physical change takes place. When these vapours are mixed with air and burn, chemical change takes place.

6. When milk is set to curd, the properties of milk are completely changed and a new product is formed. Curd cannot be converted back to milk, hence it is a chemical change.

7. Burning of wood is a chemical change while cutting it into small pieces is a physical change.

8. A saturated solution of copper sulphate is prepared by dissolving in water and heating it. A small amount of dilute sulphuric acid is added in it to prevent hydrolysis of the solution. Saturated solution is filtered and the filtrate is kept undisturbed for some time. On cooling crystals of copper sulphate are separated from the solution.

9. When an iron surface is painted, iron does not come in contact with air or moisture. Paint acts as a protective layer and prevents exposure of iron to the atmosphere. Since air and water are necessary for rusting, iron does not get rusted if painted.

10. Percentage of moisture is high in coastal areas hence iron objects get both water and air for rusting. In deserts the air is dry and there is no water or moisture in the air hence rusting does not take place as fast as in coastal areas.

11. **(ii) :** Process - A is a physical change while process - B is a chemical change.

12. **(iii) :** Making of biogas and burning of biogas both are chemical changes.

Multiple Choice Questions

1. **(d) :** Ripening of a fruit is a chemical change.

2. **(b) :** Carbon dioxide is produced when vinegar reacts with baking soda.

3. **(a) :** Rusting of iron is an irreversible chemical change.

4. **(c) :** Galvanisation is a process in which iron is coated with a layer of zinc.

5. **(d) :** Burning of a cloth is a chemical change.

6. **(d) :** Painting, alloying and galvanisation are the methods used to prevent rusting.

7. **(a) :** When an iron nail is dipped in copper sulphate solution, iron displaces copper from copper sulphate solution to form iron sulphate which is green in colour.

8. (d) : Magnesium burns in air with dazzling white flame to give magnesium oxide.

9. (d) : The change in which the substance can come back to its original form is called reversible change.

10. (a) : Hydrogen gas burns with a pop sound.

11. (b) : When carbon dioxide reacts with limewater, a new substance calcium carbonate is formed. Hence, it is a chemical change.

12. (c) : Physical changes are not always reversible, *e.g.*, a piece of paper cut into very small pieces or a wood log cut into small pieces is not reversible.

13. (b) : When a substance is dissolved in water, it is a physical change.

14. (c) : The given reaction is an example of displacement reaction.

15. (a) : Crystallisation is the process in which a substance is dissolved in a solvent to get crystals of pure substance.

16. (b) : When the ash formed by burning of magnesium is dissolved in water magnesium hydroxide is formed.

$$\text{Magnesium} + \text{Oxygen} \xrightarrow{\text{Heat}} \underset{\text{(Ash)}}{\text{Magnesium oxide}}$$

$$\text{Magnesium oxide} + \text{Water} \longrightarrow \underset{}{\text{Magnesium hydroxide}}$$

17. (c) : A cut piece of apple turns brown in air due to oxidation hence it is an example of a chemical change.

18. (d) : Crystallisation and melting of ice-cream is a physical change since no new substance is formed.

19. (d) : Salt can be obtained from sea water by evaporation and crystallisation.

20. (a) : When magnesium oxide is dissolved in water, magnesium hydroxide is formed which is a basic solution. It turns red litmus blue.

21. (b) : When curd is mixed with milk, milk changes into curd.

22. (b) : It is a chemical change because a new substance is formed and the change is irreversible.

23. (c) : Burning of magnesium in air is a chemical change.

24. (a) : Rust is hydrated oxide of iron formed by reaction of iron with air in presence of water. Ice is formed by a physical change of freezing water.

25. (c) : There will be no change in the stone in any form hence it is neither physical nor a chemical change.

26. (a) : In a physical change specific property of matter like state can change but there is no change in chemical composition.

27. (b) : Evaporation of salt solution to get salt is a physical change since no new substance is formed.

28. (c) : Rusting is a chemical and irreversible change.

29. (b) : The exposed layer of vegetables reacts with oxygen present in the atmosphere and gets oxidised as a result of which it turns brown.

30. (a) : Magnesium ribbon burns in oxygen to give magnesium oxide.

$$\text{Magnesium} + \text{Oxygen} \longrightarrow \text{Magnesium oxide}$$

31. (b) : In a displacement reaction, a more reactive element displaces a less reactive element from its salt solution.

32. (a) : $\underset{\text{(Solid)}}{\text{Ice}} \xrightarrow{\text{Heat}} \underset{\text{(Liquid)}}{\text{Water}} \xrightarrow{\text{Heat}} \underset{\text{(Gas)}}{\text{Steam}}$

All three are different states of water there is no change in the chemical structure.

33. (c) : During a chemical change, a new substance is formed.

34. (d) : Rusting and burning are irreversible changes. Physical changes are not always irreversible and carbon dioxide turns limewater milky.

35. (b) : Cutting of wood to make furniture is a physical change since there is no change in the composition of wood.

36. (b) : For crystallisation to take place, a solution must be supersaturated.

37. (b) : $\underset{\text{(Blue solution)}}{CuSO_4} + \underset{\text{(Iron nail)}}{Fe} \rightarrow \underset{\text{(Green solution)}}{FeSO_4} + \underset{\text{(Brown-red deposition)}}{Cu}$

38. (b) : Salt solution on evaporation leaves behind salt while water is evaporated.

39. (a) : When an iron spade is left in the moist atmosphere it reacts with oxygen and water to form a brown powder of iron oxide called rust.

40. (d) : When carbon dioxide is passed through limewater, it turns milky due to formation of white precipitate of calcium carbonate.

41. (b) : The other three are examples of endothermic reactions.

42. (a)

43. (b) : Growth of a plant is a chemical, irreversible change; cutting of a tree is a physical, irreversible change; burning of cooking gas is a chemical and physical change; melting of ice is a physical, reversible change.

44. (b) : Browning of sliced brinjal : Chemical, irreversible change; Baking of cake : Chemical, irreversible change.

45. (c) : Ammonium chloride forms white vapours on heating which get deposited on the upper cooler part of test tube.

46. (c) : Production of biogas from animal waste is a chemical change.

47. (b) : Iron and rust are chemically different and zinc coated iron pipes do not rust.

48. (a) : $\underset{\text{Silver bromide}}{2AgBr_{(s)}} \xrightarrow{\text{Sunlight}} \underset{\text{Silver}}{2Ag_{(s)}} + \underset{\text{Bromine}}{Br_{2(g)}}$

49. (d) : The food that we eat is broken down into simpler substances like glucose on digestion. The air we breathe in during respiration oxidises glucose into CO_2 and water with release of heat. As energy is released, the reaction is exothermic.

50. (c) : $\underset{\text{Quick lime}}{CaO_{(s)}} + \underset{\text{Water}}{H_2O_{(l)}} \longrightarrow \underset{\text{Slaked lime}}{Ca(OH)_{2(aq)}} + \text{Heat}$

51. (c) : (ii), (iii), (iv) are physical changes while (i), (v) are chemical changes.

52. (c) : When zinc reacts with dilute sulphuric acid, hydrogen gas is given off. When the burning matchstick is brought near the test tube containing hydrogen gas, hydrogen burns with a pop sound.

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + \underset{(X)}{H_{2(g)}}$

This is a displacement reaction in which Zn displaces hydrogen from the acid.

53. (c) : $\overset{\text{Oxidised}}{\overbrace{Mg_{(s)}}} + \underset{\text{Reduced}}{\underbrace{CuO_{(s)}}} \longrightarrow MgO_{(s)} + Cu_{(s)}$

Both oxidation and reduction reactions are taking place simultaneously, so it is a redox reaction. Magnesium being the more reactive element than copper, displaces copper from its oxide.

54. (c) : Electrolysis of water is a decomposition reaction.

55. (c) : $Zn_{(s)} + 2AgNO_{3(aq)} \rightarrow Zn(NO_3)_{2(aq)} + 2Ag_{(s)}$

$\Rightarrow$ Displacement, Redox reaction

$Ca(OH)_{2(s)} \xrightarrow{\text{Heating}} CaO_{(s)} + H_2O_{(g)}$

$\Rightarrow$ Decomposition reaction

$Cu(NO_3)_{2(aq)} + Na_2S_{(aq)} \longrightarrow 2NaNO_{3(aq)} + CuS_{(s)}\downarrow$

$\Rightarrow$ Precipitation reaction

$H_2SO_{3(aq)} + 2KOH_{(aq)} \longrightarrow K_2SO_{3(aq)} + 2H_2O_{(l)}$

$\Rightarrow$ Neutralization reaction

56. (c) : Depositing a layer of zinc on iron is called galvanisation. Stainless steel does not rust.

57. (a) : A, F are irreversible physical changes; B, D, E are chemical changes and C is a reversible physical change.

58. (b) : Figure 1 : $\underset{(P)}{MgO} + H_2O \longrightarrow \underset{(Q)}{Mg(OH)_2}$

Figure 2 : $\underset{(Y)}{Fe} + \underset{\text{(Blue solution)}}{CuSO_{4(aq)}} \longrightarrow \underset{\text{(Green solution)}}{FeSO_{4(aq)}} + \underset{(X)}{Cu}$

59. (c) : $Fe + \underset{\text{(Blue)}}{CuSO_{4(aq)}} \longrightarrow \underset{\text{(Green)}}{FeSO_{4(aq)}} + Cu$

$Ag + \underset{\text{(Blue)}}{CuSO_4} \longrightarrow$ No reaction

$Au + \underset{\text{(Blue)}}{CuSO_4} \longrightarrow$ No reaction

60. (a) : New substance (salt) is formed in the reaction.

61. (c) : 1 - Breaking of a glass (Physical, irreversible change)
2 - Baking a cake (Chemical, irreversible change)
3 - Burning of LPG in kitchen (Chemical and physical change)

62. (d) : Blue coloured salt, $CuSO_4.5H_2O$ on heating undergoes chemical change, loses water of crystallisation and forms the white coloured salt ($CuSO_4$) and water droplets.

63. (d) : P-(ii) : $\underset{\text{Magnesium oxide}}{MgO} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Magnesium hydroxide}}{Mg(OH)_2}$

Q-(iv): $\underset{\text{Iron}}{Fe} + \underset{\text{Copper sulphate}}{CuSO_4} \longrightarrow \underset{\text{Ferrous sulphate}}{FeSO_4} + \underset{\text{Copper (Brown)}}{Cu}$

R-(viii) : $\underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Lime water}}{Ca(OH)_2} \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3} + \underset{\text{Water}}{H_2O}$

S-(vi) : $\underset{\text{Ozone}}{O_3} \xrightarrow{\text{UV radiations}} \underset{\text{Oxygen}}{O_2} + [O]$

64. (d) : Copper sulphate ($CuSO_4$) is blue in colour whereas iron sulphate ($FeSO_4$) is green in colour.
Iron (Fe) reacts with copper sulphate ($CuSO_4$), forming iron sulphate ($FeSO_4$) and copper (Cu).

$\underset{\substack{\text{Iron}\\(q)}}{Fe} + \underset{\substack{\text{Blue}\\\text{solution}}}{CuSO_4} \longrightarrow \underset{\substack{\text{Green}\\\text{solution}}}{FeSO_4} + \underset{\substack{\text{Brown}\\(s)}}{Cu}$

This is a chemical change which is irreversible in nature, *i.e.*, *r* is chemical, irreversible change. Crystals of copper sulphate are obtained by the process of crystallisation. Thus, process (*p*) is crystallisation.

65. (c) : Portion *R* is in direct contact with salty water which enhances the process of rusting.

Fill in the Blanks

1. Carbon dioxide **2.** Alloying
3. Reversible **4.** Oxidation
5. Irreversible **6.** Evaporation
7. Rust **8.** $Fe_2O_3 \cdot xH_2O$
9. Galvanisation **10.** Chemical
11. Carbon dioxide **12.** Blue, green
13. Magnesium oxide **14.** More, less
15. Physical

True or False

1. True

2. False : The process of separation of crystals from a saturated solution on cooling is called crystallisation.

3. True **4. True**

5. False : Rusting of iron is an irreversible chemical change.

6. False : Crystallisation is a reversible physical change.

7. True

8. False : Carbon dioxide is evolved when baking soda and vinegar react.

9. False : Carbon dioxide turns limewater milky.

10. True

11. False : The blue colour of copper sulphate turns green when iron nail is added to it.

12. True **13. True**
14. True **15. True**

Match the Following

1. (b) **2. (a)** **3. (c)** **4. (d)**

5. (b) : $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)} + Heat$

$Mg_{(s)} + H_2SO_{4(aq)} \longrightarrow MgSO_{4(aq)} + H_{2(g)} + Heat$

$Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \longrightarrow \underset{\text{(Yellow ppt.)}}{PbI_{2(s)}\downarrow} + 2KNO_3$

$K_2Cr_2O_{7(aq)} + H_2SO_{4(aq)} + SO_{2(g)} \longrightarrow Cr_2(SO_4)_{3(aq)} + K_2SO_{4(aq)} + 3H_2O_{(l)}$

Assertion & Reason Type

1. (a) : Rusting can be prevented by cutting contact of iron with water and air.

2. (c) : Physical changes are not always reversible.

3. (b)

4. (a) : In freezing only physical state of water changes from liquid to solid.

5. (a) : Burning of candle involves physical change when the wax melts and chemical change when it burns.

6. (c) : Magnesium hydroxide formed by dissolving magnesium oxide in water is basic in nature hence turns red litmus blue.

7. (a) : Change of state is a physical change.

8. (b)

9. (a) : Fe is oxidised to Fe^{3+} and acts as a reducing agent.

10. (b)

Comprehension Type

PASSAGE-I

1. (a) : Change in state takes place with change in temperature.

2. (b) : Steam is chemically water only. On heating water is converted to steam while on cooling steam is converted to water.

3. (d) : A physical change may involve change in state, shape or size.

PASSAGE-II

1. (c) : Cutting of wood into small pieces is a physical change since there is no change in chemical composition of wood.

2. (b) : Ice and steam are different forms of water.

3. (d) : A chemical change involves change in colour, evolution of a gas, absorption or release of heat.

PASSAGE-III

1. (c) : Rusting is a chemical and irreversible change because a new substance iron oxide or rust is formed from which we cannot obtain original iron.

2. **(b) :** Oxygen and water are two conditions necessary for rusting.

3. **(b) :** Rusting can be prevented by cutting the contact of iron from air and water.

Subjective Problems

Very Short Answer Type

1. Galvanisation

2. Stainless steel is made up mainly of iron but being an alloy, it has lost the ability to rust.

3. Carbon dioxide gas turns limewater milky due to formation of white precipitate of calcium carbonate.

4. No, rusting requires both air and water to take place.

5. Digestion of food is a chemical change.

6. Stainless steel is an alloy of iron made by mixing iron with nickel, chromium and carbon.

7. Burning of magnesium wire is a chemical change.

8. Displacement reaction

9. A change in which one or more new substances are formed is called a chemical reaction.

10. Physical change

11. Crystallisation

12. Chemical change

13. No, crystallisation is a reversible reaction.

14. Burning of candle involves both physical and chemical changes.

15. Bronze is an alloy of copper and tin.

Short Answer Type

1. (a) A physical change in which there is no change in chemical composition of a substance but the original substance cannot be formed is a physical irreversible change.
(b) When a supersaturated solution is left for cooling, crystals of pure substance are separated. The process is known as crystallisation.

2. Evaporation is the process of conversion of a liquid into vapours. When sea water is evaporated, water is converted into vapours and salt is left behind.

3. (i) Chemical change (ii) Chemical change

4. (a) When water is frozen into ice, it is a physical change. It is reversible since ice can be converted to water again. When a piece of wood is cut into very small pieces, it is a physical change. It is irreversible since small pieces of wood cannot be converted back into the bigger piece of wood. It shows that physical changes can be reversible as well as irreversible.

(b) $\underset{\text{Baking soda}}{NaHCO_3} + \underset{\text{Vinegar}}{CH_3COOH} \longrightarrow \underset{\text{Sodium acetate}}{CH_3COONa} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2\uparrow}$

5. (a) When an iron nail is placed in copper sulphate solution, the blue colour of copper sulphate is changed to green ferrous sulphate and iron nail becomes brown due to deposition of copper.
(b) When cut vegetables and fruits are exposed to air, they turn brown due to oxidation.

6. Burning of a substance in the presence of oxygen is called combustion. It is a chemical change. Take a small piece of magnesium ribbon. Hold it with a pair of tongs and heat it on the burner. The magnesium ribbon burns with a dazzling white flame. It forms a powdery ash when it is burnt completely. A new substance is formed after burning magnesium. This powdery ash is known as magnesium oxide.

$$\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen}}{O_2} \rightarrow \underset{\text{Magnesium oxide}}{2MgO}$$

Thus, burning of magnesium in air is a chemical change due to formation of a new substance, magnesium oxide.

7. A chemical equation is the representation of a chemical reaction through symbols and chemical formulae in which number of atoms of each element on the reactant side is equal to that on the product side.
Steps for balancing the chemical equation :
(i) Write down the symbols and formulae of the reactants on the left hand side and those of the products on the right hand side of an arrow.
(ii) Count the atoms of each kind on both sides of the arrow.
(iii) Make the number of atoms of each kind, equal on both sides by using proper coefficients.
For example,

$$\underset{\substack{C=1\\H=4\\O=2}}{CH_4 + O_2} \xrightarrow{\text{Heat}} \underset{\substack{C=1\\H=2\\O=3}}{CO_2 + H_2O} \text{ (Unbalanced equation)}$$

$CH_4 + 2O_2 \xrightarrow{Heat} CO_2 + 2H_2O$ (Balanced equation)

C = 1	C = 1
H = 4	H = 4
O = 4	O = 4

8. (a)Combination (b) Decomposition
(c) Decomposition (d) Displacement

9. When dil. hydrochloric acid is added to calcium carbonate, carbon dioxide gas is evolved. When carbon dioxide gas is passed through a test tube containing lime water, it forms a white solid substance called calcium carbonate. This turns the solution milky.

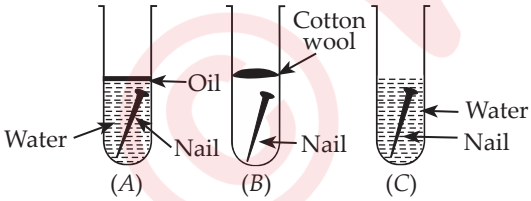
$CaCO_3 + 2HCl_{(dil.)} \rightarrow CaCl_2 + H_2O + CO_2\uparrow$
Calcium carbonate; Hydrochloric acid; Calcium chloride; Water; Carbon dioxide

$Ca(OH)_2 + CO_2\uparrow \rightarrow CaCO_3 + H_2O$
Lime water; Carbon dioxide; Calcium carbonate; Water

10. (a) (i) Spoiling of food (ii) Rusting of iron
(b) (i) Spoiled food when taken cause food poisoning.
(ii) Rusting of iron results in heavy economic loss.
(c) (i) Spoiling of food can be prevented by keeping it under low temperature.
(ii) Rusting of iron can be prevented by oiling, painting and polishing.

Long Answer Type

1. When an iron nail is exposed to dry air, moisture and air or only moisture, it is observed that rusting takes place when air and moisture both are present. In other two cases, rusting does not take place. Take three test tubes and set up the experiment as shown in the figure.



In test tube (*A*), boiled water is taken and the surface is covered with oil so air is not available to the nail.
In test tube (*B*), air is dried by a piece of calcium chloride and it is covered with cotton wool. No moisture is available to the nail.
In test tube (*C*) both air and water are available to the nail.
Rusting takes place only in (*C*) and not in (*A*) or (*B*).

2. (a) Crystallisation is the process of separating pure crystals from a supersaturated solution. To prepare crystals of alum prepare a supersaturated solution of alum in water by heating it. Filter the hot solution and let it stand for some time. Pure crystals of alum separate out.
(b) Displacement reaction is the reaction in which a more reactive metal displaces a less reactive metal from its salt solution, *e.g.*, when iron is placed in copper sulphate solution, iron displaces copper from the solution. It is a chemical reaction since new substance is formed during the reaction.
Iron + Copper sulphate ⟶ Iron sulphate + Copper

3.

	Physical change	Chemical change
(i)	No new substance is formed.	New substance is formed.
(ii)	Change in shape, size or state takes place.	Change in colour or chemical composition takes place.
(iii)	No evolution of heat, gas or smell.	Accompanied by the evolution of heat, gas or smell.
(iv)	Temporary change	Permanent change
(v)	It is easily reversible.	It is usually irreversible.

4. (a) **Exothermic reactions :** Reactions which are accompanied by rise in temperature are those in which heat is evolved such reactions are called exothermic reactions.

e.g., $C + O_2 \rightarrow CO_2 + Heat$
Carbon; Oxygen; Carbon dioxide

(b) **Oxidation reaction :** Oxidation reaction involves addition of oxygen or removal of hydrogen from a substance, *e.g.*, when carbon reacts with oxygen to form carbon dioxide, it is said to be oxidised by gaining oxygen.

$C + O_2 \rightarrow CO_2\uparrow$
Carbon; Oxygen; Carbon dioxide

When hydrogen sulphide reacts with chlorine, hydrogen sulphide is said to be oxidised to sulphur by loss of hydrogen.

$H_2S + Cl_2 \rightarrow S + 2HCl$
Hydrogen sulphide; Chlorine; Sulphur; Hydrogen chloride

(c) **Combination reaction :** In a combination or synthesis reaction, two or more reactants combine to form a product, *e.g.*, nitrogen reacts with hydrogen to form ammonia.

$N_2 + 3H_2 \rightarrow 2NH_3\uparrow$
Nitrogen; Hydrogen; Ammonia

(d) **Reduction reaction :** Reduction reaction involves addition of hydrogen or removal of oxygen from a substance, *e.g.*, when hydrogen is passed over heated black copper oxide, the latter changes to reddish-brown copper metal. Here, copper oxide is said to be reduced to copper by loss of oxygen.

$$\underset{\text{Hydrogen}}{H_2} + \underset{\text{Copper oxide}}{CuO} \rightarrow \underset{\text{Copper}}{Cu} + \underset{\text{Water}}{H_2O}$$

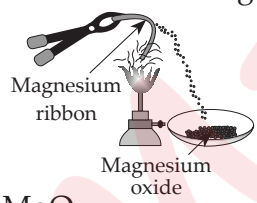
Chlorine reacts with hydrogen in the presence of diffused light to form hydrogen chloride. Chlorine is said to be reduced to hydrogen chloride by gain of hydrogen.

$$\underset{\text{Chlorine}}{Cl_2} + \underset{\text{Hydrogen}}{H_2} \rightarrow \underset{\text{Hydrogen chloride}}{2HCl}$$

(e) **Decomposition reaction :** In a decomposition reaction, single reactant breaks down into two or more simpler products, *e.g.*, when calcium hydroxide is heated, calcium oxide and steam are produced.

$$\underset{\substack{\text{Calcium}\\\text{carbonate}}}{Ca(OH)_2} \xrightarrow{\text{Heat}} \underset{\substack{\text{Calcium}\\\text{oxide}}}{CaO} + \underset{\substack{\text{Water}\\\text{(Steam)}}}{H_2O}$$

5. Take a clean ribbon of magnesium and hold it in a pair of tongs. On burning, it burns with dazzling white flame and converts into a white powder of magnesium oxide. When magnesium oxide is dissolved in water, magnesium hydroxide is formed.



$$\underset{\text{Magnesium}}{Mg} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\substack{\text{Magnesium}\\\text{oxide}}}{MgO}$$

$$\underset{\substack{\text{Magnesium}\\\text{oxide}}}{MgO} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\substack{\text{Magnesium}\\\text{hydroxide}}}{Mg(OH)_2}$$

Integer/Numerical Value Type

1. **(3) :** Properties such as shape, size and state change during a physical change.

2. **(4) :** Four methods namely painting the surface, greasing the surface, galvanisation and alloying prevent rusting.

3. **(3) :** Water can exist in three states : solid, liquid and gas.

4. **(6) :** Six changes namely rusting of iron, burning of magnesium, cooking of rice, burning of LPG, photosynthesis and digestion of food are chemical changes.

5. **(4) :** Four changes namely breaking of an earthen pitcher, falling of trees during storm, rusting of a bicycle and digestion of food are irreversible changes.

Case Based Questions

Case I

1. **(a) :** Ripening of fruit is a slow, desirable and chemical change.

2. **(b) :** Dissolving common salt in water is a physical change while others are chemical changes.

3. **(b) :** Boiling of water can be reversed by condensation process.

4. **(a)**

Case II

1. **(c) :** Growing of plant is a chemical change.

2. **(b) :** Rust is not formed in the absence of air and oxygen. Both air and water are required for rusting.

3. **(b)**

4. **(b) :** When heat is released during the chemical reaction is known as exothermic chemical change.

Case III

1. **(c) :** It is a chemical and exothermic change.

2. **(a) :** When common salt is exposed to air, no chemical reaction takes place.

3. **(c) :** $\underset{}{CO_2} + \underset{\substack{\text{Lime}\\\text{water}}}{Ca(OH)_2} \longrightarrow \underset{\substack{\text{White ppt.}\\\text{(Milky)}}}{CaCO_3\downarrow}$

4. **(b) :** Condensation of vapours is a physical change, not chemical change.

Case IV

1. **(c) :** Burning of petrol is a fast change.

2. **(d) :** Rusting of iron takes place in the presence of air and moisture.

3. **(d)**

4. **(c) :** Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese.

5. **(b)**

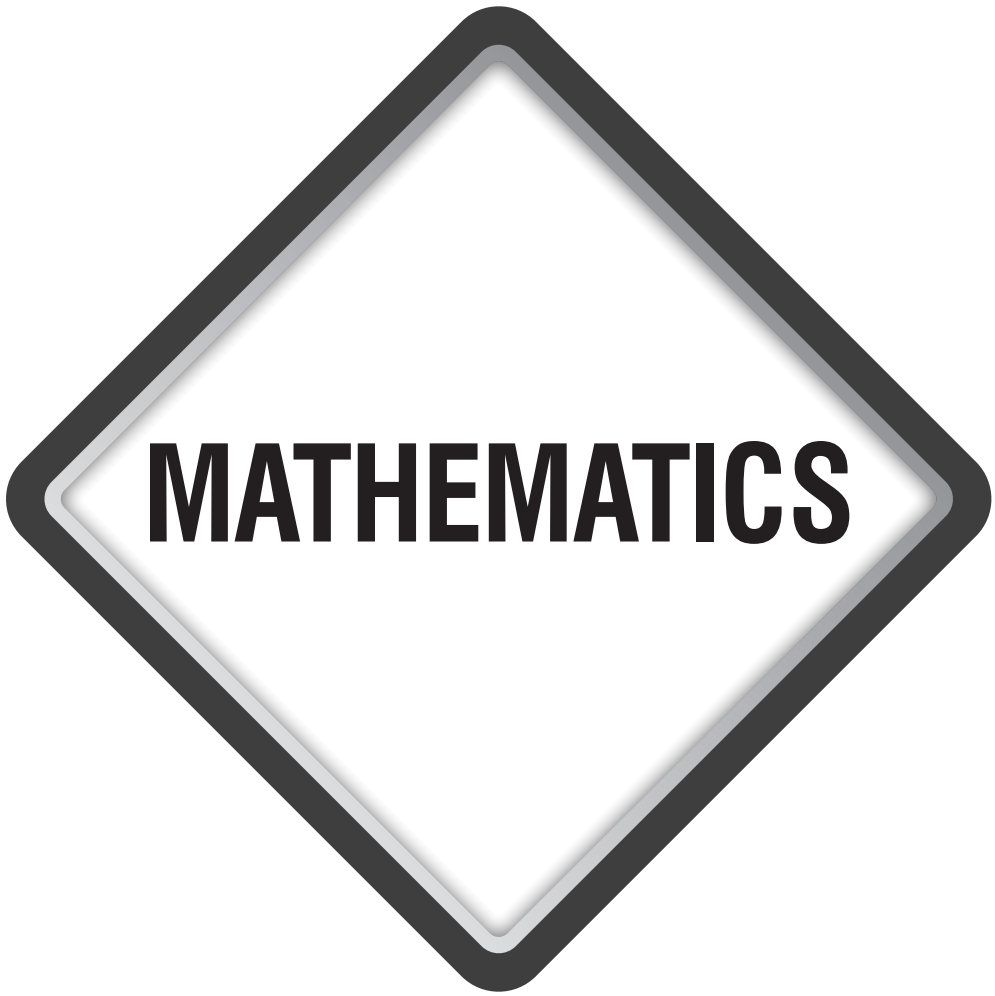
Case V

1. **(a) :** The process of obtaining salt by the evaporation of sea water is called crystallisation.

2. **(b)**

3. **(c) :** Solution must be saturated for crystallisation.

☺☺☺


MATHEMATICS

CHAPTER 06

Cubes and Cube Roots

Learning Outcomes...

- Cube of a Number
- Perfect Cube
- Cubes and their Prime Factors
- Smallest Multiple that is a Perfect Cube
- Properties of Cubes of Numbers
- Cube Roots
- Finding the Cube Roots using Unit Digit Method (For perfect cube numbers)
- Finding the Cube Roots by Prime Factorisation Method
- Cube Root of a Rational Number

Cube of a Number

When a number is multiplied three times by itself, we say that the number has been cubed and the product is called cube of that number or the number raised to the power of 3.
For example : 1 is a number and cube of $1 = 1 \times 1 \times 1 = 1^3$
2 is a number and cube of $2 = 2 \times 2 \times 2 = 2^3$
In general x is a number and cube of $x = x \times x \times x = x^3$
The following table gives the cubes of numbers from 1 to 10.

Number	Cube
1	$1^3 = 1 \times 1 \times 1 = 1$
2	$2^3 = 2 \times 2 \times 2 = 8$
3	$3^3 = 3 \times 3 \times 3 = 27$
4	$4^3 = 4 \times 4 \times 4 = 64$
5	$5^3 = 5 \times 5 \times 5 = 125$
6	$6^3 = 6 \times 6 \times 6 = 216$
7	$7^3 = 7 \times 7 \times 7 = 343$
8	$8^3 = 8 \times 8 \times 8 = 512$
9	$9^3 = 9 \times 9 \times 9 = 729$
10	$10^3 = 10 \times 10 \times 10 = 1000$

Perfect Cube

A number x is said to be a perfect cube if there is an integer y such that $x = y \times y \times y = y^3$.
For example : 216 is a perfect cube as there is an integer 6 such that $216 = 6 \times 6 \times 6 = 6^3$

Cubes and their Prime Factors

Each prime factor appears three or multiple of three times in a perfect cube.
Example : Observe the following table :

Number	Prime Factorisation	Prime factorisation of its cube
2	2	$2^3 = 8 = 2 \times 2 \times 2 = 2^3$
3	3	$3^3 = 27 = 3 \times 3 \times 3 = 3^3$
4	2×2	$4^3 = 64 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^3 \times 2^3$
6	2×3	$6^3 = 216 = 2 \times 2 \times 2 \times 3 \times 3 \times 3 = 2^3 \times 3^3$
9	3×3	$9^3 = 729 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^3 \times 3^3$
15	3×5	$15^3 = 3375 = 3 \times 3 \times 3 \times 5 \times 5 \times 5 = 3^3 \times 5^3$

ILLUSTRATIONS

1 Is 189 a perfect cube or not?

Soln.: Resolving 189 into prime factors, we get

$189 = \underline{3 \times 3 \times 3} \times 7$

3	189
3	63
3	21
7	7
	1

Making triplets, we find that one triplet is formed and we are left with one more factor.
Thus, 189 cannot be expressed as a product of triplets.

Hence, 189 is not a perfect cube.

Smallest Multiple that is a Perfect Cube

To find the smallest number by which a number must be multiplied so that product is a perfect cube and the smallest number by which a number must be divided so that the quotient is a perfect cube.

ILLUSTRATIONS

2 Is 1296 a perfect cube or not? If not, find the smallest natural number by which 1296 must be divided so that the quotient is a perfect cube.

Soln.: $1296 = 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 3$
$= \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 2 \times 3$
Thus, 1296 is not a perfect cube.
The prime factor 6 does not appear in the group of three. Since 2×3 appears only one time, if we divide the number by 6, then we will get a perfect cube.
So, $1296 \div 6 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$
Hence the smallest number by which 1296 should be divided to make it perfect cube is 6.

2	1296
2	648
2	324
2	162
3	81
3	27
3	9
3	3
	1

3 Examine if 1512 is a perfect cube. If not, find the smallest number by which it must be multiplied so that the product is a perfect cube. Also find the smallest number by which it must be divided so that the quotient is a perfect cube.

Soln.: $1512 = 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 7$
Here the prime factor 7 does not occur in a group of three. Hence, 1512 is not a perfect cube. Further, 7 appears only once. If we multiply the number by 7×7, then in the product, 7 will also appear in a group of three and the product will be a perfect cube. Thus, the smallest number by which the given number should be multiplied is 7×7 *i.e.*, 49.
Finally, if we divide the given number 1512 by 7, the resulting number will have prime factors in a group of three. In fact,
$1512 \div 7 = 216 = 2 \times 2 \times 2 \times 3 \times 3 \times 3$. Hence, the smallest number by which the given number should be divided so that quotient is a perfect cube is 7.

Properties of Cubes of Numbers

1. Cubes of all even numbers are even.
2. Cubes of all odd numbers are odd.
3. Cube of a negative number is always negative.

Cubes of the Digits 1 to 9.

x	1	2	3	4	5	6	7	8	9
x^3	1	8	27	64	125	216	343	512	729

COMPETITION WINDOW

- The sum of the cubes of first n natural numbers is equal to the square of their sum.
i.e., $1^3 + 2^3 + ... + n^3 = (1 + 2 + ... + n)^2$
$= \left(\frac{n(n+1)}{2}\right)^2$

From the table we observe that cubes of the digits 1, 4, 5, 6 and 9 are numbers ending in the same digits 1, 4, 5, 6 and 9 respectively. However 2 and 8 make a pair in the sense that the cube of 2 ends in 8 and the cube of 8 ends in 2. Numbers 3 and 7 also make a pair in the same way.

ILLUSTRATIONS

4 Find the cube of (i) 2 (ii) 4 (iii) 6 (iv) 12.

Soln.: (i) Cube of 2 :
$(2)^3 = 2 \times 2 \times 2 = 8$ (Even)
(ii) Cube of 4 :
$(4)^3 = 4 \times 4 \times 4 = 64$ (Even)
(iii) Cube of 6 :
$(6)^3 = 6 \times 6 \times 6 = 216$ (Even)
(iv) Cube of 12 :
$(12)^3 = 12 \times 12 \times 12 = 1728$ (Even)

5 Find the cube of (i) 3 (ii) 9 (iii) 13.

Soln.: (i) Cube of 3 :
$(3)^3 = 3 \times 3 \times 3 = 27$ (odd)
(ii) Cube of 9 :
$(9)^3 = 9 \times 9 \times 9 = 729$ (odd)
(iii) Cube of 13 :
$(13)^3 = 13 \times 13 \times 13 = 2197$ (odd)

6 Find the value of $1^3 + 2^3 + ... + 7^3$.

Soln.: $1^3 + 2^3 + ... + 7^3 = (1 + 2 + ... + 7)^2$

$$= \left(\frac{7(7+1)}{2}\right)^2 = (7 \times 4)^2 = (28)^2 = 784$$

7 Write the digits in the unit place for the cube of each of the given numbers :

(i) 21 (ii) 35 (iii) 69 (iv) 22
(v) 98 (vi) 83 (vii) 27

Soln.: (i) 21; Unit digit of $2\underline{1}$ is 1.
∴ The digit in the unit place for its cube is also 1.
$(21)^3 = 21 \times 21 \times 21 = 926\underline{1}$
(ii) 35; Unit digit of $3\underline{5}$ is 5.
∴ The digit in the unit place for its cube is also 5.
$(35)^3 = 35 \times 35 \times 35 = 4287\underline{5}$.
(iii) 69; Unit digit of $6\underline{9}$ is 9.
∴ The digit in the unit place for its cube is also 9.
$(69)^3 = 69 \times 69 \times 69 = 328509$
(iv) 22; Unit digit of $2\underline{2}$ is 2.
∴ The digit in the unit place for its cube is 8.
$(22)^3 = 22 \times 22 \times 22 = 1064\underline{8}$
(v) 98; Unit digit of $9\underline{8}$ is 8.
∴ The digit in the unit place for its cube is 2.
$(98)^3 = 98 \times 98 \times 98 = 941192$
(vi) 83; The digit in the unit place of $8\underline{3}$ is 3.
∴ The digit in the unit place for its cube is 7.
$(83)^3 = 83 \times 83 \times 83 = 571787$
(vii) 27; The digit in the unit place of $2\underline{7}$ is 7.
∴ The digit in the unit place for its cube is 3.
$(27)^3 = 27 \times 27 \times 27 = 19683$

Cube Roots

Finding the cube root is the inverse operation of finding cube. The symbol $\sqrt[3]{\ }$ denotes 'cube root'. Consider the following :

Statement : Cube	Inference : Cube root
$1^3 = 1$	$\sqrt[3]{1} = 1$
$2^3 = 8$	$\sqrt[3]{8} = 2$
$3^3 = 27$	$\sqrt[3]{27} = 3$
$4^3 = 64$	$\sqrt[3]{64} = 4$
$5^3 = 125$	$\sqrt[3]{125} = 5$
$6^3 = 216$	$\sqrt[3]{216} = 6$
$7^3 = 343$	$\sqrt[3]{343} = 7$
$8^3 = 512$	$\sqrt[3]{512} = 8$
$9^3 = 729$	$\sqrt[3]{729} = 9$
$10^3 = 1000$	$\sqrt[3]{1000} = 10$

Methods for Finding the Cube Roots

(i) Using unit digit method (For perfect cube numbers)

(ii) Prime factorisation method

Using Unit Digit Method (For perfect cube numbers)

Step I : Look at the digit at the unit's place and determine the digit at the unit's place in the cube root by using the table given in properties of cubes of numbers.

Step II : Strike out from the right, last three digits (unit's, ten's and hundred's) of the number. If no digit(s) is (are) left, then the digit obtained in Step I is the required cube root. Otherwise go to next step.

Step III : Consider the number left from step II. Find the number whose cube is less than or equal to this left over number. This number is the ten's digit of the cube root.

Step IV : Obtain the required cube root by forming a number whose unit digit is the number obtained in step I and ten's digit is the number obtained in step III.

ILLUSTRATIONS

8 Find the cube roots of the following numbers:

(i) 4096 (ii) 857375.

Soln.: (i) **Step 1 :** The unit's digit of 4096 is 6. Therefore, the digit at the unit's place in the cube root is 6.

Step 2 : Group 4096; two groups are 4 & 096.

Step 3 : Choose a number whose cube is less than 4.

$\because \quad 1^3 = 1$ and $2^3 = 8$

$\therefore 1 < 4 < 8 \Rightarrow 1^3 < 4 < 2^3$

Hence 1 is ten's place digit $\therefore \sqrt[3]{4096} = 16$

(ii) The given number is 857375.

Step 1 : The unit's digit of 857375 is 5. Therefore, unit's digit of its cube root is also 5.

Step 2 : Group 857375; two groups are 857 & 375.

Step 3 : Choose a number whose cube is less than 857.

$\because \quad 9^3 = 729$ and $10^3 = 1000$ and $729 < 857 < 1000$

$\Rightarrow 9^3 < 857 < 10^3 \Rightarrow 9$ is ten's place digit.

Hence, $\sqrt[3]{857375} = 95$

Prime Factorisation Method

In order to find the cube root of a perfect cube by prime factorisation method, we follow the following procedure.

Step I : Obtain the given number.

Step II : Resolve it into prime factors.

Step III : Group the factors into triplets such that all the three factors in each triplet are same.

Step IV : If no factor is left ungrouped, choose one factor from each group and take the product. The product is cube root of number. If some prime factors are left ungrouped, the number is not a perfect cube and the process stops.

ILLUSTRATIONS

9 Find the cube root of the following :

(a) 4913 (b) 19683

Soln.: (a) Resolving the given number into prime factors, we get $4913 = 17 \times 17 \times 17$

17	4913
17	289
17	17
	1

So, $\sqrt[3]{4913} = 17$

(Taking one factor from triplet)

(b) Resolving 19683 into prime factors, we get

$19683 = \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3}$

$\sqrt[3]{19683} = 3 \times 3 \times 3$

(Taking one factor from each triplet)

$\therefore \sqrt[3]{19683} = 27$

3	19683
3	6561
3	2187
3	729
3	243
3	81
3	27
3	9
3	3
	1

Cube Root of Product of Integers

We have, $\sqrt[3]{ab} = \sqrt[3]{a} \times \sqrt[3]{b}$.

ILLUSTRATIONS

10 Evaluate : $\sqrt[3]{125 \times 64}$

Soln.: We have,

$\sqrt[3]{125 \times 64} = \sqrt[3]{125} \times \sqrt[3]{64}$

$= \sqrt[3]{5 \times 5 \times 5} \times \sqrt[3]{4 \times 4 \times 4}$

$= (5 \times 4) = 20$

11 Evaluate : $\sqrt[3]{216 \times (-343)}$

Soln.: We have,

$\sqrt[3]{216 \times (-343)} = \sqrt[3]{216} \times \sqrt[3]{-343} = \sqrt[3]{216} \times (-\sqrt[3]{343})$

$= -\sqrt[3]{6 \times 6 \times 6} \times \sqrt[3]{7 \times 7 \times 7}$

$= -[6 \times 7] = -42$

Cube Root of a Rational Number

The cube root of a rational number $\frac{a}{b}$, $(b \neq 0)$, is given by $\sqrt[3]{\frac{a}{b}} = \frac{\sqrt[3]{a}}{\sqrt[3]{b}}$, where a, b are integers.

ILLUSTRATIONS

12 Evaluate : (i) $\sqrt[3]{\frac{216}{2197}}$ (ii) $\sqrt[3]{\frac{-125}{512}}$

Soln.: We have

(i) $\sqrt[3]{\frac{216}{2197}} = \frac{\sqrt[3]{216}}{\sqrt[3]{2197}} = \frac{\sqrt[3]{6 \times 6 \times 6}}{\sqrt[3]{13 \times 13 \times 13}} = \frac{6}{13}$

(ii) $\sqrt[3]{\frac{-125}{512}} = \frac{\sqrt[3]{-125}}{\sqrt[3]{512}} = \frac{-\sqrt[3]{125}}{\sqrt[3]{512}} = \frac{-\sqrt[3]{5 \times 5 \times 5}}{\sqrt[3]{8 \times 8 \times 8}} = \frac{-5}{8}$

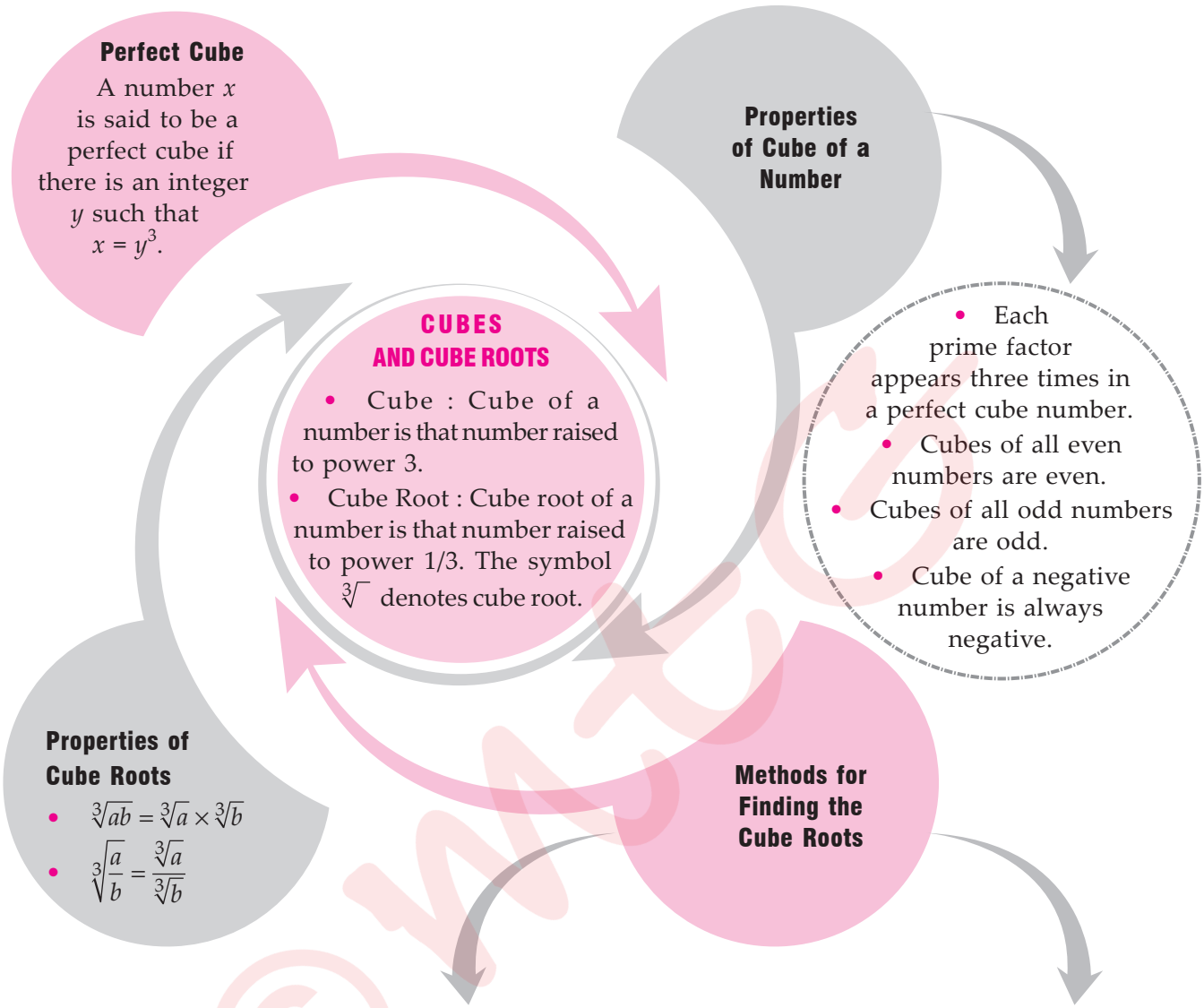
13 Evaluate : $\frac{\sqrt[3]{15625 \times 216}}{\sqrt[3]{3375}}$

Soln.: We have $\frac{\sqrt[3]{15625} \times \sqrt[3]{216}}{\sqrt[3]{3375}}$

$= \frac{\sqrt[3]{25 \times 25 \times 25} \times \sqrt[3]{6 \times 6 \times 6}}{\sqrt[3]{15 \times 15 \times 15}}$

$= \frac{25 \times 6}{15} = 10$

CONCEPT MAP



Unit Digit Method (For Perfect Cube Numbers)

Step I : Look at the digit at the unit's place and determine the digit at the unit's place in the cube root by using the table given in properties of cubes of numbers.

Step II : Strike out from the right, last three digits (unit's, ten's and hundred's) of the number. If no digit(s) is (are) left, then the digit obtained in Step I is the required cube root. Otherwise go to next step.

Step III : Consider the number left from step II. Find the number whose cube is less than or equal to this left over number. This number is the ten's digit of the cube root.

Step IV : Obtain the required cube root by forming a number whose unit's digit is the number obtained in step I and ten's digit is the number obtained in step III.

Prime Factorisation Method

Step I : Resolve the given number into prime factors.

Step II : Group the prime factors into triplets such that all the three prime factors in each triplet are same.

Step III : If no prime factor is left ungrouped, choose one prime factor from each group and take the product. The product is cube root of the given number. If some prime factors are left ungrouped, then the number is not a perfect cube and the process stops.

Solved Examples

1. Is 53240 a perfect cube? If not, then by which smallest natural number should 53240 be divided so that the quotient is a perfect cube?

Soln.: $53240 = 2 \times 2 \times 2 \times 11 \times 11 \times 11 \times 5$

The prime factor 5 does not appear in a group of three. So 53240 is not a perfect cube. To get rid of this extra five we divide the number by 5. So factorisation of the quotient will not contain 5.

2	53240
2	26620
2	13310
11	6655
11	605
11	55
5	5
	1

So, $53240 \div 5 = \underline{2 \times 2 \times 2} \times \underline{11 \times 11 \times 11}$

Hence the smallest number by which 53240 should be divided to make it a perfect cube is 5.

The perfect cube in that case is = 10648.

2. Is 246 a perfect cube ?

Soln.: Resolving 246 into prime factors, we have $246 = 2 \times 3 \times 41$

2	246
3	123
	41

Clearly, we cannot group the factors in the triplets.

Therefore, 246 is not a perfect cube.

3. Is 1331 a perfect cube ?

Soln.: Resolving 1331 into prime factors, we get

$1331 = \underline{11 \times 11 \times 11}$

We find that prime factors of 1331 can be grouped into triplets of equal factors (as shown above) and no factor is left.

$\therefore$ 1331 is a perfect cube.

4. Is 68600 a perfect cube ? If not, find the smallest number by which 68600 must be multiplied to get a perfect cube.

Soln.: We have, $68600 = \underline{2 \times 2 \times 2} \times 5 \times 5 \times \underline{7 \times 7 \times 7}$.

2	68600
7	34300
7	4900
7	700
2	100
2	50
5	25
5	5
	1

In this factorisation we find that there is no triplet of 5.

So, 68600 is not a perfect cube. To make it a perfect cube we multiply it by 5 to complete the triplet of 5.

Thus, $68600 \times 5 = \underline{2 \times 2 \times 2} \times \underline{5 \times 5 \times 5} \times \underline{7 \times 7 \times 7}$

= 343000, which is a perfect cube.

5. Prove that if a number is doubled, then its cube is eight times the cube of the given number.

Soln.: Let the given number be a. Let b denote the double of a *i.e.*, $b = 2a$. Then,

$b^3 = b \times b \times b = 2a \times 2a \times 2a = 2 \times 2 \times 2 \times a \times a \times a = 8 \times a \times a \times a = 8 \times a^3$

$\Rightarrow b^3 = 8\times$ (Cube of a).

6. Evaluate: $\{(24^2 + 7^2)^{1/2}\}^3$

Soln.: We have,

$$\{(24^2 + 7^2)^{1/2}\}^3 = \{(576 + 49)^{1/2}\}^3 = \left\{\sqrt{625}\right\}^3$$

$$= \left\{\sqrt{25 \times 25}\right\}^3 = 25^3 = 25 \times 25 \times 25 = 15625$$

7. Find the cube root of $\sqrt[3]{392} \times \sqrt[3]{448}$.

Soln.: Resolving 392 and 448 into prime factors

Now,

$$\sqrt[3]{392} \times \sqrt[3]{448} = \sqrt[3]{392 \times 448}$$

$$= \sqrt[3]{2 \times 2 \times 2 \times 7 \times 7 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 7}$$

$$= \sqrt[3]{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 7 \times 7 \times 7}$$

$$= 2 \times 2 \times 2 \times 7 = 56$$

2	392
2	196
2	98
7	49
7	7
	1

2	448
2	224
2	112
2	56
2	28
2	14
7	7
	1

8. Is $\frac{27}{125}$ a cube of a rational number ?

Soln.: We have, $\frac{27}{125} = \frac{3 \times 3 \times 3}{5 \times 5 \times 5}$

$$\Rightarrow \frac{27}{125} = \frac{3^3}{5^3} = \left(\frac{3}{5}\right)^3$$

$\therefore \frac{27}{125}$ is cube of $\frac{3}{5}$ *i.e.*, a rational number.

9. Is 1728 a perfect cube ? If yes, find its cube root.

Soln.: Resolving 1728 into prime factors, we have $1728 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 3$

2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
3	3
	1

Grouping the factors in triplets of equal factors, we get

$1728 = \{2 \times 2 \times 2\} \times \{2 \times 2 \times 2\} \times \{3 \times 3 \times 3\}$

We find that the prime factors of 1728 can be grouped into triplets of equal

factors and no factor is left over.

$\therefore$ 1728 is a perfect cube.

Taking one factor from each triplet, we obtain

$\sqrt[3]{1728} = 2 \times 2 \times 3 = 12$

Hence, 1728 is the cube of 12.

10. Find the cube root of 1.331.

Soln.: We have, $1.331 = \frac{1331}{1000}$

$$\therefore \sqrt[3]{1.331} = \sqrt[3]{\frac{1331}{1000}} = \frac{\sqrt[3]{1331}}{\sqrt[3]{1000}} = \frac{11}{10} = 1.1$$

11. Observe the following pattern.

$1^3 = 1$

$1^3 + 2^3 = (1 + 2)^2$

$1^3 + 2^3 + 3^3 = (1 + 2 + 3)^2$

Write the next three rows and calculate the value of $1^3 + 2^3 + 3^3 + \ldots\ldots\ldots\ldots + 9^3 + 10^3$ by above pattern.

Soln.: If we observe the above pattern, the next three rows can be written as follows -

$1^3 + 2^3 + 3^3 + 4^3 = (1 + 2 + 3 + 4)^2$

$1^3 + 2^3 + 3^3 + 4^3 + 5^3 = (1 + 2 + 3 + 4 + 5)^2$

$1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 = (1 + 2 + 3 + 4 + 5 + 6)^2$

The value of $1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 + 7^3 + 8^3 + 9^3 + 10^3$

$= (1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10)^2$

$$= \left[\frac{10(10 + 1)}{2}\right]^2 = [5 \times 11]^2 = (55)^2 = 3025$$

12. Find the volume of a cube whose surface area is 150 m^2.

Soln.: Let the length of each edge of the given cube be x metres. Then,

Surface area = 150 m^2

$$\Rightarrow 6x^2 = 150 \Rightarrow x^2 = \frac{150}{6} = 25 \Rightarrow x = \sqrt{25} = 5 \text{ m}$$

$\therefore$ Volume of the cube = $x^3 = 5^3$ cubic metres

= (5 × 5 × 5) cubic metres = 125 cubic metres.

13. For a big icecream of volume 2744 cm^3, Mukti wants to make a box. What should be the edge of box so that the block can be put into it?

Soln.: Volume of box = 2744 cm^3

Let edge of the box = x cm

2	2744
2	1372
2	686
7	343
7	49
7	7
	1

$\therefore$ $x^3 = 2744 \Rightarrow x = \sqrt[3]{2744}$

$$\Rightarrow x = \sqrt[3]{2 \times 2 \times 2 \times 7 \times 7 \times 7} = 2 \times 7 = 14$$

$\therefore$ Edge of the box = 14 cm.

14. Consider the following pattern :

$2^3 - 1^3 = 1 + 2 \times 1 \times 3$

$3^3 - 2^3 = 1 + 3 \times 2 \times 3$

$4^3 - 3^3 = 1 + 4 \times 3 \times 3$.

Find the value of $12^3 - 11^3$, using the above pattern.

Soln.: $12^3 - 11^3 = 1 + 12 \times 11 \times 3 = 1 + 396 = 397$

15. Find the value of $(27 \times 2744)^{1/3}$.

Soln.: $(27 \times 2744)^{1/3} = \sqrt[3]{27} \times \sqrt[3]{2744} = 3 \times 14 = 42$

16. Evaluate : $\sqrt[3]{27} + \sqrt[3]{0.008} + \sqrt[3]{0.064}$ *(NCERT Exemplar)*

Soln.: We have, $\sqrt[3]{27} + \sqrt[3]{0.008} + \sqrt[3]{0.064}$

$27 = 3 \times 3 \times 3 = 3^3$

$$\Rightarrow \sqrt[3]{27} = 3 \; ; \; 0.008 = \frac{8}{1000}$$

And $8 = 2 \times 2 \times 2 = 2^3$

$\Rightarrow \sqrt[3]{8} = 2$

Also, $1000 = 2 \times 2 \times 2 \times 5 \times 5 \times 5 = (2 \times 5)^3$

$\Rightarrow \sqrt[3]{1000} = 2 \times 5 = 10$

$$\therefore \sqrt[3]{0.008} = \frac{\sqrt[3]{8}}{\sqrt[3]{1000}} = \frac{2}{10} = 0.2$$

$0.064 = \frac{64}{1000}$

And $64 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = (2 \times 2)^3$

$\Rightarrow \sqrt[3]{64} = 2 \times 2 = 4$

And $1000 = 2 \times 2 \times 2 \times 5 \times 5 \times 5 = (2 \times 5)^3$

$\Rightarrow \sqrt[3]{1000} = 2 \times 5 = 10$

$$\therefore \sqrt[3]{0.064} = \frac{\sqrt[3]{64}}{\sqrt[3]{1000}} = \frac{4}{10} = 0.4$$

Thus, $\sqrt[3]{27} + \sqrt[3]{0.008} + \sqrt[3]{0.064}$

$= 3 + 0.2 + 0.4 = 3.6$

17. Evaluate : $\left\{\left(6^2 + (8^2)^{\frac{1}{2}}\right)\right\}^3$ *(NCERT Exemplar)*

Soln.: We have, $\left\{\left(6^2 + (8^2)^{\frac{1}{2}}\right)\right\}^3$

$6^2 = 36$

$8^2 = 64$

$\Rightarrow \sqrt{64} = 8$

$\therefore (8^2)^{\frac{1}{2}} = \sqrt{64} = 80$

Now, $\left\{\left(6^2 + (8^2)^{\frac{1}{2}}\right)\right\}^3 = (36 + 8)^3$

$= (44)^3 = 85184$

18. Is 9720 a perfect cube? If not, find the smallest number by which it should be divided to get a perfect cube. *(NCERT Exemplar)*

Soln.: No, 9720 = $\underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 3 \times 3 \times 5$, all the prime factors of 9720 does not appear in the group of three. 9720 is not a perfect cube.

We find that 9720 should be divided by $3 \times 3 \times 5$ *i.e,* 45, to get a perfect cube.

$9720 \div 45 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

= 216, which is a perfect cube.

NCERT Section

Exercise 6.1

1. Which of the following numbers are not perfect cubes?

(i) 216 (ii) 128 (iii) 1000 (iv) 100

(v) 46656.

2. Find the smallest number by which each of the following numbers must be multiplied to obtain a perfect cube.

(i) 243 (ii) 256 (iii) 72 (iv) 675

(v) 100.

3. Find the smallest number by which each of the following numbers must be divided to obtain a perfect cube.

(i) 81 (ii) 128 (iii) 135 (iv) 192

(v) 704.

4. Parikshit makes a cuboid of plasticine of sides 5 cm, 2 cm, 5 cm. How many such cuboids will he need to form a cube?

Exercise 6.2

1. Find the cube root of each of the following numbers by prime factorisation method.

(i) 64 (ii) 512 (iii) 10648 (iv) 27000

(v) 15625 (vi) 13824 (vii) 110592 (viii) 46656

(ix) 175616 (x) 91125.

2. State true or false.

(i) Cube of any odd number is even.

(ii) A perfect cube does not end with two zeros.

(iii) If square of a number ends with 5, then its cube ends with 25.

(iv) There is no perfect cube which ends with 8.

(v) The cube of a two digit number may be a three digit number.

(vi) The cube of a two digit number may have seven or more digits.

(vii)The cube of a single digit number may be a single digit number.

Exercise

Multiple Choice Questions

LEVEL - 1

1. Which of the following numbers is a perfect cube?
(a) 1525 (b) 1728
(c) 1458 (d) 3993 U

2. Which of the following numbers is not a perfect cube?
(a) 2197 (b) 512
(c) 2916 (d) 343 U

3. What least number must be multiplied to 3456 so that the product becomes a perfect cube?
(a) 2 (b) 3 (c) 4 (d) 6

4. $\sqrt[3]{5832}$ =
(a) 22 (b) 18
(c) 16 (d) 14 Ev

5. Evaluate : $\sqrt[3]{\frac{1728}{2744}}$
(a) 6/11 (b) 6/7
(c) 3/4 (d) 12/17 Ev

6. $\sqrt[3]{4\frac{12}{125}}$ equals
(a) $1\frac{3}{5}$ (b) $1\frac{2}{5}$ (c) $7\frac{1}{5}$ (d) $7\frac{2}{3}$

7. $\sqrt[3]{144} \times \sqrt[3]{12}$ equals
(a) 12 (b) 14 (c) 13 (d) 6 Ev

8. Possible unit digit of cube root of a number ending with 5 is
(a) 0 (b) 5 (c) 7 (d) 9 R

9. The surface area of a cube is 216 cm^2. What is its volume?
(a) 1296 cm^3 (b) 648 cm^3
(c) 864 cm^3 (d) 216 cm^3 Ap

10. If $(125)^x$ = 3125, then x equals
(a) 3/5 (b) 5/3 (c) 1/4 (d) 1/5

11. By what least number should 9720 be multiplied to get a perfect cube?
(a) 15 (b) 25 (c) 5 (d) 75 Ap

12. If $\sqrt[3]{(156+x)} = 12$, then the value of x is
(a) 1570 (b) 1572 (c) 1560 (d) 1512

13. The value of $\frac{\sqrt[3]{531441}}{\sqrt[3]{729}}$ is
(a) 7 (b) 8 (c) 9 (d) 10 Ev

14. If $\sqrt[3]{x-12} = 19$, then the value of x is
(a) 6871 (b) 6072 (c) 6889 (d) 5080

15. The value of $(-0.4)^3$ is
(a) 0.640 (b) 0.064
(c) – 0.064 (d) – 0.640 Ev

16. $3^3 - (-0.6)^3$ =
(a) 27.216 (b) 26.784
(c) –26.784 (d) –27.216 Ev

17. $\frac{16}{9} \times \left(-1\frac{1}{2}\right)^3$ =
(a) –12 (b) – 6 (c) –8/3 (d) 8/9

18. Which of the following is the cube of an integer?
(a) 200 (b) 9
(c) 512 (d) 1024 R

19. $\sqrt[3]{3-\frac{17}{27}}$ =
(a) 4/3 (b) 3/4
(c) 1/4 (d) 1/3 Ev

20. $\sqrt[3]{0.125} + 3$ =
(a) 8 (b) 3.5 (c) 2 (d) 0.35

21. $\sqrt[3]{3\frac{3}{8}}$ =
(a) 3/2 (b) 3/4
(c) 1/4 (d) 1/2 Ev

22. Calculate the value of $\sqrt[3]{64} + \sqrt{9^2}$.
(a) 4 (b) 3
(c) 13 (d) 77 Ev

23. Calculate the value of $\sqrt[3]{\frac{192}{81}}$.
(a) 5/3 (b) 4/3 (c) 3/2 (d) 13/9

24. $\sqrt[3]{2744} + \sqrt{9^2}$ =
(a) 0 (b) 21 (c) 23 (d) 5/2

25. Find the value of $\sqrt[3]{512} \times \sqrt[3]{3.375}$.

(a) 12 (b) 9.5
(c) 8 (d) 1.5 Ev

26. Which of the following is the cube of a negative number?

(a) –396 (b) 4096
(c) –81 (d) –2744 Ap

27. Which of the following numbers is the cube of an odd number?

(a) 79507 (b) 2744
(c) 32768 (d) 1728 U

28. Which of the following numbers is the cube of an even number?

(a) 6859 (b) 648
(c) 13824 (d) 42875 U

29. The symbol $\sqrt[3]{\ }$ denotes

(a) square (b) cube
(c) square root (d) cube root R

30. Which of the following is equal to 9?

(a) $\sqrt{729}$ (b) $3\sqrt{729}$
(c) $\sqrt[3]{729}$ (d) $(3)^3$ R

31. Find the smallest number by which 392 must be multiplied so that the product is a perfect cube.

(a) 5 (b) 3 (c) 2 (d) 7 Ap

32. Find the cube of $7\frac{2}{5}$.

(a) $\frac{50653}{125}$ (b) $\frac{50652}{125}$
(c) $\frac{50659}{125}$ (d) $\frac{50658}{125}$

33. The volume of a cube is 778688 mm^3. Find the measure of its edge.

(a) 62 mm (b) 72 mm
(c) 82 mm (d) 92 mm An

34. The cube root of 97336 is

(a) 17 (b) 18 (c) 46 (d) 23 Ev

35. Find the side of a cube whose volume is $\frac{1331}{216}$ m^3.

(a) $\frac{11}{6}$m (b) $\frac{11}{4}$m
(c) $\frac{9}{7}$m (d) $\frac{9}{4}$m An

LEVEL - 2

36. What is the least number by which 13720 must be divided so that the quotient is a perfect cube?

(a) 2 (b) 3
(c) 5 (d) 6 Ap

37. $\sqrt[3]{0.000064}$ equals

(a) 0.04 (b) 0.4 (c) 0.004 (d) 0.02

38. The value of $\frac{(2.3)^3 - 0.027}{(2.3)^2 + 0.69 + 0.09}$ is

(a) 2 (b) 2.273
(c) 2.327 (d) none of these Ev

39. The value of $\frac{\sqrt[3]{125} \times \sqrt[3]{64}}{\sqrt[3]{125} - \sqrt[3]{64}}$ is

(a) 30 (b) 40 (c) 20 (d) 50

40. The value of $\frac{\sqrt[3]{8} + \sqrt[3]{27} - \sqrt[3]{343}}{(2)^2 - 3}$ is

(a) 7 (b) – 2
(c) 8 (d) – 5 Ev

41. Observe the pattern given below

$1^3 = 1$
$2^3 = 3 + 5$
$3^3 = 7 + 9 + 11$
$4^3 = 13 + 15 + 17 + 19$
$5^3 = 21 + 23 + 25 + 27 + 29$

According to this pattern, the number of consecutive odd numbers whose sum equals 9^3 is

(a) 3 (b) 9
(c) 12 (d) 15 Cr

42. Evaluate : $\sqrt[3]{57\frac{132}{343}}$

(a) $\frac{27}{7}$ (b) $\frac{23}{7}$
(c) $\frac{23}{5}$ (d) $\frac{27}{8}$ Ev

43. The volume of a cubical box is 474.552 m^3. Find the length of each side of the box.

(a) 9.8 m (b) 7.8 m
(c) 7.4 m (d) 9.4 m An

44. The one's digit of 107^3 is

(a) 3 (b) 7 (c) 9 (d) 0 U

45. Evaluate : $\sqrt[3]{27} + \sqrt[3]{0.008}$

(a) 3.4 (b) 3.1 (c) 3.3 (d) 3.2

46. Evaluate : $\sqrt[3]{\sqrt{0.000729}}$

(a) 0.2 (b) 0.3
(c) 0.5 (d) 0.4 Ev

47. Find the smallest number which should be multiplied by 1575 so that the product becomes a perfect cube.

(a) 315 (b) 105
(c) 735 (d) 147 Ap

48. The value of $\sqrt[3]{\frac{343}{1331}}$ is

(a) $\frac{7}{5}$ (b) $\frac{7}{11}$ (c) $\frac{5}{11}$ (d) $\frac{11}{7}$

49. The smallest number by which 33075 must be multiplied to obtain a perfect cube is

(a) 12 (b) 35
(c) 6 (d) 15 Ap

50. Evaluate : $\sqrt[3]{32.768}$

(a) 3.2 (b) 4.2
(c) 5.2 (d) 1.2 Ev

LEVEL - 3 (HOTS)

Competency Focused Questions (CFQs)

51. Simplify: $\left(\sqrt[6]{27}-\sqrt{6\frac{3}{4}}\right)^2$

(a) $\frac{3}{4}$ (b) $\frac{\sqrt{3}}{2}$ (c) $\frac{3\sqrt{3}}{4}$ (d) $\frac{3}{2}$

52. By what least number 3600 must be divided to make it a perfect cube?

(a) 9 (b) 50
(c) 300 (d) 450 Ap

53. The value of $\sqrt{\frac{0.00001225}{0.00005329}}-\sqrt[3]{0.000064}$ is

(a) 0.2 (b) 0.279 (c) 0.479 (d) 0

54. Evaluate : $\sqrt[3]{\frac{-0.000008}{-0.000216}}$

(a) 3 (b) –1/3
(c) –3 (d) 1/3 Ev

55. Evaluate : $\sqrt[3]{0.008}-\sqrt[3]{-512}+\sqrt[3]{2.197}$

(a) 9.3 (b) –6.5 (c) 9.5 (d) 6.5

56. $\frac{3\sqrt[3]{13824}}{2\sqrt[3]{-15625}}\div\frac{2\sqrt[3]{-13824}}{\sqrt[3]{5832}}=$

(a) $\frac{50}{27}$ (b) $\frac{-50}{27}$
(c) $\frac{27}{50}$ (d) $\frac{-27}{50}$ Ev

57. Cube root of a number when divided by the smallest prime number gives square of the smallest prime number. Find the number.

(a) 512 (b) 8
(c) 64 (d) 125 Ap

58. If a number has digit 2 at unit place, then its cube has digit ____ at its unit place.

(a) 1 (b) 2 (c) 8 (d) 4 U

59. Which of the following is incorrect?

(a) The cube of an even natural number is always even.

(b) The cube root of a rational number $\frac{x}{y}$ is $\frac{\sqrt[3]{x}}{\sqrt[3]{y}}$.

(c) The cube of a negative number is always positive.

(d) 2197 is a perfect cube.

60. $\sqrt[3]{1-\frac{127}{343}}$ is equal to

(a) $\frac{5}{9}$ (b) $1-\frac{1}{7}$ (c) $\frac{4}{7}$ (d) $1-\frac{2}{7}$

61. If $\sqrt[3]{\frac{x}{729}}+\sqrt[3]{\frac{8x}{729}}+\sqrt[3]{\frac{27x}{5832}}=1$, then find the value of x.

(a) 1 (b) 8 (c) 3 (d) 4 Ev

62. $\left(\sqrt[3]{3}+\sqrt[3]{2}\right)\left(\sqrt[3]{9}+\sqrt[3]{4}-\sqrt[3]{6}\right)=$

(a) 5 (b) $\sqrt[9]{5}$
(c) $\sqrt[6]{5}$ (d) $\sqrt[3]{5}$ Ev

63. $\frac{\sqrt[3]{1.728}-\sqrt[3]{0.216}}{\sqrt[3]{2.197}-\sqrt[3]{0.343}}=$

(a) 1 (b) –1
(c) 2 (d) –2 Ev

64. If $3^9 + 3^{12} + 3^{15} + 3^n$ is a perfect cube, $n \in N$, then the value of n is

(a) 18 (b) 17 (c) 14 (d) 16 U

65. If $x=\sqrt[3]{2\frac{93}{125}}$, then the value of x is

(a) $2\frac{1}{5}$ (b) $1\frac{2}{5}$ (c) $3\frac{4}{5}$ (d) $4\frac{1}{5}$

66. If $\sqrt{\sqrt[3]{x \times 0.000009}} = 0.3$, then the value of $\sqrt{x}$ is

(a) 27 (b) 81

(c) 9 (d) 18

67. $\frac{\sqrt[3]{1.728}}{\sqrt[3]{13.824}} \times \frac{\sqrt[3]{4.096}}{\sqrt[3]{216}} =$

(a) $\frac{15}{8}$ (b) $\frac{4}{15}$

(c) $\frac{2}{15}$ (d) $\frac{15}{4}$ Ev

68. If $\sqrt[3]{\frac{x}{729}} + \sqrt[3]{\frac{27x}{3375}} = 1$, then find the value of x.

(a) $\frac{79507}{3375}$ (b) $\frac{91125}{2744}$

(c) $\frac{2025}{196}$ (d) $\frac{443}{125}$ Ev

69. If $x = \sqrt[3]{13\frac{103}{125}}$, then the value of x is

(a) $2\frac{1}{5}$ (b) $2\frac{2}{5}$

(c) $3\frac{4}{5}$ (d) $4\frac{1}{5}$

70. Evaluate : $\sqrt[3]{\frac{4096}{64}} + 2\sqrt[3]{\frac{5832}{216}} - 3\sqrt[3]{\frac{3375}{125}} + 4\sqrt[3]{\frac{1728}{64}}$

(a) 12 (b) 13

(c) –13 (d) –12 Ev

Match the Following

In this section each question has two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (a), (b), (c) and (d) out of which one is correct.

1. Match the numbers given in List-I with their cube roots given in List-II.

List-I	List-II
(P) 148877	(1) 24
(Q) 13824	(2) 53
(R) 35937	(3) 33
(S) 17576	(4) 26

(a) P-2, Q-3, R-4, S-1
(b) P-2, Q-1, R-3, S-4
(c) P-1, Q-2, R-3, S-4
(d) P-1, Q-3, R-2, S-4

2. Match the following :

List-I	List-II
(P) The smallest number by which 392 must be multiplied so that the product is a perfect cube is	(1) 5
(Q) The smallest number by which 8640 must be divided so that the quotient is a perfect cube is	(2) 3
(R) The smallest number by which 3087 must be multiplied so that product is a perfect cube is	(3) 25
(S) The smallest number by which 33275 must be divided so that the quotient becomes a perfect cube is	(4) 7

(a) P-4, Q-1, R-2, S-3 (b) P-1, Q-2, R-3, S-4
(c) P-2, Q-3, R-4, S-1 (d) P-4, Q-2, R-1, S-3

Assertion & Reason Type

Directions : In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If assertion is false but reason is true.

1. **Assertion :** $1^3 = 1$, $9^3 = 729$, $3^3 = 27$ where 1, 729, 27 are cubes of 1, 9, 3 respectively.
Reason : Cubes of all odd natural numbers are even.

2. **Assertion :** $14^3 = 2744$, $24^3 = 13822$
Reason : If the digits of number end with 4, then cube of the number ends with same digit 4.

3. **Assertion :** 4, 7, 10, ... are the natural numbers of the form $3n + 1$, where $n = 1, 2, ..$
Reason : The cube of natural number of the form $3n + 2$, when divided by 3 leaves remainder 2.

4. **Assertion :** We know that
$9 \div 3 = 3$ and $9^3 \div 3^3 = 27$
$8 \div 2 = 4$ and $8^3 \div 2^3 = 64$
Reason : If a divides b, then a^3 divides b^3.

5. **Assertion :** The unit digit of cube of 528, 38 and 1298 is 2.
Reason : If a number ends with 8, then its cube ends with 2.

Comprehension Type

PASSAGE-I : Three numbers are in the ratio 2 : 3 : 4.

1. The sum of their cubes is 33957. Find the numbers.
(a) 2, 4, 8 (b) 14, 21, 28
(c) 6, 9, 18 (d) 5, 10, 15

2. The cubes of these numbers are
(a) 8, 64, 512 (b) 2744, 7261, 8849
(c) 2744, 9261, 21952 (d) 7261, 125, 1000

PASSAGE-II : The volume of a cube is 9261000 m^3.

1. The side of the cube is
(a) 210 m (b) 200 m (c) 220 m (d) 250 m

2. If the volume of the cube is increased by 1387000 m^3 then the new side of the cube is
(a) 250 m (b) 200 m (c) 210 m (d) 220 m

3. If the side of a cube is 6 m, then area of one face of the cube will be
(a) 216 m^2 (b) 36 m^2 (c) 6 m^2 (d) 24 m^2

Subjective Problems

Very Short Answer Type

1. Is 1024 a perfect cube?
2. Find the unit's digit of cube of 8888.
3. Is 196 a perfect cube?
4. Find the smallest number by which 96 must be multiplied so that the product is a perfect cube.
5. Find the smallest number by which 3087 must be divided so that the quotient is a perfect cube.
6. Show that 1331 is a perfect cube.
7. Consider the following pattern.
$2^3 - 1^3 = 1 + 2 \times 1 \times 3$
$3^3 - 2^3 = 1 + 3 \times 2 \times 3$
$4^3 - 3^3 = 1 + 4 \times 3 \times 3$
Using the above pattern find the value of $7^3 - 6^3$.
8. Find the cube root of 17576.
9. Find the cube root of 0.003375.
10. Evaluate the following : $\left\{\sqrt{15^2 + 8^2}\right\}^3$.

Short Answer Type

1. Is 8000 a perfect cube? What is the number whose cube is 8000?
2. Find the cube root of 389017.
3. Find the cube root 46656.
4. Find the smallest number which when multiplied by 3600 makes the product a perfect cube. Further, find the cube root of the product.
5. Find the smallest number by which 8192 must be divided so that quotient is a perfect cube. Also, find the cube root of the quotient so obtained.
6. Find the cube root of 2300×5290.
7. Find the cube root of $\frac{0.064}{3.375}$.
8. Find the cube root of 216×1728.
9. Find the cube root of 343000.
10. Find the cube root of 85184 by prime factorisation method.

Long Answer Type

1. Find the cube root of 262144 by prime factorisation method.
2. Three numbers are in the ratio 1:2:3. The sum of their cubes is 98784. Find the numbers.
3. Evaluate : $\sqrt[3]{1372} \times \sqrt[3]{1458}$.
4. Find the cube root of $\frac{3375}{2744}$.
5. Find cube root of 110592.

Integer/Numerical Value Type

1. If $\sqrt[3]{\frac{a^6 \times b^3 \times c^{21}}{c^9 \times a^{12}}} = \frac{bc^k}{a^{k/2}}$, then $k =$ ____.

2. The cube of the number p is 16 times the number. Then find p where $p \neq 0$ and $p \neq -4$.

3. The digit in the unit place for the cube of a four digit number of the form $xyz8$ is ____.

4. The digit in the units place for the cube of the number 1234567 is ____.

5. A number is multiplied 3 times by itself and then 61 is subtracted from the product obtained. If the final result is 9200, then the number is

6. $\sqrt[3]{0.125} + \sqrt[3]{0.729} = \frac{n}{10}$. Find n.

7. If $a = 2b$ and $b = 4c$, then $\sqrt[3]{\frac{a^2}{16bc}} =$ ____.

8. If $\sqrt[3]{\frac{3^6 \times 4^3 \times 2^6}{8^9 \times 2^3}} = \left(\frac{3}{8}\right)^k$, then $k =$ ___.

9. The cube of a number ending in 3, ends in ___.

10. The cube root of 10648 is ___.

Case Based Questions

Case I : Isha, who is a maths teacher of class VIII, explained the concept of 'Cube'. She explained that a cube is a 3-dimensional figure which has all its sides equal. She further explained when a number is multiplied by itself three times, a cube number or a perfect cube is obtained. She told the students the reasons why a number can and can't be a perfect cube. She gave some questions to the students for revision.

The questions are listed below, answer them.

1. Which of the following is not a perfect cube?
   (a) 729 (b) 2724
   (c) 3375 (d) 1331

2. Which of the following is a perfect cube?
   (a) 181 (b) 521 (c) 105 (d) 216

3. If a number ends with two zeroes, then its cube ends with _____ zeroes.
   (a) 3 (b) 6 (c) 8 (d) 4

4. By which smallest number 25272 must be divided to make it a perfect cube?
   (a) 9 (b) 13 (c) 117 (d) 39

5. The smallest number by which 6860 must be divided such that the resulting quotient becomes a perfect cube is
   (a) 4 (b) 5 (c) 10 (d) 20

Case II : Mahima goes to a birthday party of one of her friends. She purchases a gift whose box is in the shape of a cuboid. The dimensions of the box are in the ratio 9 : 7 : 8 and its volume is 367416 cu. cm.

If we consider the common ratio as x, then answer the following questions. CFQs

1. Find the value of x.
   (a) 6 (b) 7 (c) 8 (d) 9

2. What is the length of the cuboid?
   (a) 80 cm (b) 81 cm (c) 82 cm (d) 83 cm

3. What is the breadth of the cuboid?
   (a) 63 cm (b) 64 cm (c) 65 cm (d) 66 cm

4. What is the height of the cuboid?
   (a) 70 cm (b) 71 cm (c) 72 cm (d) 73 cm

5. What is the unit digit in the cube of 729?
   (a) 6 (b) 7 (c) 8 (d) 9

Case III : Sumit and Kapil were students of class VIII. Before examination, they were doing revision on the topic 'Cubes and Cube Roots'. They found a statement in the book given as follows:
''The cube root of a number $740xy$ is 42''.

There were certain questions on the basis of above statement which are listed below, answer them. CFQs

1. Find the required number.
   (a) 74084 (b) 74086
   (c) 74048 (d) 74088

2. The difference between x and y is
(a) 0 (b) 1 (c) 2 (d) 3

3. The product of x and y is
(a) 32 (b) 48 (c) 64 (d) 46

4. If $\frac{x}{y} = k$, then find k.
(a) 1 (b) 2 (c) 3 (d) 4

5. Cube of a negative number is
(a) always positive (b) sometimes positive
(c) always negative (d) sometimes negative

Case IV : Mrs. Lamba, in the class VIII, described the concept of 'Cubes and Cube Roots' and after that she gave a problem to students so that they can better understand the concept.

''A number is divided by 36 and the cube root of that quotient is 12''.

On the basis of above information, answer the following questions.

1. Find the required number.
(a) 62082 (b) 62802 (c) 68002 (d) 62208

2. Find the prime factors which do not appear in the required number in the group of three.
(a) 2 and 3 (b) 2 and 5
(c) 3 and 5 (d) None of these

3. Find the least number which should be multiply to number to make it a perfect cube.
(a) 5 (b) 6 (c) 7 (d) 8

4. Find the cube root of obtained perfect cube.
(a) 70 (b) 71 (c) 72 (d) 73

5. Find the cube of root of 2744.
(a) 13 (b) 14 (c) 15 (d) 16

ANSWER KEY

Multiple Choice Questions

1.	(b)	**2.**	(c)	**3.**	(c)	**4.**	(b)	**5.**	(b)
6.	(a)	**7.**	(a)	**8.**	(b)	**9.**	(d)	**10.**	(b)
11.	(d)	**12.**	(b)	**13.**	(c)	**14.**	(a)	**15.**	(c)
16.	(a)	**17.**	(b)	**18.**	(c)	**19.**	(a)	**20.**	(b)
21.	(a)	**22.**	(c)	**23.**	(b)	**24.**	(c)	**25.**	(a)
26.	(d)	**27.**	(a)	**28.**	(c)	**29.**	(d)	**30.**	(c)
31.	(d)	**32.**	(a)	**33.**	(d)	**34.**	(c)	**35.**	(a)
36.	(c)	**37.**	(a)	**38.**	(a)	**39.**	(c)	**40.**	(b)
41.	(b)	**42.**	(a)	**43.**	(b)	**44.**	(a)	**45.**	(d)
46.	(b)	**47.**	(c)	**48.**	(b)	**49.**	(b)	**50.**	(a)
51.	(a)	**52.**	(d)	**53.**	(b)	**54.**	(d)	**55.**	(c)
56.	(c)	**57.**	(a)	**58.**	(c)	**59.**	(c)	**60.**	(b)
61.	(b)	**62.**	(a)	**63.**	(a)	**64.**	(c)	**65.**	(b)
66.	(b)	**67.**	(c)	**68.**	(b)	**69.**	(b)	**70.**	(b)

Match the Following

1.	(b)	**2.**	(a)

Assertion & Reason Type

1.	(c)	**2.**	(d)	**3.**	(b)	**4.**	(a)	**5.**	(a)

Comprehension Type

Passage-I

1.	(b)	**2.**	(c)

Passage-II

1.	(a)	**2.**	(d)	**3.**	(b)

Integer/Numerical Value Type

1.	(4)	**2.**	(4)	**3.**	(2)	**4.**	(3)	**5.**	(21)
6.	(14)	**7.**	(1)	**8.**	(2)	**9.**	(7)	**10.**	(22)

Case Based Questions

Case I

1.	(b)	**2.**	(d)	**3.**	(b)	**4.**	(c)	**5.**	(d)

Case II

1.	(d)	**2.**	(b)	**3.**	(a)	**4.**	(c)	**5.**	(d)

Case III

1.	(d)	**2.**	(b)	**3.**	(c)	**4.**	(a)	**5.**	(c)

Case IV

1.	(d)	**2.**	(a)	**3.**	(b)	**4.**	(c)	**5.**	(b)

CHAPTER 06

Cubes and Cube Roots

NCERT Section

Exercise 6.1

1. (i) $216 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

Since the prime factors of 216 appear in a group of three.

$\therefore$ 216 is a perfect cube.

(ii) $128 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 2$

Since the prime factors of 128 don't appear in a group of three.

$\therefore$ 128 is not a perfect cube.

(iii) $1000 = \underline{2 \times 2 \times 2} \times \underline{5 \times 5 \times 5}$

Since the prime factors of 1000 appear in a group of three.

$\therefore$ 1000 is a perfect cube.

(iv) $100 = 2 \times 2 \times 5 \times 5$

Since the prime factors of 100 don't appear in group of three.

$\therefore$ 100 is not a perfect cube.

(v) $46656 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3}$

Since the prime factors of 46656 appear in a group of three.

$\therefore$ 46656 is a perfect cube.

2. (i) $243 = \underline{3 \times 3 \times 3} \times 3 \times 3$

3	243
3	81
3	27
3	9
3	3
	1

Clearly the prime factor 3 doesn't appear in a group of three.

$\therefore$ 243 is not a perfect cube.

So to make 243 a perfect cube we multiply it by 3.

In that case $243 \times 3 = \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3} = 729$, which is a perfect cube.

(ii) $256 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 2 \times 2$

Clearly the prime factor 2 doesn't appear in a group of three.

$\therefore$ 256 is not a perfect cube.

So to make 256 a perfect cube we multiply it by 2.

In that case $256 \times 2 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2}$

= 512, which is a perfect cube.

(iii) $72 = \underline{2 \times 2 \times 2} \times 3 \times 3$

Clearly the prime factor 3 doesn't appear in a group of three.

$\therefore$ 72 is not a perfect cube.

So to make 72 a perfect cube, we must multiply it by 3.

In that case $72 \times 3 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

= 216, which is a perfect cube.

(iv) $675 = \underline{3 \times 3 \times 3} \times 5 \times 5$

3	675
3	225
3	75
5	25
5	5
	1

Clearly the prime factor 5 doesn't appear in a group of three.

$\therefore$ 675 is not a perfect cube.

So we multiply it by 5, to make a perfect cube.

In that case $675 \times 5 = \underline{3 \times 3 \times 3} \times \underline{5 \times 5 \times 5}$

= 3375, which is a perfect cube.

(v) $100 = 2 \times 2 \times 5 \times 5$.

Clearly both the prime factors 2 and 5 don't appear in a group of three.

$\therefore$ 100 is not a perfect cube.

So we multiply it by 2 and 5, to make it a perfect cube.

In that case $100 \times 2 \times 5 = \underline{2 \times 2 \times 2} \times \underline{5 \times 5 \times 5} = 1000$, which is a perfect cube.

3. (i) $81 = \underline{3 \times 3 \times 3} \times 3$

Clearly the prime factor 3 doesn't appear in a group of three.

$\therefore$ 81 is not a perfect cube.

So to make it a perfect cube, we must divide it by 3.

3	81
3	27
3	9
3	3
	1

$$\frac{81}{3} = \frac{3 \times 3 \times 3 \times 3}{3} = 27,$$

which is a perfect cube.

(ii) $128 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 2$

2	128
2	64
2	32
2	16
2	8
2	4
2	2
	1

Clearly the prime factor 2 doesn't appear in a group of three.

∴ 128 is not a perfect cube.

So to make it a perfect cube, we must divide it by 2.

$$\frac{128}{2} = \frac{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}{2} = 64,$$

which is a perfect cube.

(iii) $135 = \underline{3 \times 3 \times 3} \times 5$

5	135
3	27
3	9
3	3
	1

Clearly the prime factor 5 doesn't appear in a group of three.

∴ 135 is not a perfect cube.

So, to make it a perfect cube, we must divide it by 5.

i.e., $\frac{135}{5} = \frac{3 \times 3 \times 3 \times 5}{5} = 27$

Thus the smallest number is 5 by which 135 must be divided.

(iv) $192 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 3$

2	192
2	96
2	48
2	24
2	12
2	6
3	3
	1

Clearly the prime factor 3 doesn't appear in a group of three.

∴ 192 is not a perfect cube.

So to make it a perfect cube, we must divide it by 3.

$$\frac{192}{3} = \frac{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 3}{3} = 64,$$

which is a perfect cube.

(v) $704 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 11$

2	704
2	352
2	176
2	88
2	44
2	22
11	11
	1

Clearly the prime factor 11 doesn't appear in a group of three.

∴ 704 is not a perfect cube.

So to make it a perfect cube, we must divide it by 11.

$$\therefore \quad \frac{704}{11} = \frac{\underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 11}{11}$$

= 64, which is a perfect cube.

4. We have $2 \times 5 \times 5$

Clearly in above, the prime factors 2 and 5 both don't appear in a group of three.

∴ To make it a perfect cube we need to multiply it by $2 \times 2 \times 5$, we get

$2 \times 5 \times 5 \times 2 \times 2 \times 5 = \underline{2 \times 2 \times 2} \times \underline{5 \times 5 \times 5}$

= 1000, which is a perfect cube.

Thus, he needs 20 cuboids more to make it a perfect cube.

Exercise 6.2

1. (i) Prime factors of 64

2	64
2	32
2	16
2	8
2	4
2	2
	1

$64 = 2 \times 2 \times 2 \times 2 \times 2 \times 2$

$\therefore \sqrt[3]{64} = \sqrt[3]{\underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2}} = 2 \times 2 = 4.$

(ii) Prime factors of 512

2	512
2	256
2	128
2	64
2	32
2	16
2	8
2	4
2	2
	1

$512 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2}$

$\therefore \sqrt[3]{512} = 2 \times 2 \times 2 = 8.$

(iii) Prime factors of 10648

2	10648
2	5324
2	2662
11	1331
11	121
11	11
	1

$10648 = \underline{2 \times 2 \times 2} \times \underline{11 \times 11 \times 11}$

$\therefore \sqrt[3]{10648} = 2 \times 11 = 22.$

(iv) Prime factors of 27000

3	27000
3	9000
3	3000
2	1000
2	500
2	250
5	125
5	25
5	5
	1

$27000 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times \underline{5 \times 5 \times 5}$

$\therefore \quad \sqrt[3]{27000} = 2 \times 3 \times 5 = 30.$

(v) Prime factors of 15625

5	15625
5	3125
5	625
5	125
5	25
5	5
	1

$15625 = \underline{5 \times 5 \times 5} \times \underline{5 \times 5 \times 5}$

$\therefore \quad \sqrt[3]{15625} = 5 \times 5 = 25.$

(vi) Prime factors of 13824

2	13824
2	6912
2	3456
2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
3	3
	1

$13824 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

$\therefore \quad \sqrt[3]{13824} = 2 \times 2 \times 2 \times 3 = 24$

(vii) Prime factors of 110592

2	110592
2	55296
2	27648
2	13824
2	6912
2	3456
2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
3	3
	1

$110592 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

$\therefore \quad \sqrt[3]{110592} = 2 \times 2 \times 2 \times 2 \times 3 = 48.$

(viii) Prime factors of 46656

2	46656
2	23328
2	11664
2	5832
2	2916
2	1458
3	729
3	243
3	81
3	27
3	9
3	3
	1

$46656 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3}$

$\therefore \quad \sqrt[3]{46656} = 2 \times 2 \times 3 \times 3 = 36.$

(ix) Prime factors of 175616

2	175616
2	87808
2	43904
2	21952
2	10976
2	5488
2	2744
2	1372
2	686
7	343
7	49
7	7
	1

$175616 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{7 \times 7 \times 7}$

$\therefore \quad \sqrt[3]{175616} = 2 \times 2 \times 2 \times 7 = 56.$

(x) Prime factors of 91125

3	91125
3	30375
3	10125
3	3375
3	1125
3	375
5	125
5	25
5	5
	1

$91125 = \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3} \times \underline{5 \times 5 \times 5}$

$\therefore \quad \sqrt[3]{91125} = 3 \times 3 \times 5 = 45.$

2. (i) It is false.
Because the cube of any odd number is also odd.
(ii) It is true.
Because to make a perfect cube we need each and every factor to occur three times in a group.
So we need (3, 6, 9, ...) zero's to make a perfect cube.
(iii) It is false. (iv) It is false.
$\because \quad 12^3 = 1728$, which ends with 8.
(v) It is false.
$\because \quad 10^3 = 1000$, where 10 is the smallest two digit number, and its cube contains 4 digits.
(vi) It is false.
$\because \quad 99^3 = 970299$, where 99 is the largest two digit number and doesn't contain seven or more digits.
(vii) It is true.
$\because \quad 1^3 = 1$, which is a single digit number.

Multiple Choice Questions

1. **(b):** Resolving the following numbers into factors, we get

5	1525
5	305
	61

4	1728
4	432
4	108
3	27
3	9
	3

2	1458
9	729
9	81
	9

3	3993
11	1331
11	121
	11

(a) $1525 = 5 \times 5 \times 61$

(b) $1728 = \underline{4 \times 4 \times 4} \times \underline{3 \times 3 \times 3}$

(c) $1458 = 2 \times \underline{9 \times 9 \times 9}$

(d) $3993 = 3 \times \underline{11 \times 11 \times 11}$

We can see that only factors of 1728 can form triplets and in other numbers we are left with one more factor.

2. (c) : Factors of 2197 are

$2197 = \underbrace{13 \times 13 \times 13} = (13)^3$

So, 2197 is a perfect cube.

$512 = \underbrace{8 \times 8 \times 8} = (8)^3$

So, 512 is a perfect cube.

$2916 = 2 \times 2 \times \underbrace{9 \times 9 \times 9}$. Here, 2 cannot form a triplet.
So, 2916 is not a perfect cube.

$343 = \underbrace{7 \times 7 \times 7} = (7)^3$

So, 343 is a perfect cube.

3. (c) : Resolving 3456 as a product of prime factors, we get

2	3456
2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
	3

$3456 = \underbrace{2 \times 2 \times 2} \times \underbrace{2 \times 2 \times 2} \times 2 \times \underbrace{3 \times 3 \times 3}$

Clearly, to make it a perfect cube it should be multiplied by $2 \times 2 = 4$.

4. (b):

Resolving 5832 into factors, we get

2	5832
2	2916
2	1458
9	729
9	81
	9

$5832 = \underbrace{2 \times 2 \times 2} \times \underbrace{9 \times 9 \times 9}$

$\sqrt[3]{5832} = 2 \times 9 = 18$

5. (b) : $\sqrt[3]{\frac{1728}{2744}} = \frac{\sqrt[3]{1728}}{\sqrt[3]{2744}}$

4	1728
4	432
4	108
3	27
3	9
	3

2	2744
2	1372
2	686
7	343
7	49
	7

$\sqrt[3]{1728} = 4 \times 3 = 12$, $\sqrt[3]{2744} = 2 \times 7 = 14$

$\therefore \quad \sqrt[3]{\frac{1728}{2744}} = \frac{12}{14} = \frac{6}{7}$

6. (a) : $\sqrt[3]{4\frac{12}{125}} = \sqrt[3]{\frac{512}{125}} = \frac{8}{5} = 1\frac{3}{5}$.

7. (a) : $\sqrt[3]{144} \times \sqrt[3]{12} = \sqrt[3]{144 \times 12}$

$= \sqrt[3]{12 \times 12 \times 12} = 12$.

8. (b): The number having unit digit 5 has cube root ending with 5.

9. (d): Surface area of cube, $6a^2 = 216 \Rightarrow a = 6$ cm

$\therefore$ Volume of the cube $= 6^3 = 216$ cm^3

10. (b): $(5)^{3x} = 5^5 \Rightarrow \quad 3x = 5 \Rightarrow x = \frac{5}{3}$

11. (d): We have,

$9720 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 5 \times 3 \times 3$

To make it perfect cube, the given number should be multiplied by $5 \times 5 \times 3$ *i.e.*, 75.

12. (b) : $\sqrt[3]{156 + x} = 12$

$\Rightarrow \quad 156 + x = (12)^3 \quad \Rightarrow \quad 156 + x = 1728$

$\Rightarrow \quad x = 1728 - 156 = 1572$

13. (c) : $\frac{\sqrt[3]{531441}}{\sqrt[3]{729}} = \frac{81}{9} = 9$

14. (a) : $\sqrt[3]{x - 12} = 19$

$\Rightarrow \quad x - 12 = (19)^3 \quad \Rightarrow \quad x - 12 = 6859$

$\Rightarrow \quad x = 6859 + 12 \quad \Rightarrow \quad x = 6871$

15. (c) : The value of $(-0.4)^3$ is

$(-0.4) \times (-0.4) \times (-0.4) = -0.064$.

16. (a) : $3^3 - (-0.6)^3 = 27 - (-0.216)$

$= 27 + 0.216 = 27.216$.

17. (b): $\frac{16}{9} \times \left(\frac{-3}{2}\right)^3 = \frac{16}{9} \times \left(\frac{-27}{8}\right) = 2 \times (-3) = -6$

18. (c) : (a) $200 = \underline{2 \times 2 \times 2} \times \underline{5 \times 5}$

So, 200 is not a perfect cube.

(b) Resolving 9 into prime factors, we get $9 = 3 \times 3$

$\therefore$ 9 is not a perfect cube.

(c) Resolving 512 into prime factors, we get

$512 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} = 2 \times 2 \times 2$

$\therefore \quad \sqrt[3]{512} = 8$

(d) Resolving 1024 into prime factors, we get

$1024 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 2$

$\therefore$ 1024 is not a perfect cube.

19. (a) : $\sqrt[3]{3 - \frac{17}{27}} = \sqrt[3]{\frac{81 - 17}{27}} = \sqrt[3]{\frac{64}{27}} = \frac{4}{3}$

20. (b): $\sqrt[3]{0.125} + 3 = 0.5 + 3 = 3.5$

21. (a) : $\sqrt[3]{3\frac{3}{8}} = \sqrt[3]{\frac{27}{8}} = \frac{3}{2}$

22. (c) : $\sqrt[3]{64} + \sqrt{9^2} = 4 + 9 = 13$

23. (b): $\sqrt[3]{\frac{192}{81}} = \sqrt[3]{\frac{64}{27}} = \frac{4}{3}$

24. (c): $\sqrt[3]{2744} + \sqrt{9^2} = 14 + 9 = 23$

25. (a): $\sqrt[3]{512} \times \sqrt[3]{3.375} = 8 \times 1.5 = 12.0$

26. (d): Since, cube of a negative number is negative.
∴ 4096 can't be cube of a negative number.
Now, –396 = – (2 × 2 × 3 × 3 × 11)
So, it is not a cube of a negative number.
Again, –81 = – (3 × 3 × 3 × 3)
It is also not a cube of a negative number.
Now, –2744 = – (14 × 14 × 14)
So, –2744 is cube of –14.

27. (a): Since cube of an odd number is odd. So, 1728, 2744 and 32768 can't be the cube of an odd number.
Now, 79507 = 43 × 43 × 43 = $(43)^3$

28. (c): Since, cube of an even number is even. So, 6859 and 42875 can't be the cube of an even number.
Now, 648 = 2 × 2 × 2 × 3 × 3 × 3 × 3 = $2^3 \times 3^3 \times 3$
So, 648 is not a cube number.
Again, 13824 = 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 3 × 3 × 3 = $2^3 \times 2^3 \times 2^3 \times 3^3 = (24)^3$
So, 13824 is a cube of an even number 24.

29. (d)

30. (c): $\sqrt[3]{729} = 9$

31. (d): We have,
392 = 2 × 2 × 2 × 7 × 7
To make it a perfect cube, it should be multiplied by 7.

32. (a): $7\frac{2}{5} = \frac{37}{5}$

$\therefore \quad \left(7\frac{2}{5}\right)^3 = \left(\frac{37}{5}\right)^3 = \frac{50653}{125}$

33. (d): Volume of cube, a^3 = 778688 mm^3

$\Rightarrow \quad a = \sqrt[3]{778688}$ mm = 92 mm

∴ Edge of cube is 92 mm.

34. (c): $\sqrt[3]{97336} = 46$

35. (a): Volume of cube, $a^3 = \frac{1331}{216} m^3$

$\Rightarrow \quad a = \sqrt[3]{\frac{1331}{216}} = \frac{\sqrt[3]{1331}}{\sqrt[3]{216}} = \frac{11}{6}$ m

36. (c): Writing 13720 as a product of prime factors, we get

5	13720
4	2744
2	686
7	343
7	49
	7

$13720 = 5 \times \underbrace{2 \times 2 \times 2} \times \underbrace{7 \times 7 \times 7}$

Clearly, to make it a perfect cube, it must be divided by 5.

37. (a): $\sqrt[3]{.000064} = \sqrt[3]{\frac{64}{1000000}} = \frac{4}{100} = 0.04.$

38. (a): Given expression $\frac{(2.3)^3 - (0.3)^3}{(2.3)^2 + (2.3)(0.3) + (0.3)^2}$

$= \frac{12.167 - 0.027}{5.29 + 0.69 + 0.09} = \frac{12.14}{6.07} = 2$

39. (c): $\frac{\sqrt[3]{125} \times \sqrt[3]{64}}{\sqrt[3]{125} - \sqrt[3]{64}}$

$= \frac{\sqrt[3]{5 \times 5 \times 5} \times \sqrt[3]{4 \times 4 \times 4}}{\sqrt[3]{5 \times 5 \times 5} - \sqrt[3]{4 \times 4 \times 4}} = \frac{5 \times 4}{5 - 4} = \frac{20}{1} = 20$

40. (b): $\frac{\sqrt[3]{8} + \sqrt[3]{27} - \sqrt[3]{343}}{2^2 - 3} = \frac{2 + 3 - 7}{4 - 3} = \frac{-2}{1} = -2$

41. (b): According to the given pattern, number of consecutive odd numbers whose sum equals 9^3 is 9.

42. (a): $\sqrt[3]{57\frac{132}{343}} = \sqrt[3]{\frac{19683}{343}} = \frac{\sqrt[3]{19683}}{\sqrt[3]{343}} = \frac{27}{7}$

43. (b): Volume of a cubical box, a^3 = 474.552 m^3

$= \frac{474552}{1000} \quad \Rightarrow \quad a = \sqrt[3]{\frac{474552}{1000}} = \frac{78}{10} = 7.8$ m

44. (a): We know that, if a number has 7 as one's digit, then the one's digit of cube of this number is 3.

45. (d): $\sqrt[3]{27} + \sqrt[3]{0.008} = 3 + \sqrt[3]{\frac{8}{1000}} = 3 + \frac{2}{10}$

= 3 + 0.2 = 3.2

46. (b): $\sqrt[3]{\sqrt{0.000729}} = \sqrt[3]{\sqrt{\frac{729}{1000000}}} = \sqrt[3]{\frac{27}{1000}}$

$= \frac{3}{10} = 0.3$

47. (c): We have, 1575 = 3 × 3 × 5 × 5 × 7
To make it a perfect cube, it should be multiplied by 3 × 5 × 7 × 7 *i.e.*, 735.

48. (b): $\sqrt[3]{\frac{343}{1331}} = \frac{\sqrt[3]{343}}{\sqrt[3]{1331}} = \frac{7}{11}$

49. (b): We have, 33075 = 3 × 3 × 3 × 5 × 5 × 7 × 7
To make it a perfect cube, we multiply it by 5 × 7 *i.e.*, 35.

50. (a): $\sqrt[3]{32.768} = \sqrt[3]{\frac{32768}{1000}} = \frac{32}{10} = 3.2$

51. (a): We have, $\left(\sqrt[6]{27} - \sqrt{6\frac{3}{4}}\right)^2 = \left((3^3)^{1/6} - \sqrt{\frac{27}{4}}\right)^2$

$= \left(3^{1/2} - \frac{3\sqrt{3}}{2}\right)^2 = (\sqrt{3})^2 \left(1 - \frac{3}{2}\right)^2 = 3\left(\frac{-1}{2}\right)^2 = \frac{3}{4}$

52. (d): Prime factorisation of 3600 is,

2	3600
2	1800
2	900
2	450
3	225
3	75
5	25
5	5
	1

Now, 3600
$= 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 5 \times 5$
So, to make 3600 a perfect cube,
it should be divided by
$2 \times 3 \times 3 \times 5 \times 5 = 450$

53. (b): We have,

$$\sqrt{\frac{0.00001225}{0.00005329}} - \sqrt[3]{0.000064} = \frac{35}{73} - \left(\frac{8}{1000}\right)^{1/3}$$

$$= \frac{35}{73} - \frac{2}{10} = \frac{204}{730} = 0.279$$

54. (d): $\sqrt[3]{\frac{-0.000008}{-0.000216}} = \sqrt[3]{\frac{8}{216}} = \frac{2}{6} = \frac{1}{3}$

55. (c): $\sqrt[3]{0.008} - \sqrt[3]{-512} + \sqrt[3]{2.197}$

$= 0.2 - (-8) + 1.3 = 0.2 + 8 + 1.3 = 9.5$

56. (c): $\frac{3\sqrt[3]{13824}}{2\sqrt[3]{-15625}} \div \frac{2\sqrt[3]{-13824}}{\sqrt[3]{5832}}$

$$= \frac{3 \times 24}{2 \times (-25)} \div \frac{2 \times (-24)}{18} = \frac{-36}{25} \div \frac{-8}{3} = \frac{-36}{25} \times \frac{3}{-8} = \frac{27}{50}$$

57. (a): Let the number be x.

$\therefore \quad \sqrt[3]{x} \div 2 = 2^2 \Rightarrow \sqrt[3]{x} = 4 \times 2 = 8 \Rightarrow x = 8^3 = 512$

58. (c): The number having unit digit 2 has its cube ending with 8.

59. (c): The cube of a negative number is always negative.

60. (b): We have,

$$\sqrt[3]{1 - \frac{127}{343}} = \left(\frac{343 - 127}{343}\right)^{1/3} = \left(\frac{216}{343}\right)^{1/3} = \frac{6}{7} = 1 - \frac{1}{7}$$

61. (b): Given, $\sqrt[3]{\frac{x}{729}} + \sqrt[3]{\frac{8x}{729}} + \sqrt[3]{\frac{27x}{5832}} = 1$

$$\Rightarrow \quad \frac{x^{1/3}}{(9^3)^{1/3}} + \frac{(2^3 x)^{1/3}}{(9^3)^{1/3}} + \frac{(3^3 x)^{1/3}}{(18^3)^{1/3}} = 1$$

$$\Rightarrow \quad \frac{x^{1/3}}{9} + \frac{2x^{1/3}}{9} + \frac{3x^{1/3}}{18} = 1$$

$$\Rightarrow \quad \frac{2x^{1/3} + 4x^{1/3} + 3x^{1/3}}{18} = 1 \Rightarrow \quad \frac{9x^{1/3}}{18} = 1$$

$\Rightarrow x^{1/3} = 2 \quad \Rightarrow x = 8$

62. (a): $(\sqrt[3]{3} + \sqrt[3]{2})(\sqrt[3]{9} + \sqrt[3]{4} - \sqrt[3]{6})$

$= \sqrt[3]{3}(\sqrt[3]{9} + \sqrt[3]{4} - \sqrt[3]{6}) + \sqrt[3]{2}(\sqrt[3]{9} + \sqrt[3]{4} - \sqrt[3]{6})$

$= \sqrt[3]{27} + \sqrt[3]{12} - \sqrt[3]{18} + \sqrt[3]{18} + \sqrt[3]{8} - \sqrt[3]{12}$

$= \sqrt[3]{3^3} + \sqrt[3]{2^3} = 3 + 2 = 5$

63. (a): $\frac{\sqrt[3]{1.728} - \sqrt[3]{0.216}}{\sqrt[3]{2.197} - \sqrt[3]{0.343}} = \frac{1.2 - 0.6}{1.3 - 0.7} = \frac{0.6}{0.6} = 1$

64. (c): We have, $3^9 + 3^{12} + 3^{15} + 3^n$

$= 3^9[1 + 3^3 + 3^6 + 3^{n-9}] = 3^9[757 + 3^{n-9}]$

Since, 3^9 is a perfect cube, so $757 + 3^{n-9}$ will also be a perfect cube for $n = 14$

$[\because 757 + 3^{14-9} = 757 + 243 = 1000]$

So, $n = 14$.

65. (b): We have, $x = \sqrt[3]{2\frac{93}{125}}$

$$\Rightarrow x = \sqrt[3]{\frac{343}{125}} = \frac{7}{5} \Rightarrow x = 1\frac{2}{5}$$

66. (b): $\sqrt{\sqrt[3]{x \times 0.000009}} = 0.3$

Taking square on both sides, we get

$\sqrt[3]{x \times 0.000009} = (0.3)^2 = 0.09$

Taking cube on both sides, we get

$x \times 0.000009 = (0.09)^3 = 0.000729$

$$\therefore \quad x = \frac{0.000729}{0.000009} = 81$$

67. (c): $\frac{\sqrt[3]{1.728}}{\sqrt[3]{13.824}} \times \frac{\sqrt[3]{4.096}}{\sqrt[3]{216}} = \frac{1.2}{2.4} \times \frac{1.6}{6} = \frac{1}{2} \times \frac{4}{15} = \frac{2}{15}$

68. (b): We have, $\sqrt[3]{\frac{x}{729}} + \sqrt[3]{\frac{27x}{3375}} = 1$

$$\Rightarrow \quad \frac{\sqrt[3]{x}}{9} + \frac{3 \cdot \sqrt[3]{x}}{15} = 1 \qquad [\because \sqrt[3]{729} = 9 \text{ and } \sqrt[3]{3375} = 15]$$

$$\Rightarrow \quad \frac{5 \cdot \sqrt[3]{x} + 9 \cdot \sqrt[3]{x}}{45} = 1$$

$$\Rightarrow \quad 14\sqrt[3]{x} = 45 \Rightarrow \sqrt[3]{x} = \frac{45}{14} \Rightarrow x = \left(\frac{45}{14}\right)^3 = \frac{91125}{2744}$$

69. (b): $x = \sqrt[3]{13\frac{103}{125}} = \sqrt[3]{\frac{1728}{125}} = \frac{12}{5} \Rightarrow x = 2\frac{2}{5}$

70. (b): $\sqrt[3]{\frac{4096}{64}} + 2\sqrt[3]{\frac{5832}{216}} - 3\sqrt[3]{\frac{3375}{125}} + 4\sqrt[3]{\frac{1728}{64}}$

$$= \frac{16}{4} + 2 \times \frac{18}{6} - 3 \times \frac{15}{5} + 4 \times \frac{12}{4}$$

$= 4 + 2 \times 3 - 3 \times 3 + 4 \times 3 = 4 + 6 - 9 + 12 = 13$

Match the Following

1. (b): **P → 2; Q → 1; R → 3; S → 4**

(P) $\sqrt[3]{148877}$

Resolving 148877 into prime factors, we get

53	148877
53	2809
53	53
	1

$148877 = \underline{53 \times 53 \times 53}$

$\sqrt[3]{148877} = 53$

(Q) Resolving 13824 into prime factors, we get

$13824 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

2	13824
2	6912
2	3456
2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
	3

$\therefore \sqrt[3]{13824} = 2 \times 2 \times 2 \times 3 = 24$

(R) Resolving 35937 into prime factors, we get

$35937 = \underbrace{3 \times 3 \times 3} \times \underbrace{11 \times 11 \times 11}$

$\therefore \sqrt[3]{35937} = 3 \times 11 = 33.$

3	35937
3	11979
3	3993
11	1331
11	121
	11

(S) Resolving 17576 into prime factors, we get

$17576 = \underbrace{2 \times 2 \times 2} \times \underbrace{13 \times 13 \times 13}$

$\therefore \sqrt[3]{17576} = 2 \times 13 = 26.$

2	17576
2	8788
2	4394
13	2197
13	169
	13

2. (a) : P → 4; Q → 1; R → 2; S → 3

(P) Resolving 392 into prime factors, we get

$392 = \underbrace{2 \times 2 \times 2} \times 7 \times 7$

Clearly to make 392 a perfect cube it should be multiplied by 7.

2	392
2	196
2	98
7	49
	7

(Q) Resolving 8640 into prime factors, we get

$8640 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 5$

Clearly, we can see that 8640 must be divided by 5 to make it a perfect cube.

2	8640
2	4320
2	2160
2	1080
2	540
2	270
3	135
3	45
3	15
5	5
	1

(R) Resolving 3087 into prime factors, we get

$3087 = 3 \times 3 \times \underbrace{7 \times 7 \times 7}$

Clearly, to make 3087 a perfect cube the number should be multiplied by 3.

3	3087
7	1029
7	147
7	21
	3

(S) Resolving 33275 into prime factors, we get

$33275 = 5 \times 5 \times \underbrace{11 \times 11 \times 11}$

We can see that the smallest number by which 33275 must be divided so that the quotient is a perfect cube is 25.

5	33275
5	6655
11	1331
11	121
	11

Assertion & Reason Type

1. (c) : Cubes of all odd numbers are odd.
Assertion : True; **Reason :** False

2. (d): $14^3 = 2744$, $24^3 = 13824$
Assertion : False; **Reason :** True

3. (b): $4 = 3 \times 1 + 1$, $7 = 3 \times 2 + 1$,
$10 = 3 \times 3 + 1$
$\therefore$ 4, 7, 10, ... are of form $3n + 1$.

$(3n + 2)^3 = 27n^3 + 54n^2 + 36n + 8$
$= 3(9n^3 + 18n^2 + 12n + 2) + 2$ ...(i)

When (i) is divided by 3 then it gives remainder 2.
Assertion : True; **Reason :** True but is not the correct explanation of assertion.

4. (a) : a divides b
$\Rightarrow$ $b = ak$, for some k, $b^3 = a^3k^3$
$\therefore$ a^3 divides b^3.
Assertion : True; **Reason :** True and is the correct explanation of assertion.

5. (a) : **Assertion :** True; **Reason :** True and is the correct explanation of assertion.

Comprehension Type

PASSAGE-I

1. (b): Let the three numbers be $2x$, $3x$ and $4x$ respectively.

$\therefore$ $(2x)^3 + (3x)^3 + (4x)^3 = 33957$ (Given)

$\Rightarrow 8x^3 + 27x^3 + 64x^3 = 33957 \Rightarrow 99x^3 = 33957$

$\Rightarrow x^3 = \frac{33957}{99}$

$\Rightarrow x^3 = 343 \Rightarrow x = 7$

First number is $2x = 2 \times 7 = 14$
Second number is $3x = 3 \times 7 = 21$
Third number is $4x = 4 \times 7 = 28$
So, the numbers are 14, 21, 28.

2. (c) : The cubes of (14), (21) and (28) are 2744, 9261 and 21952 respectively.

PASSAGE-II

1. (a) : Since, volume of a cube = 9261000 m^3

$\Rightarrow$ Side = $\sqrt[3]{9261000}$

3	9261000
3	3087000
3	1029000
7	343000
7	49000
7	7000
10	1000
10	100
	10

Resolving 9261000 into prime factors, we get

$9261000 = \underline{3\times3\times3}\times\underline{7\times7\times7}\times\underline{10\times10\times10}$

$\therefore \quad \sqrt[3]{9261000} = 3\times7\times10 = 210.$

$\therefore$ Side of the cube = 210 m

2. (d): New volume of the cube
= 9261000 + 1387000
= 10648000m^3
Volume of cube = $(\text{Side})^3$
$\Rightarrow$ $(\text{Side})^3 = 10648000\ m^3$
$\Rightarrow$ Side of the cube
$= \sqrt[3]{10648000}$

2	10648000
2	5324000
2	2662000
11	1331000
11	121000
11	11000
10	1000
10	100
	10

Resolving 10648000 into factors, we get

$10648000 = \underline{2\times2\times2}\times\underline{11\times11\times11}\times\underline{10\times10\times10}$

$\sqrt[3]{10648000} = 2\times11\times10.$

$\therefore$ New side of the cube is 220 m.

3. (b): Area of one face of the cube = Area of the square.
Now, area of square = $(\text{Side})^2$
= 6 × 6 = 36 m^2 ($\because$ Side = 6 m)

Subjective Problems

Very Short Answer Type

1. Resolving 1024 into prime factors, we get
1024 = 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2

2	1024
2	512
2	256
2	128
2	64
2	32
2	16
2	8
2	4
2	2
	1

From the prime factors of 1024, we find that if we try to group triplets of same factors, we are left with 2. Therefore, 1024 is not a perfect cube.

2. Here the unit's digit is 8. So the cube of 8888 will have 2 as its unit's digit.

3. Resolving 196 into prime factors, we get
196 = 2 × 2 × 7 × 7
Clearly grouping the factors in triplets cannot be formed.
Therefore 196 is not a perfect cube.

2	196
2	98
7	49
7	7
	1

4. Resolving 96 into prime factors, we get
96 = 2 × 2 × 2 × 2 × 2 × 3
96 must be multiplied by
2 × 3 × 3 = 18, so that the product becomes a perfect cube.

3	96
2	32
2	16
2	8
2	4
2	2
	1

5. Resolving 3087 into prime factors, we get
3087 = 3 × 3 × 7 × 7 × 7
Clearly, if we divide 3087 by 3 × 3 = 9 the quotient would be 7 × 7 × 7 which is a perfect cube. Therefore we must divide 3087 by 9 so that the quotient is a perfect cube.

3	3087
3	1029
7	343
7	49
7	7
	1

6. Resolving 1331 into prime factors, we get
1331 = 11 × 11 × 11
So, 1331 is the cube of 11.

7. $7^3 - 6^3 = 1 + 7 \times 6 \times 3 = 1 + 126 = 127$

8. The given number is 17576
Here, units digit of 17576 is 6. Therefore, the units digit of the cube root of the given number, is 6.
Step 1 : 17576; Taking two groups 17 and 576.
Step 2 : First group is 576; unit's place digit of required cube root is 6.
Step 3 : Second group is 17
$2^3 = 8$ and $3^3 = 27$ and $2^3 < 17 < 3^3$
$\therefore$ 2 is the ten's place digit of required cube root.
Hence $\sqrt[3]{17576} = 26$

9. We have, $0.003375 = \dfrac{3375}{1000000}$

$\therefore \quad \sqrt[3]{0.003375} = \sqrt[3]{\dfrac{3375}{1000000}} = \dfrac{\sqrt[3]{3375}}{\sqrt[3]{1000000}} = 0.15$

$\left[\because \quad 3375 = 3^3 \times 5^3 \text{ and } 1000000 = (100)^3\right.$

$\left.\therefore \quad \sqrt[3]{3375} = 3\times5 = 15 \text{ and } \sqrt[3]{1000000} = 100\right]$

10. We have, $\left\{\sqrt{15^2 + 8^2}\right\}^3 = \left\{\sqrt{225 + 64}\right\}^3$

$= \left(\sqrt{289}\right)^3 = \left(\sqrt{17\times17}\right)^3 = 17^3 = 17\times17\times17 = 4913$

Short Answer Type

1. Resolving 8000 into prime factors, we get

$8000 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 5 \times 5 \times 5$

$= \{2\times2\times2\}\times\{2\times2\times2\}\times\{5\times5\times5\}$

We find that prime factors of 8000 can be grouped into triplets of equal factors and no factor is left over. Therefore, 8000 is a perfect cube.

To determine the number whose cube is 8000, we collect one factor from each group.

Taking one factor from each triplet, we obtain

$2 \times 2 \times 5 = 20$

Thus, 8000 is the cube of 20.

2. Cube root of 389017

Step 1 : 389017; taking two groups 389 and 017

Step 2 : First group is 017; unit's place digit of required cube root is 3.

Step 3 : Second group is 389

$7^3 = 343$ and $8^3 = 512$

$\therefore$ 7 is the ten's place digit.

$\therefore$ Required cube root of 389017 is 73.

3. Cube root of 46656

Step 1 : 46656; taking two groups 46 and 656.

Step 2 : First group is 656; unit's place digit of required cube root is 6.

Step 3 : Second group is 46

$3^3 = 27$ and $4^3 = 64$

$3^3 < 46 < 4^3$

$\therefore$ 3 is the ten's place digit of required cube root.

$\therefore \sqrt[3]{46656} = 36$

4. Resolving 3600 into prime factors, we get

$3600 = \underline{2 \times 2 \times 2} \times 2 \times 5 \times 5 \times 3 \times 3$

We know that if a number is to be a perfect cube, then each of its prime factors must occur thrice. Hence, the smallest number by which the given number must be multiplied in order to make the product a perfect cube is $2 \times 2 \times 5 \times 3 = 60$

So the product = $3600 \times 60 = 216000$

Now, $216000 = \underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{5\times5\times5}\times\underline{3\times3\times3}$

$\Rightarrow \sqrt[3]{216000} = 2\times2\times5\times3 = 60$

5. Resolving 8192 into prime factors, we get

$8192 = \underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}\times2$

For a number to be perfect cube, each of its prime factors must occur thrice. Therefore the smallest number by which the given number must be divided in order to make the quotient a perfect cube is 2. Also the quotient,

$$\frac{8192}{2} = 4096 = \underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}$$

So, $\sqrt[3]{4096} = \sqrt[3]{\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}}$

$\therefore \sqrt[3]{4096} = 16$

6. We have, $\sqrt[3]{2300\times5290}$

$= \sqrt[3]{23\times529\times1000} = \sqrt[3]{23\times529}\cdot\sqrt[3]{1000}$

$= \sqrt[3]{23\times23\times23}\cdot\sqrt[3]{10\times10\times10} = 23 \times 10 = 230$

7. $$\frac{0.064}{3.375} = \frac{64}{3375} = \frac{4\times4\times4}{15\times15\times15} = \frac{4^3}{15^3}$$

$$\therefore \sqrt[3]{\frac{0.064}{3.375}} = \sqrt[3]{\frac{4^3}{15^3}} = \frac{4}{15}$$

8. $\sqrt[3]{216\times1728} = \sqrt[3]{216}\times\sqrt[3]{1728}$

Now, resolving 216 and 1728 into prime factors, we get

$216 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3}$

$\therefore \sqrt[3]{216} = 6$

$\sqrt[3]{1728} = 12$

$\therefore \sqrt[3]{216}\times\sqrt[3]{1728}$

$= 6 \times 12 = 72.$

2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
3	3
	1

9. Resolving into prime factors, we get

7	343000
7	49000
7	7000
10	1000
10	100
10	10
	1

$343000 = \underline{7 \times 7 \times 7} \times \underline{10 \times 10 \times 10}$

$\therefore \sqrt[3]{343000} = 7\times10 = 70$

10. Resolving 85184 into prime factors, we get

2	85184
2	42592
2	21296
2	10648
2	5324
2	2662
11	1331
11	121
11	11
	1

$85184 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{11 \times 11 \times 11}$

Therefore, $\sqrt[3]{85184} = 2\times2\times11 = 44$

Long Answer Type

1. $262144 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2}$

$\therefore \sqrt[3]{262144} = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$

2	262144
2	131072
2	65536
2	32768
2	16384
2	8192
2	4096
2	2048
2	1024
2	512
2	256
2	128
2	64
2	32
2	16
2	8
2	4
2	2
	1

2. Let the numbers be x, $2x$ and $3x$. Then

$(x)^3 + (2x)^3 + (3x)^3 = 98784$

$\Rightarrow \quad x^3 + 8x^3 + 27x^3 = 98784$

$\Rightarrow \quad 36x^3 = 98784$

$\Rightarrow \quad x^3 = \dfrac{98784}{36}$

$\Rightarrow \quad x^3 = 2744 \quad \Rightarrow \quad x = \sqrt[3]{2744}$

2	2744
2	1372
2	686
7	343
7	49
7	7
	1

$\therefore \quad x = \sqrt[3]{2\times2\times2\times7\times7\times7} \Rightarrow \quad x = 2 \times 7 = 14$

Hence, the numbers are $x = 14$,
$2x = 2 \times 14 = 28$ and $3x = 3 \times 14 = 42$.

3. We observe that 1372 and 1458 both are not perfect cubes. Therefore, we factorize them using the property : $\sqrt[3]{a} \times \sqrt[3]{b} = \sqrt[3]{ab}$

$\therefore \quad \sqrt[3]{1372} \times \sqrt[3]{1458} = \sqrt[3]{1372 \times 1458}$

Now, resolving 1372 and 1458 into prime factors

2	1372
2	686
7	343
7	49
7	7
	1

2	1458
3	729
3	243
3	81
3	27
3	9
3	3
	1

$\therefore \quad \sqrt[3]{1372} \times \sqrt[3]{1458}$

$= \sqrt[3]{2\times2\times7\times7\times7\times2\times3\times3\times3\times3\times3\times3}$

$= \sqrt[3]{2\times2\times2\times7\times7\times7\times3\times3\times3\times3\times3\times3}$

$= 2 \times 7 \times 3 \times 3 = 126.$

4. We have, $\sqrt[3]{\dfrac{3375}{2744}} = \dfrac{\sqrt[3]{3375}}{\sqrt[3]{2744}}$

Now, resolving 3375 and 2744 into prime factors, we get

$3375 = \underbrace{5\times5\times5}\times\underbrace{3\times3\times3}$

and $2744 = \underbrace{2\times2\times2}\times\underbrace{7\times7\times7}$

$\therefore \sqrt[3]{3375} = 5\times3 = 15$

and $\sqrt[3]{2744} = 2\times7 = 14$

5	3375
5	675
5	135
3	27
3	9
3	3
	1

2	2744
2	1372
2	686
7	343
7	49
7	7
	1

Hence, $\sqrt[3]{\dfrac{3375}{2744}} = \dfrac{\sqrt[3]{3375}}{\sqrt[3]{2744}} = \dfrac{15}{14}$.

5. Resolving 110592 into prime factors, we get

2	110592
2	55296
2	27648
2	13824
2	6912
2	3456
2	1728
2	864
2	432
2	216
2	108
2	54
3	27
3	9
3	3
	1

$$\sqrt[3]{110592} = \sqrt[3]{\underbrace{2\times2\times2}\times\underbrace{2\times2\times2}\times\underbrace{2\times2\times2}\times\underbrace{2\times2\times2}\times\underbrace{3\times3\times3}}$$

$= 2 \times 2 \times 2 \times 2 \times 3 = 48.$

Integer/Numerical Value Type

1. **(4) :** We have $\sqrt[3]{\dfrac{a^6\times b^3\times c^{21}}{c^9\times a^{12}}} = \sqrt[3]{a^{6-12}\times b^3\times c^{21-9}}$

$= \sqrt[3]{\dfrac{b^3\times c^{12}}{a^6}} = \dfrac{(b^3)^{1/3}(c^{12})^{1/3}}{(a^6)^{1/3}} = \dfrac{bc^4}{a^2} = \dfrac{bc^4}{a^{4/2}}$

Hence $k = 4$.

2. **(4) :** We are given that $p^3 = 16p$

$\Rightarrow \quad p^3 - 16p = 0$

$\Rightarrow \quad p(p^2 - 16) = 0$

$\Rightarrow$ either $p = 0$ or $p^2 - 16 = 0$

But $p \neq 0$ (Given)

$\Rightarrow \quad p^2 - 16 = 0 \Rightarrow \quad p = \pm4$

But $p \neq -4$, Hence $p = 4$.

3. (2) : Since the unit's place digit of $xyz8$ is 8
$\therefore$ Unit's place digit of cube of $xyz8$ is 2.

4. (3) : Since the unit's place digit of number 1234567 is 7.
$\therefore$ Unit's place digit of cube of number is 3.

5. (21) : According to the question, let the number be x.

$\therefore \quad x \times x \times x - 61 = 9200$

$\Rightarrow \quad x^3 - 61 = 9200 \quad \Rightarrow \quad x^3 = 9261$

Taking cube root on both sides, we get

$x = (9261)^{1/3} \Rightarrow x = 21$

6. (14) : $\sqrt[3]{\frac{125}{1000}} + \sqrt[3]{\frac{729}{1000}} = \sqrt[3]{\frac{5\times5\times5}{10\times10\times10}} + \sqrt[3]{\frac{9\times9\times9}{10\times10\times10}}$

$= \left(\frac{5^3}{10^3}\right)^{1/3} + \left(\frac{9^3}{10^3}\right)^{1/3} = \frac{5}{10} + \frac{9}{10} = \frac{14}{10} = \frac{n}{10}$

Hence, $n = 14$.

7. (1) : We have $a = 2b$, $b = 4c$

$\sqrt[3]{\frac{a^2}{16bc}} = \sqrt[3]{\frac{(2b)^2}{16\times4c\times c}}$

$= \sqrt[3]{\frac{4b^2}{16\times4\times c^2}} = \sqrt[3]{\frac{4\times16\times c^2}{16\times4\times c^2}} = \sqrt[3]{1} = 1$

8. (2) : $\sqrt[3]{\frac{3^6\times4^3\times2^6}{8^9\times2^3}} = \sqrt[3]{\frac{3^6\times(2^2)^3\times2^6}{(2^3)^9\times2^3}}$

$= \sqrt[3]{\frac{3^6\times2^6\times2^6}{2^{27}\times2^3}} = \sqrt[3]{\frac{3^6}{2^{18}}} = \frac{(3^6)^{1/3}}{(2^{18})^{1/3}}$

$= \frac{3^2}{2^6} = \frac{3^2}{(2^3)^2} = \frac{3^2}{8^2} = \left(\frac{3}{8}\right)^2 = \left(\frac{3}{8}\right)^k$

Hence $k = 2$

9. (7) : If unit's place digit of number is 3, then unit's place digit of its cube is 7.

10. (22) : By the method of prime factorisation.

2	10648
2	5324
2	2662
11	1331
11	121
11	11
	1

Resolving 10648 into prime factors, we get
$10648 = \underline{2 \times 2 \times 2} \times \underline{11 \times 11 \times 11}$

$\therefore \quad \sqrt[3]{10648} = 2\times11 = 22$

Hence, cube root of 10648 is 22.

Case Based Questions

Case I

1. (b): (a) Prime factorisation of
$729 = \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3}$

$\therefore$ 729 is a perfect cube.

(b) Prime factorisation of $2724 = 2 \times 2 \times 3 \times 227$. Since, 2724 cannot be expressed as a product of triplets.
$\therefore$ 2724 is not a perfect cube.

(c) Prime factorisation of
$3375 = \underline{3 \times 3 \times 3} \times \underline{5 \times 5 \times 5}$

$\therefore$ 3375 is a perfect cube.

(d) Prime factorisation of $1331 = \underline{11 \times 11 \times 11}$
$\therefore$ 1331 is a perfect cube.

2. (d): (a) Since, 181 cannot be expressed as a product of triplets. So, 181 is not a perfect cube.

(b) Since, 521 cannot be expressed as a product of triplets. So, 521 is not a perfect cube.

(c) Since, factorisation of $105 = 3 \times 5 \times 7$ cannot be expressed as a product of triplets. So, 105 is not a perfect cube.

(d) Prime factorisation of $216 = \underline{6 \times 6 \times 6}$
$\therefore$ 216 is a perfect cube.

3. (b): If a number ends with one zero, then its cube ends with three zeros. So, if a number ends with two zeroes, then its cube ends with six zeroes.

4. (c) : Prime factorisation of 25272
$= \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 3 \times 3 \times 13$

The prime factor $3 \times 3 \times 13 = 117$ does not appear in the group of three.

So, we divide the number 25272 by 117 to make it a perfect cube.

5. (d): Prime factorisation of 6860
$= 2 \times 2 \times 5 \times \underline{7 \times 7 \times 7}$

The prime factor $2 \times 2 \times 5 = 20$ does not appear in the group of three. So, we divide the number 6860 by 20, to make it a perfect cube.

Case II

1. (d) : Let the length, breadth and height be $9x$, $7x$ and $8x$ respectively.

Volume of the cuboid = 367416 cm^3 (given)

$\Rightarrow \quad 9x \times 7x \times 8x = 367416$

$\Rightarrow \quad x^3 = 729 \Rightarrow x = \sqrt[3]{729} = \sqrt[3]{9\times9\times9} \Rightarrow x = 9$

2. (b): Length of the cuboid $= 9x = 9 \times 9 = 81$ cm

3. (a) : Breadth of the cuboid $= 7x = 7 \times 9 = 63$ cm

4. (c) : Height of the cuboid $= 8x = 8 \times 9 = 72$ cm

5. (d): Unit digit of the number 729 is 9.
$\therefore$ Unit digit of its cube must be 9.

Case III

1. (d): $\sqrt[3]{740xy} = 42$

$\Rightarrow \quad 740xy = (42)^3$

$= 42 \times 42 \times 42 = 74088$

2. (a): The given number is $740xy$

Compare it with 74088, we get, $x = 8$ and $y = 8$

$\therefore$ Required difference $= 8 - 8 = 0$

3. (c) : Required product $= x \times y = 8 \times 8 = 64$

4. (a): Given $\frac{x}{y} = k$, where $x = 8$ and $y = 8$

$\Rightarrow \quad \frac{8}{8} = k \Rightarrow \quad k = 1$

5. (c): Cube of a negative number is always negative.

Case IV

1. (d): Let the number be x.

Now, cube root of quotient = 12.

$\therefore$ Quotient $= (12)^3 = 1728$

A.T.Q., $\frac{x}{36} = 1728 \Rightarrow x = 62208$

$\therefore$ The required number is 62208.

2. (a): Prime factorisation of 62208

$= 2 \times 2 \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 3 \times 3$

Thus, the prime factors 2 and 3 do not appear in the group of three.

3. (b): The least number by which 62208 must be multiplied to make it a perfect cube is $2 \times 3 = 6$.

4. (c) : Number obtained $= 62208 \times 6 = 373248$

Now, $373248 = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times \underline{3 \times 3 \times 3}$

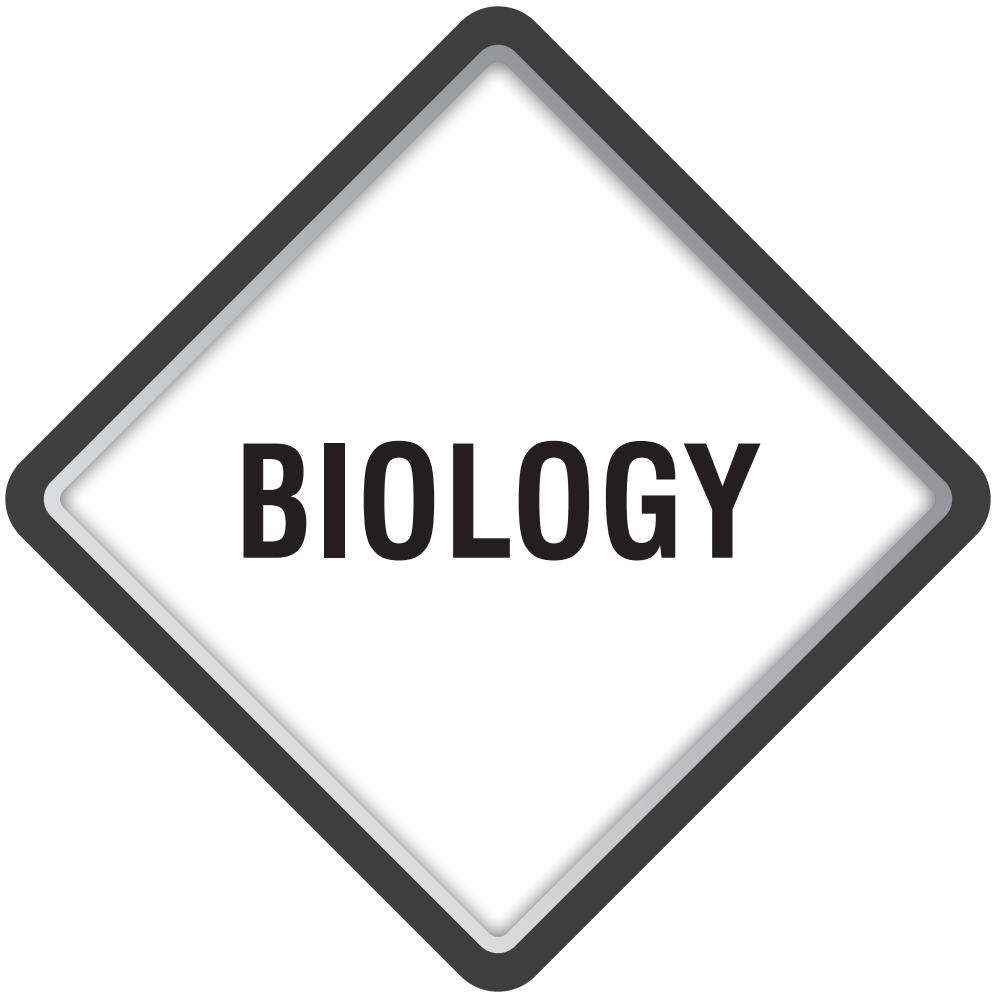
$\therefore \quad \sqrt[3]{373248} = \sqrt[3]{2^3 \times 2^3 \times 2^3 \times 3^3 \times 3^3}$

$= 2 \times 2 \times 2 \times 3 \times 3 = 72$

5. (b) : The prime factorisation of 2744 is $2 \times 2 \times 2 \times 7 \times 7 \times 7$

$\therefore$ Cube root of $2744 = 2 \times 7 = 14$

☺☺☺


BIOLOGY

CHAPTER 04

Heredity

Learning Outcomes...

- **Accumulation of Variations**
- **Heredity and Genetics**
- **Rules for Inheritance**
- Monohybrid Cross
- Dihybrid Cross
- **Sex Determination**

Introduction

Every individual, be it a bird or an animal or a human, produces individuals similar to it by reproductive processes. Thus, parent's characters are transferred to offsprings. Transmission of characters from parents to offsprings is known as heredity. Thus, **heredity is defined as process of transmission/inheritance of characters from one generation to the next generation.**

Although, offsprings inherit characters from their parents, they are not exact copies of their parents. They may differ in their skin, colour, height, facial features, etc. All these differences are called variations. The term **variation is defined as the "differences in the traits or characters among the individuals of a species"**. Variations are inherited and accumulated. In long term, they lead to evolution and development of a new species.

Accumulation of Variations

Variations are generated due to changes in environmental factors and reproduction.

Environmental factors

A common basic body design is inherited from parent generation which is subjected to possible changes, that may enable the organism to be better adapted to environment. Thus, second generation organisms will show variations from first generation organisms and subsequent generation organisms will show variations from their parent generations.

For example, in a bacterial colony, various individuals show variations in their heat resistance capacity. If temperature rises, then most bacteria will die, and only few variants will be left which will be able to withstand higher environmental temperature. This variation of comparatively more heat resistance will go on accumulating in the bacteria of successive generations and ultimately highly heat resistant variants will develop which will be able to survive even at very high temperature.

Reproduction

Reproduction maintains newly created differences in second generation besides those variations that they inherit from the first generation. It can be explained by the given figure.

In asexually reproducing organisms *e.g.*, bacteria, individual bacteria generated would be very similar to parents and are known as **clones**. There would be very minor differences between them, due to small inaccuracies in DNA copying or due to some environmental factors like light, scarcity of food, abundance of food, temperature etc., or mutation which are sudden changes in genes.

Whereas, in sexual reproduction greater variations are generated because of:

(i) Exchange of DNA segments during crossing over in gamete formation.

(ii) Union of traits from two different parents during fertilisation.

Variations get accumulated or discarded as a combined effect of environmental factors and reproduction process. This selection or rejection of variations forms the basis for evolution.

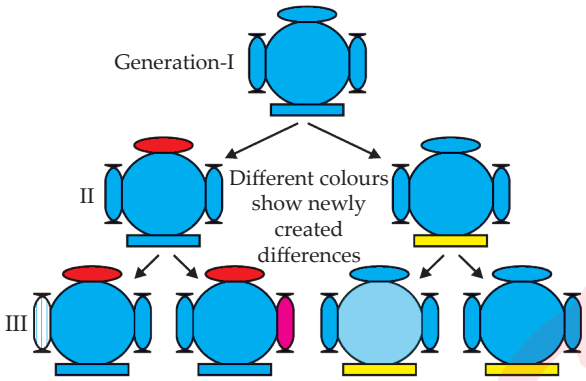


Fig.: Creation of diversity over succeeding generations. The original organism at the top will give rise to, say two individuals, similar in body design, but with subtle differences. Each of them, in turn, will give rise to two individuals in the next generations. Each of the four individuals in the bottom row will be different from each other. While some of these differences will be unique, others will be inherited from their respective parents, who were different from each other.

Mutation

COMPETITION WINDOW

- **Mutation** is a sudden random change in the genetic material of a cell that can cause alteration in appearance or behaviour (*i.e.*, in phenotype) from the normal type. This change can be heritable and pass on to the next generation. An organism affected by a mutation (especially one with visible effects) is described as a **mutant**. **Somatic mutations** affect the non-reproductive cells and are therefore restricted to the tissues of a single organism, but **germline mutations** which occur in the reproductive cells or their precursors get transmitted to the organism's descendants and cause abnormal development. Mutations occur naturally at a low rate but this may be increased by radiation and by some chemicals called **mutagens**. Mutation is therefore essential for evolution, as it is the ultimate source of genetic variation.

Heredity and Genetics

Heredity is the process of transmission of characters/traits from parents to the offsprings.

Genetics is defined as a branch of science which deals with the study of heredity and variation. **W. Bateson** first coined the term genetics in 1905.

DO YOU KNOW?

- Word genetics is derived from the Greek word "*genesis*" meaning 'to grow into' or 'to become'.
- Mutations were discovered by Hugo de Vries.

Characters that are seen in an individual (*e.g.*, height, facial features, body colour, etc.) are called traits. They are of two types:

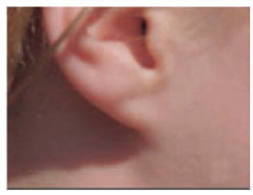
- **Inherited traits :** Traits that are transferred from one generation to another are called inherited traits. These traits are determined by germplasm or, specifically by genes of an individual (*e.g.*, body colour, eye colour, etc.). They may also generate spontaneously due to environmental factors (mutation in genes) and then get transferred to future generations.

ACTIVITY CORNER

To study variations of ear lobes among your classmates.

- **Procedure :** (i) Count the number of students with free ear lobes.
  (ii) Count the number of students with fused ear lobes.
  (iii) Find out percentage of these two types of ear lobes in your class and tabulate the findings.

Free ear lobes



Fused ear lobes

  (iv) Ask them about ear lobe types of their parents, tabulate the data.
  (v) Correlate the ear lobe type of each student with that of his/her parents.
- **Observe :** (i) Which ear lobe type is most common ?
  (ii) Does the child with fused ear lobes have one of the parents with fused ear lobes ?
  (iii) If yes, then can we say that ear lobe type is an inherited character?
- **Conclusion :** Free ear lobes are more common. Children with fused ear lobes have either one or both parents with fused ear lobes. Thus ear lobe type is inherited from parents and shows variations among a group of human individuals.

- **Acquired traits** : These traits are simply acquired during the lifetime of an individual and are not transferred to future generations as they have not affected genes (*e.g.*, loss of an organ in an accident, experiences gained in life). Thus these traits are not important in studies of genetics and evolution. *E.g.*, if, we surgically remove tail of a mouse, its future generations will not be tail-less; because removal of the tail cannot change the genes in the germ cells of the mouse.

ACTIVITY CORNER

If you know a person with any organ loss (*e.g.*, eye, leg or hand) then find out whether organ loss is an inherited or acquired trait.

- **Procedure :** Track history of a person's past generations for absence or presence of that organ. Find out if his children lack that particular organ. Analyse the findings.
- **Analysis and Conclusion :** No one in his past or future generations shows absence of that particular organ. It shows that it is an acquired trait and not an inherited one.

Illustrations

1 If a trait A exists in 10% of a population of an asexually reproducing species and a trait B exists in 60% of the same population, which trait is likely to have arisen earlier? **(NCERT)**

Ans.: During reproduction, variations accumulate. Variations occurring in first generation will be inherited to subsequent generations, thus should be more frequent. Here trait B occurs in more individuals thus it is likely to have arisen earlier.

2 How does the creation of variations in a species promote survival? **(NCERT)**

Ans.: Variations are produced to enable the organisms to lead for better adaptation to their environment. An organism adapted better to its environment will have better chances of survival.

3 What is the difference between genetics and heredity?

Ans.: Heredity is the transmission of characters/ traits from parents to the offsprings. While genetics is defined as a branch of science which deals with the study of heredity and variation.

Gregor Johann Mendel (1822 – 1884)

- Mendel joined a monastery and went on to study science and mathematics at the **University of Vienna.** Failure in the examinations for a teaching certificate did not suppress his zeal for scientific quest. He went back to his monastery and started growing peas. Many other scientists had studied the inheritance of traits in peas and other organisms earlier, but Mendel blended his knowledge of science and mathematics and was the first one to keep count of individuals exhibiting a particular trait in each generation. This helped him to arrive at the **laws of inheritance**. He published his findings in 1866 in the "Annual proceedings of the Natural History Society of Brunn". His findings remained unknown until these were rediscovered by three biologists namely, **Hugo de Vries** of Netherland, **Karl Correns** of Germany and **Erich von Tschermark** of Austria independently in 1900. The forgotten work of Mendel was republished in 1901. Mendel's findings formed the basis of the science of genetics and he is credited as the **father of genetics**.

COMPETITION WINDOW

Rules for Inheritance – Mendel's Contributions

Our knowledge about inheritance of traits is based upon **Mendel's** work. He conducted his experiments over a period of eight years on the common **garden pea plant** (*Pisum sativum*).

Selection of garden pea as the experimental plant

Mendel observed the following advantages in selecting pea plant:

- Garden pea plant has a short life cycle. It makes possible to study several generations within a short period.
- It shows several well defined, easily detectable contrasting traits. *E.g.*, violet and white flowers.
- Bisexual pea flower; maturing of male and female reproductive organs at the same time and complete enclosure of reproductive parts by petals ensure self-pollination. Self pollination helps to maintain purity of genes.
- Artificial cross pollination (hybridisation *i.e.*, removal of stamens and dusting the pistil of flowers with pollen grains of desired plants) can be easily achieved as reproductive organs are large enough to be seen with naked eyes.
- Seven traits selected by Mendel were readily available in all pea plants. They can be raised, maintained and handled conveniently.
- Pea plants produce large number of seeds in one generation. This helps in drawing authentic conclusions. Mendel performed separate crosses involving one, two or three different contrasting characters. These crosses were respectively called **monohybrid, dihybrid** and **trihybrid crosses**.

S. No.	Character	Dominant trait	Recessive trait
1.	Seed shape	Round	Wrinkled
2.	Seed colour	Yellow	Green
3.	Flower colour	Violet	White
4.	Pod shape	Full	Constricted
5.	Pod colour	Green	Yellow
6.	Flower position	Axial	Terminal
7.	Stem height	Tall	Dwarf

Fig.: Seven pairs of contrasting characters in pea plant studied by Mendel

DO YOU KNOW?

- Mendel performed experiments in 3 stages :
  - Selection of pure or true breeding parents obtaining F_1 generation.
  - Self-pollination of F_1 plants to get subsequent generations.
  - Hybridisation to produce hybrid.

Important Terms

- **Mendelian factor or Gene:** A gene is the segment of DNA which is carried from the parent to progeny by gametes and controls the expression of a character in the organism along with another factor or its allele. Gene is considered as unit of inheritance.
- **Alleles or Allelomorphs:** The two Mendelian factors which occur on the same loci in the homologous chromosomes of an individual and control a character are called alleles or allelomorphs, *e.g.*, T, and t are considered alleles of gene for plant height.
- **Multiple alleles** are three or more alternative forms of a gene (alleles) that can occupy the same locus but only two of the alleles can be present in a single organism. For example, the ABO system of blood groups is controlled by three alleles I^A, I^B and *i* only two of which are present in an individual.
- **Homozygous organism:** An organism which contains identical alleles of a character on homologous chromosomes is said to be homozygous or genetically pure for that character. Homozygous organisms give rise to offsprings having the same traits on self breeding. For example, pea plants with TT or tt alleles are homozygous for height.
- **Heterozygous organism:** An organism which contains two different alleles for a character on its homologous chromosomes is called heterozygous or hybrid for that particular character. These organisms on self breeding produce offsprings in the ratio of 3 : 1. For example, pea plants with alleles Tt are heterozygous for height.
- **Genotype** is the genetic constitution of an organism, *e.g.*, genotype of a hybrid tall is Tt, pure tall is TT and dwarf is tt with regard to the character of height.
- **Phenotype:** Phenotype of an individual refers to the expressed or observable, structural and functional traits produced by the interaction of genes and environment, for example, height of a plant, colour of a flower, colour and shape of a seed, etc.
- **Back cross:** It is a cross which is made between a hybrid and one of its parents. In plant breeding, such crosses are performed to improve the variety of crop plants. For example, a crop plant is crossed with a wild variety (all crop plants are originated from wild varieties) in order to obtain its disease resistance.
- **Reciprocal cross:** Reciprocal cross involves the same trait but sexes are reversed to those in the original cross.
- **Test cross:** Cross between an individual of unknown genotype and recessive parent.

COMPETITION WINDOW

Monohybrid cross

Crosses between the parents which differ only in one pair of contrasting characters are known as monohybrid crosses. Mendel crossed two sets of pea plants with contrasting characters for height. One set of pea plants was above 6′ (six feet) in height and the other set was of short plants with an average height of 1′ (one foot). Mendel called these plants **homozygous tall** and **homozygous dwarf**. These plants represented the **parent generation (P generation)**.

The pollen grains were collected from a flower of tall plant and dusted over the pistils of emasculated flower of dwarf plant (*vice-versa* reciprocal cross would not make any difference in the results). Care was taken that the plants of P generation do not get self pollinated. After cross pollination the flowers were covered with bags.

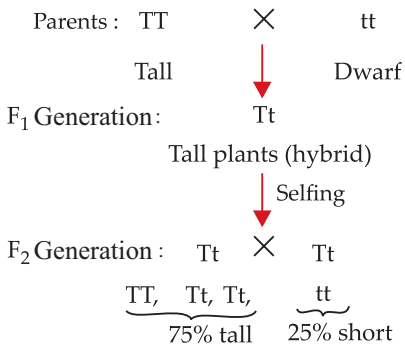


Fig.: Monohybrid cross

The plants grown from the seeds of parental plants were hybrid plants, they belonged to the **F_1 generation** or **first filial generation**. All plants of F_1 generation were heterozygous tall (Tt).

The plants of F_1 generation were self pollinated and seeds were collected. The plants raised from these seeds belonged to **second filial generation** or **F_2 generation**. Mendel observed that among the plants of F_2 generation 75% were tall and 25% were dwarf, *i.e.*, tall and dwarf plants were produced in the ratio of **3 : 1**. F_2 plants were self pollinated to produce, **F_3 generation**.

Mendel observed that (i) dwarf plants (25%) of F_2 generation produced only dwarf plants. (ii) 25% F_2 tall plants produced tall plants on self-pollination. These were called **pure tall or homozygous tall plants**. (iii) 50% tall plants produced tall and dwarf in the ratio of 3 : 1 on self-pollination. These were called **hybrid tall plants**.

Thus, it concluded that out of the two characters of parents only one expresses itself in hybrids. This character was termed as dominant trait and the other as recessive trait. It also showed that dominant trait (tallness) is expressed in both homo or heterozygous conditions while recessive trait appears only in homozygous conditions.

Dihybrid cross

Crosses which involve parents differing in two pairs of contrasting characters simultaneously are referred to as dihybrid crosses.

Mendel selected pure breeding plants for yellow and green colour of seeds, and round and wrinkled shape of the seeds. He cross-pollinated pure pea plants having round yellow seeds (RRYY) and wrinkled green seeds (rryy).

The plants of this generation were referred as P generation or parent generation. The seeds produced belonged to F_1 generation (first filial generation) and all were round and yellow. Plants of F_1 generation were self-pollinated. On self-pollination these produced different seeds in next generation (F_2 generation or second filial generation) as shown in the given dihybrid cross.

The ratio resulted in the following conclusions:

Findings of Mendel's dihybrid cross

- F_1 offsprings always exhibited only one of the parental form of a trait and not the other.
- Trait which was hidden in F_1 generation appeared in F_2 generation. In F_2 generation, both the parental traits appeared. Mendel termed the form of the trait expressed in F_1 generation as **dominant trait.**
- Mendel observed a difference in the behaviour of plants raised from F_2 offsprings with dominant trait. One-third were true breeding, rest two-third of plants were not true breeding and resembled the F_1 hybrid plants in their behaviour.

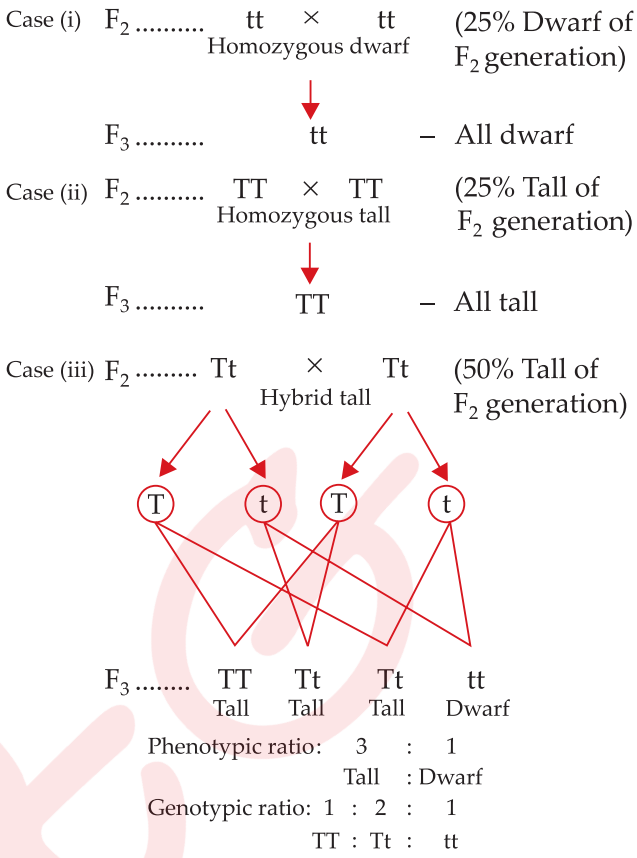
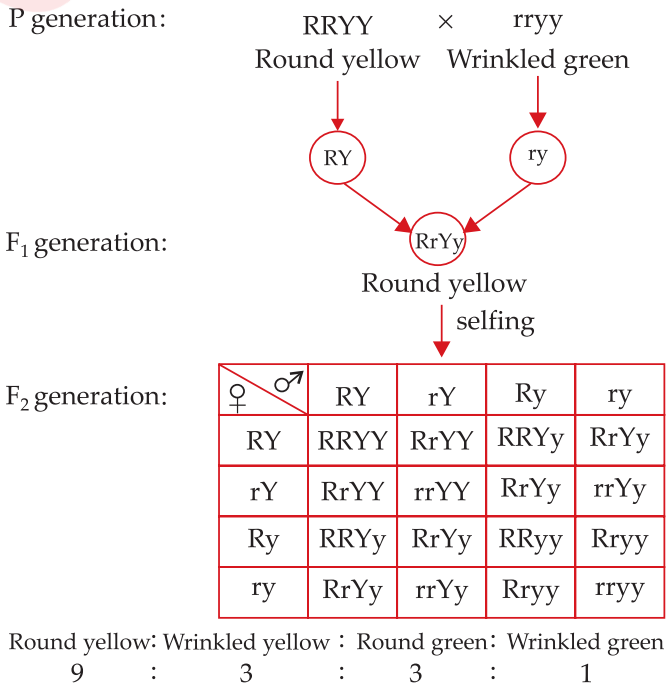


Fig.: Progenies obtained from monohybrid cross



♀ \ ♂	RY	rY	Ry	ry
RY	RRYY	RrYY	RRYy	RrYy
rY	RrYY	rrYY	RrYy	rrYy
Ry	RRYy	RrYy	RRyy	Rryy
ry	RrYy	rrYy	Rryy	rryy

Round yellow : Wrinkled yellow : Round green : Wrinkled green
9 : 3 : 3 : 1

Fig.: Dihybrid cross

- Mendel observed that one of the parental forms of the trait was always absent in F_1 hybrid but reappeared unchanged in the F_2 generation. It proved that alternate forms of a trait can retain their identity in the hybrid and can re-emerge unchanged in subsequent generations.
- In dihybrid crosses Mendel observed four types of plants in F_2 generation. He concluded that the factors of each of the two characters assort independent to each other.
- 4 types of phenotypes – round yellow : round green : wrinkled yellow : wrinkled green

  Phenotypic ratio 9 : 3 : 3 : 1

(i) **Round and yellow seeded plants – (9/16)**

9 in all are of the following four genotypes in the ratio of 1 : 2 : 2 : 4.

(a) One plant with RRYY genotypic constitution (Homozygous) – 1/16

(b) Two plants with RRYy genotypic constitution (Heterozygous) – 2/16

(c) Two plants with RrYY genotypic constitution (Heterozygous) – 2/16

(d) Four plants with RrYy genotypic constitution (Heterozygous) – 4/16

(ii) **Round and green seeded plants – (3/16)**

3 in all are of the following two genotypes in the ratio of 1 : 2.

(a) One plant with RRyy genotypic constitution (Homozygous) – 1/16

(b) Two plants with Rryy genotypic constitution (Heterozygous) – 2/16

(iii) **Wrinkled and yellow seeded plants – (3/16)**

3 in all are of the following two genotypes in ratio of 1 : 2.

(a) One plant with rrYY genotypic constitution (Homozygous) – 1/16

(b) Two plants with rrYy genotypic constitution (Heterozygous) – 2/16

(iv) **Wrinkled and green seeded plants – (1/16)**

Only one plant with rryy genotypic constitution (Homozygous) – 1/16.

- Thus, genotypic ratio in dihybrid cross will be 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1

Mendel's laws

The above observations led Mendel to formulate his three principles/laws of heredity.

Conclusion drawn by Mendel on the basis of monohybrid cross

Principle or law of dominance

In a hybrid or heterozygous individual two dissimilar unit factors are present for one character. Out of two **factors** (genes) only one is able to express itself and it prevents expression of the other. The one which expresses itself is called **dominant gene** or **factor** and the one which remains unexpressed is called **recessive gene** or **factor**. For example, in hybrid tall (Tt) only factor (gene) of tallness expresses itself, hence it is called dominant character. These two contrasting characters are expressed by two different alleles (forms) of a single gene.

Principle or law of segregation

The two unit factors of a character which remain together in an individual, do not get mixed up, and keep their distinct identity. They separate or segregate during gamete formation so that each gamete receives only one factor (gene) for each character and is always pure. This postulate is also called **principle of purity of gametes**.

For example, in a hybrid tall pea plant, unit factors of tallness (T) and dwarfness (t) separate out or segregate out during gamete formation. The two unit factors occur with equal frequency in male and female gametes.

Illustrations

4 How do Mendel's experiments show that traits may be dominant or recessive? **(NCERT)**

Ans.: When plants with two contrasting characters (*e.g.*, tall and dwarf) are crossed, only one character is visible in F_1 generation and other character is suppressed. It shows dominance of one character over other (recessive character).

5 How can we say that gametes maintain their purity during reproduction?

Ans.: F_1 hybrids when selfed, produced plants with both dominant and recessive phenotypes. It showed that the two unit factors of a character which remain together in an individual do not get mixed up, or get contaminated and keep their distinct identity. They separate or segregate during gamete formation.

6 How do Mendel's experiments show that traits are inherited independently? **(NCERT)**

Ans.: In a dihybrid cross when two pairs of contrasting characters were considered simultaneously by Mendel, in F_1 generation only two dominant characters showed their appearance but in F_2 generation phenotypically two different types of recombinant characters appeared with parental characters. Mendel concluded that each character is independent and it is due to their independent assortment that individuals with four different combinations are produced.

7 A man with blood group A marries a woman with blood group O and their daughter has blood group O. Is this information enough to tell you which of the traits – blood group A or O – is dominant? Why or why not ? **(NCERT)**

Ans.: No, information is not sufficient because daughter may have blood group O in both cases whether blood group A or blood group O is dominant. It can be explained as follows:

(a) If blood group A is dominant – Mother will be homozygous for recessive allele O. Father with blood group A may be homo or heterozygous. In homozygous condition he will lack allele O. Daughter will get allele O from her mother only and allele O being recessive will not be expressed. But if heterozygous, then father will also have an allele for O. Daughter may get alleles for O from both parents and being homozygous for recessive allele O, she will have blood group O.

(b) If blood group O is dominant – Father must lack allele O to show blood group A. Mother may be either homozygous or heterozygous for allele O. In both the conditions daughter will get one allele for blood group O . Allele O being dominant will be expressed always and the daughter will have blood group O.

Thus, as daughter may have blood group O in both conditions thus we cannot say with certainty which blood group is dominant.

8 A tall and a short pea plant are crossed and all tall F_1 progenies are obtained. F_1 tall plants are selfed and produced tall and dwarf plants in 3 : 1 ratio in F_2. Find out the genotype of F_1 tall plant.

Ans.: As one dwarf plant has been produced in F_2 generation and dwarf character is recessive, dwarf F_2 plant must have gained 't' gene from both its parents. Thus, F_1 plant must have one 't' gene. And, as F_1 plants have also produced tall plants with gene T, thus, it must have gene 'T' in its genotype. Thus F_1 plant has a 'T' and a 't' gene and its genotype will be Tt *i.e.*, hybrid tall.

Conclusion drawn by Mendel on the basis of dihybrid cross

Principle or law of independent assortment

This principle states that the unit factor of each character is assorted or distributed into the gametes independent of the unit factors (genes) of any other character and gets randomly rearranged in the offspring. For example, in Mendel's dihybrid cross the offsprings of F_1 generation after self breeding produced four types of offsprings. Two types were similar to parents while the remaining two types had combination of traits. This became possible because the unit factors of the two characters assorted independent to each other.

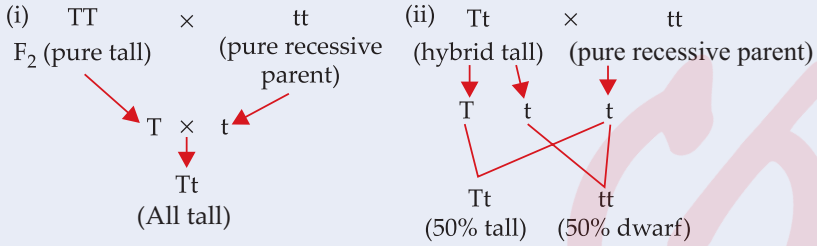
ACTIVITY CORNER

To test if a F_2 dominant phenotype is a pure strain or hybrid.

In a monohybrid cross experiment, a dominant phenotype (say, yellow seed colour) may be exhibited by homozygous (YY) or a heterozygous (Yy) genotype *i.e.*, a 'pure'or a 'hybrid' form. The genotype of such an offspring can be determined by a simple test called test cross. 'A test cross is a cross in which an individual with an unknown genotype but with dominant phenotype is crossed with an individual (or parent) which is homozygous recessive for that trait.' There are two possibilities –

(i) If all plants produced after test cross show dominant phenotypes then, F_2 plants must be pure strain.

(ii) If after test cross 50% tall and 50% dwarf plants are produced, then it must be a hybrid.



Inheritance of Traits

After knowing that characters are inherited from parents, the question arises that which entity controls inheritance. Mendel proposed that a pair of factors, which are now called **genes**, control inheritance.

According to Mendelian experiments both parents must be contributing equally to the DNA of the progeny during sexual reproduction, *i.e.*, both parents must be contributing a copy of the same gene.

Thus, each progeny must have two sets of all genes, one inherited from each parent and for this mechanism to work, a gamete must have only one gene set. **Meiosis** works for this purpose.

If progeny plants inherited a single whole gene set from each parent, then independent assortment cannot work, because the two characteristics would then be linked to each other and cannot be independently inherited. This is explained by the fact that each gene set is present, not as a single long thread of DNA, but as separate independent pieces called a **chromosome**. Thus, each cell will have two copies of each chromosome, one each from the male and female parents. Every germ cell will take one chromosome from each chromosome pair and these may be of either maternal or paternal origin. When two germ cells combine, they will restore the normal number of chromosomes in the progeny, ensuring the stability of the DNA of the species.

The paired condition of chromosomes is said to be **diploid**. The chromosome number in somatic cells of higher organisms is diploid and is represented by 2N or 2n. A set of unpaired chromosomes is said to be **haploid** and is represented by N or n. Gametes (sperm and ovum) have haploid set of chromosomes.

A section of DNA carries information for a particular type of protein to be synthesised. The protein may be an enzyme which controls appearance of a particular character.

Let us take the example of inheritance of tallness in plants.

The height of a plant depends upon the amount of growth hormone. Gene for tallness carries the information for synthesis of more efficient enzyme which in turn produces more amount of hormone which leads to greater height of a plant. On the other hand if plant has both alleles for dwarfness then less efficient enzymes will be produced which in turn will synthesise less amount of hormone and plant will remain dwarf. In this way genes control characteristics or traits of organisms.

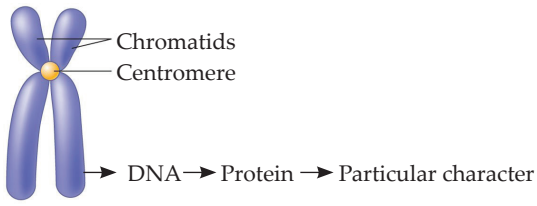


Fig.: Chromosome

Basic features of the mechanism of inheritance

(i) Characters (traits) are controlled by genes which are present on chromosomes.

(ii) There may be two or more forms (alleles) of the gene. One form may be dominant over the other form.

(iii) The two forms of the gene separate at the time of gamete formation so that each gamete has only one allele.

(iv) The two forms of the gene (alleles) are brought together in the zygote after fertilisation of male and female gametes.

DO YOU KNOW?

- The chromosomes present in the nucleus of living cells serve as the vehicles of transmission of characters.
- Garden pea has 14 chromosomes and human beings have 46 chromosomes.

Expression of Traits

- Mendel proposed that a pair of factors, which are now called **genes**, control inheritance. Later on, they were found to occupy specific positions on thread like structures called **chromosomes.**
- **Sutton** and **Boveri** proposed chromosomal theory of inheritance.
- **E. Strasburger** discovered **chromosomes** in 1875. They appeared as thread like structures during cell division. These were called chromosomes (*Chroma* = colour) due to their affinity for basic dyes.
- **The genetic material present in chromosomes is DNA. Genes are segments of DNA.**
- Chromosomes are present in the nuclei of all living cells. Each chromosome consists of two strands called **chromatids** which are joined together at a point called **centromere**. Each species has a fixed number of chromosome in its cells. In diploid organisms, chromosomes are present in pairs, *e.g.*, in human beings 46 chromosomes or 23 pairs of chromosomes are present in each cell.

DNA

- The expanded form of DNA is **deoxyribonucleic acid.** It was first isolated by the scientist **Frederick Meischer** from the nucleus of the pus cells in 1869. He named it as **'nuclein'** or **nucleic acid** because of its acidic nature. Later, it was experimentally proved by the scientists **Griffith** (1928), and **Avery, MacLeod** and **McCarty** (1944) that DNA is the carrier of the genetic information from generation to generation. It transmits the hereditary characters in a coded language from parents to the offspring (*i.e.*, from one generation to another).
- DNA is a macromolecule or polymer. It is made of very large number of 'nucleotide' units and hence is termed **polynucleotide**.
- Each nucleotide unit in a DNA molecule is made up of three components:

(i) **Deoxyribose sugar:** It is a pentose sugar.

(ii) **Nitrogenous base:** Each nucleotide unit has a nitrogen containing base. In a DNA molecule, nitrogenous bases are of two types:

(a) **Purines:** The purines in a DNA molecule are – **Adenine** (A) and **Guanine** (G).

(b) **Pyrimidines:** The pyrimidines in a DNA molecule are – **Cytosine** (C) and **Thymine** (T).

(iii) **Phosphate group:** The phosphate group contains one phosphorus atom and four specifically linked oxygen atoms.

- Thus, there are four types of nucleotides in a DNA molecule depending upon the kind of nitrogenous base present in each nucleotide.

COMPETITION WINDOW

Genes

- The word **'gene'** was introduced by **Johannsen** in **1909**.
- Genes are segments of DNA on a chromosome occupying specific positions. For example, 30,000 – 40,000 genes are present on 46 human chromosomes.
- Chemically, each gene has a specific sequence of nucleotides which determines its functional property. It is the genes which determine all the characters of an organism, like appearance, complexion, shape and colour of eyes, shape of nose and chin, etc. Actually, gene is a segment of DNA molecule which has coded information to form a particular protein in the cell. This protein can function either as a structural protein or as a functional protein (enzyme).
- On the basis of modern molecular concept, **a gene is a hereditary unit**, a segment of DNA having specific sequence of nucleotides that determines its specific biological function. It can maintain constancy from generation to generation but at times may also undergo sudden inheritable changes to bring variations known as **mutations**.
- In sexual reproduction both parents contribute equal amount of DNA to the offsprings.

Sex Determination

Sex of a newborn individual is determined in different ways in different species. Some species rely entirely on environmental factors. Thus, in some animals, the temperature at which fertilised eggs are kept, determines the sex of the individual. In snails, individuals can change sex, indicating that sex is not genetically determined. However, in human beings, the sex of the individual is genetically determined. In other words, the genes inherited from the parents decide the sex of the offsprings.

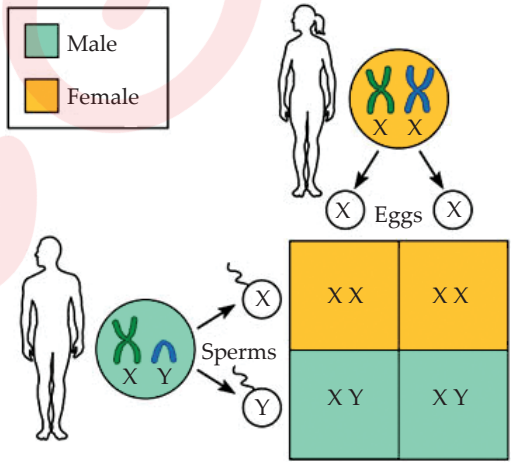


Fig.: Sex determination in human beings

In diploid (2N) organisms with separate sexes, a specific pair of **chromosomes** determine the sex of the individual. They are called **sex chromosomes**. All other chromosomes are called **autosomes**.

In case of autosomes, a pair of chromosomes are exactly similar as far as the shape and size are concerned, hence they are called **homologous chromosomes**. Sex chromosomes are **heterologous** *i.e.*, different in shape and size. In human beings, 23 pairs of chromosomes are present in each cell. Out of 23 pairs, 22 pairs of chromosomes carry genes which control somatic traits, these are called autosomes. The 23rd pair of chromosomes determine the sex, hence these chromosomes are called sex chromosomes.

The **human females have two X-chromosomes (*i.e.*, XX) as sex chromosomes**. Both the members of sex chromosomes are similar or **homomorphic**. However, **human males have XY sex chromosomes**, where X-chromosome is morphologically distinct from Y-chromosome. Y-chromosome is smaller than X-chromosome. Thus, they are dissimilar or **heteromorphic**.

During fertilisation there are equal chances that an ovum is fertilised by either a sperm having X-chromosome or a sperm having Y-chromosome. When a sperm carrying X-chromosome fertilises an egg, the zygote develops into a female (XX condition). When a sperm carrying Y-chromosome fertilises an egg, the zygote develops into a male (XY condition). Thus, **the sex of a baby is determined at the time of fertilisation.** The mechanism by which the sex of an individual is determined as it begins life, is called **sex determination.**

In grasshoppers and some other insects, the male has one sex chromosome (XO) whereas the female has two homomorphic (of same size and shape) sex chromosomes (XX). This type of sex determination mechanism is called **XX-XO** mechanism.

In different organisms, different mechanisms for sex determination work. For instance, in *Drosophila* (fruit fly) ratio between the number of X chromosomes and number of complete sets of autosomes will determine the sex. In higher plants heterologous sex chromosomes (like human) determine sex. In some plants like *Asparagus* single gene controls sex determination. Sometimes, as in lower animals, hormones control sex *e.g.*, in *Bonellia* all larvae are genetically and cytologically same, but those who land on another female worm develop into male (under influence of sex hormones of female worm) while those who develop free in water, develop into female. In many reptiles, environmental factors (*e.g.*, temperature) determine sex *e.g.*, in most turtle species only females are produced at 30 – 35°C and only males at 23 – 28°C.

Illustrations

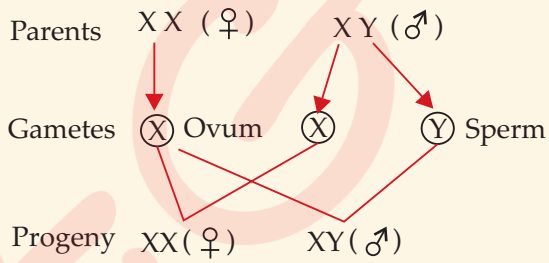
9 The human male is heterogametic while human female is homogametic. Why are they called so?

Ans.: The human male produces two different types of gametes (sperm with X-chromosome and sperm with Y-chromosome) thus termed heterogametic (*heteros*–different). Human female produces only one type of gametes (ova with X-chromosomes) thus termed homogametic.

10 How is the sex of the child determined in human beings? **(NCERT)**

Ans.: Human female (XX) produces all gametes (ova) with X-chromosomes, while human male (XY) produces 50% gametes (sperms) with X-chromosome while 50% gametes with Y-chromosome.

If sperm having X chromosome fertilizes the ovum with X chromosome then a female child is produced, otherwise a male child is produced.



Sex of the child (offspring) is determined by the type of sperm that fuses with ovum at the time of fertilization. Therefore, there is 50% chance of a male child being born and a 50% chance of a female child being born.

Heredity

Heredity

Branch of science which deals with inheritance of characters from parents to offsprings.

Variations

Differences in traits shown by individuals of a species. They provide base for natural selection.

Traits

Features (both similarities or differences) of an individual.

Acquired traits

Non-genetic, not transferred to future generations.

Inherited traits

Controlled by specific genes and transferred to future generations.

Inheritance of traits

Mechanism of trait transfer from generations to generations. Worked out by Mendel. His laws are –

Monohybrid

Law of dominance

- One allele of a gene shows dominance over the other.
- The two contrasting characters are expressed by two different alleles (forms) of a single gene.

Dihybrid cross

Law of segregation or purity of gametes

- Alleles present in a generation retain their purity (do not mix up) and segregate in next generation.
- Each gamete receives only one factor (gene) for each character and is always pure.

Law of independent assortment

- Alleles of genes for two different characters can assort independent of each other.
- In four types of offspring, two types were similar to parents while the remaining two types had combination of traits.

Sex determination

Mechanism by which sex of newborn is determined.

Environmental

- Environmental factors like temperature, etc., determine the sex of newborn.

Genetic/chromosomal

- Sex chromosomes determine the sex of newborn.
- In diploid organisms, autosomes and sex chromosomes are present.
- Sex chromosomes in human females are homomorphic (XX) while in males are heteromorphic (XY).
- Sperm containing Y-chromosome fuses with egg and leads to maleness (XY) wherease sperm containing X-chromosome fuses with egg and leads to femaleness (XX).

Solved Examples

1. What is genetics?

Ans.: Genetics is the branch of biology that deals with the study of heredity and variations. The term `genetics' was coined by William Bateson in 1905.

2. What are genes?

Ans.: Genes are segments of DNA having specific sequence of nucleotides that determines its specific biological function.

3. What is the result of small inaccuracies generated during DNA multiplication?

Ans.: The small inaccuracies generated during DNA multiplication lead to variations. As changed DNA codes for changed proteins, thus affects organism's structure and organisation, making it different from other individuals of species in a particular aspect.

4. Differentiate between inherited and acquired traits.

Ans.: Differences between inherited and acquired traits are as follows:

S. No.	Inherited traits	Acquired traits
(i)	These are obtained from the parents.	These are developed during the life of an individual.
(ii)	These are genetic variations.	These are somatic variations.
(iii)	These develop due to crossing over phenomenon and mutations.	These develop due to use and disuse of organs and direct effect of environment.
(iv)	These are passed on from one generation to the other.	These are lost with the death of the individual.

5. When a red flowered plant was crossed with white flowered plant, all F_1 progeny showed only red flowers. Define that law of Mendel which supports this result.

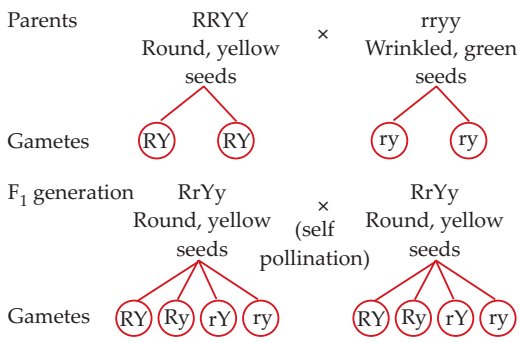
Ans.: It is first law of Mendel or the principle of dominance which states that out of the two alternative factors or alleles, only one expresses itself in offsprings which is known as dominant allele and other one which does not show its effect on the offsprings in first generation is termed as recessive allele.

6. A woman has only daughters. Analyse the situation genetically and provide a suitable explanation. **(NCERT Exemplar)**

Ans.: In human beings, females have XX and males have XY as a set of sex chromosomes. Female produces gametes (ovum) each with one X chromosome. Males on the other hand produces two types of gametes, half containing X chromosome and half containing Y chromosome. A female child (daughter) is produced when ovum is fertilised by X chromosome containing sperm. Since, woman has daughters only, this shows that X chromosome containing sperm has always fertilised the ovum.

7. Give reasons for the appearance of new combinations of characters in the F_2 progeny. **(NCERT Exemplar)**

Ans.: A breeding experiment dealing with two characters at the same time is called a dihybrid cross. In such a cross only one parental combination appears in F_1 generation. However, in F_2 generation raised by self pollination, four combinations of traits appear. These include two parental types and two new combinations. A typical dihybrid cross in pea plant is depicted as follows :-



F_2 generation :

Plant with round and yellow seeds		Plant with round and green seeds		Plant with wrinkled and yellow seeds		Plant with wrinkled and green seeds
9	:	3	:	3	:	1

New combinations of characters appear in F_2 generation because the inheritance of factors controlling a particular trait in an organism are independent of each other. This is called law of independent assortment. At the time of reproduction, two pairs of factors of each of the two traits in a dihybrid cross segregate independently during gamete formation and randomly form combinations in F_2 generation.

NCERT Section

1. A Mendelian experiment consists of breeding tall pea plants bearing violet flowers with short pea plants bearing white flowers. The progeny all bore violet flowers, but almost half of them were short. This suggests that the genetic make-up of the tall parent can be depicted as
   (a) TTWW
   (b) TTww
   (c) TtWW
   (d) TtWw.
2. A study found that children with light coloured eyes are likely to have parents with light coloured eyes. On this basis, can we say anything about whether the light eye colour trait is dominant or recessive? Why or why not?
3. Outline a project which aims to find the dominant coat colour in dogs.
4. How is the equal genetic contribution of male and female parents ensured in the progeny?

Exercise

Multiple Choice Questions

LEVEL - 1

1. Allele that cannot express itself in presence of another is
(a) codominant (b) dominant
(c) recessive (d) complementary. R

2. An organism with two unlike genes for a trait is called
(a) homozygous (b) heterozygous
(c) wild variety (d) dominant variety.

3. Mendel conducted his famous breeding experiments by working on
(a) *Drosophila* (b) *Pisum sativum*
(c) *Escherichia coli* (d) all of these.

4. Which of the following is a recessive trait in garden pea plant?
(a) Tall stem
(b) Wrinkled seeds
(c) Green coloured pod
(d) Round seeds R

5. Which of the following represents the characteristic of a pleiotropic gene?
(a) Controls sexual characters
(b) Present only in prokaryotes
(c) Controls one character in association with the other
(d) Controls more than one character

6. The main reason for Mendel's success in discovering the principles of inheritance was
(a) he considered each character separately
(b) he was lucky not to encounter with linkage problem
(c) the plant was pure breeding
(d) all of these. U

7. If a plant is heterozygous for tallness, the F_2 generation has both tall and dwarf plants. This proves the principle of
(a) dominance
(b) segregation
(c) independent assortment
(d) none of these.

8. The genotypic ratio in F_2 generation of monohybrid cross will be
(a) 1 : 2 : 1 (b) 3 : 1
(c) 1 : 1 (d) 1 : 2.

9. Which one is a possible progeny in F_2 generation of pure breed tall plant with round seeds and short plant with wrinkled seeds?
(a) Tall plant with round seeds
(b) Tall plant with wrinkled seeds
(c) Short plant with round seeds
(d) All of these Ap

10. A segment of DNA providing information for a protein is called
(a) nucleus (b) chromosomes
(c) trait (d) gene.

11. Mendel studied seven contrasting characters for his breeding experiment with *Pisum sativum*. Which of the following character did he not use?
(a) Pod colour (b) Pod shape
(c) Leaf shape (d) Plant height

12. Mendel's laws apply only when
(a) F_1 in monohybrid cross shows two types of individuals
(b) the characters are linked
(c) parents are pure breeding
(d) first pair of contrasting character is dependent upon other pairs. An

13. Mendel crossed a pure recessive white flowered pea plant with a pure dominant red flowered plant. The first generation of hybrids from the cross should show
(a) 50% white flowers and 50% red flowers
(b) all red flowered plants
(c) 75% red flowered and 25% white flowered plants
(d) all white flowered plants. Ap

14. Mutation is a
(a) change that causes evolution when inherited
(b) change which affects the parents only but never inherited
(c) change which affects the offspring of F_2 generation only
(d) factor responsible for plant growth. R

15. Why were pea plants more suitable than dogs for Mendel's experiments ?
(a) There were no pedigree records of dogs.
(b) Pea plants can be self-fertilised.
(c) All pea plants have only two chromosomes.
(d) Dogs have many genetic traits.

16. If a tall plant is crossed with a dwarf plant, this type of cross is called
(a) dihybrid (b) monohybrid
(c) reciprocal (d) trihybrid.

17. How many genes a child receives from its father ?
(a) 25% (b) 50%
(c) 75% (d) 100% U

18. Segregation of alleles takes place during
(a) meiosis (b) cleavage
(c) fertilisation (d) crossing over.

19. Law of independent assortment can be proved on the basis of which of the following ratios?
(a) 1 : 3 : 1 (b) 2 : 1 : 1
(c) 9 : 3 : 3 : 1 (d) 2 : 1

20. In a dihybrid cross four phenotypes form in the ratio of 9 : 3 : 3 : 1, because of
(a) dominance of one phenotype in each pair of contrasting traits
(b) independent assortment of the genes of contrasting traits
(c) crossing over of genes
(d) mixed effect of dominance and independent assortment. U

21. An allele is said to be dominant if
(a) it is expressed in both homozygous and heterozygous conditions
(b) it is expressed only in second generation
(c) it is expressed only in heterozygous condition
(d) it is expressed only in homozygous condition.

LEVEL - 2

22. Two pink coloured flowers on crossing resulted in 1 red, 2 pink and 1 white flower progeny. The nature of the cross will be
(a) double fertilisation
(b) self pollination
(c) cross fertilisation
(d) no fertilisation. **(NCERT Exemplar)**

23. If a heterozygous tall plant is crossed with a homozygous dwarf plant, the proportion of dwarf progeny will be
(a) 50% (b) 75%
(c) 100% (d) 25%.

24. The crossing of a homozygous tall plant with a dwarf would yield plants in the ratio of
(a) two tall and two dwarf
(b) one homozygous tall, one homozygous dwarf and two heterozygous tall
(c) all homozygous dwarf
(d) all heterozygous tall. Ap

25. A true breeding tall plant is crossed with a true breeding short plant and the F_1 produced is self pollinated to produce F_2 generation. Ratio of true breeding tall and true breeding short plant in F_2 generation will be
(a) 1 : 2 (b) 1 : 1
(c) 2 : 1 (d) 1 : 3.

26. Blue eye colour in human is recessive to brown eye colour. The expected children of a marriage between blue-eyed woman and brown-eyed male who had a blue-eyed mother are likely to be in the ratio of
(a) all blue-eyed
(b) three blue-eyed and one brown-eyed
(c) all brown-eyed
(d) one blue-eyed and one brown-eyed. Ap

27. Chromosome theory of heredity was formulated for the first time on the basis of which of the following observations?
(a) Chromosomes (like Mendelian factors) exhibiting segregation and independent assortment during meiosis
(b) Chromosomes being main structure in nucleus

(c) Determination of sex through sex chromosomes
(d) A fixed number of chromosomes in each cell of an organism

28. Recessive mutations are expressed
(a) always since it is a mutation
(b) in heterozygous condition
(c) neither in homozygous nor in heterozygous condition
(d) in homozygous condition. R

29. A true breeding tall and smooth-seeded pea plant was crossed with a true breeding dwarf and wrinkled-seeded plant. All the F_1 plants were tall and demonstrate
(a) principle of assortment of characters
(b) that recombination of characters appears in F_2 generation
(c) that P tall plants were heterozygous
(d) that tallness was dominant over dwarfness. U

30. The fact that F_1 plants when backcrossed with the recessive parent type yielded four types of plants in equal proportion; it proved that the F_1 plants produced
(a) four types of gametes in 9 : 3 : 3 : 1 ratio
(b) four types of gametes in equal numbers
(c) two types of gametes in 3 : 1 ratio
(d) three types of gametes in 3 : 1 : 1 ratio.

31. In *Drosophila*, red eye character is dominant over white eye character. When a homozygous red-eyed individual is crossed with a homozygous white-eyed individual, and individuals of F_1 generation are intercrossed, 12 individuals are produced. White-eyed individuals of these will be
(a) three (b) six
(c) nine (d) twelve. Ap

32. In his experiments, Mendel did not come across linkage, because
(a) he studied only pea plants
(b) he did not have a powerful microscope
(c) characters he studied were located on different chromosome pairs
(d) there were too many chromosomes involved.

33. Which one of the following is not one of the direct conclusions that can be drawn from Mendel's experiment?
(a) Only one parental trait is expressed.
(b) Two copies of each trait is inherited in sexually reproducing organism.
(c) For recessive trait to be expressed, both copies should be identical.
(d) Natural selection can alter frequency of an inherited trait. U

LEVEL - 3 (HOTS)

Competency Focused Questions (CFQs)

34. In human males all the chromosomes are paired perfectly except one. This/these unpaired chromosome is/are
(i) large chromosome (ii) small chromosome
(iii) Y-chromosome (iv) X-chromosome
(a) (i) and (ii) (b) (iii) only
(c) (iii) and (iv) (d) (ii) and (iv)
(NCERT Exemplar)

35. In a plant, smooth seeds (S) are dominant over wrinkled seeds(s) and green seeds (G) are dominant over orange seeds (g). A plant homozygous for smooth and green seeds is crossed with a plant having wrinkled and orange seeds. The F_1 offspring are self-crossed to produce F_2 generation. If a total of 144 offspring are produced, how many plants are expected to be having wrinkled and green seeds in F_2 generation, according to a typical Mendelian cross?
(a) 9 (b) 18
(c) 27 (d) 81 Ap

36. Some humans are able to roll their tongue, while others are not. Two parents (both tongue-rollers) have four children, all of whom are not tongue-rollers. Which of the following statements hold true regarding this?
(i) The allele for tongue-rolling is dominant.
(ii) The probability that their next child will be a tongue-roller is 0.5.
(iii) The probability that their next child will not be a tongue roller is 0.75.
(iv) Both parents have one allele for tongue-rolling and one allele for non-tongue-rolling.

(a) (i) and (iii) only (b) (i) and (iv) only
(c) (ii) and (iii) only (d) (ii) and (iv) only

37. A pea plant with yellow and round seeds (YYRR) is crossed with a pea plant having green and wrinkled (yyrr) seeds, then in F_2 generation of this dihybrid cross, 320 plants are produced. Out of which 180 plants have same phenotypic characters. Identify this phenotype.
(a) Yellow and wrinkled seeds
(b) Yellow and round seeds
(c) Green and round seeds
(d) Green and wrinkled seeds An

38. Ruby crossed a tall pea plant with white flowers and a dwarf pea plant with violet flowers. She performed a _____ .
(a) test cross (b) dihybrid cross
(c) natural selection (d) monohybrid cross

39. The dwarf variety of garden pea plants are now known to have a mutation in a gene needed for synthesis of gibberellin. F_1 plant obtained by Mendel from the tall (TT) × dwarf (tt) cross were tall.
Which of the following inferences can be drawn from the given information?
(i) Gibberellin causes elongation of stems.
(ii) Heterozygous (Tt) plants produce the same amount of gibberellin as homozygous dominant (TT) plants.
(iii) Gibberellin induces production of auxin.
(iv) Mutation may have occurred in a gene producing an enzyme.
(a) (i) and (ii)
(b) (ii), (iii) and (iv)
(c) (i), (ii), (iii) and (iv)
(d) (i), (ii) and (iv)

40. If, in a plant, red colour of the flower is dominant over white. A cross was made between a plant containing red flower and other with white flower. The cross yielded 50% white flowered plant and 50% red flowered plant. The genotype of the parent with red flower is
(a) homozygous
(b) heterozygous
(c) cannot be determined
(d) can be homozygous or heterozygous. Ap

Assertion & Reason Type

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If assertion is false but reason is true.

1. **Assertion :** Mendel successfully postulated laws of heredity.
Reason : He recorded and analysed results of breeding experiments quantitatively.

2. **Assertion :** In a monohybrid cross, offsprings of F_1 generation express dominant character.
Reason : Dominance occurs only in heterozygous state.

3. **Assertion :** Pure lines are called true breeds.
Reason : True breeds are used for cross breeding.

4. **Assertion :** The principle of segregation given by Mendel is the principle of purity of gametes.
Reason : Gametes are pure for a character and do not mix up.

5. **Assertion :** A gene may have several allelomorphs.
Reason : Wild form can mutate in more than one form.

Subjective Questions

Very Short Answer Type

1. Define heredity.
2. Name two human traits that show variations.
3. What decides the sex of the child, sperm or ova?
4. What is a gene?
5. Who is known as "Father of Genetics"?

6. What are acquired traits?
7. What are inherited traits?

Short Answer Type

1. What is meant by chemical basis of heredity?
2. How will you justify selection of pea plant by Mendel for heredity experiments?
3. What were the results of Mendel's monohybrid cross?
4. Write the basic features of mechanism of inheritance.
5. Crossing of a pea plant with purple flower and pea plant with white flowers, produces 50 plants with only purple flowers. On selfing, the plants produced 470 plants with purple flowers and 160 with white flowers. Explain the genetic mechanism accounting for the above results.
6. Why variations are more pronounced in sexual reproduction than asexual one?
7. When does a geneticist need to carry a test cross? How is it carried?
8. Explain the inherited traits and acquired traits.

Long Answer Type

1. Define Mendel's experimental technique.
2. Explain determination of sex among human beings, with the help of a diagram.
3. **(a)** State and explain the law of segregation as proposed by Mendel in a monohybrid cross.
   (b) Name the pattern of inheritance where F_1 phenotype:
   (i) resembles only one of the two parents.
   (ii) does not resemble either of the two parents and is in between the two.

Case Based Questions

Case I : In an insect, the (A) gene responsible for red eye colour is dominant over white eye (a) whereas (B) gene responsible for long wings is dominant over short wings (b). Consider the following dihybrid cross represented by Punnett square.

F_1 selfing AaBb × AaBb

Gametes: AB, Ab, aB, ab × AB, Ab, aB, ab

F_2

♀ \ ♂	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

CFQs

1. How many insect progenies would have red eye and long wings?
   (a) 3/16 (b) 6/16
   (c) 9/16 (d) 1/16
2. The number of progenies with recombinant phenotypes are
   (a) 4/16 (b) 9/16
   (c) 15/16 (d) 6/16.
3. What will be the genotypic ratio in this cross?
   (a) 9 : 3 : 3 : 1
   (b) 1 : 2 : 1 : 2 : 1 : 2 : 1
   (c) 15 : 1
   (d) 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1
4. Find out the ratio of White eyed short wings : Red eyed short wings : Red eyed long wings : White eyed long wings.
   (a) 9 : 3 : 3 : 1 (b) 1 : 3 : 3 : 9
   (c) 1 : 3 : 9 : 3 (d) 1 : 2 : 2 : 4
5. If a parent insect from the above given cross is test crossed, then find out the fraction of progenies with short wings.
   (a) 9/16 (b) 1/2
   (c) 1/4 (d) 3/16

Case II : A person has one of the four blood groups : A, B, AB or O. This blood group system is controlled by a gene which has three alleles denoted by the symbols I^A, I^B and i. When I^A and I^B are present together they both express their own types, hence, they are codominant. However, alleles I^A and I^B both are completely dominant over the i. Since there are three different alleles, so, six different combinations of alleles are possible and therefore, a total of six different genotypes of human ABO blood type are possible.

CFQs

1. What will be the genotype of a person that has 'A' blood group?
   (a) I^AI^A (b) I^AI^B
   (c) I^Ai (d) I^AI^A or I^Ai

2. If a man with blood group A marries a woman with blood group B, what could be the possible blood group of their child?
   (a) A or B only (b) A or AB only
   (c) A, B, AB or O (d) AB only

3. If a male with *ii* genotype marries a female with I^AI^B genotype, then what will be the blood group of their child?
   (a) O (b) AB
   (c) AB or O (d) A or B

4. In ABO blood group system
   (a) I^B is dominant over I^A
   (b) *i* is dominant over I^A and I^B
   (c) *i* is recessive to I^A and I^B
   (d) I^A and I^B are recessive over *i*.

5. If a woman with I^Ai genotype marries a man with the same genotype, then what will be the chances of having a child with the same genotype?
   (a) 2/4 (b) 1/4
   (c) 3/4 (d) 1

Case III : During the study of inheritance of two genes, teacher taught student a dihybrid self cross, between AaBb and AaBb in which 1280 progenies were produced. Based upon the above given information answer the following questions.

CFQs

1. How many progenies produced are homozygous (pure breed)?
   (a) 480 (b) 380
   (c) 160 (d) 240

2. How many progenies will have one dominant and one recessive character?
   (a) 1280 (b) 640
   (c) 320 (d) 480

3. How many progenies will be hybrid for both the dominant and recessive characters?
   (a) 640 (b) 320
   (c) 160 (d) 80

4. The number of progenies that will be homozygous recessive are
   (a) 80 (b) 160
   (c) 40 (d) 320.

5. Which among the following genotype will be found in maximum number?
   (a) Aabb (b) AABb
   (c) AaBb (d) aaBb

ANSWER KEY

Multiple Choice Questions

1.	(c)	2.	(b)	3.	(b)	4.	(b)	5.	(d)
6.	(d)	7.	(b)	8.	(a)	9.	(d)	10.	(d)
11.	(c)	12.	(c)	13.	(b)	14.	(a)	15.	(b)
16.	(b)	17.	(b)	18.	(a)	19.	(c)	20.	(b)
21.	(a)	22.	(c)	23.	(a)	24.	(d)	25.	(b)
26.	(d)	27.	(a)	28.	(d)	29.	(d)	30.	(b)
31.	(a)	32.	(c)	33.	(d)	35.	(c)	36.	(b)
37.	(b)	38.	(b)	39.	(d)	40.	(b)		

Assertion & Reason Type

1.	(a)	2.	(c)	3.	(b)	4.	(a)	5.	(a)

Case Based Questions

Case I

1.	(c)	2.	(d)	3.	(d)	4.	(c)	5.	(b)

Case II

1.	(d)	2.	(c)	3.	(d)	4.	(c)	5.	(a)

Case III

1.	(c)	2.	(d)	3.	(b)	4.	(a)	5.	(c)

CHAPTER 04

Heredity

NCERT Section

1. (c) : All progeny bore violet flowers, so they all must have gene for violet flower. As violet colour appears in hybrids thus it must be the dominant character. So, white flowered plant should have ww genes to show recessive white character. It indicates that all progenies got allele W (violet colour) from tall-violet flowered plant, thus its all gametes should have W allele. To serve the purpose, plant must have WW genes. But, tallness was found in 50% progenies, thus half of its gametes contained T gene and other half contained t gene. Inclusively, the tall plant had TtWW genotype.

2. No. From the given statement, we cannot say with certainity whether light eye colour is dominant or recessive. However, since both children and their parents have light eye colour, the possibility is that light eye colour is a recessive trait. If the light eye colour had been a dominant trait, the homozygous light eyed parents would have only light eyed children but heterozygous light eyed parents might had some recessive dark eyed children (3 : 1 ratio).

3. (i) Select two varieties of dogs one with white coat colour, the other with black coat colour.
(ii) Crossbreed them taking male dog from one variety and bitch (female dog) from the other variety.
(iii) Observe the colour of offsprings of F_1 generation.
(iv) Now, bring about breeding among the organisms of F_1 generation.
(v) Observe the coat colour of organisms (pups) of F_2 generation and note the variations in coat colour.
(vi) Draw conclusions on the basis of your study.
One of the probable inheritance pattern may be as given below.
Phenotypic ratio = 3 : 1, Black coat colour (3) : White coat colour (1)

4. A zygote is formed by the fusion of sperm and ovum. During the formation of gametes as a result of reductional division (meiosis), sperms and eggs receive only half of the genetic material of parent cell and thus become haploid. When fertilisation occurs, zygote is formed, which is diploid (2n). In this way, both male and female parents contribute exactly equal amount of genetic material to the offspring.

Multiple Choice Questions

1. (c) : According to Mendel's observations, in a hybrid only one of the alleles is expressed. The allele that cannot express itself in presence of the other allele (dominant allele) is called recessive allele.

2. (b) : An organism with two unlike alleles of a gene for a trait is called heterozygous for that particular trait. For example pea plant with Tt alleles. It is heterozygous for height.

3. (b) : Mendel conducted his famous breeding experiments by working on garden pea, *Pisum sativum*.

4. (b) : Wrinkled seed is a recessive character. It was among seven pairs of contrasting characters chosen by Mendel.

5. (d)

6. (d) : Before Mendel, several scientists performed breeding experiments to study inheritance, but they could not succeed. Reasons for Mendel's success were all the mentioned factors. Besides these, most important reason for Mendel's success was that he kept definite numerical records which helped him to deduce ratios of different progenies.

7. (b) : According to Mendel's law of segregation if two alleles remain together in an organism (heterozygous tall) they do not get mixed and separate or segregate in next generation.

8. (a) : The genotypic ratio in F_2 generation of monohybrid cross will be 1(pure, dominant) : 2(hybrid, dominant) : 1 (pure, recessive).

9. (d): A cross between pure breed tall plant with round seeds and short plant with wrinkled seeds produces four types of phenotypes in their progenies which are as follows:

Parent TT RR × ttrr

Pure tall plant with round seeds × Pure short plant with wrinkled seeds

F_1 generation TtRr

Hybrid tall with round seeds

F_2 generation — Selfing

♀ \ ♂	TR	Tr	tR	tr
TR	TTRR	TTRr	TtRR	TtRr
Tr	TTRr	Ttrr	TtRr	Ttrr
tR	TtRR	TtRr	ttRR	ttRr
tr	TtRr	Ttrr	ttRr	ttrr

9 : 3 : 3 : 1

Tall plant with round seeds : Tall plant with wrinkled seeds : Short plant with round seeds : Short plant with wrinkled seeds

10. (d): A segment of DNA providing information for a protein is called gene. Gene stores information in the form of nucleotide sequence and acts as unit of inheritance.

11. (c): Mendel did not use leaf shape character. He used seven characters which were pod colour, pod shape, seed shape, seed colour, flower colour, flower position and stem height.

12. (c): Mendelian principles apply only when parents are pure breeding. They are having similar alleles of the gene for the character in concern. Their purity can be checked as on selfing they produce morphologically and structurally similar offsprings.

13. (b): In first generation, all plants will have one dominant allele and one recessive allele. Presence of dominant allele in all progenies will produce all red flowered plants in F_1 generation.

14. (a): Mutations are sudden inheritable changes in DNA of the cell. They occur naturally and are usually recessive. They can also be induced. Mutations create inheritable variations which cause evolution.

15. (b): Dogs are unisexual. A female can produce progeny only after fertilisation by a male. It will always result in new combination of genes and purity of individuals will not be maintained which is essential for inheritance studies. While in pea plant self fertilisation occurs mostly and it has shorter life cycle as compared to dogs.

16. (b): If a tall plant is crossed with a dwarf plant then it is a monohybrid cross because it is taking one character at a time.

17. (b): Father and mother both give haploid number (n) of chromosomes to child which together form diploid (2n) chromosome number. Thus one parent's contribution is $= \frac{n}{2n} \times 100 = 50\%$

18. (a): Segregation of alleles takes place during meiosis. Meiosis is a reductional division in which a chromosome number is reduced to half, so the alleles present on homologous chromosome segregate.

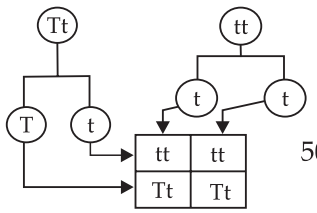
19. (c): In Mendel's dihybrid cross, with yellow round and green wrinkled seeds 9 : 3 : 3 : 1 ratio was obtained showing four phenotypes. Yellow colour was originally present with round seeds but in F_2 generation it was assorted independently of round seed character and expressed with wrinkled seeds. Same is the case with green colour. Thus, it shows independent assortment of characters.

20. (b): *Refer to answer 19.*

21. (a): An allele is said to be dominant if it is expressed in both homozygous and heterozygous conditions. It is generally represented by capital alphabets.

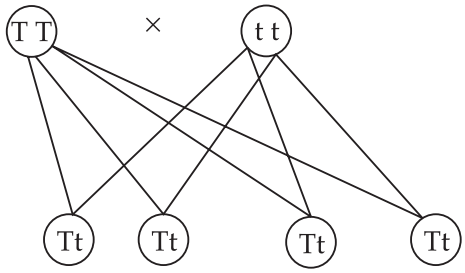
22. (c): Self pollination involves the transfer of pollen grains from the anther of a flower to the stigma of the same or another flower borne on the same plant. Cross fertilisation is act of fertilisation (fusion of male and female gamete) that occurs between different individuals of same species. Since the progeny is produced, so the pollination must have occurred followed by fertilisation.

23. (a): If a heterozygous tall plant is crossed with a homozygous dwarf plant, then proportion of dwarf progeny will be 50%. It is a test cross.



50% tall, 50% dwarf

24. (d): The crossing of a homozygous tall plant with a dwarf would yield all heterozygous tall plants containing both the alleles. Tallness is a dominant trait over dwarfism. So even in heterozygous condition all plants are tall.



25. (b): When a true breeding tall plant is crossed with a true breeding short plant and the F_1 produced is self pollinated to produce F_2 generation, the ratio of true breeding tall and short plant in F_2 will be 1 : 1.

TT × tt

↓

Tt

↓ Selfing

♀ \ ♂	T	t
T	TT	Tt
t	Tt	tt

Genotype : TT : Tt : tt

1 : 2 : 1

Ratio of true breeding tall (TT) and true breeding short (tt) = 1 : 1

26. (d): Recessive character is expressed only in homozygous condition thus blue-eyed woman will have bb genotype, while brown-eyed man may have BB or Bb genotype. But the man had a blue-eyed mother so, he will have Bb genotype. It can be explained as follows:

bb

(Blue eyed mother)

↓

Bb — Brown eyed man × bb — Blue eyed woman

↓ ↓ ↓ ↓

B b b b (gametes)

Bb Bb bb bb (expected children)

2 brown eyed: 2 blue eyed

or 1 : 1

27. (a): Chromosome theory of heredity was formulated by Sutton and Boveri. They proved that genes (factors of Mendel) are situated on chromosomes. These are not genes but chromosomes that separate and cross over during sexual reproduction and carry out inheritance and variations.

28. (d): Recessive mutations can express only in homozygous condition as in heterozygous condition presence of dominant normal gene will mask their expression.

29. (d): When a true breed tall and smooth seeded pea plant crossed with a true breed dwarf and wrinkled seeded plant, all plants were tall and smooth seeded in F_1. It demonstrates that tallness and seed smoothness was dominant over dwarfness and wrinkled seed. F_1 plants were genotypically hybrids but phenotypically dominant character was expressed.

30. (b): Recessive parent will produce single type of gametes. Thus four phenotypes may result due to four different gametes produced by F_1 plants. F_1 plants are hybrids and contain both of the alleles of characters.

31. (a): It is a monohybrid cross. Monohybrid cross produces progeny of F_2 generation in ratio 3 : 1 where 1 is the ratio of recessive progeny. Here in, the number of recessive white eyed individuals can be found by:

Total number according to ratio = 3 + 1 = 4.

Total number of individuals produced actually = 12

Number of white eyed individuals = $\frac{1}{4} \times 12 = 3$

32. (c): Linkage is found between those genes which are situated in close proximity. Characters studied by Mendel were located distantly on different chromosome pairs.

33. (d): 'Natural selection can alter frequency of an inherited trait' is not concluded by Mendel's experiments because all the experiments of Mendel were done in controlled environment and there was no scope of natural selection to act.

34. (c): In human beings, a specific pair of chromosomes called sex chromosomes, in each

diploid cell determines the sex of the individual. Women have a perfect pair of sex chromosomes, both called X. Men on the other hand have a mismatched pair in which one is normal sized X and other one is short Y. So women are XX and male are XY.

35. (c) : When a plant homozygous for smooth and green seeds is crossed with a plant having wrinkled and orange seeds and the F_1 produced is self pollinated to produce F_2 generation, four types of phenotypes are produced in their progenies as follows:

Parents SSGG (Smooth green) X ssgg (Wrinkled orange)

Gametes SG sg

F_1 generation SsGg (Smooth green)

F_2 generation

♀ \ ♂	SG	Sg	sG	sg
SG	SSGG	SSGg	SsGG	SsGg
Sg	SSGg	SSgg	SsGg	Ssgg
sG	SsGG	SsGg	ssGG	ssGg
sg	SsGg	Ssgg	ssGg	ssgg

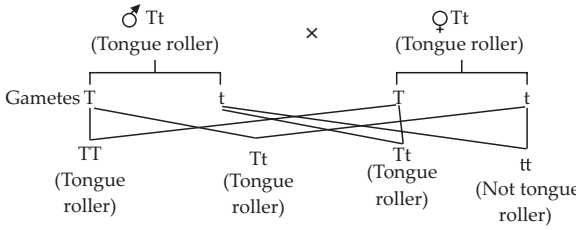
Phenotypic ratio :

9 :	3 :	3 :	1
Smooth Green Seeds	Wrinkled Green Seeds	Smooth Orange Seeds	Wrinkled Orange Seeds

If total number of offsprings are 144, then number of plants having wrinkled and green seeds are $\frac{3}{16}\times 144 = 27.$

36. (b) : In the given case the parents should be heterozygous, for tongue rolling character with the genotype Tt.

The probability that their next child will be a tongue roller is 0.75 while the probability of not being tongue roller is 0.25.



37. (b) : In a normal cross, we have the phenotypic ratio of 9 : 3 : 3 : 1, where offsprings are 9 - Yellow round seeds, 3 - Green round seeds, 3 - Yellow wrinkled seeds, 1 - green wrinkled seeds

In 320 offsprings, 180 offsprings have same phenotype, this states that these 180 plants have phenotype yellow and round seeds. This can be explained as follows

$$\frac{x}{16}\times 320 = 180 \; ; \; x = \frac{180\times 16}{320} = 9$$

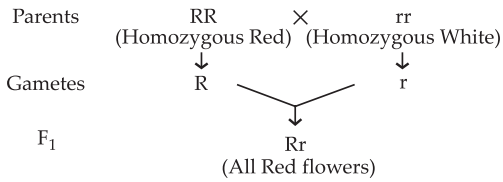
So, 180 offsprings will have yellow round seeds.

38. (b)

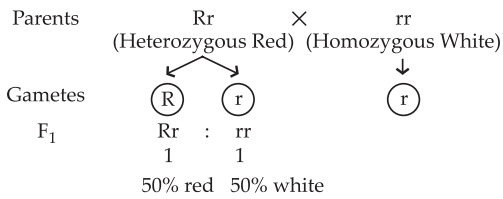
39. (d) : The given data says that dwarf plants have mutated gene for gibberellin synthesis, it indicates that gibberellin causes elongation of stems. As both heterozygous (Tt) and homozygous dominant (TT) plants obtained from the cross between tall (TT) and dwarf (tt) plants are tall, it indicates that both of them produce the same amount of gibberellin. Mutation that has affected gibberellin synthesis may be one that resulted in non-synthesis of a protein that functions as an enzyme during the process of gibberellin synthesis. The data says nothing about the relationship between gibberellin and auxin, thus the inference (iii) cannot be made.

40. (b) : Two possible genotypes of plant with red flower are RR and Rr.

Case I



Case II



Thus, the genotype of parent with red flower is Rr.

Assertion & Reason Type

1. (a)

2. (c) : Monohybrid cross is a cross between two organisms of a species considering a single pair of

alleles or factors of a character. Dominant character express itself whether present in homozygous or heterozygous state. In F_1 generation, progenies are heterozygous dominant.

3. (b) : Pure line is a strain of genetically true breeding individuals. Members of pure line are homozygous for one or more characters. In homozygous form both the factors express the same effect. They are used for cross breeding in order to get the desired improvement in crops.

4. (a) : According to principle of segregation (first law of Mendel), the two factors of a character which remain together in an individual do not get mixed up but keep their identity distinct and separate at the time of gametogenesis. Gametes carry a single factor or allele for a trait. The two Mendelian factors present in the F_1 plants segregate during gamete formation. The principle of segregation is called the principle of purity of gametes because segregation of the two Mendelian factors of a trait results in gametes receiving only one factor out of a pair. As a result gametes are always pure for a character.

5. (a) : According to Mendel's concept of inheritance, each gene has two alternative forms or allelomorphs, one being dominant and the other recessive. Practically, the wild form can mutate in several ways. The mutant form can also mutate once again to give rise to another mutant form. Therefore, a gene can have more than two allelomorphs. These allelomorphs make a series of multiple alleles.

Subjective Questions

Very Short Answer Type

1. Heredity is the inheritance of characters from one generation to the next.

2. Colour of eyes and shape of external ears.

3. The sperm decides the sex of the child because it may be carrying X chromosome or Y chromosome, while egg always carries X chromosome.

4. Gene is the unit of inheritance. It is a segment of the chromosome which controls hereditary characteristics.

5. G.J. Mendel is known as "Father of Genetics".

6. Acquired traits are changes in the non-reproductive tissues caused by environmental factors.

7. Traits that are transferred from one generation to another are called inherited traits, *e.g.*, eye colour.

Short Answer Type

1. Transmission of characters from one generation to another is termed as heredity. Carrier of hereditary information are genes that are segments of DNA. DNA (a chemical compound) is the chemical basis of heredity. Chemically, each gene has a specific sequence of nucleotides which determines its functional property.
Chromosome → DNA → genes → proteins.
These proteins (either functional or structural) express phenotype of the individual.

2. Mendel selected pea plant for breeding experiments because of the following features:

S. No.	Feature	Advantage
(i)	Annual plant	Short life cycle helped to study larger number of generations in shorter time.
(ii)	Contrasting characters	Made analysis more convenient and reliable.
(iii)	Easy hybridisation	Artificial cross pollination is quite easy due to large reproductive structures. It helped in crossing pure plants with contrasting characters.
(iv)	Self fertility	Made possible to maintain homozygous pure lines for a particular character.
(v)	High number of seeds	Thus, sufficient number of progenies of each generation obtained.

3. Monohybrid cross involves single pair of contrasting characters *e.g.*, cross between a tall and a dwarf plant. Results obtained from Mendel's monohybrid cross were –
(i) When a cross is made between the contrasting pair of a trait, only one of the traits appears in F_1 generation. Mendel named it dominance of one trait over the other (recessive one).
(ii) The trait which has failed to express itself in F_1 generation again expresses itself (reappears) in F_2 generations. Mendel named it law of purity of gametes.

4. The basic features of mechanism of inheritance are as follows:
(i) Characters are controlled by genes and each gene controls one character.
(ii) Chromosomes are gene carrier and genes are basic unit of heredity.
(iii) One form of gene may be dominant on other, *i.e.*, genes are allelic in nature.
(iv) The two forms of alleles separate at the time of gamete formation *i.e.*, they do not mix with each other.
(v) Two allelic forms of a gene are brought together in zygote.

5. In this breeding experiment, ratio of purple to white flowers is approximately 3 : 1 in F_2 generation. So the ratio is according to Mendelian monohybrid cross. The cross further explains the following facts:
(i) F_1 is represented only by dominant trait, *i.e.*, purple flowered plants.
(ii) Both the traits, *i.e.*, purple and white flower colour appear in F_2 generation.

6. Asexual reproduction is monoparental (one parent is involved) and produces identical offsprings with only very minor variations (due to environmental factors). Sexual reproduction is biparental *i.e.*, it involves a father and a mother. Every offspring produced through sexual reproduction receives some characters of father and some characters of mother. Genetic recombinations occur at gametogenesis by crossing over during meiosis. Therefore, offsprings show some similarities and some marked differences (variations) among themselves as well as from their parents.

7. To determine the genotype of a plant, *i.e.*, whether the individual is exhibiting dominant character is homozygous or heterozygous, a test cross is carried out by a geneticist. The individual having dominant phenotype is crossed with its homozygous recessive parent. If heterozygous tall is crossed with homozygous recessive parent, tall and dwarf will be produced, in equal proportion while if homozygous tall is crossed with homozygous recessive, the upcoming progenies will contain all tall plants.

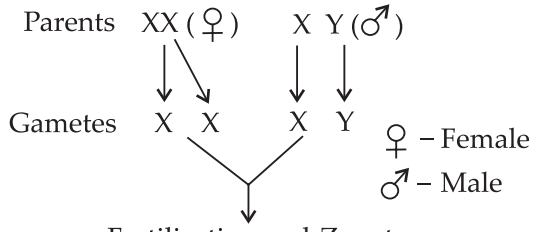
8. Inherited traits are controlled by genes and are passed on from one generation to another. Any alteration in the DNA (genes) will be passed on, through germ cells, to the progeny resulting in variations in them. Acquired traits are changes in non reproductive tissues caused by environmental factors. These are not inheritable.

Long Answer Type

1. Mendel conducted his breeding experiments in three steps. These steps are :
(i) Selection of pure breeding parent plants (*i.e.*, plants producing same phenotype and genotype in every generation).
(ii) Production of first generation of plants by cross breeding (hybridisation).
(iii) Raising of second and subsequent generations by self-fertilisation of hybrids.
While performing his cross breeding experiments, Mendel took a number of precautions. He always focused on the inheritance of the specific traits under consideration and simply ignored others.
In cross breeding experiments, to avoid self-fertilisation between two varieties or traits of plants, Mendel removed the anthers (male reproductive parts) of the flowers well before the maturity of the female reproductive part, *i.e.*, gynoecium of the flowers. This process is called emasculation. Such flowers were covered to avoid entry of any foreign pollen grain from outside by wind or animals. For making a desired cross, mature pollen grains from the anther of the flower of the desired plant were transferred on the stigma (female reproductive part) of the emasculated mature flower. The seeds formed by such crosses were collected. These seeds belonged to the first filial generation or F_1 generation. To draw effective conclusions, Mendel used the seeds of F_1 generation to raise the F_2 generation by self pollination and also the F_2 seeds for raising F_3 generation by self-pollination. He maintained all the records of his experiments.

2. Diploid organisms like human beings have separate sexes. In organisms, where sex is determined genetically, a pair of chromosomes called sex chromosomes determines the sex of the individual. All other chromosomes are termed autosomes. In human beings, there are 46 chromosomes. Of these, one pair is of sex chromosomes which are of two types – X chromosome and Y chromosome.
(i) A male individual contains one X chromosome and one Y chromosome *i.e.*, XY.

(ii) A female contains two X chromosomes *i.e.*, XX. The sex of the child is determined at the time of fertilisation when male and female gametes fuse to form zygote. It can be shown as follows:



♀ \ ♂	X	Y
X	XX(♀)	XY(♂)
X	XX(♀)	XY(♂)

3. (a) Law of segregation states that, "when a pair of contrasting factor or gene are brought together in a hybrid; these factors do not blend or mix up but simply associate themselves and remain together and separate at the time of gamete formation", *i.e.*, allele pairs segregate during gamete formation and the paired condition is restored by random fusion of gametes during fertilisation.

(b) (i) Complete dominance is the condition in which the F_1 phenotype resembles the dominant parent, *i.e.*, one of the two parents.

(ii) Incomplete dominance is the condition in which the F_1 phenotype does not resemble both the parents and is in between the two.

Case Based Questions

Case I

1. (c) : The progenies with red eyes and long wings will have the genotypes AABB, AABb, AaBB and AaBb.

2. (d) : The total number of progenies with a recombinant phenotypes *i.e.*, with red eyes, short wings and white eyes, long wings are 6 out of 16.

3. (d) : In a dihybrid cross, the genotypic ratio will be 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1.

4. (c) : The number of insect progenies with white eyed short wings are 1, red eyed short wings are 3, red eyed long wings are 9 and white eyed long wings are 3.

5. (b) : Test cross between the parent and recessive parent is as follows:

AaBb × aa bb

Resulting progenies:
- AaBb → 1 Red eyed long wings
- Aabb → 1 Red eyed short wings
- aaBb → 1 White eyed long wings
- aabb → 1 White eyed short wings

Case II

1. (d) : I^A allele is dominant over i. So, a person with either I^Ai or I^AI^A genotype will have (A) blood group.

2. (c) : Phenotype of blood group depends on the genotype of the parents.

(i) If the man has I^AI^A genotype and the woman has I^BI^B genotype then the child will have I^AI^B genotype and blood group will be AB.

(ii) If the man's genotype is I^Ai and woman's genotype is I^Bi then the child will have I^AI^B or ii genotype that means child will either have AB or O blood group.

(iii) If man's genotype is I^Ai and woman's genotype is I^BI^B then the child genotype will be I^AI^B or I^Bi. So, the child will have AB or B blood group.

(iv) If man's genotype is I^AI^A and woman's genotype is I^Bi then child will have I^AI^B or I^Ai genotype and will have AB or A blood group.

3. (d) : If a male with ii genotype marries a female with I^AI^B genotype, then the child will have I^Ai or I^Bi genotype and will have A or B blood group.

4. (c) : In ABO blood group system, I^A allele which produce A and I^B allele which produce B blood group are both dominant over i (*i.e*, i is recessive). I^A and I^B are codominant.

5. (a) :

Woman I^Ai × Man I^Ai

Children → I^AI^A (1) I^Ai I^Ai (2) ii (1)

2 out of 4 children will have the same genotype (I^Ai) as parents.

Case III

1. (c) : AaBb × AaBb

↓

1280 progenies

Homozygous progenies

AABB ⟶ 1

aa bb ⟶ 1

2 out of 16 progenies will be homozygous. So, out of 1280 progenies number of homozygous progenies will be

$\frac{2}{16} \times 1280 = 160$

2. (d) : Genotypes of the progenies are as follows:

Both dominant characters : AABB(1) : AaBB(2) : AABb(2) : AaBb(4)

One dominant and one : AAbb(1) : Aabb(2)
Recessive character aaBB(1) : aaBb(2)] 6

Both recessive character : aabb(1)

6 out of 16 progenies will have one dominant and one recessive character. So, out of 1280 progenies, the number of progenies with one dominant and one recessive character will be

$\frac{6}{16} \times 1280 = 480$

3. (b) : Progenies that will be hybrid for both the characters will have the genotype AaBb. In a dihybrid cross, 4 out of 16 progenies have AaBb genotype. So, out of 1280, number of progenies that are hybrid for both the characters will be

$\frac{4}{16} \times 1280$ or $\frac{1}{4} \times 1280 = 320.$

4. (a) : Progenies that will have homozygous recessive character will have aabb genotype. In a dihybrid cross number of aabb genotype will be 1 out of 16. So, out of 1280 progenies, homozygous recessive progenies will be $\frac{1}{16} \times 1280 = 80.$

5. (c) : Genotype AaBb will be found in maximum number because their ratio is 4/16 which is maximum among all the genotypes.

☺☺☺