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5

Exploring Forces

1. INTRODUCTION (FORCE)

We use force all the time. We use force to open a door. We use force to pick up the school bag. We use force to brush our teeth. We use force to squeeze out toothpaste from a tube and so on.

Force is not an object which can be seen, force can be experienced or measured. We can experience the force of pull of earth on us and can measure it by a weight machine.

Now we are in position to define the force

“Force is a push or pull acting on an object”

2. FORCE

“Force is a push or pull which changes or tends to change the state of rest or of uniform motion, direction of motion, or the shape and size of a body”.

Unit: A unit of force on SI is **Newton** (represented by N).

It is a vector quantity.

One Newton force is that much force which produces an acceleration of 1 ms^{-2} in a body of mass 1 kg.

Unit of force on **c.g.s.** system is **dyne**.

One dyne force is that much force which produces an acceleration of 1 cms^{-2} in a body of mass one gram.

Force is equal to the product of mass of body and acceleration produced in the body due to force.

$$F = m \times a$$

Relation between newton and dyne

$$1 \text{ N} = 10^5 \text{ dyne}$$



Let's know

A force produces or tries to produce motion in a body at rest, stops or tries to stop a moving body, changes or tries to change the direction of motion of a body and produces and tries to produce a change in the shape of a body.

3. EFFECTS OF FORCE

3.1 Force Acting on a Body Can Change Its State of Motion or of Rest :

- A force can make a stationary body move. When you kick a stationary football it moves.
- A force can stop a moving body. A fielder catches a moving cricket ball to stop its motion.
- A force can increase the speed of a moving object when a force is applied on a moving object in the direction of motion, its speed increases.
- A force can decrease the speed of a moving object when a force is applied on a moving object in the direction opposite to the direction of motion its speed decreases.



A force can make a body move

3.2 Force Can Change The Direction of Motion of a Moving Object :

There are many activities that show that a force can change the direction of motion of a moving object. During the game of cricket, the batsman changes the direction of the moving ball by touching or striking it with the bat at a suitable angle.



Force can change the direction of a moving body

3.3 Force Can Change The Shape And Size of an Object :

When a force is applied on a soft object, it changes the size and shape of the object. For example,

- (a) When an inflated balloon is pressed between the two hands, its shape and size change.
- (b) When a ball of wheat flour is pressed its shape changes. In fact, it can be given any shape.
- (c) When a spring is pulled, its shape and size change.
- (d) Foam or sponge can be compressed by applying force on it.
- (e) The shape of tooth paste tube changes on squeezing.

Thus we see that force acting on a body is push, pull or a squeeze.



Force can change the shape and size of object

4. BALANCED AND UNBALANCED FORCES

A number of forces acting on an object may either be balanced or unbalanced.

4.1 Balanced Forces : If a number of forces acting on an object does not produce any change in its state of rest or uniform motion or direction of motion then, they are called as balanced forces.

➤ **For example**

- (i) A person holding a briefcase in hand.
- (ii) A book resting on table.
- (iii) Squeezing a lemon etc.

4.2 Unbalanced Forces : If a number of forces acting on an object produce a change in its state of rest or uniform motion or direction of motion, then they are termed as unbalanced forces.

➤ **For example**

- (i) A briefcase released from a person's hand.
- (ii) A stone dropped etc.

Resultant force: If a number of forces act on an object then a single force that produces same change in the state of rest or motion is called as resultant force

If two forces act on an object in the same direction then the resultant force is obtained by adding them.

If two forces act on an object in the opposite direction then the resultant force is obtained by subtracting them.



Let's know

If resultant force is zero it means either object is in rest or in uniform motion.

5. FORCE CAN BE CLASSIFIED INTO TWO CLASSES

Type of Forces :

5.1 Contact forces

5.2 Non-contact forces

5.1 Contact Force :

- In all the above cases we observed that force acts on an object only when the force is in contact with the object. Such forces are called Contact force



- Contact forces represent the result of physical contact between two objects, one by which force is exerted and the other on which force is exerted.
- Pulling (stretching) of a coiled spring, pulling of a cart and kicking of a football are some examples of contact forces. The force exerted on us by the wind is also a contact force.
- Contact forces are the following types :

5.1.1 Muscular Force : If a school bag is lifted or a football is kicked, force is applied. Whatever you do, you do it with the force of your muscles. Your body has to be in contact with the object to apply a force. **This force exerted by the muscles is called a muscular force.** All animals and human beings use their muscles to do work. The muscles exert a force on the object that brings it in motion. Muscular force can also change the speed of moving bodies [fig. (a) & (b)].



(a) To slow down or stop a moving object (b) To make a moving object move faster

Muscular Force

5.1.2 Mechanical Force : The force exerted by a machine is called **mechanical force**. Machines do not produce force by themselves. In order to produce force they need energy from other sources. Mechanical force produced by a car engine, and mechanical force produced by the turbines in a hydroelectric power station (figure) are examples of contact forces. A crane lifting heavy objects with the help of a mechanical force is also an example of contact force. Here the heavy object and the crane come in contact with each other. Therefore the mechanical force that makes the crane lift the object is a **contact force**.

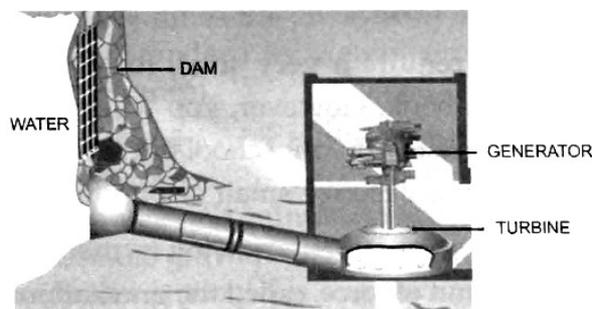


Fig.: Muscular Force

5.1.3 Applied Forces : The forces that we use with our hands, legs, figures, etc. are collectively called **applied forces**. When we tie a stone to a string and suspend it, the tension in the string opposes the force of gravity of the Earth and keeps the stone from falling down. When we do work with our hands, like lifting a weight, or pulling an object, the force required is provided by the tension of our muscles. When we need to apply a force, the brain sends a signal to the muscle (in the form of electrical signals via the nerve cells), which makes the muscle contract. This is how we can apply a force with our hands, legs, etc.

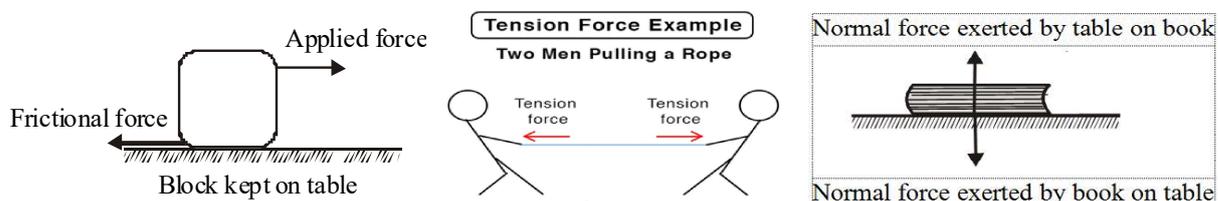
5.1.4 Frictional Force : The resistance into the motion experienced when two surfaces in contact move with respect to each other is called **friction**. Whenever the surface of one body slides over that of another, each exerts a force on the other which opposes the motion of the body. This is called frictional force. Frictional force comes into play only when two surfaces are in physical contact and is, therefore, a contact force.

Friction is a very complex phenomenon, and there is a lot about it that still needs to be explained. Two simple explanations for why friction is caused are as follows:

- Any surface, however smooth, has a lot of irregularities when seen under a microscope. These irregularities are like hills and valleys. When two such surfaces slide over each other, there will be a resistance to motion (friction).
- Another theory that explains friction says that when two surfaces come in contact, their atoms and molecules pull each other due to electrostatic forces. They 'stick' to each other at a microscopic level. When we try to slide the surfaces with respect to each other, these offer a resistance to motion. Frictional force depends on two main factors : the nature of the surfaces in contact and the mass of the object.

5.1.5 Tension Force : Tension is a force exerted by string, ropes, fibres and cables when they are pulled.

5.1.6 Normal Force : The force perpendicular to the surfaces of the objects in contact is called normal force.



6. WEIGHT AND ITS MEASURE

Mass and weight are two commonly used terms in everyday life, but they represent different physical quantities. Although they are related, they are not the same.

6.1 Mass

Mass is the amount of matter present in an object.
It tells us how much substance an object is made of.

Characteristics of Mass:

- Mass remains **constant everywhere**.
- It does **not depend on gravity**.
- It is an **intrinsic property** of an object.
- The SI unit of mass is **kilogram (kg)**.
- Mass is measured using a **beam balance**.

Example:

A body having a mass of 1 kg on Earth will also have a mass of 1 kg on the Moon or any other planet.

6.2 Weight

Weight is the force with which the Earth (or any other planet) attracts an object towards its centre.

Weight depends on the **gravitational force** acting on the object.

Characteristics of Weight:

- Weight **changes from place to place**.
- It depends on the **gravity** of the planet.
- It is a **force**, not a property.
- The SI unit of weight is **newton (N)**.
- Weight is measured using a **spring balance**.

6.3 Relationship Between Mass and Weight

Weight is directly proportional to mass and is given by the formula:

$$\text{Weight (W)} = \text{Mass (m)} \times \text{Gravitational acceleration (g)}$$

$$W = m \times g$$

Where

- W = Weight (in newton)
- m = mass (in kg)
- g = acceleration due to gravity

On Earth, the value of g is approximately 10 m/s²

6.4 Variation of Weight on Different Planets

The gravitational force is different on different planets and satellites.

Hence, the **weight of the same object is different**, but its **mass remains the same**.

Example (Mass = 1 kg)

Planet/Satellite	Weight	Reason
Earth	10 N	Moderate gravity
Moon	1.6 N	Very low gravity
Mars	3.8 N	Less gravity than Earth
Venus	9 N	Slightly less gravity
Jupiter	25.4 N	Very strong gravity

Thus, an object weighs:

- **Least on the Moon**
- **Most on Jupiter**

6.5 Why We Are Not Crushed by Atmospheric Pressure

Although atmospheric pressure exerts a large force on our body, we do not feel crushed because:

- The fluids and tissues inside our body exert an **equal and opposite pressure outward**.
- This balances the external pressure.

6.6 Difference Between Mass and Weight

Mass	Weight
Amount of matter	Force of gravity
Constant everywhere	Varies with gravity
Measured in kg	Measured in N
Independent of gravity	Depends on gravity

CONCLUSION

- Mass remains the same everywhere.
- Weight depends on gravitational force.
- Weight changes from planet to planet, but mass does not.

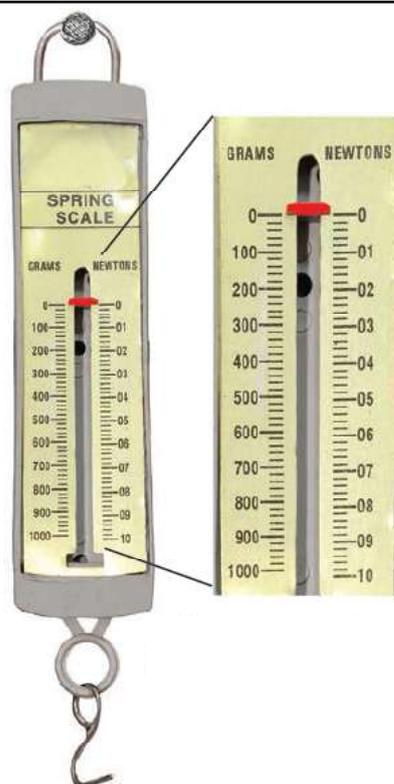
Mass and weight are often confused, but they represent different physical quantities. **Mass** refers to the amount of matter present in an object. It remains the same everywhere, whether the object is on the Earth, the Moon, or any other planet. Mass is measured using a beam balance, and its SI unit is **kilogram (kg)**.

Weight, on the other hand, is the force with which the Earth (or any celestial body) attracts an object due to gravity. Since the strength of gravity varies from place to place, the weight of an object also changes accordingly. Weight is measured using a spring balance, and its SI unit is **newton (N)**.

In daily life, when we say that “the weight of a bag of rice is 10 kg,” we actually mean its **mass**, because kilogram is a unit of mass, not weight. Scientifically, it is correct to say that “the mass of the bag of rice is 10 kg.”

7. SPRING BALANCE

A spring balance is an instrument used to **measure the weight of an object**. It works on the principle that a spring stretches when a force is applied to it. The more the weight of the object, the greater is the extension of the spring. The reading on a spring balance depends on the **gravitational force**, so the weight of the same object may change from place to place. The weight measured by a spring balance is expressed in **newtons (N)**.



Tabletop (Beam) Balance

A tabletop balance is used to **measure the mass of an object**. It compares the unknown mass with known standard masses. Since mass does not depend on gravity, the reading of a tabletop balance remains the same everywhere. The mass measured using this balance is expressed in **kilograms (kg)**.

Difference in Use

- A **spring balance** measures **weight** and gives readings in newtons.
- A **tabletop balance** measures **mass** and gives readings in kilograms.

8. FLOATING AND SINKING

When an object is placed in a liquid, the liquid exerts an **upward force** on it. This upward force is called **upthrust** or **buoyant force**. According to **Archimedes' Principle**, the upward force acting on an object immersed in a liquid is **equal to the weight of the liquid displaced by the object**.

Conditions for Floating and Sinking

- If the **weight of the liquid displaced** by an object is **less than the weight of the object**, the object **sinks** in the liquid.
- If the **weight of the liquid displaced** is **equal to the weight of the object**, the object **floats fully submerged** in the liquid.
- If the **weight of the liquid displaced** is **greater than the weight of the object**, the object **floats on the surface** of the liquid.

Examples

- Iron sinks in water because it displaces less water than its own weight.
- A submarine can float fully submerged by balancing its weight with the buoyant force.
- Cork floats on water because it displaces more water than its own weight.

Floating and Sinking in Terms of Density

- If the **density of an object is greater than the density of the liquid**, the object **sinks**.
- If the **density of an object is equal to the density of the liquid**, the object **floats completely immersed**.
- If the **density of an object is less than the density of the liquid**, the object **floats on the surface**.

An iron nail sinks in water because its density is higher than water. However, an iron ship floats because its **average density**, due to the hollow air-filled part, is **less than that of water**.

9. WHY PUMICE FLOATS

Most normal rocks sink in water because their density is higher than that of water. However, **pumice stone floats** on water.

Pumice is formed during **volcanic eruptions**. When hot lava containing a large amount of gas and water vapour cools very quickly, **tiny air bubbles get trapped inside the rock**. This makes the pumice stone **porous, light, and full of air pockets**.

Due to these air-filled spaces, the **average density of pumice becomes lower than that of water**.

As a result, pumice floats on the surface of water.

EXERCISE-I

NCERT Essentials

Q.1 Match items in Column A with the items in Column B.

Column A (Type of force)		Column B (Example)	
(i)	Muscular force	(a)	A cricket ball stopping on its own just before touching the boundary line
(ii)	Magnetic force	(b)	A child lifting a school bag
(iii)	Frictional force	(c)	A fruit falling from a tree
(iv)	Gravitational force	(d)	Balloon rubbed on woollen cloth attracting hair strands
(v)	Electrostatic force	(e)	A compass needle pointing North

Q.2 State whether the following statements are True or False.

- (i) A force is always required to change the speed of motion of an object.
- (ii) Due to friction, the speed of the ball rolling on a flat ground increases.
- (iii) There is no force between two charged objects placed at a small distance apart.

Q.3 Two balloons rubbed with a woollen cloth are brought near each other. What would happen and why?

Q.4 When you drop a coin in a glass of water, it sinks, but when you place a bigger wooden block in water, it floats. Explain.

Q.5 If a ball is thrown upwards, it slows down, stops momentarily, and then falls back to the ground. Name the forces acting on the ball and specify their directions.

- (i) During its upward motion
- (ii) During its downward motion
- (iii) At its topmost position

Q.6 A ball is released from the point P and moves along an inclined plane and then along a horizontal surface as shown in the Fig. It comes to stop at the point A on the horizontal surface. Think of a way so that when the ball is released from the same point P, it stops (i) before the point A (ii) after crossing the point A.

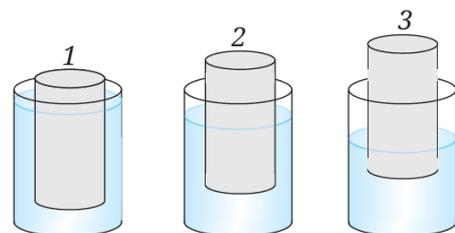


Q.7 Why do we sometimes slip on smooth surfaces like ice or polished floors? Explain.

Q.8 Is any force being applied to an object in a non-uniform motion?

Q.9 The weight of an object on the Moon becomes one-sixth of its weight on the Earth. What causes this change? Does the mass of the object also become one-sixth of its mass on the Earth?

Q.10 Three objects 1, 2, and 3 of the same size and shape but made of different materials are placed in the water. They dip to different depths as shown in Fig. If the weights of the three objects 1, 2, and 3 are w_1 , w_2 , and w_3 , respectively, then



- (i) $w_1 = w_2 = w_3$
- (ii) $w_1 > w_2 > w_3$
- (iii) $w_2 > w_3 > w_1$
- (iv) $w_3 > w_1 > w_2$

EXERCISE-II**Brain Booster MCQs****MCQ BASED QUESTIONS :**

- Q.1** A batsman hits a cricket ball which then rolls on the level ground. After covering a short distance the ball comes to rest. The ball stops due to
(A) magnetic force (B) frictional force
(C) gravitational force (D) muscular force
- Q.2** When two forces applied on an object are equal and opposite, then these forces
(A) may move the object.
(B) may stop a moving object.
(C) may move the object and also cause a change in its shape.
(D) do not move the object but may cause a change in its shape.
- Q.3** When two unbalanced forces act on a body, in opposite directions, the net force is equal to
(A) the sum of the individual unbalanced forces.
(B) zero.
(C) difference between the two unbalanced forces and is in the direction of the larger force.
(D) difference between the two unbalanced forces and is in the direction of smaller force.
- Q.4** Nails have pointed ends. This results in
(A) a decrease in the force exerted on them.
(B) a decrease in the effect of the force exerted on them.
(C) an increase in the force exerted on them.
(D) an increase in the effect of the force exerted on them.
- Q.5** Which of the following is an example of contact force?
(A) Magnetic force
(B) Muscular force
(C) Electrostatic force
(D) Gravitational force
- Q.6** Fruits falling from trees is an example of
(A) Gravitational force
(B) Muscular force
(C) Frictional force
(D) Electrostatic force
- Q.7** During dry weather, rubbing a plastic scale with dry hair, attracts small pieces of paper. This is due to
(A) gravitational force
(B) electrostatic force
(C) frictional force
(D) muscular force
- Q.8** Force is a
(A) Pull
(B) Push
(C) Pull and push both
(D) None of these.
- Q.9** The strength of force is expressed by
(A) Weight
(B) Mass
(C) Magnitude
(D) Longitudinal force.
- Q.10** The force between two charged bodies is called
(A) Muscular force
(B) Gravitational force
(C) Magnetic force
(D) Electrostatic force.
- Q.11** State of motion is described by
(A) Position of rest
(B) Position of motion
(C) Both by the state of rest or motion
(D) None of these.
- Q.12** Magnetic force is
(A) Contact force
(B) Non-contact force
(C) both (A) and (B)
(D) None.
- Q.13** Force acts on an object may change
(A) Direction (B) Shape
(C) Speed (D) All of above.
- Q.14** The net force on an object is zero if the two forces acting on it in
(A) Opposite direction
(B) Same direction
(C) Sometimes opposite sometimes same direction.
(D) All of above.

- Q.15** Leaves or fruits fall on the ground due to
 (A) Magnetic force
 (B) Gravitational force
 (C) Electrostatic force
 (D) Muscular force
- Q.16** Force can affect the state of motion of a body by changing
 (A) direction or speed (B) increasing speed
 (C) decreasing speed (D) all of the above
- Q.17** In an aneroid barometer, the liquid used is
 (A) water (B) mercury
 (C) alcohol (D) no liquid
- Q.18** Which is not the non-contact force?
 (A) Electrostatic force (B) Magnetic force
 (C) Force due to gravity (D) Muscular force
- Q.19** The standard unit of force is
 (A) metre/second (B) newton
 (C) metre/second² (D) gram/weight
- Q.20** The force exerted by animal body is called
 (A) muscular force (B) mechanical force
 (C) gravitational force (D) magnetic force
- Q.21** 1 kilogram weight is
 (A) 98 N (B) 9.8 N
 (C) 0.98 N (D) 0.098 N
- Q.22** The force exerted by one object on another by virtue of their masses is
 (A) magnetic force
 (B) electrostatic force
 (C) gravitational force
 (D) frictional force
- Q.23** If a rock is brought from the surface of the moon
 (A) its mass will change
 (B) its weight will change, but not mass
 (C) both mass and weight will change
 (D) its mass and weight will remain the same
- Q.24** When an object undergoes acceleration
 (A) its speed always increases
 (B) its velocity always increases
 (C) its always falls towards the earth
 (D) a force always acts on it
- Q.25** External forces are :
 (A) always balanced
 (B) never balanced
 (C) may or may not be balanced
 (D) none of these
- Q.26** The net force acting on a body of mass 1 kg moving with a uniform velocity of 5 ms^{-1} is
 (A) 5 N (B) 0.2 N
 (C) 0 N (D) None of these
- Q.27** How many dynes are equal to 1 N?
 (A) 10^6 (B) 10^4
 (C) 10^5 (D) 10^3
- Q.28** A force can :
 (A) change the direction of a moving body
 (B) change the state of rest or uniform motion of a body
 (C) change the shape of a body
 (D) all of the above
- Q.29** A vacuum cleaner work on the principle of
 (A) Electro magnetic Indication
 (B) Suction
 (C) Mutual Induction
 (D) Energy conservation
- Q.30** Which of the following is true?
 (A) If an object moves 6 m in 2 second then its speed is zero
 (B) When an object moves 10 m in 3 second then its speed is 30 m/s
 (C) Speed = Velocity \times Distance
 (D) When an object moves 12 m in 4 second then its speed is 3 m/s
- Q.31** In which of the following case you are not applying any force on a chair?
 (A) When you are sitting on the chair
 (B) When you are pulling the chair but it is not moving
 (C) When you are pushing the chair and it is moving
 (D) When you are just seeing the chair
- Q.32** Distance is measured in:
 (A) Force
 (B) Second
 (C) Length
 (D) Metre

- Q.33** SI unit of force is:
 (A) Newton (B) Dyne
 (C) Joule (D) m/s^2
- Q.34** A man is running on the ground. Which of the following is not true?
 (A) Man is applying force on the ground
 (B) The ground is applying force on the man
 (C) The air is not applying any force on the man
 (D) The air is applying some force on the man
- Q.35** Which of the following comes with a movement only?
 (A) Force (B) Mass
 (C) Speed (D) Time
- Q.36** When you push a tree?
 (A) The tree also pushes you
 (B) The tree pulls you
 (C) The tree neither push nor pull it is at rest
 (D) The tree pushes when you stop pushing it
- Q.37** The SI unit of speed is:
 (A) km/hr (B) m/s
 (C) length/second (D) distance/second
- Q.38** Which force enables us to perform all activities involving movement or bending of our body?
 (A) Contact force
 (B) Non-contact force
 (C) Muscular force
 (D) Gravitational force
- Q.39** The force exerted by a magnet is an example of;
 (A) Contact force
 (B) Non-contact force
 (C) Gravitational force
 (D) Muscular force
- Q.40** Wind is a kind of
 (A) Contact force
 (B) Non contact force
 (C) Action at a distance force
 (D) None of these
- Q.41** Gravitational force is
 (A) Contact force
 (B) Repulsive force
 (C) Attraction force
 (D) None of these
- Q.42** A force
 (A) can change the shape and size of object
 (B) can be seen
 (C) is a scalar physical quantity
 (D) none of these
- Q.43** Which of the following class of forces is different from others?
 (A) Magnetic force
 (B) Electrostatic force
 (C) Gravitational force
 (D) Stretching of a spring
- Q.44** A contact force cannot act through
 (A) Empty space
 (B) Touching
 (C) Touching with metal rod
 (D) Touching with wooden rod
- Q.45** Density is equal to
 (A) $\frac{\text{volume}}{\text{mass}}$ (B) $\frac{\text{mass}}{\text{weight}}$
 (C) $\frac{\text{mass}}{\text{volume}}$ (D) $\text{mass} \times \text{volume}$
- Q.46** Frictional force can't be measured in
 (A) kg weight (B) newton
 (C) dyne (D) kg ms^{-1}
- Q.47** 1 Dyne is equal to
 (A) 98 g weight (B) 1/980 g weight
 (C) 980 g weight (D) none of these
- Q.48** The density of water is
 (A) $10^{-3} \text{ kg m}^{-3}$ (B) $10^{-2} \text{ kg m}^{-3}$
 (C) 10^2 kg m^{-3} (D) 10^3 kg m^{-3}
- Q.49** The hot air balloon rises because it is
 (A) denser
 (B) less dense
 (C) equally dense
 (D) the given statement is wrong
- Q.50** 1 millibar is equal to
 (A) 100 Nm^{-2} (B) 100 N/m^{-2}
 (C) 1 Nm^{-2} (D) $1/100 \text{ Nm}^{-2}$

EXERCISE-III**Concept Check****TRUE AND FALSE:**

- Q.1** Force of friction is an example of non-contact force.
- Q.2** If two unequal forces act in opposite directions on an object, the net force is the difference between the two forces.
- Q.3** The forces of friction can be reduced by using lubricants.
- Q.4** The force exerted per unit area is called magnitude.
- Q.5** A force can change the state of motion of an object.
- Q.6** Muscular force is a kind of Contact force.
- Q.7** Force of gravity is contact force.
- Q.8** At least two objects must interact for a force to come into play.
- Q.9** Pascal is the unit of force.
- Q.10** To move an object faster it has to be pushed or pulled repeatedly
- Q.11** Force can change the shape of an object.
- Q.12** Muscular force is type of non-contact force.

FILL IN THE BLANKS:

- Q.1** The pull or push is called _____.
- Q.2** Force of friction is an example of _____ force.
- Q.3** The wear and tear in the machine parts is due to _____.
- Q.4** Force acting due to action of muscles is called _____.
- Q.5** The force exerted per unit area is called _____.
- Q.6** A force applied on an object may change its _____.

- Q.7** Force has _____ as well as _____.
- Q.8** Water in rivers flows _____ due to the force of gravity.
- Q.9** A _____ or a _____ on an object is called force.
- Q.10** An object _____ with another object results in a force between the two objects.
- Q.11** A force applied on an object causes either a change in it's _____ of _____ or its _____.
- Q.12** Magnetic force is a _____ force.

ASSERTION & REASON :

- Q.1** **Assertion (A):** Weight of an object varies from place to place.
Reason (R): Gravitational force varies slightly from place to place.
- Q.2** **Assertion (A):** Magnetic force is a non-contact force.
Reason (R): Magnets can attract iron objects without touching them.
- Q.3** **Assertion (A):** Muscular force is a contact force.
Reason (R): Muscles need to be in contact with objects to exert force.
- Q.4** **Assertion (A):** Gravitational force acts on all objects.
Reason (R): Every object in the universe attracts every other object.
- Q.5** **Assertion (A):** Air resistance opposes the motion of objects.
Reason (R): Air resistance is a type of friction.

CASE STUDY :**Case Study 1:****Floating and Sinking Experiment**

A student placed different objects in water: a wooden block floated, an iron nail sank, a plastic bottle with cap closed floated, but when the cap was removed and bottle filled with water, it sank.

- Q.1** Why did the wooden block float?
 (A) It is light
 (B) It is less dense than water
 (C) It is magnetic
 (D) It has no weight
- Q.2** Why did the iron nail sink?
 (A) It is heavy
 (B) It is denser than water
 (C) It is magnetic
 (D) It has more weight
- Q.3** Why did the closed plastic bottle float?
 (A) Plastic is light
 (B) Air inside makes it less dense
 (C) It is waterproof
 (D) It is elastic
- Q.4** Why did the bottle sink when filled with water?
 (A) Water is heavy
 (B) Overall density increased
 (C) Plastic became heavy
 (D) Air escaped
- Q.5** What principle explains floating and sinking?
 (A) Newton's law
 (B) Archimedes' principle
 (C) Hooke's law
 (D) Pascal's law

Case Study 4: Spring Balance Experiment

Students used a spring balance to measure weights of different objects. They observed that heavier objects caused more stretch in the spring, and the reading increased proportionally.

- Q.6** What does a spring balance measure?
 (A) Mass (B) Weight
 (C) Volume (D) Density
- Q.7** Why does the spring stretch when an object is hung?
 (A) Gravitational force on object
 (B) Magnetic force
 (C) Air pressure
 (D) Heat expansion
- Q.8** What is the SI unit shown on spring balance?
 (A) Kilogram (B) Gram
 (C) Newton (D) Pound
- Q.9** If an object weighs 10 N on Earth, what will it weigh on Moon?
 (A) 10 N (B) 60 N
 (C) 1.67 N (D) 0 N
- Q.10** What principle does a spring balance work on?
 (A) Archimedes' principle
 (B) Pascal's law
 (C) Hooke's law
 (D) Newton's law

MATCH THE COLUMN:

- Q.1** Match the following scientists with their contributions:

Column A		Column B	
(i)	Archimedes	(a)	Laws of motion
(ii)	Newton	(b)	Principle of buoyancy
(iii)	Galileo	(c)	Theory of relativity
(iv)	Einstein	(d)	Telescope invention
(v)	Hooke	(e)	Law of elasticity

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

Q.2 Match the following with their effects:

Column A		Column B	
(i)	Pushing a ball	(a)	Change in shape
(ii)	Pressing clay	(b)	Change in speed
(iii)	Applying brakes	(c)	Change in direction
(iv)	Hitting a ball	(d)	Object starts moving
(v)	Kicking a ball	(e)	Object stops moving

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

Q.3 Match the following forces with their applications:

Column A		Column B	
(i)	Friction	(a)	Satellites orbiting Earth
(ii)	Gravity	(b)	MRI machines
(iii)	Magnetism	(c)	Car brakes
(iv)	Buoyancy	(d)	Photocopying
(v)	Electrostatic	(e)	Ships floating

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

Q.4 Match the following with their properties:

Column A		Column B	
(i)	Like charges	(a)	Attract each other
(ii)	Unlike charges	(b)	Repel each other
(iii)	Like poles	(c)	No magnetic effect
(iv)	Unlike poles	(d)	Strong attraction
(v)	Non-magnetic materials	(e)	Cannot be magnetized

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

Q.5 Match the following materials with their friction:

Column A		Column B	
(i)	Ice	(a)	High friction
(ii)	Sandpaper	(b)	Very low friction
(iii)	Oil	(c)	Medium friction
(iv)	Rubber	(d)	Low friction
(v)	Smooth glass	(e)	Variable friction

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

EXERCISE-IV

Subjective Assessment

VERY SHORT TYPE QUESTIONS:

Q.1 What is force?

Ans. A push or a pull on an object is called force.

Q.2 What is the requirement for a force to come into play?

Ans. Interaction between two objects is required for force to come into play.

Q.3 What is the resultant force when two forces act in same direction?

Ans. Forces applied on an object in the same direction add to one another.

Q.4 What will be the resultant force when two forces act in opposite directions on an object?

Ans. When two forces act in opposite directions on an object then the net force will be the difference between two forces.

Q.5 What happens in a tug of war when two teams pull equally hard?

Ans. When two teams pull equally hard then the rope does not move in any direction.

Q.6 When does the net force become zero?

Ans. When two forces acting on an object in opposite directions are equal then the net force becomes zero.

Q.7 What is muscular force?

Ans. The force resulting due to the action of muscles is known as muscular force.

Q.8 Give two examples of contact forces.

Ans. (i) Muscular force (ii) Force of friction

Q.9 What are non-contact forces?

Ans. The forces acting from a distance without making contact are called non-contact forces.

Q.10 Give an example of a non-contact force.

Ans. Magnetic force.

Q.11 What is magnetic force?

Ans. The force exerted by a magnet on any magnetic object is called magnetic force.

Q.12 What are the interaction of poles of two magnets?

Ans. (i) Like poles repel each other.
(ii) Unlike poles attract each other.

Q.13 What kind of force is an electrostatic force?

Ans. It is non-contact force.

Q.14 What is gravitational force?

Ans. The force by which earth or any other object attracts objects towards itself is called the gravitational force.

Q.15 What is atmosphere?

Ans. The envelop of air around us is called atmosphere.

SHORT TYPE QUESTIONS :

Q.1 What is a force? Explain with the help of some examples.

Ans. Force is a pull or push of the objects. The action like, pushing, pulling, picking, hitting, lifting, running and bending are the examples of force. Moving or stopping of a body, changing shape and direction of motion of objects are various actions which show force in play.

Q.2 What is the effect of force on the shape of an object?

Ans. A force can change or try to change the shape of an object. When a force is applied on an object then change in shape may take place. It may be smaller or greater. At last we can say that the application of force on an object may change its shape.

Q.3 Explain contact and non-contact forces.

Ans. **Contact forces:** The forces which come in action only when two objects come in the contact with each other are called contact forces. Muscular force and force of friction are the examples of contact forces.

Non-contact forces: The forces which come in the action without any contact with one another are called non-contact forces. Electrostatic and magnetic forces are the examples of non-contact forces.

Q.4 What is muscular force? Why is it called contact force?

Ans. The force resulting due to the action of muscles is known as the muscular force. Muscular force is called contact force because it comes in action when two bodies come in contact with each other.

Q.5 What do you understand about the force of friction?

Ans. The force which always acts on all the moving objects and whose direction is always opposite to the direction of motion is called force of friction. Since the force of friction arises due to contact between surfaces, it is also called contact force.

Q.6 What is electrostatic force? Why is it called non-contact force?

Ans. The force exerted by a charged body on another charged or uncharged body is called electrostatic force. This force comes into play even when the bodies are not in contact, so it is called non-contact force.

Q.7 Explain force of gravity.

Ans. Objects or the things fall towards the earth because the earth pulls them. This force is called force of gravity or the force due to gravitation. It is an attractive force. This force acts on all objects.

Q.8 Why does a boat come to rest when we stop rowing it?

Ans. The boat comes to rest when we stop rowing it due to the force of friction acting between the surface of water and the boat.

LONG TYPE QUESTIONS:

Q.1 What are contact forces? State different contact forces.

Ans. The forces which come in to play only when two objects come in contact with each other are called contact forces.

Some contact forces are:

(i) **Muscular force:** The forces resulting due to the action of muscles are known as muscular forces. Muscular force is a contact force because it comes in play when two bodies come in contact with each other

(ii) **Force of friction:** When a body is moving, then a force equal and opposite to direction of motion is exerted on that moving body. This force is called force of friction. It is also a contact force because it is exerted when two surfaces come in contact with each other.

Q.2 What are non-contact forces? Explain different types of non-contact forces.

Ans. The forces which can be exerted from a distance, without establishing a contact are called non-contact forces. Some non-contact forces are:

(i) **Magnetic force:** The force exerted by a magnet on other magnet or some other magnetic substances like iron is called magnetic force. Like poles of a magnet repel each other and unlike poles of a magnet attract each other without contact. So it is called non-contact force.

(ii) **Electrostatic force:** The force exerted by a charged body on other charged or uncharged body is called electrostatic force. Electrostatic force also acts without making a direct contact with other charged or uncharged body. So it is also a non-contact force.

(iii) **Force of gravity:** Earth pulls every thing or body towards it. The force of attraction exerted by earth on every object is called force of gravity. This is also a non-contact force as it acts from a distance.

Q.3 Prove that the force of friction depends on the nature of the two surfaces in contact.

Ans. Collect the following things: A thick book, nylon cloth, gunny cloth, plastic sheet, jute cloth and sand paper.

Place the book on each of the materials and slide it on the floor one by one. If your book slides off the plastic sheet or nylon cloth, use adhesive tape to stick it firmly on the surface of the book.

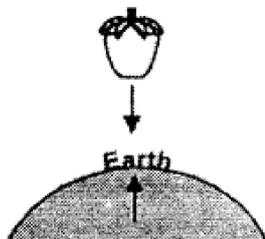
You will observe that the different materials offer different amounts of resistances to sliding.

This activity shows that force of friction depends on the nature of the surface in contact. In general, smooth surface offers lesser friction than rough surface.

EXERCISE-V

Competition Edge

- Q.1** With the help of given figure, find which of the following options is correct ?

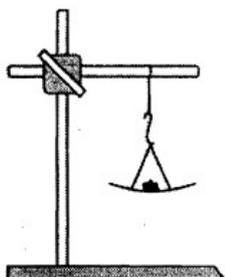


- (A) The apple pulls with greater force than the earth pulls the apple
 (B) The apple pulls with smaller force than the earth pulls the apple
 (C) The apple pulls the earth with the same force that the earth pulls the apple
 (D) All of these

- Q.2** When a force is applied to a stationary object, several effects are possible. Which of the following effect is not possible ?

- (A) The object moves
 (B) The object rotates
 (C) The object remains stationary
 (D) The mass of the object increases

- Q.3** Satish found that when he hung standard weights on a particular spring, the spring was extended. He measured the length of the spring when 100g, 250 g and 400 g weights were hung on it and recorded the results in the table given below.



Weight used(g)	Length of spring(cm)
100	10
250	13
400	16

Satish then hung his textbook on the spring and found that the length of the spring was 14.5 cm. The weight of his textbook in g is _____.

- (A) 275 (B) 325
 (C) 300 (D) 375

- Q.4** Match column-I with Column-II and select the correct option from the codes given below.

Column-I

Column-II

- (a) A child running to catch the school bus
 (b) A man blowing a balloon
 (c) A woman pushing a table
 (d) A cricketer catching a ball
- (i) Force can make a stationary object to move
 (ii) Force can stop a moving object
 (iii) Force can change the shape of an object
 (iv) Force can make an object move faster

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

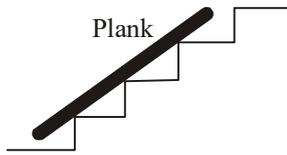
- Q.5** When a constant force acts on a mass, and the mass starts moving from rest, then the :

- (i) acceleration is constant
 (ii) velocity increases at a constant rate
 (iii) distance travelled is directly proportional to the time

Which of the above statements is/are correct ?

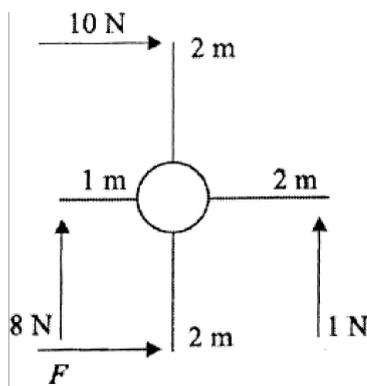
- (A) (i) only
 (B) (i) and (ii) only
 (C) (i) and (iii) only
 (D) (ii) and (iii) only

Q.6 A plank is supported on the steps of a staircase as shown in the figure. How many forces are acting on the plank ?



- (A) 4
- (B) 5
- (C) 6
- (D) 7

Q.7 A windmill is pushed by four external forces as shown in the given figure. The force F required to make the windmill stand still is :



- (A) 10 N
- (B) 13 N
- (C) 15 N
- (D) 18 N

Q.8 Which of the following objects experience balanced forces ?

- (A) A ball dropping vertically
- (B) A car accelerating uniformly from rest
- (C) A trolley moving at a constant velocity down an inclined plane
- (D) A plane flying in a circle with constant speed

PREVIOUS YEAR NSO QUESTIONS:

Q.9 Match the columns and mark the correct option from the codes given below.

(NSO)

Column-I

- (a) Force
- (b) Contact force
- (c) Force of gravity

Column-II

- (i) Non-contact force
- (ii) Push or pull
- (iii) Muscular force

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

Q.10 An object will continue moving uniformly until _____ (NSO)

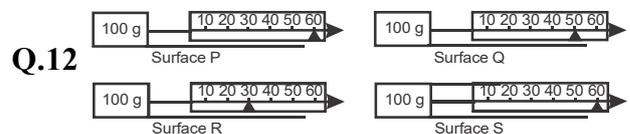
- (A) The resultant force acting on it begins to decrease
- (B) The resultant force on it is zero
- (C) The resultant force is at right angle to its rotation
- (D) The resultant force on it increases continuously

Q.11 Read the statements carefully and mark the correct option (NSO)

Statement 1 : Inertia is the property by virtue of which the body is unable to change by it self the state of rest

Statement 2 : The bodies do not change their state unless acted upon by an unbalanced external force

- (A) Both statement 1 and 2 are true and statement 2 is the correct explanation of statement 1
- (B) Both statement 1 and 2 are true but statement 2 is not the correct explanation of statement 1
- (C) Statement 1 is true and statement 2 is false
- (D) Both statements 1 and 2 are false



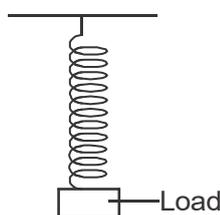
Q.12

The above figures show the forces required to move a 100 g object over different surfaces. The friction is greatest at _____ . (NSO)

- (A) Surface P
- (B) Surface Q
- (C) Surface R
- (D) Surface S

- Q.13** A wooden block is floating in water contained in a beaker. During the free fall of the beaker, the upthrust on the block will be **(NSO)**
 (A) Equal to the weight of the block
 (B) Slightly more than the weight of the block
 (C) Slightly less than the weight of the block
 (D) Zero

- Q.14** In the given diagram, when a weight of 100 g is hung from the spring, its length is 9 cm. When a weight of 150 g is hung from it, its length is 11 cm. What is the length of the spring when there's no weight hanging from it? **(NSO)**



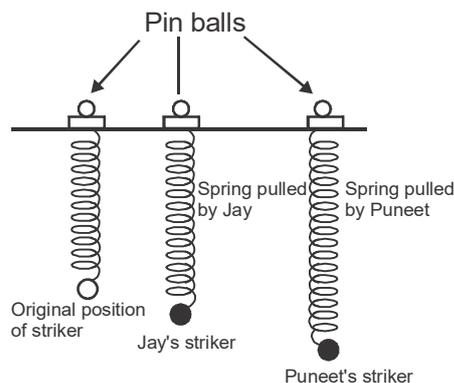
- (A) 2 cm (B) 4 cm
 (C) 5 cm (D) 7 cm

- Q.15** A box was pushed over an equal distance on four different surfaces. The force needed for each surface was recorded in the table below. **(NSO)**

Surface	P	Q	R	S
Force needed (N)	550	475	500	450

- On which surface was the friction least?
 (A) P (B) Q
 (C) R (D) S

- Q.16** Jay and Puneet go to the amusement park to play the pin ball game. The figure shows the extent to which each of them pulls the striker. Which one of the following statements is correct? **(NSO)**



- (A) Jay's ball will move faster because spring of his striker is more elastic.
 (B) Puneet's ball will move faster because the spring of his striker is more elastic.
 (C) Jay's ball will move faster because the spring of his striker stores more potential energy.
 (D) Puneet's ball will move faster because the spring of his striker stores more potential energy.

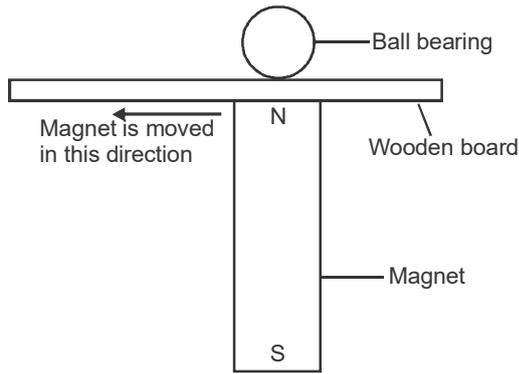
- Q.17** Does a falling body accelerate? Why? **(NSO)**

- (A) Yes, because the gravity is a force that causes it to move faster
 (B) No, because the gravity is a force that causes it to move at constant speed
 (C) Yes, because the air causes it to accelerate
 (D) No, because air keeps it moving at constant speed

- Q.18** A body is at rest on the surface of the earth. Which of the following statements is correct? **(NSO)**

- (A) No force is acting on the body
 (B) Only weight of the body acts on it
 (C) Net downward force is equal to the net upward force
 (D) None of these

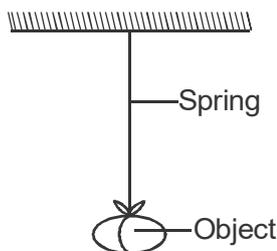
- Q.19** A boy set up an experiment as shown in the diagram. As he slide the magnet across the wooden board, the ball bearing followed the magnet's movement and direction. What does the experiment show? **(NSO)**



- (i) Magnetic force can be seen
 - (ii) Friction and gravity help to move the ball bearing
 - (iii) The ball bearing is made of a magnetic substance
 - (iv) Magnetic force can pass through the wooden board
- (A) (i) and (ii)
 (B) (iii) & (iv)
 (C) (i), (iii) & (iv)
 (D) (ii), (iii) & (iv)

- Q.20** It is easier to swim in sea water than in river water because **(NSO)**
- (A) Sea water is more dense than river water
 - (B) Sea water has waves
 - (C) Sea has large quantity of water
 - (D) None of the these

- Q.21** The diagram shows an object hanging from a string. Which of the following is the correct statement about the diagram? **(NSO)**



- (A) The object does not fall because there is no gravity
- (B) The object does not fall because there is friction between the object and the string
- (C) The object does not fall because a magnetic force is acting on it
- (D) The object does not fall because the string is exerting a force against the earth's gravity

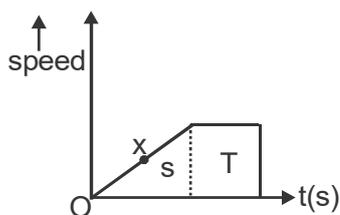
- Q.22** **Statement 1** : While walking, force exerted by the ground makes us move forward.
Statement 2 : It is a reaction force **(NSO)**
- (A) Both statements 1 and 2 are true and statement 2 is the correct explanation of statement 1
 - (B) Both statements 1 and 2 are true but statement 2 is not the correct explanation of statement 1
 - (C) Statement 1 is true and statement 2 is false
 - (D) Both statements 1 and 2 are false

- Q.23** Match the columns and select the correct option from the codes given below **(NSO)**

Column-I	Column-II
(a) Child running to catch the school bus	(i) Force can make a stationary object to move
(b) A man blowing	(ii) Force can stop a moving object
(c) A woman pushing a table	(iii) Force can change the shape of an object
(d) A cricketer catching a ball	(iv) Force can make an object move the faster

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

- Q.24** The given graph illustrates the motion of an object. Which feature of the graph represent the distance travelled by the object moving at a constant speed? **(NSO)**

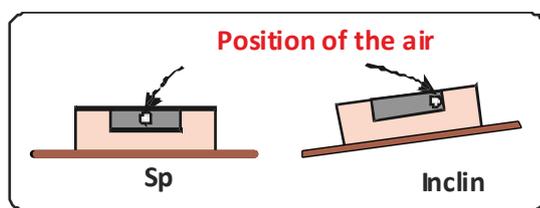


- (A) Area S
 (B) Area S + area T
 (C) Area T
 (D) The gradient at point X

PREVIOUS YEAR NSTSE QUESTIONS:

Q.25 A spirit level is used to determine the surface level as shown below.

(NSTSE 2022)



Why does the air bubble at the centre of the tube move to the right when the surface is inclined ?

- (A) The forces acting on the air bubble are in equilibrium.
 (B) Unbalanced forces act on the air bubble.
 (C) Air bubbles always rise.
 (D) Frictional force act on the air bubble.
- Q.26** When a coin and a feather are dropped simultaneously from the same height, the coin strikes the ground first. Why?
 (A) Gravitational force is less in the case of the coin.
 (B) Mass of coin is less.

- (C) Frictional force is less in the case of the coin.
 (D) Magnetic force is stronger in the case of the coin

Q.27 When the tension in the string of a guitar is increased, but other factors remain unchanged, the sound produced _____.
 (A) Is louder
 (B) Has higher pitch
 (C) Has longer wavelength
 (D) Travels faster

Q.28 A floor has a maximum loading capacity of 5 kN m^{-2} . Which of the following is allowed on this floor ?

(Take $g = 10 \text{ N kg}^{-1}$)

- (A) An elephant weighing 50 kN stands on 4 legs with each foot covering 400 cm^2 of the floor.
 (B) A 50 kg lady wears a pair of high heel shoes, each shoe has a contact area of 9 cm^2 with the floor.
 (C) A 100 kg washing machine stands on a surface area of 6500 cm^2 .
 (D) A designer's table weighing 1000 N stands on 3 legs, each leg has a contact area of 0.1 cm^2 with the floor.

Q.29 An iron block of dimensions $5 \text{ cm} \times 10 \text{ cm} \times 15 \text{ cm}$ has to be pushed along the floor. The force required will be minimum when the surface in contact with ground is

- (A) $(10 \text{ cm} \times 15 \text{ cm})$ surface
 (C) $(5 \text{ cm} \times 15 \text{ cm})$ surface
 (B) $(10 \text{ cm} \times 5 \text{ cm})$ surface
 (D) Force is same for all surfaces.

ANSWER KEY

EXERCISE-II

MULTIPLE CHOICE QUESTIONS :

Q.1	B	Q.2	B	Q.3	C	Q.4	D	Q.5	B	Q.6	A	Q.7	B
Q.8	C	Q.9	C	Q.10	D	Q.11	C	Q.12	B	Q.13	D	Q.14	A
Q.15	B	Q.16	B	Q.17	D	Q.18	D	Q.19	B	Q.20	A	Q.21	B
Q.22	C	Q.23	B	Q.24	D	Q.25	C	Q.26	C	Q.27	C	Q.28	D
Q.29	B	Q.30	D	Q.31	D	Q.32	D	Q.33	A	Q.34	C	Q.35	C
Q.36	A	Q.37	B	Q.38	C	Q.39	B	Q.40	A	Q.41	C	Q.42	A
Q.43	D	Q.44	A	Q.45	C	Q.46	D	Q.47	C	Q.48	A	Q.49	B
Q.50	A												

EXERCISE-III

TRUE AND FALSE :

Q.1	F	Q.2	T	Q.3	T	Q.4	F	Q.5	T	Q.6	T	Q.7	F
Q.8	T	Q.9	F	Q.10	T	Q.11	T	Q.12	F				

FILL IN THE BLANKS:

Q.1	Force	Q.2	Contact	Q.3	Friction	Q.4	Muscular force
Q.5	Pressure	Q.6	Speed or Shape	Q.7	Magnitude, Direction		
Q.8	Down ward	Q.9	Push, Pull	Q.10	Interaction		
Q.11	State, Motion, Shape	Q.12	Non-contact				

ASSERTION & REASON :

Q.1	(A)	Q.2	(A)	Q.3	(A)	Q.4	(A)	Q.5	(A)
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

CASE STUDY :

Q.1	(B)	Q.2	(B)	Q.3	(B)	Q.4	(B)	Q.5	(B)
Q.6	(B)	Q.7	(A)	Q.8	(C)	Q.9	(C)	Q.10	(C)

MATCH THE COLUMN:

Q.1	(B)	Q.2	(C)	Q.3	(A)	Q.4	(D)	Q.5	(A)
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EXERCISE-IV

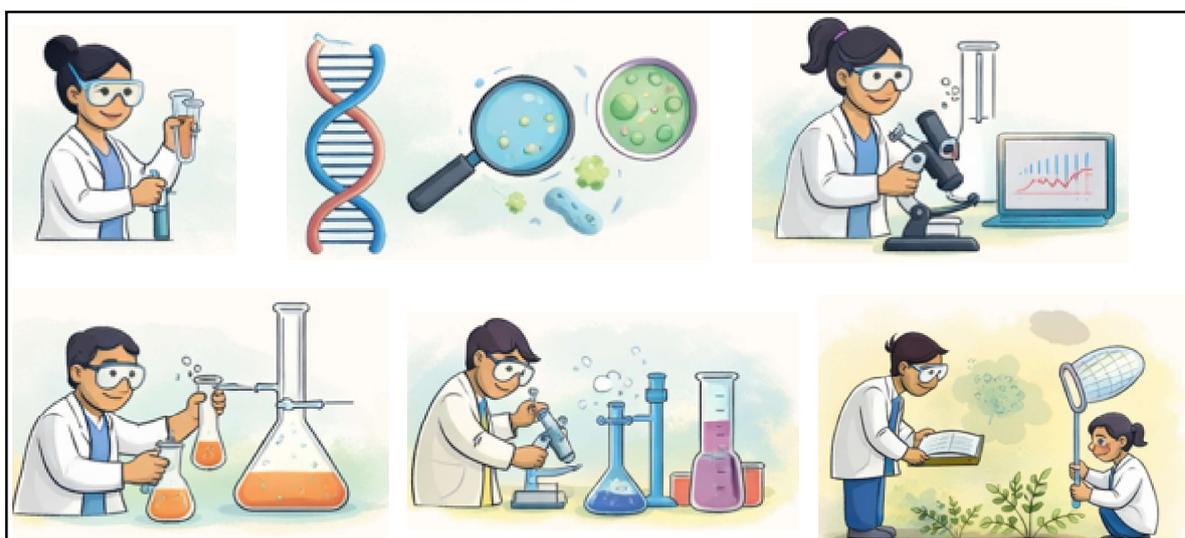
Q.1	C	Q.2	D	Q.3	B	Q.4	S	Q.5	B	Q.6	D	Q.7	B
Q.8	C	Q.9	B	Q.10	B	Q.11	A	Q.12	C	Q.13	D	Q.14	C
Q.15	D	Q.16	D	Q.17	A	Q.18	C	Q.19	B	Q.20	A	Q.21	D
Q.22	B	Q.23	A	Q.24	C	Q.25	B	Q.26	C	Q.27	B	Q.28	C
Q.29	D												

1

Exploring the Investigative World of Science

1. INTRODUCTION

This chapter focuses on **investigative science**, which means learning how to ask questions, explore ideas, and discover answers instead of just memorising facts. Science is shown as a process of **curiosity, observation, and experimentation** that helps us understand the world around us. The chapter explains how even **small observations**, such as microbes in water, are connected to **bigger issues** like climate change. It highlights the relationship between **humans, the environment, and science** in solving real-life problems. Overall, curiosity is presented as the key to exploring nature, asking meaningful questions, and finding logical answers.



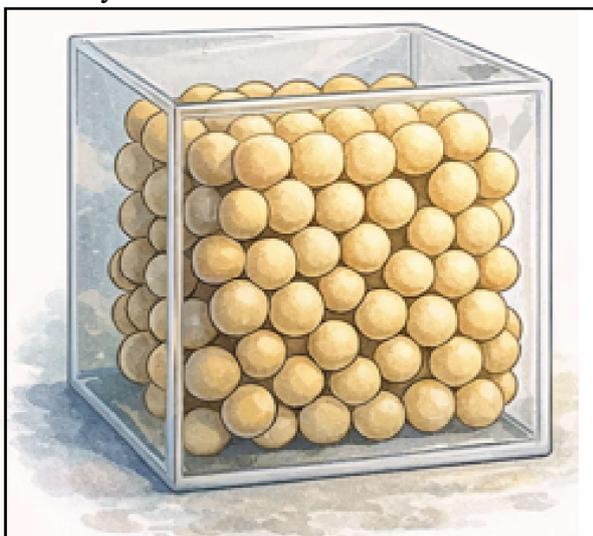
2. INVESTIGATIVE SCIENCE

Science grows by asking new questions and making new discoveries. It is not only about learning facts but also about **finding new facts**. Scientific investigation works best when **careful observation** is combined with **creative thinking**. Through investigative science, we explore the world from **tiny microbes to large global problems** that affect the entire planet. Asking questions, using prior knowledge, and thinking logically are important steps in the scientific learning journey.



3. STATES OF MATTER

Matter exists in three main states: **solids, liquids, and gases**. These states differ because of how their particles are arranged and how they move.



3.1 Solids

In solids, particles are packed very closely in a fixed and orderly pattern. The particles cannot move freely and only vibrate in their fixed positions. Because of this, solids have a **fixed shape and a definite volume**. For example, an ice cube keeps its shape unless it melts.

3.2 Liquids

In liquids, particles are close to each other but are not arranged in a fixed pattern. They can slide past one another, which allows liquids to flow. Liquids have a **definite volume but no fixed shape**. They take the shape of the container they are poured into, such as water in a bottle.

3.3 Gases

In gases, particles are very far apart with a lot of empty space between them. These particles move randomly at high speed and collide with each other and the container walls. Gases have **neither a fixed shape nor a definite volume** and spread out to fill the entire container.

4. CLASSIFICATION OF MATTER

Matter can be classified into **elements, compounds, and mixtures** based on its composition

4.1 Elements

An element is a **pure substance** made up of only one type of atom. It is the simplest form of matter and cannot be broken down into simpler substances by chemical means. Examples include **oxygen (O₂), hydrogen (H), gold (Au), and iron (Fe)**.

4.2 Compounds

A compound is a **pure substance** formed when two or more different elements are chemically bonded in a fixed ratio. The properties of a compound are different from the elements that form it. For example, **water (H₂O)** is made from hydrogen and oxygen but has completely different properties.

4.3 Mixtures

A mixture is formed when two or more substances are **physically mixed** together. The substances in a mixture retain their own properties and can usually be separated by physical methods.

In a mixture, the substances are **not chemically bonded**. They can be separated by **physical methods** such as filtration, evaporation, or distillation.

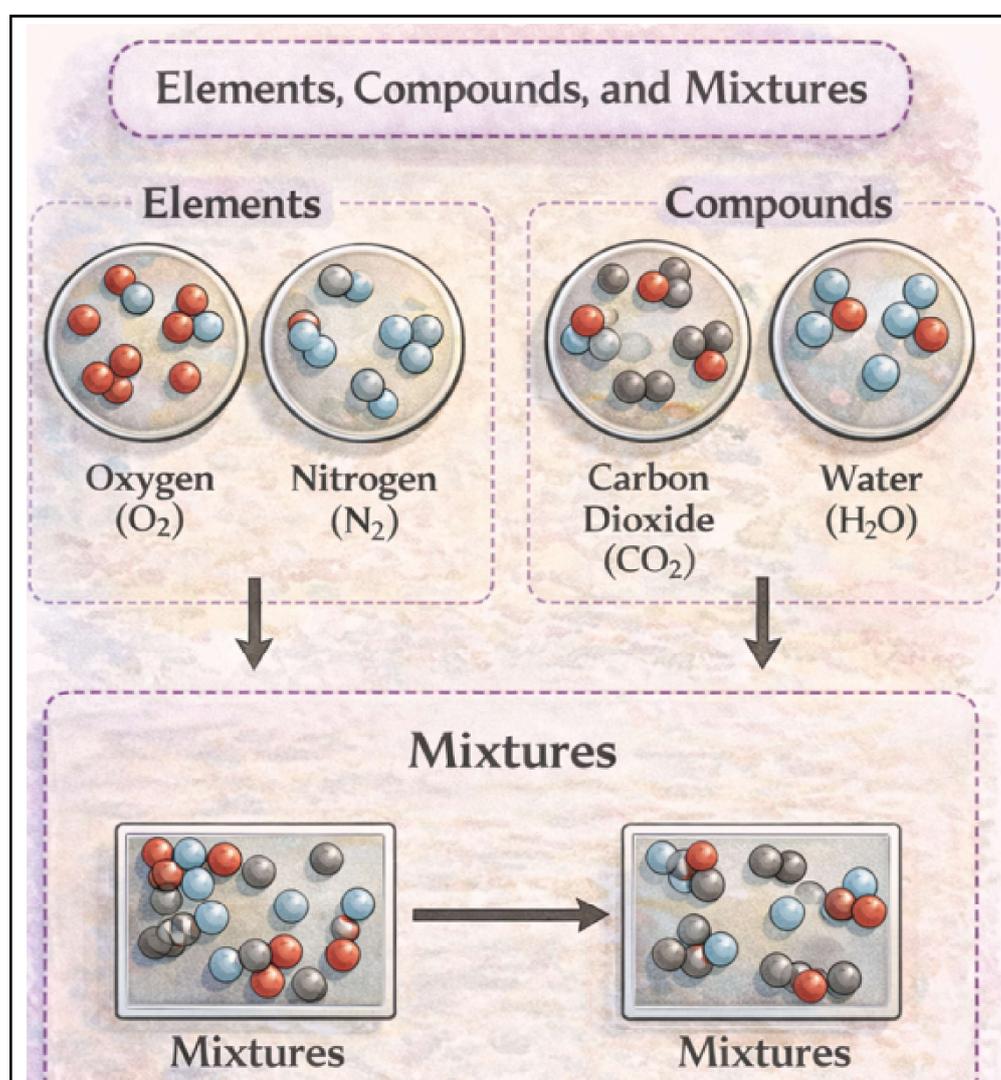
The properties of a mixture depend on the **properties of all the substances present** in it.

Examples:

- **Salt water** – a mixture of salt and water
- **Air** – a mixture of gases like nitrogen and oxygen

4.4 Elements, Compounds, and Mixtures

- **Elements** contain only one type of atom (e.g., oxygen, nitrogen).
- **Compounds** are formed when elements are chemically combined in a fixed ratio (e.g., carbon dioxide, water).
- **Mixtures** are formed when elements or compounds are physically mixed without chemical bonding.



5. LIGHT



5.1 Reflection

When light falls on a smooth and shiny surface like a mirror, it **bounces back**. This bouncing of light is called **reflection**.

Reflected rays change direction in a predictable way, allowing us to see images.

5.2 Refraction

When light passes from one transparent medium to another (like air to glass), it **changes speed and direction**. This bending of light is called **refraction**.

Lenses use refraction to focus or spread light.

5.3 Applications of Light

- Lenses in spectacles help us see clearly.
- Smooth and rough surfaces reflect light differently.
- The Moon shines because it **reflects sunlight**.

6. THE MOON AND CALENDARS

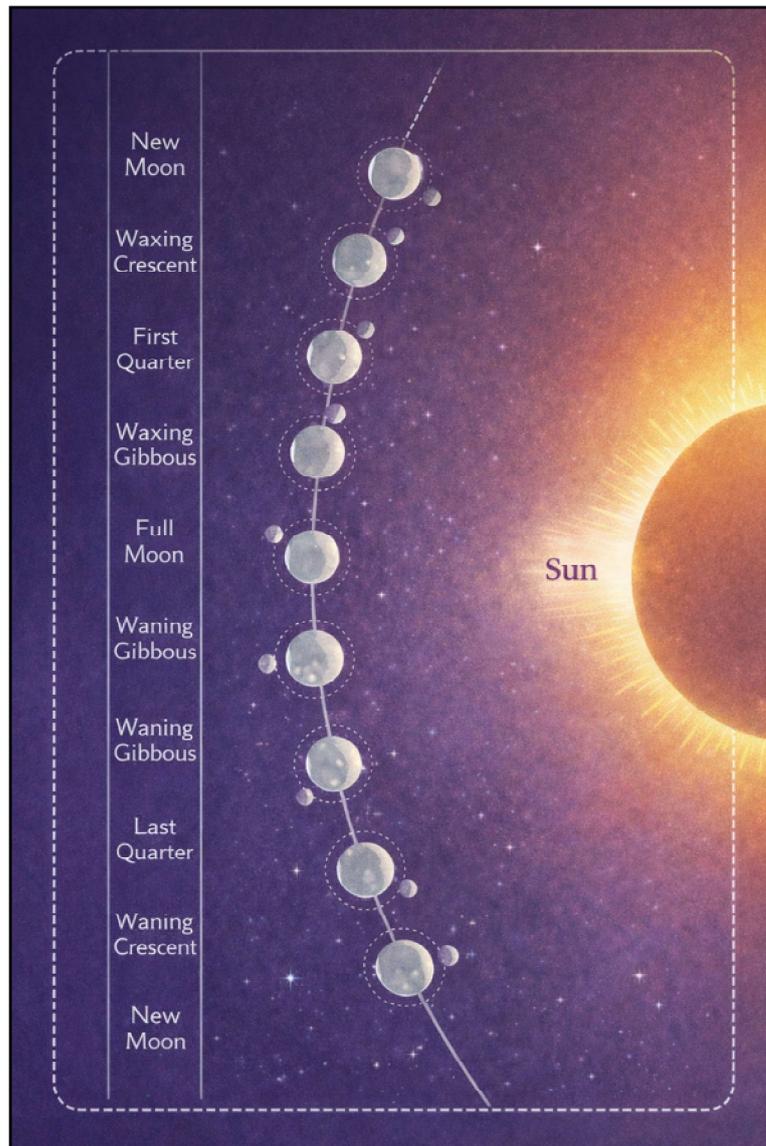
Phases of the Moon

The Moon takes about **29.5 days** to complete one full cycle of phases, from new moon to full moon and back again.

These phases occur because of the **changing positions of the Earth, Moon, and Sun** as the Moon revolves around the Earth.

The repeated cycles of the Moon were used to create the **first calendars**.

Early humans observed celestial events like **sunrise, sunset, and lunar phases**, which helped them track time and seasons.



7. ECOSYSTEMS AND LIFE ON EARTH



Earth supports life because:

- It is at the **right distance from the Sun**, so temperatures are suitable.
- The **atmosphere provides oxygen** and protects us from harmful UV rays.
- **Liquid water** is available.

All living organisms interact with their **environment** such as air, water, sunlight, soil, and other organisms. Ecosystems are **delicate** and can be easily disturbed by changes.

8. CLIMATE CHANGE AND HUMAN IMPACT



Human activities like **pollution, deforestation, and release of greenhouse gases** disturb Earth's natural balance.

Effects include:

- Global warming
- Climate change
- Extreme and dangerous weather patterns

Science helps us **understand the causes** of these problems and **find solutions**.

9. SCIENTIFIC INVESTIGATION EXAMPLE:

Why does a puri puff up unevenly?***

A puri puffs up because the **water in the dough turns into steam** when heated, making it expand like a balloon.

Factors affecting puffing:

- Thickness of the dough
- Temperature of the oil
- Whether the dough is fresh or stored

10. CONCLUSION: EXPLORING THE INVESTIGATIVE WORLD OF SCIENCE

This chapter teaches us that **science is everywhere**—

in **small daily activities** like a puffing puri and in **big global problems** like climate change.

Main Ideas:

- **Curiosity leads to questions.**
- **Observation and experiments help us find answers.**
- Science follows a clear process:
Ask a question → Plan an experiment → Observe carefully → Draw conclusions
- Science connects our **daily life** to the **natural world and the universe**.

With the help of science, we can:

- Understand the world better
- Solve real-life problems
- Protect Earth for the future

EXERCISE-I**Brain Booster MCQs**

- Q.1** Which symbol represents deep foundation of knowledge in the textbook design?
(A) Kite (B) Root
(C) Moon (D) Sun
- Q.2** In Grade 6, science began with:
(A) Complex experiments
(B) Wonder and simple "Why?" questions
(C) Mathematical calculations
(D) Advanced theories
- Q.3** Investigation in science means:
(A) Just looking at something
(B) Asking only simple questions
(C) Asking focused questions and designing experiments
(D) Reading textbooks only
- Q.4** What do microorganisms include according to the chapter?
(A) Only harmful bacteria
(B) Only helpful bacteria
(C) Both helpful and harmful organisms
(D) Only viruses
- Q.5** What helps motors run and machines function?
(A) Heating effect of current
(B) Magnetic effect of current
(C) Chemical effect of current
(D) Mechanical effect of current
- Q.6** Pressure is defined as:
(A) The total force applied
(B) How force is distributed over an object
(C) The speed of an object
(D) The weight of an object
- Q.7** Everything around us is made of:
(A) Large visible particles
(B) Tiny particles
(C) Energy waves
(D) Magnetic fields
- Q.8** Materials can be classified into:
(A) Only elements and compounds
(B) Elements, compounds, and mixtures
(C) Only pure substances
(D) Only mixtures
- Q.9** Light rays can:
(A) Only travel in straight lines
(B) Reflect off mirrors and bend through lenses
(C) Only reflect, never bend
(D) Only bend, never reflect
- Q.10** Moon phases are caused by:
(A) Earth's rotation only
(B) Relative positions of Earth, Moon, and Sun
(C) Moon's internal changes
(D) Cloud cover on Earth
- Q.11** Ecosystems are formed by:
(A) Only plants
(B) Only animals
(C) Relationships between living organisms and environment
(D) Only non-living things
- Q.12** What makes Earth 'just right' for life?
(A) Only the presence of water
(B) Only the atmosphere
(C) Perfect distance from Sun and protective atmosphere
(D) Only the magnetic field
- Q.13** Human activities can cause:
(A) No changes to Earth
(B) Small changes in Earth's temperature
(C) Only positive changes
(D) Changes only in local weather
- Q.14** What should we observe when frying a puri?
(A) Only if it puffs up
(B) Time taken to puff, thickness changes, oil behavior
(C) Only the color change
(D) Only the size
- Q.15** Scientific investigation requires:
(A) Expensive equipment only
(B) Curiosity and careful observation
(C) A formal laboratory only
(D) Advanced mathematics only

- Q.16** The phenomenon of puri swelling is:
(A) Completely understood by scientists
(B) Not really completely understood by scientists
(C) Very simple to explain
(D) Not worth studying
- Q.17** Solutions are formed when:
(A) Two solids mix
(B) Sugar dissolves in tea
(C) Oil mixes with water
(D) Gases combine
- Q.18** Rough surfaces:
(A) Never reflect light
(B) Reflect light as well as mirrors
(C) Only absorb light
(D) Only transmit light
- Q.19** The Moon reflects light from:
(A) Earth
(B) Other planets
(C) The Sun
(D) Stars
- Q.20** Scientific principles help us:
(A) Only understand problems
(B) Understand and guide our actions
(C) Create more problems
(D) Ignore environmental issues
- Q.21** What is needed for systematic investigation?
(A) Changing many variables
(B) Controlling variables and careful observation
(C) Guessing results
(D) Using only complex equipment
- Q.22** The kitchen can be used for:
(A) Only cooking
(B) Simple scientific experiments and observations
(C) Complex chemical reactions only
(D) Nothing related to science
- Q.23** Oil temperature affects:
(A) Nothing in cooking
(B) How well puri puffs up
(C) Only the taste
(D) Only the color
- Q.24** Keeping notes during experiments helps in:
(A) Wasting time
(B) Recording observations systematically
(C) Making the experiment longer
(D) Confusing the results
- Q.25** The way dough is dropped in oil affects:
(A) Nothing
(B) How the puri puffs up
(C) Only the cooking time
(D) Only the oil temperature
- Q.26** Scientific questions arise from:
(A) Textbooks only
(B) Careful observation of everyday phenomena
(C) Internet only
(D) Teacher's instructions only
- Q.27** Investigation in science works best when we balance:
(A) Speed and accuracy
(B) Observation and creative thinking
(C) Cost and benefit
(D) Time and effort
- Q.28** The hidden world in a drop of water contains:
(A) Only clean water
(B) Tiny organisms
(C) Only minerals
(D) Nothing special

EXERCISE-II**Concept Check****TRUE/FALSE QUESTIONS**

- Q.1** All microorganisms are harmful to humans. **True/False**
- Q.2** In solids, particles can move around freely. **True/False**
- Q.3** Ecosystems involve only living organisms. **True/False**
- Q.4** The phenomenon of puri swelling is completely understood by scientists. **True/False**
- Q.5** Scientific investigation requires expensive equipment. **True/False**

FILL IN THE BLANKS

- Q.1** In Grade 7, students learned that science is always _____.
- Q.2** _____ help explain why a ball falls back to the ground.
- Q.3** Materials can be classified into elements, compounds, and _____.
- Q.4** The first _____ were created by observing lunar cycles.
- Q.5** A puri puffs up when placed in _____ oil.

ASSERTION & REASON

Instructions: Choose the correct option:

- (A) Both assertion and reason are true, and reason is the correct explanation of assertion
- (B) Both assertion and reason are true, but reason is not the correct explanation of assertion
- (C) Assertion is true but reason is false
- (D) Assertion is false but reason is true

- Q.1** **Assertion:** Forces can make objects change direction.
Reason: Brakes use force to stop moving cars.
- Q.2** **Assertion:** The first calendars were based on celestial observations.
Reason: Ancient people observed moon phases and sun cycles.

- Q.3** **Assertion:** Scientific investigation requires expensive laboratories.
Reason: Simple observations can be made in everyday settings like kitchens.
- Q.4** **Assertion:** Solutions form when substances dissolve completely.
Reason: Sugar dissolving in tea creates a solution.
- Q.5** **Assertion:** Cyclones are caused only by temperature differences.
Reason: Pressure differences in air can also cause strong winds and cyclones.

CASE STUDY**Case Study 1: Microorganism Investigation**

Dr. Sharma shows her Grade 8 students a drop of pond water under a microscope. The students are amazed to see tiny moving organisms that are invisible to the naked eye. She explains that some microorganisms help humans by aiding digestion and producing medicines, while others can cause infections. The students learn that understanding these tiny organisms is crucial for health and medicine.

- Q.1** What did students observe in the pond water?
(A) Only clean water
(B) Tiny moving microorganisms
(C) Fish eggs
(D) Plant particles only
- Q.2** According to the passage, microorganisms can be:
(A) Only helpful
(B) Only harmful
(C) Both helpful and harmful
(D) Neither helpful nor harmful
- Q.3** How do some microorganisms help humans?
(A) By causing diseases
(B) By aiding digestion and producing medicines
(C) By polluting water
(D) By destroying food

Q.4 Why is understanding microorganisms important?

- (A) For entertainment only
 (B) For health and medicine
 (C) For cooking only
 (D) For weather prediction

Q.5 What tool was essential for this observation?

- (A) Telescope
 (B) Microscope
 (C) Magnifying glass
 (D) Camera

MATCH THE COLUMNS

Q.1 Match the effects with their applications:

Column A		Column B	
(a)	Heating effect of current	i	Motors and machines
(b)	Magnetic effect of current	ii	Electric heaters
(c)	Light reflection	iii	Mirrors and shiny surfaces
(d)	Light bending	iv	Corrective glasses

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

Q.2 Match the classification with examples:

Column A		Column B	
(a)	Elements	i	Salt water
(b)	Compounds	ii	Gold, Silver
(c)	Mixtures	iii	Water, Carbon dioxide
(d)	Solutions	iv	Oil and water

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

Q.3 Match the grade levels with learning focus:

Column A		Column B	
(a)	Grade 6	i	Science is evolving
(b)	Grade 7	ii	Wonder and simple questions
(c)	Grade 8	iii	Advanced research
(d)	Grade 9	iv	Investigative world

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

Q.4 Match the forces with their effects:

Column A		Column B	
(a)	Gravitational force	i	Stopping a car
(b)	Frictional force	ii	Objects falling down
(c)	Magnetic force	iii	Stretching a spring
(d)	Elastic force	iv	Attracting iron objects

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

Q.5 Match the investigation steps with their purposes:

Column A		Column B	
(a)	Observation	i	Testing ideas
(b)	Hypothesis	ii	Recording data
(c)	Experimentation	iii	Noticing patterns
(d)	Documentation	iv	Predicting outcomes

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

EXERCISE-III**Subjective Assessment****SHORT QUESTION**

- Q.1** Why is it important to study microorganisms?
- Q.2** How do particles behave differently in solids, liquids, and gases?
- Q.3** How did ancient people create calendars using celestial observations?
- Q.4** Why is note-taking important during scientific investigations?
- Q.5** Explain why the Moon appears to shine even though it doesn't produce light.
- Q.6** How do solutions form and what are their characteristics?
- Q.7** How do microorganisms both help and harm humans?
- Q.8** How do living organisms depend on their environment?
- Q.9** How can simple everyday observations lead to scientific understanding?
- Q.10** How does understanding light behavior help in practical applications?

LONG ANSWER

- Q.1** Why is it important to study microorganisms?
- Q.2** How do particles behave differently in solids, liquids, and gases?
- Q.3** How did ancient people create calendars using celestial observations?
- Q.4** Why is note-taking important during scientific investigations?
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- Q.7** How do microorganisms both help and harm humans?
- Q.8** How do living organisms depend on their environment?
- Q.9** How can simple everyday observations lead to scientific understanding?
- Q.10** How does understanding light behavior help in practical applications?

ANSWER KEY**EXERCISE-I**

Q.1	(B)	Q.7	(B)	Q.13	(B)	Q.19	(C)	Q.25	(B)
Q.2	(B)	Q.8	(B)	Q.14	(B)	Q.20	(B)	Q.26	(B)
Q.3	(C)	Q.9	(B)	Q.15	(B)	Q.21	(B)	Q.27	(B)
Q.4	(C)	Q.10	(B)	Q.16	(B)	Q.22	(B)	Q.28	(B)
Q.5	(B)	Q.11	(C)	Q.17	(B)	Q.23	(B)		
Q.6	(B)	Q.12	(C)	Q.18	(B)	Q.24	(B)		

EXERCISE-II**TRUE/FALSE QUESTIONS**

Q.1	False	Q.2	False	Q.3	False	Q.4	False	Q.5	False
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FILL IN THE BLANKS

Q.1	evolving	Q.3	mixtures	Q.5	hot
Q.2	Forces	Q.4	calendars		

ASSERTION & REASON

Q.1	(B)	Q.2	(A)	Q.3	(D)	Q.4	(A)	Q.5	(D)
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CASE STUDY

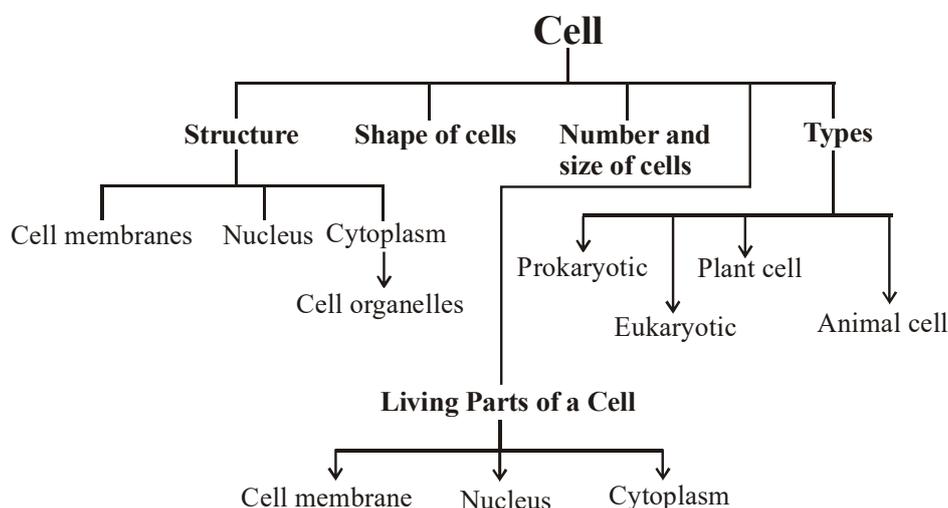
Q.1	(B)	Q.2	(C)	Q.3	(B)	Q.4	(B)	Q.5	(B)
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MATCH THE COLUMNS

Q.1	(A)	Q.2	(D)	Q.3	(C)	Q.4	(D)	Q.5	(A)
------------	-----	------------	-----	------------	-----	------------	-----	------------	-----

2

The Invisible Living World : Beyond Our Naked Eye



1. INTRODUCTION

- **Cell is the structural and functional unit of all life forms.** A single cell organism such as **bacteria, Amoeba and Chlamydomonas** are also a type of life forms.
- The simplest organism like amoeba consist of one cell while humans have as many as few trillion cells.
- **The microscopic study of cell is called Cytology.** A cell may be defined as a unit of protoplasm surrounded by a membrane.

2. THE HUMAN EYE

The **human eye** allows us to see objects around us, but it has a limitation. We can only see objects that are larger than a certain size. Very tiny living organisms like **bacteria and fungi** are too small to be seen with our naked eyes.

3. THE MICROSCOPE

To observe such extremely small objects, we use a **microscope**. A microscope is a scientific instrument that **magnifies very small objects**, making them appear much larger and clearer. It helps us explore a hidden world of microscopic life that cannot be seen with the human eye.

Thus, while the human eye helps us see the visible world, the microscope helps us discover the **invisible microscopic world**.

4. DISCOVERY OF THE CELL

- Robert Hooke was the first to coin the term 'Cell' for small structures in a piece of cork under a microscope (1665). He observed a no. of tiny little boxes or compartments in the slice of cork.
- These tiny boxes appeared like a honeycomb. That's why it was called a honeycomb structure. He gave the term 'cells' to each box (cell means little room in latin).
- What Hooke observed as boxes or cells in the cork were actually dead cells.
- This observation was published in his book named "Micrographia".

- Anton Van Leeuwenhoek in 1674 observed living cells i.e. one celled structures like bacteria, protozoans and blood cells under microscope for the 1st time.
- It was **Robert Brown** in **1831**, who discovered the **nucleus** in the cell.
- **J.E. Purkinje** in **1839** gave the term '**protoplasm**' for the **living fluid substance of the cell**.
- **Cell theory** : It was given by German botanist **M.J. Schleiden (1838)** and German zoologist **T. Schwann (1839)**.
 - (i) A cell is the basic unit of life.
 - (ii) Cell does not arise de novo (Denovo–Spontaneous).
- **Modern cell theory or cell principle or cell doctrine states -**
 - (i) All organisms are made up of cells.
 - (ii) Cells arise from pre-existing cells. (Omnis cellula -e-cellula) added by **Rudolf Virchow**.
 - (iii) All organisms start their life from single cell.
 - (iv) Multiplication of cell and their growth leads to the growth of an organisms.

5. ORGANIZATION OF CELLS IN ORGANISMS

Cells usually group together to make tissues, organs, organ systems and finally organisms.

- I. Tissue:** It is a group of cells of the same size, shape and function. Example: Muscle tissue, nerve tissue etc.
- II. Organ :** It is a structure that contains more than one type of tissues. Example: Heart, brain (in animals), and leaves, roots and stems in plants.
- III. Organ system:** A group of organs working together is called an organ system. Example : Digestive system.
- IV. Organism:** The different organ system working together form the organism.

6. CELL STRUCTURE, SHAPE, SIZE AND NUMBER

I. Structure of Cell :

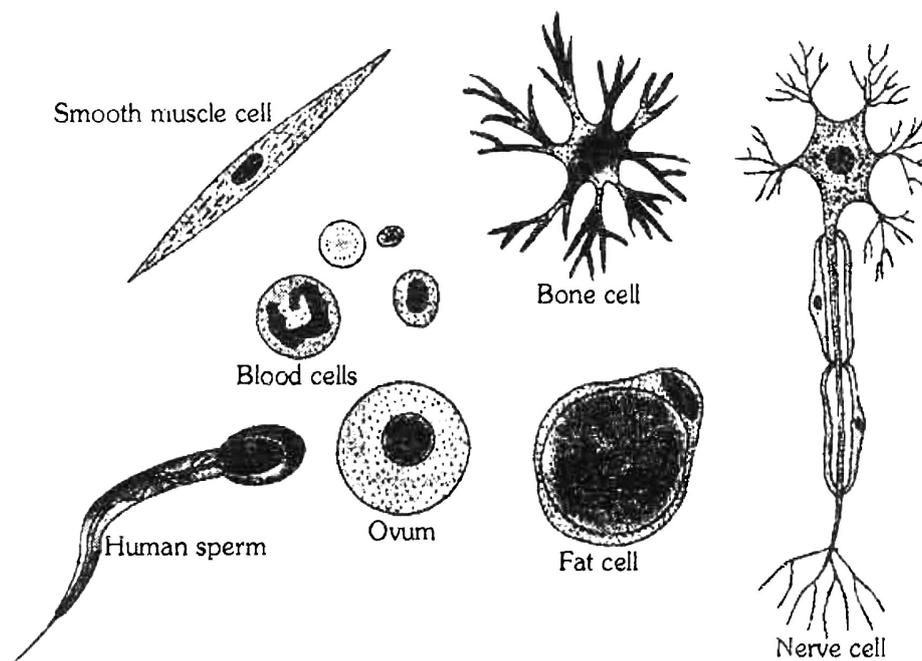
- All cells have three major functional regions, viz. plasma membrane, nucleus and cytoplasm.
- The **cytologists** used to divide the cell into two major components – the nucleus and the cytoplasm.

II. Shape of Cell :

There is a great variability in shape of cells. The shape of cell is usually related with its function.

Fixed shapes of cells are of following types :

- (i) Flattened e.g. skin cells (upper layer).
- (ii) Columnar e.g. cells lining the intestine.
- (iii) Discoidal e.g. R.B.C.
- (iv) Spherical e.g. eggs of many animals.
- (v) Spindle shaped e.g. smooth muscle fibres.
- (vi) Elongated e.g. nerve cells.
- (vii) Branched e.g. pigment cells of the skin.
- (viii) Bean shaped e.g. guard cells of stomata



III. Size of Cell

- The smallest cells ($0.1 - 0.2 \mu\text{m}$) are found in bacteria and some **pleuropneumonia-like organisms (PPLO)**, eg. **Mycoplasma**.
- The largest cell is the egg of an Ostrich which measures 6 inches in diameter with shell and 3 inches, if its shell is removed.
- The largest human cell is the female ovum (0.01 mm in diameter).
- The smallest human cell is the red blood cell (0.0075 mm or $7.5 \mu\text{m}$).

IV. Number of Cell

- The number of cells in living organisms also varies greatly.
 - Unicellular organisms** : In unicellular organisms, a single cell constitutes its body eg. *Amoeba* and *Paramecium* (**Protist Organisms**) and *Chlamydomonas*.
 - Multicellular organisms** : are those which are made up of a few to billions of cells. **Eg.** Most plants and animals.

V. STRUCTURE OF CELL

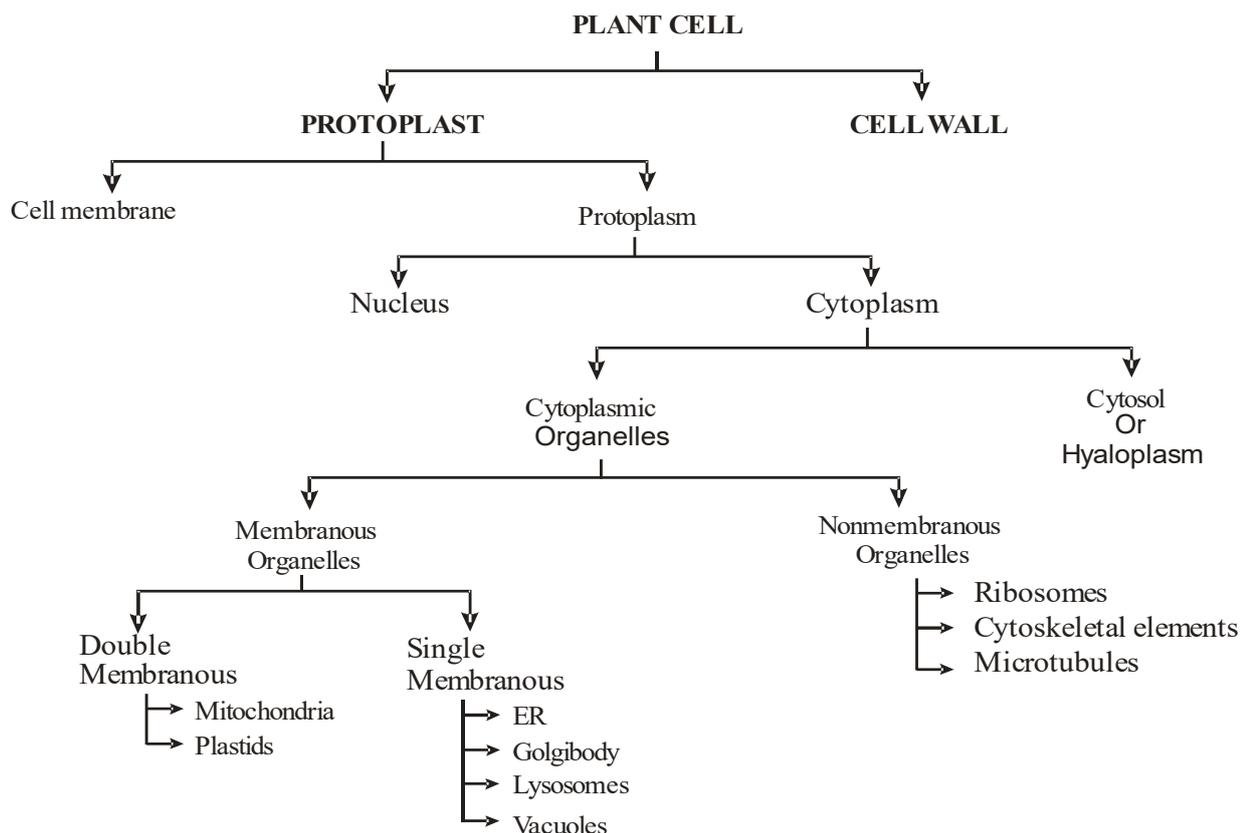
- Cell has three main components :

(A) Cell membrane

(B) Cytoplasm

(C) Nucleus

But in case of plants, bacteria and fungal cell, cellwall is also present outside the cell membrane.

**(A) Cell wall**

- It is the outermost covering of the plant cells.
- It is absent in animal cells.
- Cell wall is rigid, strong, thick, porous and non living structure. It is made up of cellulose and hemicellulose.
- Cell walls of two adjacent cells are joined by a layer called middle lamellae. It is made up of calcium and magnesium pectate.

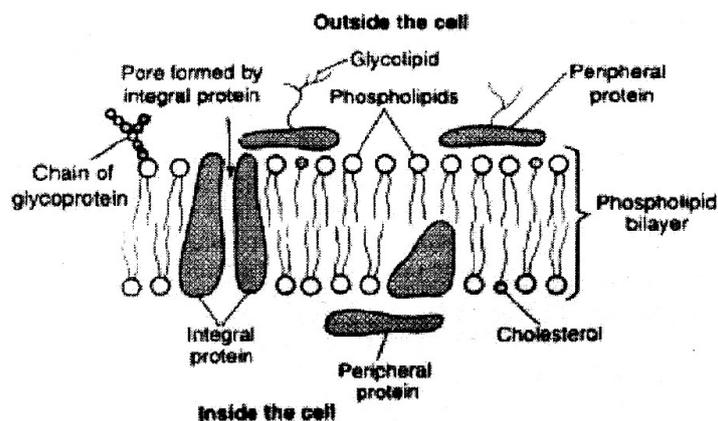
➤ Functions of cell wall

- It provides definite shape to the cell.
- It provides strength to the cell.
- It is permeable for the entry of molecules of different sizes.

(B) Cell Membrane :

- Cell membrane is also called as **Plasma Membrane** or **Plasma lemma**.
- It is the limiting boundary of each cell which separates the cytoplasm from its surroundings.
- It is found in both plant as well as animal cells.
- It is the outer most covering of a cell in case of animals and lies below the cell wall in case of plants.
- It is made up of proteins and lipids where proteins are sandwiched between bilayer of lipids.
- Plasma membrane name was given by **Nageli**.
- Plasma membrane is selectively permeable in nature. It allows or permits the entry and exit of some materials in and out of the cell.
- **Singer** and Nicholson gave the fluid mosaic model of plasma membrane according to him it consists of a protein layer sandwiched between two layers of lipids. It is in quasifluid state. It is 75Å thick.

- It is flexible and can be folded, broken and reunited.



➤ Functions :

- It protects the internal components of the cell.
- It provides shape to the cell.
- It allows materials to enter and leave the cell through the tiny holes.



Let's know

- **Transportation of molecules across the plasma membrane:**

This can be done by following ways:

- (A) **Diffusion:** Movement of solutes or ions from higher concentration to lower concentration is called as diffusion. It does not require energy therefore it is called as passive transport.
- (B) **Osmosis:** The movement of solvent or water from higher concentration (solvent) to lower concentration (solute) through a semipermeable membrane is called as **osmosis**.

Or

The movement of solvent or water from lower concentration to higher concentration of solution through a semipermeable membrane is called as **osmosis**. Osmosis can also be called as “**diffusion of solvents**”.

- **Endosmosis:** Movement of solvent into the cell is called as Endosmosis.
- **Exosmosis:** Movement of solvent outside the cell is called as Exosmosis.

(C) **Cytoplasm**

- A transparent, jelly like protoplasmic mass of cell inner to plasma membrane and excluding nucleus is called cytoplasm. Cytoplasm was discovered by **Kolliker** in **1862**.
- It can be divided into two parts:
 - (i) **Cytosol:** Aqueous soluble part contains various fibrous proteins forming cytoskeleton.
 - (ii) **Cell organelles:** Living part of the cells having definite shape, structure and function bounded By Plasma membrane.

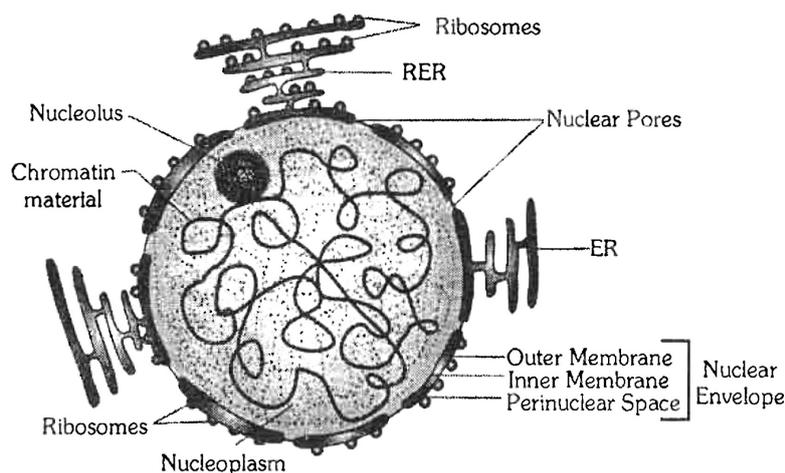
(D) **Nucleus**

- Important and essential part of the cell, also called as **director/ master of the cell**, present in cytoplasm.
- First described by **Robert Brown (1831)**.
- In prokaryotic cells well defined nucleus is absent due to absence of nuclear membrane. Such undefined nuclear region is called a **nucleoid** or **genophore**.
- **Structure of Nucleus:**

It has four parts :

I. Nuclear Membrane
III. Nucleolus

II. Nucleoplasm
IV. Chromosomes



- (i) **Nuclear Membrane (Karyotheca)**
 - It is bilayered, also called nuclear envelope.
 - Has nuclear pores that allow exchange of substances between nucleus and cytoplasm etc.
- (ii) **Nucleoplasm**
 - Transparent, homogenous, semifluid substance, having chromatin material and nucleolus.
 - Having water, sugar, minerals and various enzymes.
- (iii) **Nucleolus**
 - It is a spherical body in the nucleus. It is composed of RNA and is ribosome factory.
- (iv) **Chromosome**
 - The hereditary units of chromosomes are the genes. They are responsible for the transmission of characters from parents to the offspring.

➤ **Functions :**

- Controls all cellular activities.
- Chromosome contains hereditary informations of the cell and transfer the genetic information from one generation to another.
- Plays central role in cellular reproduction.

7. CELL ORGANELLES

These are living sub-cellular structures of the cytoplasm and are also called protoplasmic bodies or organoids. These includes -

I. Double membrane bound organelles : Mitochondria and plastids.

II. Single membrane bound organelles : Endoplasmic reticulum, golgi apparatus, lysosome, vacuole etc.

III. Non- membrane bound organelles : Ribosomes etc.

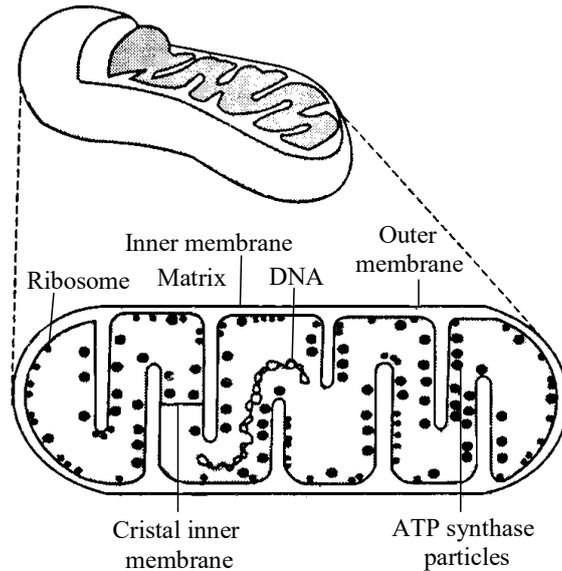
I. Double membrane bound organelles

(A) Mitochondria

- It was first seen by Kolliker in insect cells and named by Benda.
- It is found in cytoplasm of all eukaryotic cells except mammalian RBC's. These are also absent in prokaryotes.
- Maximum mitochondria are found in metabolically active cells.
- Mitochondria are small, rod-shaped organelles found in large numbers.
- Each mitochondrion is bounded by two membranes-outer and inner.

- The outer membrane is smooth and the inner membrane is pushed inwards at intervals forming crests called cristae. The cristae lie in a ground substance called matrix.
- Mitochondria possess enzymes necessary for the oxidation of carbohydrates. This process releases energy in the form of ATP. This is why mitochondria are known as the power houses of the cell.
- Mitochondria have their own DNA and ribosomes. They can synthesize their own proteins.

➤ **Function :** Mitochondria provide energy for the vital activities of living cells.



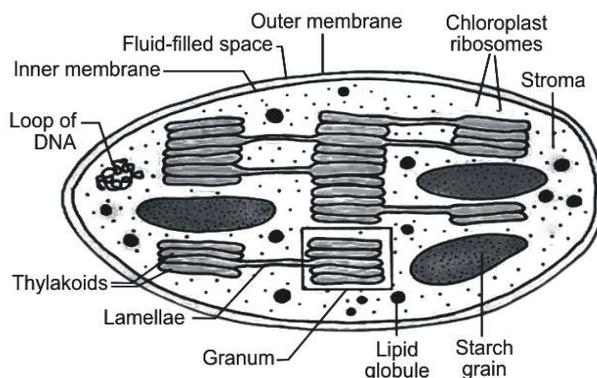
Mitochondria

(B) Plastid : Plants and some protists have several types of double membrane bound organelles called plastids, which harvest solar energy, manufacture nutrient molecules and store materials.

- Plastid term was coined by E.Haeckel.
- Plastids generally contain pigments and may synthesize & accumulate various substances.
- **Plastids are of three types**

(i) Chloroplasts (Chlore – green) : Most common plastids with the greatest biological importance. They take part in photosynthesis to produce life supporting gas, oxygen and most of the energy (glucose) used on our planet by living beings.

Blue green algae lack chloroplasts and have loosely arranged membrane in the cytoplasm in the form of sacs of typical unit membrane structure called lamellae. First seen by A. V. Leeuwenhoek.



Chloroplast

- (ii) **Chromoplast** : These are coloured plastids (other than **green**) found in petals, fruits and roots of certain higher plants.
- (iii) **Leucoplasts** : These are colourless plastids, found in underground plant parts which are not exposed to light. They store food materials. These are also found in embryonic cells, germ cells and meristematic cells.



Let's know

- **Leucoplast are of three types**
 - (a) Amyloplasts – Store starch
 - (b) Elaioplasts – Store fats & essential oils
 - (c) Proteinoplasts or Aleuoplast – store proteins
- The red colour of ripe tomatoes is the result of chromoplasts which contain the red pigment called **lycopene**.

II. Single membrane bound organelles

(A) Endoplasmic reticulum

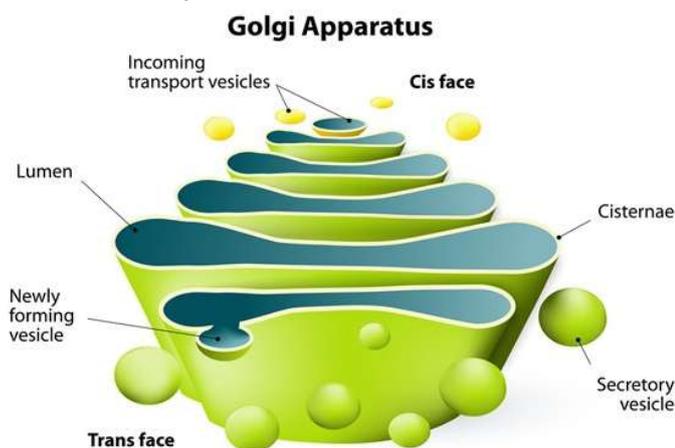
- The endoplasmic reticulum is a network of tube-like structures running through the cytoplasm. If ribosomes are attached to it, the reticulum is rough and known as rough endoplasmic reticulum, if ribosome are absent it is smooth and known as smooth endoplasmic reticulum.
- Function : It gives internal support to the colloidal matrix (cytoplasm).
- Rough endoplasmic reticulum (RER) is associated with the synthesis of proteins.
- Smooth endoplasmic reticulum is associated with membrane biogenesis.

(B) **Golgi body** : It was discovered by camilo golgi. It is absent in prokaryotes and mammalian RBC. In plants golgi body is called as **Dictyosome**.



Functions :

- It is secretory in nature.
- It helps in formation of middle lamellae
- It helps in formation of lipids
- Lipids and proteins synthesized in endoplasmic reticulum are packed at golgi complex.
- They provide the site for assembly of new membrane material.



(C) **Lysosome** : Lysosomes (Lyso = digestive, soma = body)

- Discovered by Christian de Duve.
- They occur in animal cells and a few in plant cells.
- Commonly known as “**Suicidal bags**”.
- They do not have a definite shape or size.
- They are bounded by a single membrane.

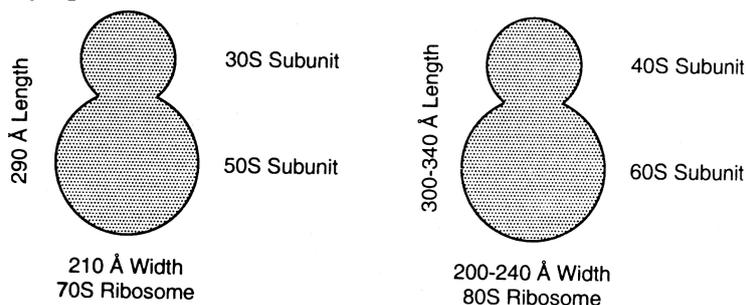
- These are tiny sac like granules containing hydrolysing enzymes called acid hydrolases for intracellular digestion.
- Their main function is phagocytosis i.e. digestion.

(D) Vacuole:

- Vacuoles are membrane bound non-cytoplasmic sacs that contain non-living or solid contents.
- The covering membrane of vacuole is known as **tonoplast**.
- Sap vacuole stores salts, sugars, amino acids, organic acids & some proteins.
- It is also known as **dump** for waste produced in plant cells.
- Vacuoles are either absent or smaller in size in animal cells while they are large in size and single in number in plant cell

III. Non- membrane bound organelles**(A) Ribosomes**

- First reported by Claude and named by G. Palade.
- They are one of the smallest cell organelles of cell.
- It is of two types that is 70s (Prokaryotic), 80s (Eukaryotic).
- Ribosomes are the sites of protein synthesis. All structural and functional (enzymes) proteins coded by the nuclear DNA, are synthesized upon cytoplasmic ribosomes.

**Ribosomes**

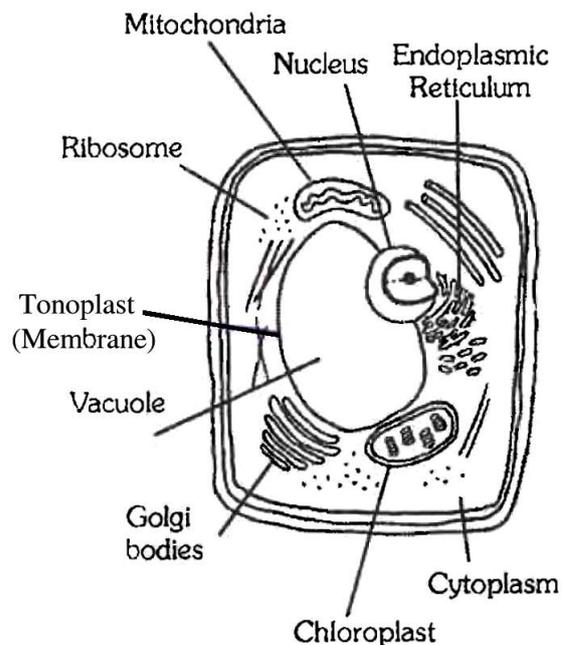
- (B) Centrosome:** It is a star-like structure found mostly in animal cells. It consists of **centrioles**. It helps in cell division.

Cell Organelles and Their Functions

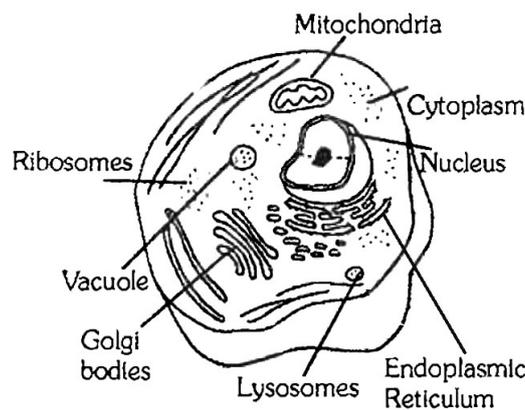
Organelle	Function(s)
Mitochondria (singular mitochondrion) 'Power house of cell'	Perform the function of respiration, provide the cell with energy.
Chloroplast (present only in plant cells)	Contain a green pigment called chlorophyll which helps in food manufacture (photosynthesis); also provides green colour to the leaves.
Endoplasmic reticulum	Being a network of membranes, it provides a large surface area for life functions to take place; synthesis of proteins and lipids.
Golgi complex	It collects and distributes the substances made in the cell (for example, proteins); synthesis and secretion of many materials.
Lysosomes (suicide bags)	Contain enzymes which help in breaking down or destroying the various materials.
Ribosomes	Site of protein synthesis.

8. TYPES OF CELL

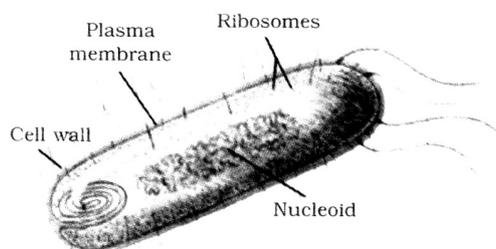
- On the basis of well organised nucleus, cells can be of two types
- (i) **Prokaryotic Cells :** These are cells having primitive nucleus without nuclear membrane. Organism with primitive nucleus are known as prokaryotes.
Eg. Bacteria and Blue green algae etc.
- (ii) **Eukaryotic Cells :** These are cells having a well organised nucleus with nuclear membrane. Organisms with true nucleus are known as eukaryotes.
Eg. Man, Elephant, Onion etc.



Plant Cell



Animal Cell



Bacterial cell

Differences between Prokaryotic and Eukaryotic Cells

S.No.	Prokaryotic Cell	Eukaryotic Cell
1	Size is Generally small (1-10 μm)	Size is Generally large (1-100 μm)
2	Protoplasm is relatively rigid, usually non vacuolate.	Protoplasm is typically more fluid like, generally vacuolate..
3	True nucleus absent, i.e. nuclear membrane and nucleolus absent. They have incipient nucleus or nucleoid or genophore	True nucleus present, i.e. nuclear membrane and nucleolus present.
4	Membrane-bound cell organelles like plastids, mitochondria, Golgi bodies, E.R. absent.	Membrane-bound cell organelles like plastids, mitochondria, Golgi bodies, E.R. present.
5	Ribosomes are of 70S type.	Ribosomes are of 80S type.
6	Examples: Bacteria, blue-green algae, mycoplasma.	Examples: Cell of all higher organisms, including plants and animals

9. DIFFERENCES BETWEEN PLANTS CELL AND ANIMAL CELL

S.No.	Plant Cell	Animal Cell
1	It has a definite cell wall. Cellulose is present in the cell wall.	Cell wall is absent.
2	One or more vacuoles are present.	Vacuoles may or may not be present.
3	Plastids are usually present.	Plastids are absent.
4	Centrosome is absent.	Centrosome is present near the nucleus.

10. WHAT IS BIOLOGICAL ORGANISATION?

- **Biological organisation** refers to the **step-by-step arrangement of living parts** in an organism.
- All living organisms are made up of **smaller parts that work together in an organised manner**.
- These parts are arranged **from the smallest unit (cell) to the complete organism**.
- Each level of organisation has a **specific function** and helps in the **survival of the living being**.

11. LEVELS OF BIOLOGICAL ORGANISATION (SMALLEST TO LARGEST)

1. Cell

- The **cell is the basic unit of life**.
- All living organisms are made of cells.
- Different cells perform different functions

Example:

- Red blood cells carry oxygen
- Nerve cells carry messages

2. Tissue

- A **tissue is a group of similar cells** working together.
- Each tissue performs a **specific function**.

Example:

- Muscle tissue helps in movement
- Skin tissue protects the body
- Xylem tissue in plants transports water

3. Organ

- An **organ is made of different tissues** working together.
- Each organ performs a **major function**.

Example:

- Heart pumps blood
- Stomach helps in digestion
- Lungs help in breathing

4. Organ System

- An **organ system** is a group of organs working together.
- It performs a **body function**.

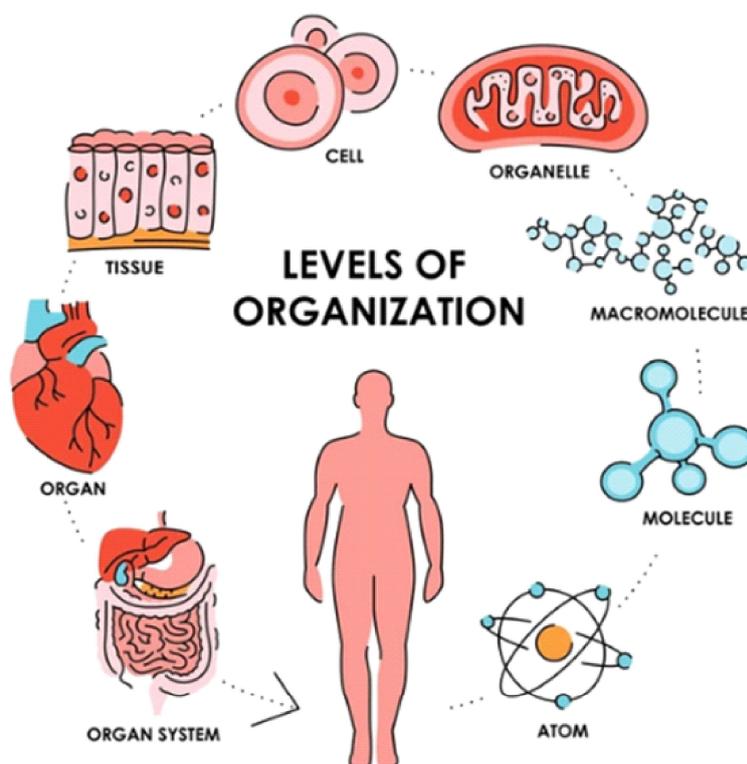
Example:

- Digestive system digests food
- Respiratory system helps in breathing
- Circulatory system transports blood

5. Organism

- An **organism** is a complete living being.
- It is made up of **one or more organ systems**.
- All systems work together to **keep the organism alive and healthy**.

Example: Human, plant, animal



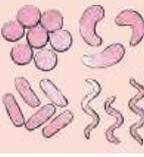
12. MICROORGANISMS: THE INVISIBLE HELPERS

- **Microorganisms** are very **small living organisms** that **cannot be seen with the naked eye**.
- They are found **everywhere**—in **air, water, soil**, and even **inside our bodies**.
- Microorganisms can be **useful or harmful**.
- They may be **unicellular** (single-celled) like **bacteria and protozoa**, or **multicellular** like **fungi and some algae**.
- They play an important role in **digestion, medicine, food production, and maintaining balance in nature**.

Table 1 : Organisms present in pond water

S.No.	Diagram	Remarks
1.	<p><i>Amoeba</i> (Protozoa)</p> 	Single cell, moving, irregular shape
2.	<p><i>Paramecium</i> (Protozoa)</p> 	Single cell, moves from one place to another, movement takes place with the help of specialised structures
3.	<p>Algae</p> 	Single cell, looks green because of the presence of green pigment, movement takes place with the help of specialised structures

Table 2 : Organisms present in soil suspension

S.No.	Diagram	Remarks
1.	<p>Bread mould (Fungi)</p> 	Branched filament without chlorophyll having sac-like structure
2.	<p>Mould (Fungi)</p> 	Branched filament without chlorophyll having brush-like structure
3.	<p>Algae</p> 	Spherical, presence of chlorophyll—a green pigment
4.	<p>Bacteria</p> 	Spherical, comma, spiral or rod-shaped, one long hair-like structure and many small hair-like projections around the cell

13. HOW WE ARE CONNECTED TO MICROBES

- **Microbes are found everywhere**—in air, water, soil, and even on food items.
- They can survive in **extreme conditions**, such as **hot water springs**, **snow-cold regions**, and also at **moderate temperatures**.
- **Microbes live inside our bodies**, especially in the **gut**, where many of them are **useful**.
- Some microbes are responsible for **rotting of food**, causing **powdery or cotton-like growth** on spoiled items.
- Like plants and animals, microbes show **great diversity in shape, size, and function**.
- Humans depend on microbes for **digestion, immunity, food preparation, and maintaining balance in nature**.

14. USEFUL MICROORGANISMS

1. Micro-Decomposers at Work

- Microorganisms like **bacteria and fungi** decompose **organic waste** such as fruit peels, dead plants, and animals.
- They convert complex waste into **simpler substances**, forming **manure**.
- Manure is **nutrient-rich** and improves **soil fertility**.
- Microbes help **recycle nutrients** and keep the environment **clean naturally**.
- Proper manure formation needs **suitable temperature and moisture**.
- In ancient Indian texts (e.g., **Atharvaveda**), microbes were called “**krimi**”, which could be visible or invisible and have both good and harmful effects.

2. Microbes & Energy: From Waste to Flame (Biogas)

- Some microorganisms live **without oxygen** (anaerobic).
- They decompose **plant and animal waste** from sewage and wastewater.
- This process produces **biogas**, mainly containing **methane** and some **carbon dioxide**.
- **Methane** is used as a fuel for:
 - Cooking
 - Heating
 - Generating electricity
 - Vehicle fuel
- Microorganisms also help in **environmental conservation**, such as cleaning **oil spills** using oil-degrading bacteria.

3. Microbes in Your Kitchen – Yeast

- **Yeast** is a type of **fungus**.
- It is used in making **bread and cakes**.
- Yeast respire **anaerobically** and releases **carbon dioxide**, which:
 - Makes dough **soft and fluffy**
- It also produces a **small amount of alcohol**, giving bread its **aroma**.

15. LACTOBACILLUS

- **Lactobacillus** is a **bacterium**.
- It converts **milk into curd** by fermenting **lactose (milk sugar)** into **lactic acid**.
- Lactic acid gives curd its **sour taste**.
- This process happens **faster in warm conditions**.

Example: Curd sets quickly in summer.

16. MICROBES AS NATURE'S FERTILISER FACTORY – RHIZOBIUM

- **Rhizobium** is a **nitrogen-fixing bacterium**.
- It lives in the **root nodules of leguminous plants** (peas, beans, gram, lentils).
- It converts **atmospheric nitrogen** into a **usable form for plants**.
- This is a **symbiotic relationship** (both plant and bacteria benefit).
- It **improves soil fertility** and reduces the need for **chemical fertilisers**.

Example: Farmers grow legumes to naturally enrich soil.

17. MICROALGAE – TINY HELPERS IN WATER

Microalgae are **plant-like microorganisms** that:

- Perform **photosynthesis**.
- Release a **large amount of oxygen** into the atmosphere.
- Serve as **nutritious food** for aquatic animals.
- Are used by humans as **dietary supplements and medicines**.

Examples of Microalgae:

- **Chlorella**
- **Spirulina**
- **Diatoms**

Spirulina is commonly used as a **health supplement**.

18. IMPORTANCE OF MICROALGAE

- Help in **cleaning water**.
- Used in producing **biofuels**.
- Play an important role in maintaining **ecological balance**.

Their survival is **threatened by pollution and climate change**, so **conservation is essential**.

19. ALGAE IN SPACE (SPIRULINA)

- **Spirulina** is considered a **superfood** because of its many health benefits.
- It is an **excellent source of protein**, making up **more than 60% of its dry weight**.
- It contains **very low amounts of fat and sugar**.
- Spirulina is a good source of **Vitamin B12**, which is essential for the human body.
- Because of its high nutrition and easy cultivation, **spirulina is used as food for astronauts in space**.
- Its cultivation is being recognised as a **sustainable source of income** for many people.

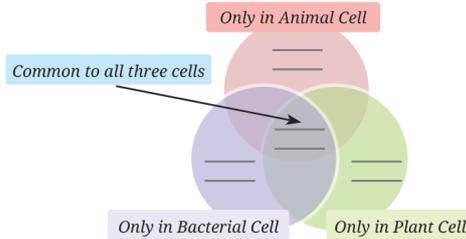
20. WHY SPIRULINA IS IMPORTANT

- Highly nutritious
- Easy to grow
- Requires less space and resources
- Helpful in solving food shortage problems
- Useful for future space missions

EXERCISE-I

NCERT Essentials

- Q.1** Various parts of a cell are given below. Write them in the appropriate places in the following diagram.



Nucleus
Chloroplast
Cell membrane

Cytoplasm
Cell wall
Nucleoid

- Q.2** Aanandi took two test tubes and marked them A and B. She put two spoonfuls of sugar solution in each of the test tubes. In test tube B, she added a spoonful of yeast. Then she attached two incompletely inflated balloons to the mouth of each test tube. She kept the set-up in a warm place, away from sunlight.

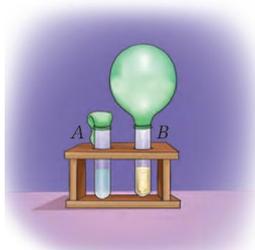


Fig. Experimental set-up

- (i) What do you predict will happen after 3–4 days? She observed that the balloon attached to test tube B was inflated. What can be a possible explanation for this?
 - (a) Water evaporated in test tube B and filled the balloon with the water vapour.
 - (b) The warm atmosphere expanded the air inside the test tube B, which inflated the balloon.
 - (c) Yeast produced a gas inside the test tube B which inflated the balloon.
 - (d) Sugar reacted with warm air, which produced gas, eventually inflating the balloon.
- (ii) She took another test tube, 1/4 filled with lime water. She removed the balloon from test tube B in such a manner that the gas inside the balloon did not escape. She attached the balloon to the test tube with lime

water and shook it well. What do you think she wants to find out?

- Q.3** A farmer was planting wheat crops in his field. He added nitrogen-rich fertiliser to the soil to get a good yield of crops. In the neighbouring field, another farmer was growing bean crops, but she preferred not to add nitrogen fertiliser to get healthy crops. Can you think of the reasons?
- Q.4** Snehal dug two pits, A and B, in her garden. In pit A, she put fruit and vegetable peels and mixed it with dried leaves. In pit B, she dumped the same kind of waste without mixing it with dried leaves. She covered both the pits with soil and observed after 3 weeks. What is she trying to test?

- Q.5** Identify the following microorganisms:
- (i) I live in every kind of environment, and inside your gut.
 - (ii) I make bread and cakes soft and fluffy.
 - (iii) I live in the roots of pulse crops and provide nutrients for their growth.

- Q.6** Devise an experiment to test that microorganisms need optimal temperature, air, and moisture for their growth.

- Q.7** Take 2 slices of bread. Place one slice in a plate near the sink. Place the other slice in the refrigerator. Compare after three days. Note your observations. Give reasons for your observations.

- Q.8** A student observes that when curd is left out for a day, it becomes more sour. What can be two possible explanations for this observation?

- Q.9** Observe the set-up given in Fig. 2.15 and answer the following questions.

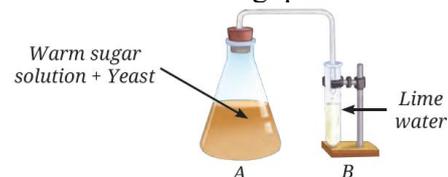


Fig. Experimental set-up

- (i) What happens to the sugar solution in flask A?
- (ii) What do you observe in test tube B after four hours?
Why do you think this happened?
- (iii) What would happen if yeast was not added in flask A?

EXERCISE-II

Brain Booster MCQs

MCQ BASED QUESTIONS :

- Q.1** Which of the following statements is not correct?
 (A) In plant cells, vacuoles are absent.
 (B) Vacuole is bounded by a single membrane.
 (C) In *Amoeba*, contractile vacuole is important for excretion.
 (D) Flagellum is important for transport of bacteria.
- Q.2** Which of the following cell organelles are non-membranous and found in both prokaryotic and eukaryotic cells?
 (A) Lysosome (B) Vacuoles
 (C) Ribosome (D) Mitochondria
- Q.3** The scientist who described cell as “many little boxes” was
 (A) Robert Hooke
 (B) Theodar Schwann
 (C) Anton Van Leeuwenhoek
 (D) Rudolf Virchow
- Q.4** The characteristic of a nerve cell that relates directly to its function is its
 (A) Long extensions
 (B) Flat shape
 (C) Ability to change shape
 (D) Ability to engulf bacteria
- Q.5** Old cell organelles, viruses, bacteria etc. that a cell can ingest are broken down in
 (A) Ribosomes (B) RER
 (C) SER (D) Lysosomes
- Q.6** A cell that contains a cell wall, chloroplasts and a central vacuole is
 (A) Plant cell (B) Animal cell
 (C) Yeast cell (D) Bacterial cell
- Q.7** Cells that have a high energy requirement generally have many
 (A) Ribosomes (B) Nucleus
 (C) Mitochondria (D) Chloroplast
- Q.8** Which of the following organelles is found in plant cells but not in animal cells?
 (A) Nucleus (B) Mitochondrion
 (C) Chloroplast (D) Golgi apparatus
- Q.9** Smallest cell organelle is
 (A) Mitochondria (B) Ribosome
 (C) Vacuole (D) Lysosome
- Q.10** Plasma membrane is
 (A) Permeable
 (B) Selectively permeable
 (C) Impermeable
 (D) Semi-permeable
- Q.11** All organism consist of smaller part called
 (A) organs (B) cell
 (C) cell wall (D) organelle
- Q.12** Which part of the cell contains organelles?
 (A) Protoplasm (B) Nucleoplasm
 (C) Chromosomes (D) Cytoplasm
- Q.13** Which of the following is **not** a plastid?
 (A) Chloroplast (B) Chromoplast
 (C) Leucoplast (D) Ribosome
- Q.14** The colour of chlorophyll pigment is
 (A) yellow (B) green
 (C) red (D) blue
- Q.15** Cell wall of plants is made up of
 (A) starch (B) lignin
 (C) cellulose (D) protein
- Q.16** Which of the following is **not** a unicellular organism?
 (A) Yeast (B) Paramecium
 (C) Hydra (D) Amoeba
- Q.17** Mitosis is a
 (A) cell division (B) cell death
 (C) cell elongation (D) cell wall
- Q.18** DNA stands for
 (A) deoxy ribosome nucleic acid
 (B) deoxy ribonucleic acid
 (C) dioxide nucleic acid
 (D) dihydrogen ribose nucleic acid
- Q.19** Which of the following is the site for energy production?
 (A) Mitochondria
 (B) Nucleoplasm
 (C) Cytoplasm
 (D) Nuclear membrane
- Q.20** The largest cell is that of
 (A) plant (B) ostrich egg
 (C) hen egg (D) human cheek

- Q.21** Why don't microorganisms grow well in pickles?
(A) Lack of water
(B) High salt/sugar concentration
(C) Presence of oil
(D) Low temperature
- Q.22** Which microorganisms are acellular?
(A) Bacteria
(B) Fungi
(C) Viruses
(D) Protozoa blood cells
(D) He studied plant cells
- Q.23** Which part of the cell controls all activities?
(A) Cell membrane (B) Cytoplasm
(C) Nucleus (D) Cell wall
- Q.24** What is the function of the cell membrane?
(A) To provide rigidity
(B) To control entry and exit of materials
(C) To store food
(D) To produce energy
- Q.25** Which structure is present in plant cells but absent in animal cells?
(A) Nucleus (B) Cell membrane
(C) Cell wall (D) Cytoplasm
- Q.26** Which microorganism lives in root nodules of legumes?
(A) Lactobacillus (B) Yeast
(C) Rhizobium (D) Paramecium
- Q.27** What is the function of Rhizobium bacteria?
(A) Nitrogen fixation
(B) Oxygen production
(C) Food spoilage
(D) Disease causing
- Q.28** Which microorganism is called a superfood?
(A) Yeast (B) Spirulina
(C) Lactobacillus (D) Rhizobium
- Q.29** What percentage of Earth's oxygen is produced by microalgae?
(A) 25% (B) 40%
(C) More than 50% (D) 75%
- Q.30** What does 'Krimi' refer to in ancient texts?
(A) Only visible organisms
(B) Only invisible organisms
(C) Both visible and invisible tiny entities
(D) Large animals
- Q.31** What type of environment do some bacteria prefer for biogas production?
(A) High oxygen
(B) Low oxygen
(C) Oxygen-free
(D) High temperature only
- Q.32** Which scientist developed bacteria to clean oil spills?
(A) Robert Hooke
(B) Louis Pasteur
(C) Dr. Ananda Mohan Chakrabarty
(D) Alexander Fleming
- Q.33** What type of cell is a muscle cell?
(A) Spherical (B) Spindle-shaped
(C) Rectangular (D) Irregular
- Q.34** How do nerve cells help the body?
(A) Provide strength (B) Carry messages
(C) Store food (D) Filter waste
- Q.35** What is the shape of nerve cells?
(A) Round
(B) Square
(C) Long with branches
(D) Triangular
- Q.36** Why don't microorganisms grow well in pickles?
(A) Lack of water
(B) High salt/sugar concentration
(C) Presence of oil
(D) Low temperature
- Q.37** What is the magnification power of Robert Hooke's microscope?
(A) 100-200 times (B) 200-300 times
(C) 300-400 times (D) 400-500 times
- Q.38** Which structure in bacteria replaces the nucleus?
(A) Nucleoid (B) Ribosome
(C) Plasmid (D) Flagella
- Q.39** What is the main component of biogas?
(A) Carbon dioxide
(B) Methane
(C) Oxygen
(D) Nitrogen
- Q.40** Which tool is used as a low-cost alternative to microscopes?
(A) Magnifying glass
(B) Foldscope
(C) Telescope
(D) Camera

EXERCISE-III**Concept Check****TRUE/FALSE QUESTIONS :**

- Q.1** All microorganisms are harmful to humans. **True/False**
- Q.2** Yeast is a type of bacteria used in bread making. **True/False**
- Q.3** All cells have the same shape and size. **True/False**
- Q.4** The cell membrane is permeable to all substances. **True/False**
- Q.5** Chloroplasts are found in both plant and animal cells. **True/False**
- Q.6** All microorganisms need oxygen to survive. **True/False**
- Q.7** Muscle cells help in carrying messages in the body. **True/False**

FILL IN THE BLANKS :

- Q.1** Ribosomes are located on the surface of _____.
- Q.2** _____ store hydrolytic enzymes.
- Q.3** _____ regarded as director of cell.
- Q.4** _____ and _____ are called semi-autonomous cell organelles.
- Q.5** _____ are the main sites for synthesis of ATP in mitochondria.
- Q.6** Protoplasm consist of two parts _____ and _____.
- Q.7** _____ is the basic unit of life.
- Q.8** _____ separates the content of a cell from its surrounding medium.
- Q.9** Cell wall is absent in _____ cells
- Q.10** Cell wall is made up of _____ in plant cell.
- Q.11** _____ allows exchange of substances between nucleus and cytoplasm.
- Q.12** _____ are units of hereditary material.
- Q.13** RER helps in the synthesis of _____.
- Q.14** When lysosomes bring self destruction of a cell, they are called _____.
- Q.15** Vacuoles are fluid filled sacs covered by a membrane called _____.

CASE STUDY :**Case Study 1: Microscopic Observation**

During a laboratory session, students observed onion peel cells and human cheek cells under a microscope. They noticed that onion cells appeared rectangular and closely packed, while cheek cells looked round and scattered. Both cell types showed a nucleus and cell membrane, but only onion cells had a thick outer boundary.

- Q.1** What is the thick outer boundary seen only in onion cells?
- (A) Cell membrane
(B) Cell wall
(C) Nuclear membrane
(D) Cytoplasm
- Q.2** Why do onion cells appear closely packed?
- (A) They are smaller in size
(B) Cell wall provides rigidity
(C) They have more cytoplasm
(D) They lack vacuoles
- Q.3** What stain would be most appropriate for observing onion cells?
- (A) Methylene blue
(B) Safranin
(C) Iodine
(D) Congo red
- Q.4** Why do cheek cells appear round and scattered?
- (A) They lack cell wall
(B) They are dead cells
(C) They have more water
(D) They are larger in size
- Q.5** What is the primary function of cheek cells?
- (A) Photosynthesis
(B) Protection and lining
(C) Storage
(D) Reproduction

MATCH THE COLUMN:

[A] **[ONE TO ONE]:**
Column-I and **column-II** contains **four** entries each. Entries of column-I are to be matched with some entries of column-II. Only One entries of column-I may have the matching with the same entries of column-II and one entry of column-II Only one matching with entries of column-I

Q.1 Match the column**Column I**

- (a) Mitochondria
- (b) Golgi complex
- (c) Lysosomes
- (d) Centrosome

Column II

- (p) Secretion
- (q) Suicidal bags
- (r) ATP
- (s) Cell division

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

ASSERTION & REASON TYPE QUESTIONS

Direction: Each of these questions contains an Assertion follows by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

- (A) If both **Assertion** and **Reason** are correct and Reason is the **correct explanation** of Assertion.
- (B) If both **Assertion** and **Reason** are correct and Reason is **not the correct explanation** of Assertion.
- (C) If **Assertion** is **correct** but Reason is **incorrect**.
- (D) If **Assertion** is **incorrect** but Reason is **correct**.

Q.1 Assertion : Mitochondria does not help in photosynthesis.

Reason : Mitochondria have enzymes for photosynthesis.

Q.2 Assertion : Lysosomes have basic enzymes.

Reason : Lysosomes are called autophagosomes.

Q.3 Assertion : A cell membrane shows fluid-mosaic behavior.

Reason : A membrane is composed of lipids and proteins.

Q.4 Assertion : The true nucleus is generally absent in prokaryotes.

Reason : An undifferentiated, unorganised fibrillar nucleus is observed in prokaryotic cells.

Q.5 Assertion : Mitochondria is called power house of cell.

Reason : Mitochondria produce ADP.

EXERCISE-IV**Subjective Assessment****VERY SHORT TYPE QUESTIONS :**

- Q.1** What is cytoplasm?
- Q.2** What is protoplasm?
- Q.3** Write the functions of cell wall.
- Q.4** Define the term cell.
- Q.5** What is the function of endoplasmic reticulum ?
- Q.6** Name the three types of plastids.
- Q.7** Name the largest and smallest cell known to you.
- Q.8** Expand the terms : RNA and DNA.
- Q.9** Name the instrument used for viewing a cell.
- Q.10** Which cell organelle is called as brain of the cell ?

SHORT TYPE QUESTIONS :

- Q.1** Explain various types of organisms on the basis of number of cells.
- Q.2** What are the functions performed by single cell organisms?
- Q.3** What is gene? What is its function?
- Q.4** Write the functions of mitochondria, golgi bodies and ribosomes.
- Q.5** What is the function of a cell membrane ?
- Q.6** How do plant cells differ from animal cells? Give any three differences.
- Q.7** What is the function of chloroplasts in plant cells?
- Q.8** What is the importance of microalgae for Earth's atmosphere?
- Q.9** Why don't microorganisms grow in pickles and preserved foods?
- Q.10** How do microorganisms adapt to extreme environmental conditions?
- Q.11** What is the role of glycerine in slide preparation?

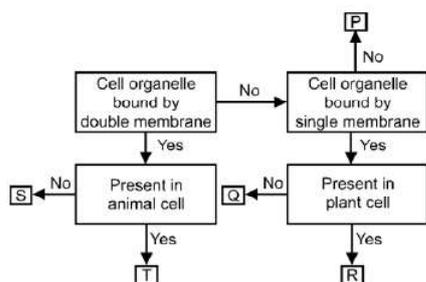
LONG TYPE QUESTIONS :

- Q.1** Explain prokaryotic and eukaryotic cells.
- Q.2** List four differences between a plant cell and an animal cell.
- Q.3** Which organelle is called as power house of the cell ? Why is it called so ?
- Q.4** Draw a neat diagram of a typical cell and label at least five parts in it.
- Q.5** Write a short note on nucleus.
- Q.6** Describe in detail the process of preparing and observing onion peel cells under a microscope. Include the materials required, step-by-step procedure, observations, and scientific principles involved.
- Q.7** Explain the characteristics that distinguish bacteria from other microorganisms. Discuss their cell structure, genetic organization, and ecological importance with specific examples.
- Q.8** Describe the role of microorganisms in food production and preservation. Include detailed examples of fermentation processes in bread making, curd formation, and traditional fermented foods.
How have fermented foods contributed to nutrition, food security, and cultural identity?
- Q.9** Discuss the concept of levels of organization in living organisms. How do cells organize to form tissues, organs, and organ systems? Provide examples from both plant and animal kingdoms.
- Q.10** Describe in detail the process of preparing and observing onion peel cells under a microscope. Include the materials required, step-by-step procedure, observations, and scientific principles involved.
- Q.11** Discuss the significance of microalgae in maintaining Earth's atmospheric balance. Explain their role in oxygen production, carbon dioxide absorption, and their potential as a sustainable food source.
- Q.12** Analyze the factors that affect microbial growth and reproduction. How do temperature, moisture, pH, and nutrients influence microbial activity? Provide experimental evidence.

EXERCISE-V

Competition Edge

Q.1 Study the given flow chart. [NSO-2016]



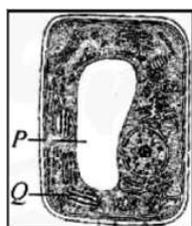
Which of the following holds true for P, Q, R, S and T?

- (A) P takes part in cell autophagy and autolysis whereas Q takes part in osmoregulation.
 (B) R takes part in protein synthesis and is also present in bacteria.
 (C) Inner membrane of T contains stalked particles whereas inner membrane of S is connected to thylakoids at various places.
 (D) T takes part in preparation of food whereas S takes part in oxidation of food to release energy.

Q.2 Sravani observed some cell samples under a microscope. In which of these they could not find chloroplasts? [NSTSE-2018-19]

- (I) Potato cells (II) Spinach cells
 (III) Cabbage cells (IV) Onion cells
 (A) I and II only (B) II and III only
 (C) III and IV only (D) I and IV Only

Q.3 In the given figure, showing the ultrastructure of a plant cell, identify the parts marked as P and Q and select the correct option regarding them. [NSO-2018]



- (i) Part P helps in osmoregulation.
 (ii) Cellular respiration occurs in part Q.
 (iii) Synthesis of sugars occurs in part Q.
 (iv) Part P provides colour to flowers and

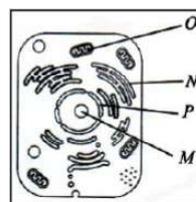
fruits.

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

Q.4 Rectify the given statements by replacing the underlined words (wherever necessary) and select the incorrect option. [NSO-2018]

- (i) Protoplasm occupies the space between cell membrane and the nucleus.
 (ii) Centriole synthesises, stores and transport material within the cell.
 (iii) Energy is synthesised and stored in the form of ATP by mitochondria.
 (iv) By-products of metabolic activity get stored in lysosome.
 (A) Protoplasm must be replaced with cytoplasm.
 (B) Centriole must not be replaced as it is correctly mentioned.
 (C) ATP must not be replaced as it is correctly mentioned.
 (D) Lysosome must be replaced with vacuole.

Q.5 The figure given below shows the structure of an animal cell. Which letter represents mitochondria? [IOS-2018-19]



- (A) P (B) M
 (C) N (D) O

Q.6 The table given below has certain terms and five spaces named a, b, c, d and e.

Cell	Feature/Part	Function
Bacteria	a	Movement
Plant cell	Chloroplast	b
c	Spindle shaped	d
e	Selectively permeable	Gives shape to the cell

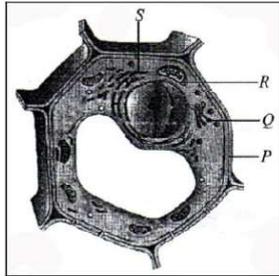
From the options given below choose the correct combination of terms to fill in the table.

[ISO-2018-19]

- (A) a-pseudopodia, b-respiration, c-muscle cell, d-expansion, e-nucleus.
- (B) a-flagella, b-photosynthesis, c-nerve cell, d-contraction, e-cell vacuole.
- (C) a-cilia, b-reproduction, c-blood cell, d-contraction, e-nucleus.
- (D) a-flagella, b-photosynthesis, c-muscle cell, d-contraction, e-cell membrane.

Q.7 Refer to the given ultrastructure of a plant cell.

[NSO-2019-20]

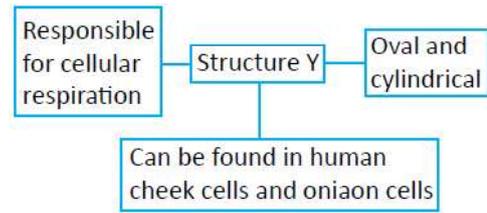


Identify the labelled parts P-S and select the incorrect statement regarding them.

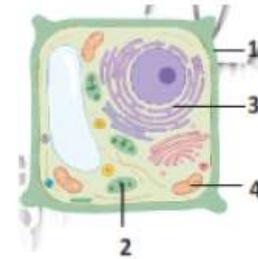
- (i) P provides strength and support to the plant.
 - (ii) S is known as the secretory organelle of the cell.
 - (iii) Q synthesises proteins and lipids and serves as transport channel for materials to pass.
 - (iv) R is absent in animal cell.
- (A) (i) and (ii) only (B) (ii) and (iii) only

Q.8

- (C) (i) and (iii) only (D) (ii) and (iv) only
- Study the concept map below.



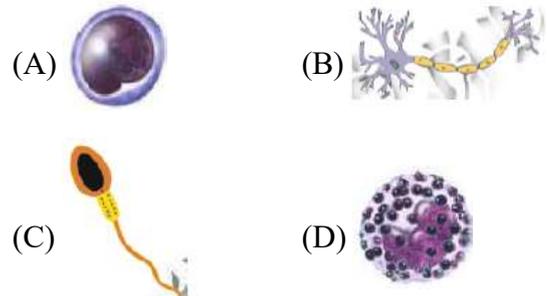
Structure Y is represented by _____ in the diagram below. [NSTSE 2022]



- (A) 1 (B) 2
- (C) 3 (D) 4

Q.9

Identify the cell that carries information to the brain? [NSTSE 2022]



ANSWER KEY

EXERCISE-II

MULTIPLE CHOICE QUESTIONS :

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

EXERCISE-III

TRUE/FALSE QUESTIONS :

Q.1	False	Q.2	False	Q.3	False	Q.4	False	Q.5	False	Q.6	False	Q.7	False
------------	-------	------------	-------	------------	-------	------------	-------	------------	-------	------------	-------	------------	-------

FILL IN THE BLANKS :

Q.1	Endoplasmic reticulum	Q.2	Lysosomes	Q.3	Nucleus
Q.4	Plastid, mitochondria	Q.5	Oxysome	Q.6	Cytoplasm, nucleus
Q.7	Cell	Q.8	Plasma membrane	Q.9	Animal
Q.10	Cellulose	Q.11	Nuclear pore	Q.12	Genes
Q.13	Proteins	Q.14	Suicidal bags	Q.15	Tonoplast

CASE STUDY :

Q.1	(B)	Q.2	(B)	Q.3	(B)	Q.4	(A)	Q.5	(B)
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MATCH THE COLUMN :

Q.1 A

ASSERTION BASED QUESTION

Q.1	C	Q.2	D	Q.3	A	Q.4	A	Q.5	C
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EXERCISE-V

Q.1	C	Q.2	B	Q.3	D	Q.4	D	Q.5	B	Q.6	D	Q.7	B
Q.8	D	Q.9	B										

1. INTRODUCTION

Every shape is made by different curves or straight lines

A curve is plane figure formed by joining a number of points without lifting a pencil from the paper A straight line is also a curve.



(i)

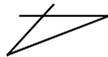


(ii)

- **Open curve:** A curve which does not cut it self is called an open curve.



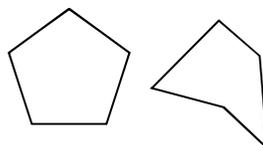
- **Closed curve:** A curve cuts it self is called a closed curve.



- **Simple closed curve:** A closed curve is called a simple closed curve, if it does not passes through one point more than once.

2. POLYGONS:

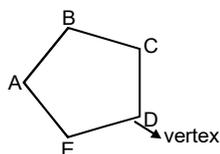
A simple closed curve made up of only line segment is called a “ polygon”.



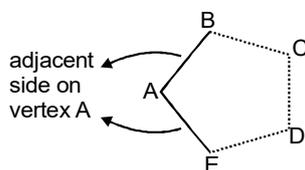
The following figures are not polygons.



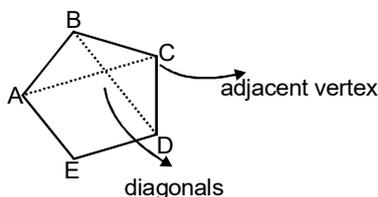
let a polygon ABCDE to understand following terms



- I. **Vertex:** A, B, C, D and E are called vertex, i.e point of intersection of two lines.
- II. **Sides:** The line segment forming the polygon i.e AB, BC, DC, DE and DA.
- III. **Adjacent sides:** Any two sides with a common end-point (vertex), are called adjacent sides.



- IV. **Adjacent vertex:** The end-points of the same side of a polygon are known as adjacent vertex
- V. **Diagonals:** The line segment obtained by joining vertex which are not adjacent are called the diagonals of polygon.



2.1 Classification of Polygon

- **On the basis of number of sides**

Polygons are classified according to the number of sides they have. The following lists the different types of polygons based on the number of sides they have:

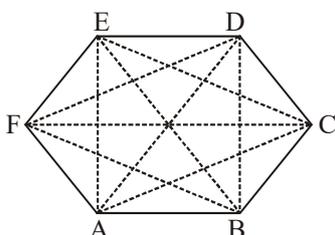
- When there are three sides, it is **triangle**
- When there are four sides, it is **quadrilateral**
- When there are fives sides, it is **pentagon**
- When there are six sides, it is **hexagon**
- When there are seven sides, it is **heptagon**
- When there are eight sides, it is **octagon**
- When there are nine sides, it is **nonagon**
- When there are ten sides, it is **decagon**

Number of sides or vertices	Name of the polygon	Shape
3	Triangle	
4	Quadrilateral	
5	Pentagon	
6	Hexagon	
7	Heptagon	
8	Octagon	
9	Nonagon	
10	Decagon	
⋮	⋮	
n	n-gon	

2.2 Diagonals of a Polygon

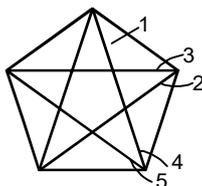
A diagonal is a line segment connecting two non-consecutive vertices of a polygon.

Thus, in the figure ABCDEF is a polygon and each of the line segments AC, AD, AE, BD, BE, BF, CE, CF, DF is a diagonal of the polygon.



If there are n-sides of a convex polygon, then number of diagonals are $\frac{n(n-3)}{2}$, $n > 3$

Example: Consider the polygon with 5 sides



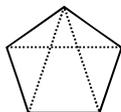
there are 5 diagonals by counting now use formula $\frac{n(n-3)}{2}$ for $n=5$

$$= \frac{5(5-3)}{2} = \frac{5 \times 2}{2} = 5 \text{ diagonals}$$

2.3 Convex and Concave Polygon

- Convex polygon:**

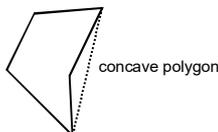
A polygon is a convex polygon if the line segment joining any two points inside it lies completely inside the polygon.



Example:

- Concave polygon:**

If the line segment joining any two vertex passes through outside the polygon, then its called concave polygon.



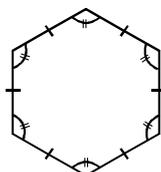
Example:

In concave polygon, at least one angle is greater than 180° .

2.4 Regular polygon and Irregular polygon:

- Regular polygon:**

A polygon whose all sides and all angles are equal is called Regular polygon.



- Irregular polygon:**

A polygon which is not regular i.e. it is not equilateral and equiangular, is an irregular polygon.

2.5 Angle sum property of general polygon

Property: I

Sum of all interior angle of a polygon of 'n' sides are $(n-2) \times 180^\circ$

Proof: A n- side polygon is cut into $(n-2)$ triangle by diagonal from a same vertex thus sum of all angles of triangles are $(n-2) \times 180^\circ$.

Property II:

A sum of all exterior angles of a n-sided polygon is 360° .

Proof: In a polygon there are n-straight lines which form n -straight angles, thus sum of all interior angle and exterior angle are $n \times 180^\circ$ i.e

$$\text{sum of interior angles} + \text{sum of exterior angles} = n \times 180^\circ$$

$$\text{sum of all exterior angle} = n \times 180 - (n - 2) \times 180^\circ = n \times 180^\circ - n \times 180^\circ + 2 \times 180^\circ$$

$$\text{sum of all exterior angle} = 360^\circ \text{ proved.}$$

In a regular polygon, every interior angles are $\frac{(n-2) \times 180^\circ}{n}$ and exterior angle is $\frac{360}{n}$.


EXAMPLES


Example: 1 How many sides does a regular polygon have if the measure of an exterior angle is 24° ?

Solution: Let there be n sides of the regular polygon. Then, the measure of each exterior angle is

$$\left(\frac{360}{n}\right)^\circ$$

$$\therefore \frac{360}{n} = 24 \Rightarrow n = \frac{360}{24} = 15$$

So, the polygon has 15 sides.

Example: 2 How many sides has a regular polygon, each angle of which is of measure 108° ?

Solution: Let there be n sides of the polygon. Then, each interior angle is of measure

$$\left(\frac{2n-4}{n} \times 90\right)^\circ.$$

$$\therefore \frac{2n-4}{n} \times 90 = 108$$

$$\Rightarrow (2n-4) \times 90 = 108n$$

$$180n - 360 = 108n$$

$$180n - 108n = 360$$

$$72n = 360$$

$$n = 5$$

So, the polygon has 5 sides.

Aliter: Let there be n side of the regular polygon. Then, the measure of each exterior angle

$$\text{is} \left(\frac{360}{n}\right)^\circ.$$

It is given that the measure of each interior angle is 108°

$$\therefore \text{The measure of each exterior angle} = 180^\circ - 108^\circ = 72^\circ$$

$$\therefore \frac{360}{n} = 72 \Rightarrow n = \frac{360}{72} = 5$$

Example: 3 Two regular polygons are such that the ratio between their number of sides is 1 : 2 and the ratio of measures of their interior angles is 3 : 4. Find the number of sides of each polygon.

Solution: Let the number of sides of the regular polygon be n and $2n$. Then, their interior angles

$$\text{are } \left(\frac{2n-4}{n} \times 90\right)^\circ \text{ and } \left(\frac{2(2n)-4}{2n} \times 90\right)^\circ$$

It is given that the ratio of measures of interior angles is $3 : 4$.

$$\therefore \frac{\frac{2n-4}{n} \times 90}{\frac{2(2n)-4}{2n} \times 90} = \frac{3}{4} \Rightarrow \frac{2n-4}{n} \times \frac{2n}{4n-4} = \frac{3}{4}$$

$$\Rightarrow \frac{2(n-2)}{1} \times \frac{2}{4(n-1)} = \frac{3}{4} \Rightarrow \frac{n-2}{n-1} = \frac{3}{4}$$

$$\Rightarrow 4n - 8 = 3n - 3$$

$$\Rightarrow 4n - 3n = 8 - 3$$

$$\Rightarrow n = 5$$

Hence, number of sides of regular polygon be 5 and 10.

3. SUM OF THE MEASURES OF THE EXTERIOR ANGLES OF A POLYGON

We know that an exterior angle and the adjacent interior angle of a polygon form a linear pair.

$$\text{Interior angle} + \text{Exterior angle} = 180^\circ$$

If the polygon has n sides (or vertices), then

$$\text{Sum of all interior angles} + \text{Sum of all exterior angle} = n \times 180^\circ = (2n) \text{ right angles}$$

$$\text{or } (2n - 4) \text{ right angles} + \text{sum of all exterior angles} = (2n) \text{ right angles}$$

$$\begin{aligned} \text{or } \text{sum of all exterior angles} &= (2n) \text{ right angles} - (2n - 4) \text{ right angles} \\ &= 4 \text{ right angles} \\ &= 4 \times 90^\circ = 360^\circ \end{aligned}$$

Hence, Sum of all exterior angles of a polygon = 360°



Let's know

For a regular polygon of n -sides

$$(i) \text{ Each exterior angle} = \frac{360^\circ}{n}$$

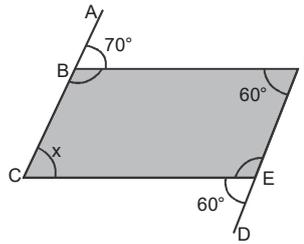
$$(ii) n = \frac{360^\circ}{\text{each exterior angle}}$$



TRY YOURSELF

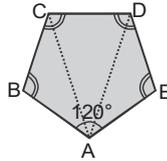
- Q.1** In a square ABCD, the diagonals bisect at O. What type of a triangle is AOB?
 (A) An equilateral triangle.
 (B) An isosceles but not a right angled triangle.
 (C) A right angled but not an isosceles triangle
 (D) An isosceles right angled triangle.

- Q.2** ABC and DEF are straight lines.



Find the value of 'x'

- (A) 60° (B) 70° (C) 80° (D) 85°
- Q.3** Four of the angles of a pentagon are of equal size. The remaining angle is 120° .



Find the value of each of the equal angles.

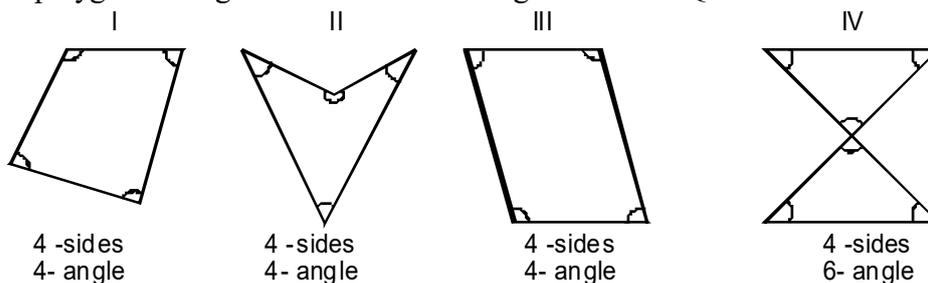
- (A) 210° (B) 110° (C) 540° (D) 105°
- Q.4** Each interior angle of a regular polygon is 150° . How many sides has the polygon?
 (A) 8 (B) 12 (C) 9 (D) 10
- Q.5** Each interior angle of a regular polygon is 162° . How many sides has the polygon?
 (A) 12 (B) 20 (C) 16 (D) 10
- Q.6** The exterior angle of a regular polygon is one -third of its interior angle. How many sides does the polygon has?
 (A) 10 (B) 8 (C) 9 (D) 13

ANSWER KEY

- Q.1** D **Q.2** B **Q.3** D **Q.4** B **Q.5** B **Q.6** A

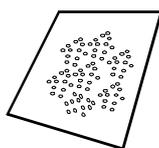
4. QUADRILATERAL:

A polygon having four sides and four angles is called Quadrilateral.

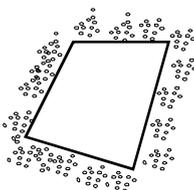


then IV figure is not a quadrilateral.

- All the point inside the quadrilateral are called interior points of quadrilateral.



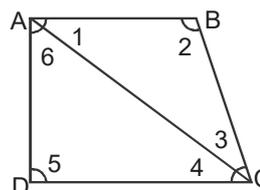
- All the point outside the quadrilateral are called exterior points of quadrilateral.



- The Interior of Quadrilateral with quadrilateral is called “Quadrilateral Region”.
- Angle sum property of Quadrilateral**

“In a quadrilateral, sum of all interior angle is 360° this is called interior angle sum property.

Property I:



Proof: let a quadrilateral ABCD connect AC

In $\triangle ABC$, $\angle 1 + \angle 2 + \angle 3 = 180^\circ$ (i)

In $\triangle ADC$, $\angle 6 + \angle 5 + \angle 4 = 180^\circ$ (ii)

{triangle sum property}

adding (i) & (ii)

$$\angle 1 + \angle 2 + \angle 3 + \angle 6 + \angle 5 + \angle 4 = 360^\circ$$

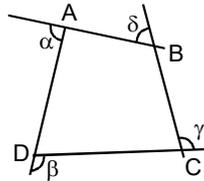
$$(\angle 1 + \angle 6) + \angle 2 + (\angle 4 + \angle 3) + \angle 5 = 360^\circ$$

$$\angle A + \angle B + \angle C + \angle D = 360^\circ \quad \text{Proved}$$

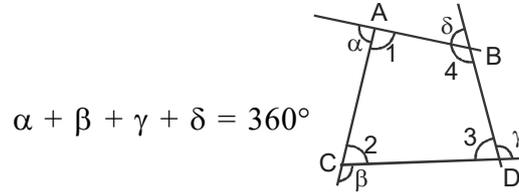
Property II:

If the sides of a quadrilateral are produced in order, the sum of four exterior angles so formed is 360°

$\alpha + \beta + \gamma + \delta = 360^\circ$ this is called exterior angle sum property.



Proof: To prove



In the following figure

$$\angle 1 + \angle \alpha = 180^\circ \quad \dots\dots\dots (i)$$

$$\angle 2 + \angle \beta = 180^\circ \quad \dots\dots\dots (ii)$$

$$\angle 3 + \angle \gamma = 180^\circ \quad \dots\dots\dots (iii)$$

$$\angle 4 + \angle \delta = 180^\circ \quad \dots\dots\dots (iv)$$

now add all we get

$$\angle 1 + \angle \alpha + \angle 2 + \angle \beta + \angle 3 + \angle \gamma + \angle 4 + \angle \delta = 4 \times 180^\circ$$

$$(\angle \alpha + \angle \beta + \angle \gamma + \angle \delta) + (\angle 1 + \angle 2 + \angle 3 + \angle 4) = 720^\circ$$

$$(\angle \alpha + \angle \beta + \angle \gamma + \angle \delta) + 360^\circ = 720^\circ$$

$$\text{or } (\angle \alpha + \angle \beta + \angle \gamma + \angle \delta) = 360^\circ \text{ proved}$$

Example: 4 In a quadrilateral ABCD, the angles A, B, C and D are in the ratio 1 : 2 : 3 : 4. Find the measure of each angle of the quadrilateral.

Solution: We have, $\angle A : \angle B : \angle C : \angle D = 1 : 2 : 3 : 4$

Sol, let $\angle A = x^\circ$, $\angle B = 2x^\circ$,
 $\angle C = 3x^\circ$ and $\angle D = 4x^\circ$

$$\therefore \angle A + \angle B + \angle C + \angle D = 360^\circ$$

$$\Rightarrow x + 2x + 3x + 4x = 360^\circ$$

$$\Rightarrow 10x = 360^\circ$$

$$\Rightarrow x = 36^\circ$$

Thus, the angles are:

$$\angle A = 36^\circ, \angle B = (2 \times 36^\circ) = 72^\circ, \angle C = (3 \times 36^\circ) = 108^\circ \text{ and, } \angle D = (4x^\circ) \\ = (4 \times 36^\circ) = 144^\circ$$

Example: 5 The measure of two adjacent angles of a quadrilateral are 125° and 35° and the other two angles are equal. Find the measure of each of the equal angles.

Solution: Let ABCD be the quadrilateral such that $\angle A = 125^\circ$, $\angle B = 35^\circ$ and $\angle C = \angle D$

By angle sum property of a quadrilateral, we have

$$\angle A + \angle B + \angle C + \angle D = 360^\circ$$

$$125^\circ + 35^\circ + \angle C + \angle C = 360^\circ \text{ [}\because \angle C = \angle D\text{]}$$

$$160^\circ + 2\angle C = 360^\circ$$

$$2\angle C = 360^\circ - 160^\circ$$

$$2\angle C = 200^\circ$$

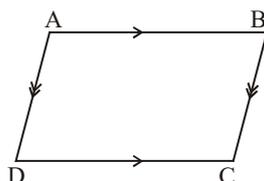
$$\angle C = \left(\frac{200^\circ}{2}\right) = 100^\circ$$

Hence, $\angle C = \angle D = 100^\circ$

5. VARIOUS TYPES OF QUADRILATERAL

(I) PARALLELOGRAM

A parallelogram is a quadrilateral in which both pairs of opposite sides are parallel.
In the given figure, $AB \parallel DC, AD \parallel BC$, therefore ABCD is a parallelogram.

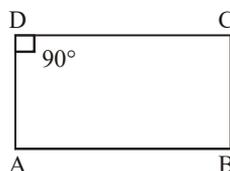


PROPERTIES :-

- (i) The opposite sides of a parallelogram are parallel.
- (ii) The opposite sides of a parallelogram are equal.
- (iii) The opposite angles of a parallelogram are equal.
- (iv) The adjacent angles of a parallelogram are supplementary.
- (v) The diagonals of a parallelogram bisect each other; but they are not equal.

(II) RECTANGLE

A rectangle is a parallelogram, whose one angle is a right angle.
In the given figure, ABCD is a parallelogram in which $\angle A = 90^\circ$, hence ABCD is a rectangle.



• PROPERTIES :-

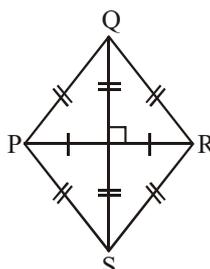
A rectangle is a parallelogram in which each angle is a right angle.
In rectangle,

- (i) The opposite sides are equal and parallel,
- (ii) Opposite angles are equal,
- (iii) Diagonals are equal
- (iv) Diagonals bisect each other.

Note : A rectangle is an equiangular figure but not an equilateral one.

(III) RHOMBUS

A rhombus is a parallelogram having a pair of adjacent sides are equal.
In the figure, ABCD is a parallelogram in which $AB = AD$. Hence, ABCD is a rhombus.



• **PROPERTIES :-**

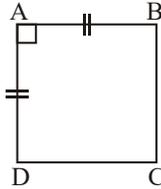
A rhombus is a parallelogram in which all four sides are equal.

In a rhombus,

- (i) Opposite sides are parallel,
- (ii) All sides are equal,
- (iii) Opposite angles are equal
- (iv) Diagonals bisect each other at right angles.

(IV) SQUARE

A square is a parallelogram having a pair of adjacent sides are equal and one angle a right angle. In the given figure, ABCD is a parallelogram with $AB = AD$ and $\angle A = 90^\circ$. Hence, it is a square.



• **PROPERTIES :-**

A parallelogram having all of its sides equal and measure of each angle being 90° , is called a square.

In a square,

- (i) All four sides are equal,
- (ii) Opposite sides are parallel,
- (iii) Each angle being equal to 90° ,
- (iv) The diagonal are equal,
- (v) The diagonals bisect each other at right angles.



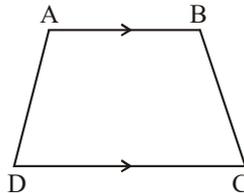
Let's know

A square is an equilateral and equiangular quadrilateral. Therefore it is called a regular polygon.

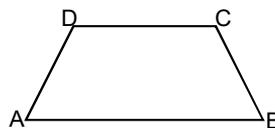
(V) TRAPEZIUM

A trapezium is a quadrilateral with only one pair of opposite sides parallel.

In the given figure, ABCD is a trapezium in which $AB \parallel DC$.



(VI) Isosceles trapezium:



In a trapezium, if the non-parallel sides are equal, then it is called an isosceles trapezium.

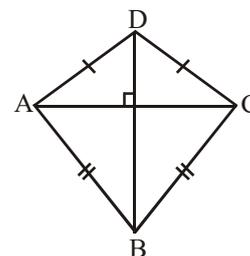
In the figure, $\overline{AB} \parallel \overline{CD}$ and $BC = AD$

Hence, ABCD is an isosceles trapezium.

(VII) KITE

It is a quadrilateral in which two pairs of adjacent sides are equal.

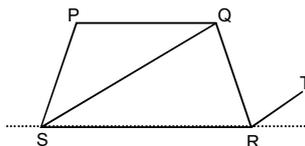
- (i) $AD = DC$ and $AB = BC$
- (ii) Diagonals are perpendicular but not bisect
- (iii) Only one diagonal divide the figure into two congruent triangles.





TRY YOURSELF

- Q.1** If each pair of opposite sides of a quadrilateral are equal and parallel, then it is a _____.
 (A) Kite (B) Trapezium
 (C) Parallelogram (D) None of these
- Q.2** In the given figure, line RT is drawn parallel to SQ. If $\angle QPS = 100^\circ$, $\angle PQS = 40^\circ$, $\angle PSR = 85^\circ$ and $\angle QRS = 70^\circ$, then $\angle QRT =$ _____.



- (A) 45° (B) 65° (C) 85° (D) 90°
- Q.3** Which of the quadrilaterals is NOT a parallelogram?
 (A) Rectangle (B) Square (C) Kite (D) Rhombus
- Q.4** A trapezium in which non- parallel sides are equal is said to be _____.
 (A) Right trapezium (B) Equilateral trapezium
 (C) Isosceles trapezium (D) None of these
- Q.5** Which of the following can never be the measure of exterior angle of a regular polygon?
 (A) 22° (B) 36° (C) 45° (D) 30°
- Q.6** The quadrilateral having only one pair of opposite sides parallel is called a _____.
 (A) Square (B) Rhombus (C) Trapezium (D) Parallelogram

ANSWER KEY

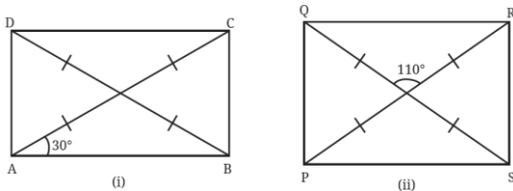
- Q.1** C **Q.2** B **Q.3** C **Q.4** C **Q.5** A **Q.6** C

EXERCISE-I

NCERT Essentials

Figure it Out (Page No. 94)

Q.1 Find all the other angles inside the following rectangles.



Q.2 Draw a quadrilateral whose diagonals have equal lengths of 8 cm that bisect each other, and intersect at an angle of
 (i) 30° (ii) 40°
 (iii) 90° (iv) 140°

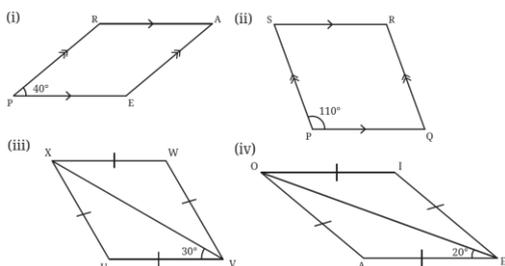
Q.3 Consider a circle with centre O. Line segments PL and AM are two perpendicular diameters of the circle. What is the figure APML? Reason and/or experiment to figure this out.

Q.4 We have seen how to get 90° using paper folding. Now, suppose we do not have any paper but two sticks of equal length, and a thread. How do we make an exact 90° using these?

Q.5 We saw that one of the properties of a rectangle is that its opposite sides are parallel. Can this be chosen as a definition of a rectangle? In other words, is every quadrilateral that has opposite sides parallel and equal, a rectangle?

Figure it Out (Page No. 102)

Q.1 Find the remaining angles in the following quadrilaterals.



Q.2 Using the diagonal properties, construct a parallelogram whose diagonals are of lengths 7 cm and 5 cm, and intersect at an angle of 140° .

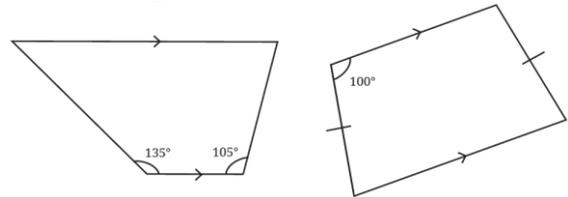
Q.3 Using the diagonal properties, construct a rhombus whose diagonals are of lengths 4 cm and 5 cm.

Figure it Out (Page No. 107)

Q.1 Find all the sides and the angles of the quadrilateral obtained by joining two equilateral triangles with sides 4 cm.

Q.2 Construct a kite whose diagonals are of lengths 6 cm and 8 cm.

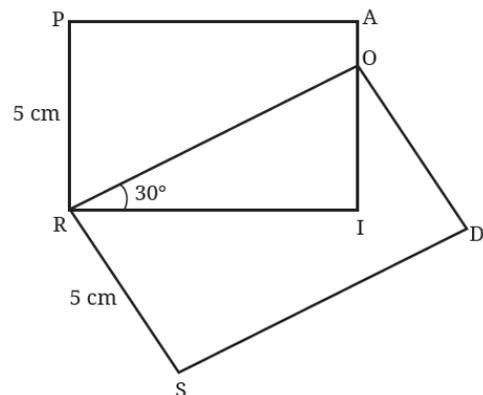
Q.3 Find the remaining angles in the following trapeziums —



Q.4 Draw a Venn diagram showing the set of parallelograms, kites, rhombuses, rectangles, and squares. Then, answer the following questions —

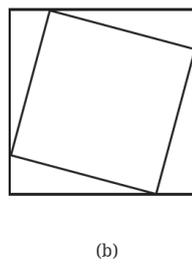
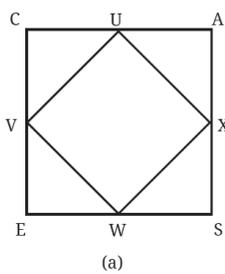
- (i) What is the quadrilateral that is both a kite and a parallelogram?
- (ii) Can there be a quadrilateral that is both a kite and a rectangle?
- (iii) Is every kite a rhombus? If not, what is the correct relationship between these two types of quadrilaterals?

Q.5 If PAIR and RODS are two rectangles, find $\angle IOD$.



Q.6 Construct a square with diagonal 6 cm without using a protractor.

Q.7 CASE is a square. The points U, V, W and X are the midpoints of the sides of the square. What type of quadrilateral is UVWX? Find this by using geometric reasoning, as well as by construction and measurement. Find other ways of constructing a square within a square such that the vertices of the inner square lie on the sides of the outer square, as shown in Figure (b).

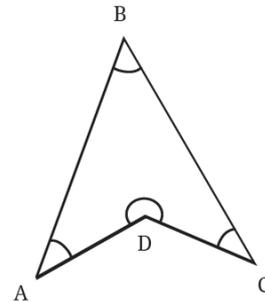


Q.8 If a quadrilateral has four equal sides and one angle of 90° , will it be a square? Find the answer using geometric reasoning as well as by construction and measurement.

Q.9 What type of a quadrilateral is one in which the opposite sides are equal? Justify your answer.

Hint: Draw a diagonal and check for congruent triangles.

Q.10 Will the sum of the angles in a quadrilateral such as the following one also be 360° ? Find the answer using geometric reasoning as well as by constructing this figure and measuring.



Q.11 State whether the following statements are true or false. Justify your answers.

- (i) A quadrilateral whose diagonals are equal and bisect each other must be a square.
- (ii) A quadrilateral having three right angles must be a rectangle.
- (iii) A quadrilateral whose diagonals bisect each other must be a parallelogram.
- (iv) A quadrilateral whose diagonals are perpendicular to each other must be a rhombus.
- (v) A quadrilateral in which the opposite angles are equal must be a parallelogram.
- (vi) A quadrilateral in which all the angles are equal is a rectangle.
- (vii) Isosceles trapeziums are parallelograms.

EXERCISE-II

Brain Booster MCQs

MCQ BASED QUESTIONS:

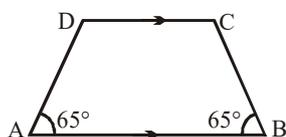
Q.1 The number of sides of a regular polygon whose each exterior angle has a measure of 45° , is
 (A) 5 (B) 6
 (C) 7 (D) 8

Q.2 If the sides of a quadrilateral are produced in an order, the sum of the four exterior angles so formed is
 (A) 180° (B) 360°
 (C) 540° (D) 720°

Q.3 The measure of each angle of a convex quadrilateral is
 (A) less than 180° (B) equal to 180°
 (C) greater than 180° (D) none of these

Q.4 The angle of a quadrilateral are in the ratio $1 : 2 : 3 : 4$. The largest angle is
 (A) 36° (B) 72°
 (C) 108° (D) 144°

Q.5 In the figure, the measure of $\angle C$ is



(A) 65° (B) 115°
 (C) 135° (D) 125°

Q.6 A quadrilateral has three acute angles each measuring 70° . The measure of fourth angle is
 (A) 140° (B) 150°
 (C) 105° (D) 120°

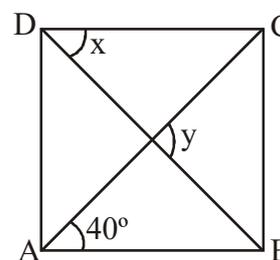
Q.7 If the angle of a quadrilateral are x° , $(x - 10)^\circ$, $(x + 30)^\circ$ and $2x^\circ$, then the greatest angle is
 (A) 136° (B) 180°
 (C) 68° (D) 148°

Q.8 The measures of two angles of a quadrilateral are 115° and 45° , and the other two angles are equal. The measure of each of the equal angles is
 (A) 200° (B) 120°
 (C) 100° (D) 160°

Q.9 In a square PQRS, the diagonals bisect at T. Then ΔPTQ is.
 (A) An equilateral triangle
 (B) An isosceles but not right angled
 (C) A right angled but not isosceles
 (D) An isosceles right angled

Q.10 A diagonal of a rectangle is inclined to one side of the rectangle at 35° . The acute angle between the diagonals is
 (A) 35° (B) 45°
 (C) 70° (D) 55°

Q.11 In fig. ABCD is a rhombus. The value of $y - x$ is



(A) 40° (B) 50° (C) 20° (D) 10°

Q.12 The sum interior angles of a hexagon is
 (A) 180° (B) 360°
 (C) 540° (D) 720°

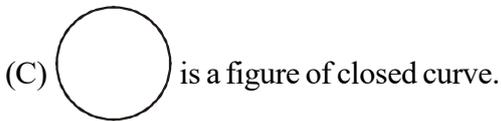
Q.13 The diagonals of a rhombus ABCD intersect at O, $AO = 3$ cm, $BO = 4$ cm then, length of BC is
 (A) 6 cm (B) 8 cm
 (C) 5 cm (D) none.

Q.14 A quadrilateral whose angles are equal but only adjacent side are equal, then the quadrilateral is a
 (A) square
 (B) rectangle
 (C) rhombus
 (D) parallelogram

Q.15 The adjacent angles of a prallelogram are in the ratio $4 : 5$, then the measure of the adjacent angles is
 (A) $40^\circ, 50^\circ$ (B) $80^\circ, 80^\circ$
 (C) $100^\circ, 100^\circ$ (D) $80^\circ, 100^\circ$

- Q.16** One of the diagonals of a rhombus is of same length as the of the side of the rhombus. The angles of the rhombus measure.
 (A) $80^\circ, 100^\circ$
 (B) $60^\circ, 80^\circ$
 (C) $90^\circ, 90^\circ$
 (D) $60^\circ, 120^\circ$

- Q.17** Which of the following is not true ?
 (A) A plane figure formed by joining a number of points without lifting the pencil from the paper and without retracting any portion of the drawing other than single point is called a curve.
 (B) a simple closed curve made up of only line segments is called a polygon.



(D) None of these

- Q.18** Adjacent sides of a polygon are
 (A) any two sides of the polygon
 (B) any two sides connecting two non-consecutive vertices of a polygon
 (C) any two sides with a common vertex
 (D) None of these

- Q.19** Adjacent vertices are
 (A) uncommon vertices of two adjacent sides of a polygon
 (B) end points of the same side of a polygone
 (C) end points of the diagonal of a polygon
 (D) none of these

- Q.20** In the given figure



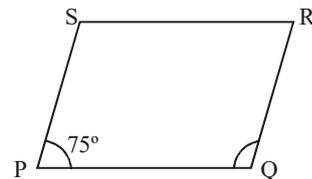
- (A) point A and B are in the interior of the curve
 (B) point B and C are at the exterior of the curve
 (C) point A is at the exterior of the curve and point C is in the interior of the curve
 (D) point A is in the interior of the curve and point C at the exterior of the curve

- Q.21** Which of the following is not true ?
 (A) a polygon is a convex polygon if the line segment joining any two points inside it lies completely inside the polygon
 (B) if a polygon has position of its diagonal in tis exterior then it is known as a concave polygon
 (C) a polygon having all sides and all agnles equal is a regular polygon
 (D) rohombus is a regular polygon

- Q.22** Which of the following is not true?
 (A) equilateral triangle is a regular polygon
 (B) square is a regular polygon
 (C) rectangle is a regular polygon
 (D) a regular polygon is both equiangular and equilateral.

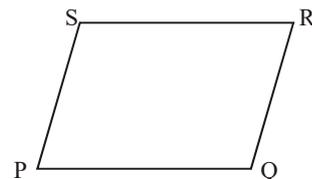
- Q.23** Which of the following is not true
 (A) every trapezium is a parallelogram but every parallelogram is not a trapezium
 (B) opposite sides of a parallelogram are not equal
 (C) opposite angles of a parallelogram are equal
 (D) both (A) and (B)

- Q.24** In the given figure, PQRS is a parallelogram. If $\angle P = 75^\circ$, then $\angle Q$ is



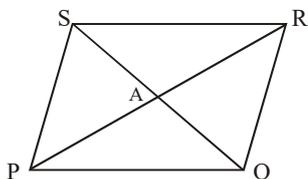
- (A) 75° (B) 90°
 (C) 105° (D) 100°

- Q.25** In the given figure, PQRS is a parallelogram. If perimeter of ||gm PQRS is 40 cm and $PQ = 12$ cm then PS is equal to

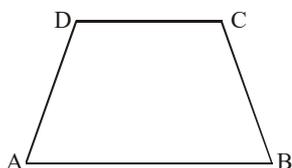


- (A) 12 cm
 (B) 10 cm
 (C) 8 cm
 (D) 9 cm

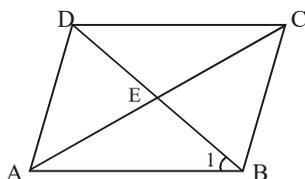
- Q.26** In the given figure, PQRS is a parallelogram and diagonal PR and QS intersect each other at A. If $QA = 3$ cm, $AR = 5$ cm and $PS = 6$ cm, then perimeter of ΔAQR is



- (A) 16 cm (B) 14 cm
(C) 12 cm (D) 10 cm
- Q.27** In the given figure, ABCD is a trapezium in which $AB \parallel CD$. If $\angle A = 50^\circ$ then $\angle D$ is equal to



- (A) 50° (B) 100°
(C) 130° (D) 120°
- Q.28** Which of the following is not the property of a square ?
- (A) each angle of a square is a right angle
(B) the diagonals of a square are not equal
(C) the sides of a square are equal
(D) the diagonals of a square bisect each other at right angle
- Q.29** In the given figure, ABCD is a rhombus. Diagonals AC and BD intersect each other at E. If $\angle 1 = 50^\circ$ then $\angle BCD$ is equal to



- (A) 100°
(B) 90°
(C) 80°
(D) none of these
- Q.30** How many diagonals does a regular hexagon have ?
- (A) 2 (B) 0
(C) 4 (D) 9

- Q.31** The angle sum of a convex polygon with number of sides 7 is
- (A) 900° (B) 1080°
(C) 1440° (D) 720°

- Q.32** Two adjacent angles of a quadrilateral measure 130° and 40° . The sum of the remaining two angles is
- (A) 190° (B) 180°
(C) 360° (D) 90°

- Q.33** the measure of each exterior angle of a regular polygon of 15 sides is
- (A) 30° (B) 45°
(C) 60° (D) 24°

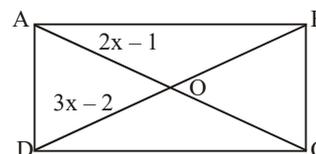
- Q.34** How many sides does a regular polygon have if each of its interior angles is 165° ?
- (A) 12 (B) 24
(C) 9 (D) 6

- Q.35** In a regular polygon of n sides, the measure of each internal angle is
- (A) $\frac{360^\circ}{n}$ (B) $\left(\frac{2n-4}{n}\right)90^\circ$
(C) $n90^\circ$ (D) $2n$ right angles.

- Q.36** If one angle of a parallelogram is of 65° then the measure of the adjacent angle is
- (A) 65° (B) 115°
(C) 25° (D) 90°

- Q.37** In a kite, what is false ?
- (A) The diagonals are perpendicular to each other
(B) The diagonals equal to each other
(C) Only one pair of opposite angles is equal
(D) All the four sides are equal

- Q.38** ABCD is rectangle. Its diagonals meet at O.



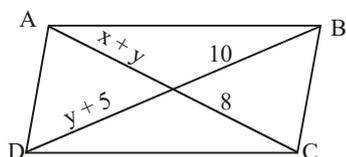
- $OA = 2x - 1$, $OD = 3x - 2$. Find x
- (A) 1 (B) 2
(C) 3 (D) -1

- Q.39** In a parallelogram $\angle A : \angle B = 1 : 2$. Then $\angle A =$
- (A) 30° (B) 60°
(C) 45° (D) 90°

Q.40 Two adjacent angles of a parallelogram are of equal measure. The measure of each angle of the parallelogram is

- (A) 45° (B) 30°
(C) 60° (D) 90°

Q.41 ABCD is a parallelogram as shown. Find x and y.



- (A) 1, 7 (B) 2, 6
(C) 3, 5 (D) 4, 4

Q.42 The diagonals of a square:

- (A) Are equal and perpendicular
(B) Are unequal
(C) Don't bisect each other
(D) Are not perpendicular

Q.43 In a rhombus, all sides are:

- (A) Different
(B) Equal
(C) Perpendicular
(D) Parallel only

Q.44 A kite has:

- (A) All sides equal
(B) Two pairs of adjacent sides equal
(C) Opposite sides equal
(D) No sides equal

Q.45 A trapezium has:

- (A) No parallel sides
(B) All sides parallel
(C) At least one pair of parallel sides
(D) Two pairs of parallel sides

Q.46 The sum of adjacent angles in a parallelogram is:

- (A) 90°
(B) 180°
(C) 270°
(D) 360°

Q.47 In a kite ABCD with $AB = BC$ and $AD = CD$, which diagonal bisects the other?

- (A) AC (B) BD
(C) Both (D) Neither

Q.48 A quadrilateral with exactly one pair of parallel sides is:

- (A) Parallelogram
(B) Rectangle
(C) Rhombus
(D) Trapezium

Q.49 If three angles of a quadrilateral are 70° , 80° , and 120° , the fourth angle is:

- (A) 90° (B) 100°
(C) 110° (D) 95°

Q.50 The angle between diagonal and side in a square is:

- (A) 30° (B) 45°
(C) 60° (D) 90°

EXERCISE-III

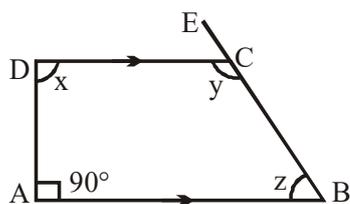
Concept Check

TRUE AND FALSE :

- Q.1 Every rectangle is a trapezium.
- Q.2 A quadrilateral can be drawn if all four sides and one angle is know.
- Q.3 Triangle is a polygon whose sum of exterior angles is double the sum of interior angles.
- Q.4 If diagonals of a quadrilateral are equal, it must be a rectangle.
- Q.5 The sum of the measures of all the four angles of a quadrilateral is 720°

FILL IN THE BLANKS :

- Q.1 The minimum interior angle possible for a regular polygon is _____.
- Q.2 The sum of the measures of interior angle of a polygon of n-sides is 360° . Is it True?
- Q.3 Can we have a regular polygon whose each exterior angle is 120° ? _____.
- Q.4 One angle of a parallelogram is 100° then its opposite angle and adjacent angle are _____, _____ respectively.
- Q.5 If one angle of a rhombus is 60° , then the other angles is _____.
- Q.6 Is every square a rhombus? _____
- Q.7 Is every rhombus a square ? _____
- Q.8 Is every parallelogram a rhombus? _____.
- Q.9 If $\angle A = 90^\circ$, $\angle ECD = 60^\circ$, then the measures of x, y and z in the trapezium ABCD is _____, _____, _____.



- Q.10 Diagonals of a rhombus are equal and perpendicular to each other. Is it true? _____.

ASSERTION & REASON :

Assertion-Reason Instructions:

Choose the correct option:

- (A) Both assertion and reason are true, and reason explains assertion
- (B) Both assertion and reason are true, but reason doesn't explain assertion
- (C) Assertion is true, reason is false
- (D) Assertion is false, reason is true

1. **Assertion:** A parallelogram with one right angle is a rectangle.
Reason: In a parallelogram, opposite angles are equal.
2. **Assertion:** The diagonals of a square are perpendicular.
Reason: Square is a rhombus with all angles equal.
3. **Assertion:** A quadrilateral with equal diagonals is a rectangle.
Reason: Only rectangles have equal diagonals.
4. **Assertion:** Opposite sides of a parallelogram are equal.
Reason: Opposite triangles formed by diagonal are congruent.
5. **Assertion:** Sum of adjacent angles in rhombus is 180° .
Reason: Rhombus is a parallelogram.
6. **Assertion:** A trapezium can have at most two right angles.
Reason: Sum of all angles in quadrilateral is 360° .

MATCH THE COLUMN:

Q.1 Match the Column

Column A		Column B	
a	Diagonals of a rectangle	p	Bisect each other at right angles
b	Diagonals of a Square	q	Bisect each other
c	Diagonals of a rhombus	r	Equal and bisect each other
d	Diagonals of a parallelogram	s	Equal and bisect each other at right angles

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

Q.2 Match the Column

Column A		Column B	
a	Rectangle	p	All angles 90°
b	Rhombus	q	Opposite angles equal
c	Kite	r	Two pairs of adjacent angles equal
d	Trapezium	s	One pair of co-interior angles supplementary

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

Q.3 Match the Column

Column A		Column B	
a	Square	p	(0,0), (3,0), (3,4), (0,4)
b	Rectangle	q	(0,0), (2,0), (2,2), (0,2)
c	Rhombus	r	(0,2), (2,0), (0,-2), (-2,0)
d	Parallelogram	s	(0,0), (3,0), (4,2), (1,2)

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

Q.4 Match the Column

Column A		Column B	
a	Square	p	Rectangle with equal sides
b	Rectangle	q	Parallelogram with right angles
c	Rhombus	r	Parallelogram with equal sides
d	Isosceles Trapezium	s	Trapezium with equal non-parallel sides

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

Q.5 Match the Column

Column A		Column B	
a	SSS	p	Proving triangles in rhombus
b	SAS	q	Proving rectangle properties
c	ASA	r	Proving parallelogram properties
d	AAS	s	Proving kite properties

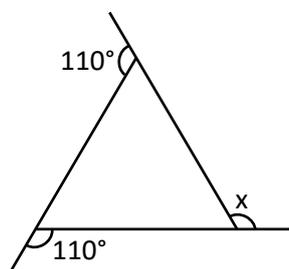
- (A) (a)-(s), (b)-(q), (c)-(r), (d)-(p)
 (B) (a)-(r), (b)-(p), (c)-(s), (d)-(q)
 (C) (a)-(q), (b)-(r), (c)-(p), (d)-(s)
 (D) (a)-(p), (b)-(q), (c)-(r), (d)-(s)

EXERCISE-IV

Subjective Assessment

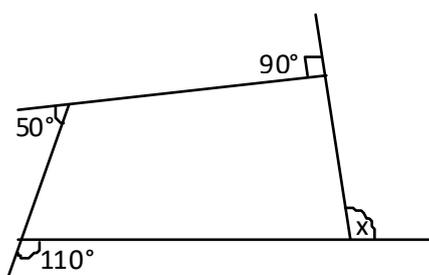
VERY SHORT ANSWER TYPE QUESTIONS:

Q.1 Find the measure of x in the given figure.



Q.2 In a quadrilateral PQRS; $\angle P = 70^\circ$, $\angle Q = 90^\circ$; $\angle R = 55^\circ$. Find the measure of $\angle S$.
What kind of quadrilateral is it, convex or concave ?

Q.3 Find the measure of x .



Q.4 Which of the following groups of angles can be the angles of a quadrilateral ?

(i) $120^\circ, 90^\circ, 75^\circ, 30^\circ$

(ii) $100^\circ, 100^\circ, 70^\circ, 90^\circ$

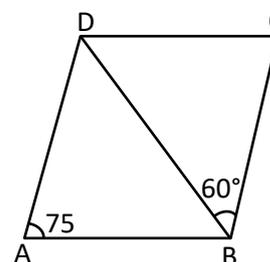
SHORT ANSWER TYPE QUESTIONS:

Q.1 Three angles of a quadrilateral are in the ratio $1 : 2 : 3$. The mean of these angles is 32° . Find all the four angles.

Q.2 ABCD is a rhombus whose diagonals AC and BD intersect at a point O. If side $AB = 10\text{cm}$ and diagonal $BD = 16\text{ cm}$, find the length of diagonal AC.

Q.3 ABCD is a parallelogram in which $\angle A = 65^\circ$. Find the measure of each of the angles $\angle B, \angle C$ and $\angle D$.

Q.4 In the given figure, ABCD is a parallelogram in which $\angle BAD = 75^\circ$ and $\angle DBC = 60^\circ$.



Calculate: (i) $\angle CDB$ (ii) $\angle ADB$.

Q.5 How is a square different from a rhombus?

Q.6 Explain why every square is a rectangle but every rectangle is not a square.

Q.7 What are the conditions for a parallelogram to be a rectangle?

Q.8 State the properties that are common to all parallelograms.

Q.9 What is the maximum number of right angles a quadrilateral can have?

Q.10 How can you verify that a quadrilateral is a rhombus using its diagonals?

Q.11 What is the relationship between area of rhombus and product of its diagonals?

Q.12 How do you construct a parallelogram when two adjacent sides and included angle are given?

Q.13 What are the different ways to prove that a quadrilateral is a square?

LONG ANSWER TYPE QUESTIONS:

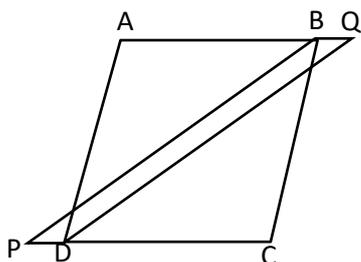
Q.1 The exterior angle of an angular polygon is one-third of its interior angle. How many sides the polygon has?

Q.2 In a quadrilateral ABCD, AO and BO are the bisectors of $\angle A$ and $\angle B$ respectively. Prove that

$$\angle AOB = \frac{1}{2}(\angle C + \angle D)$$

Q.3 In the given figure, bisectors of $\angle B$ and $\angle C$ of quadrilateral ABCD meet CD and AB produced at P and Q respectively. Prove that

$$\angle P + \angle Q = \frac{1}{2}(\angle ABC + \angle ADC).$$

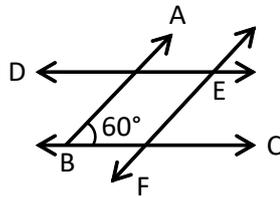


- Q.4** Prove that if the diagonals of a parallelogram are equal, then it is a rectangle. Conversely, prove that the diagonals of a rectangle are equal.
- Q.5** A quadrilateral ABCD has vertices A(0,0), B(6,0), C(8,4), and D(2,4). Prove that ABCD is a parallelogram and find the area of parallelogram ABCD.
- Q.6** In a kite ABCD, $AB = AD$ and $CB = CD$. Prove that: (i) The diagonal AC is the perpendicular bisector of diagonal BD (ii) The diagonal AC bisects angles A and C.
- Q.7** Prove that opposite angles of a parallelogram are equal and adjacent angles are supplementary. Use this to find all angles of a parallelogram if one angle is 65° .
- Q.8** A carpenter wants to check if a wooden frame is rectangular. He measures the diagonals and finds them to be 50 cm and 50 cm. He also checks that they bisect each other. Is this sufficient to conclude the frame is rectangular? Justify your answer.
- Q.9** Prove that if one angle of a parallelogram is a right angle, then all its angles are right angles, making it a rectangle. Extend this to prove the properties of a square.
- Q.10** In parallelogram ABCD, the bisectors of angles A and B meet at point P, bisectors of angles B and C meet at point Q, bisectors of angles C and D meet at point R, and bisectors of angles D and A meet at point S. Prove that PQRS is a rectangle.
- Q.11** Prove that in any quadrilateral, if both pairs of opposite sides are equal, then it is a parallelogram. Use this to establish the converse: if a quadrilateral is a parallelogram, then both pairs of opposite sides are equal.
- Q.12** Design a floor pattern using squares, rectangles, and rhombus tiles such that: (i) All squares have side 2 units (ii) All rectangles have dimensions 2×3 units (iii) All rhombus have diagonals 2 and 4 units. Calculate the total area if you use 10 of each type.
- Q.13** In an isosceles trapezium ABCD with $AB \parallel CD$, $AB = 14$ cm, $CD = 8$ cm, and $AD = BC = 5$ cm, find: (i) The height of the trapezium (ii) Area of the trapezium (iii) Length of diagonals AC and BD.

EXERCISE-V

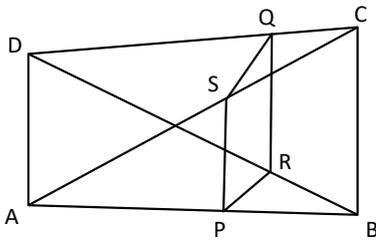
Competition Edge

Q.1 In figure $AB \parallel EF$, $DE \parallel BC$ & $\angle ABC = 60^\circ$, find $\angle DEF$ [NTSE 2010]



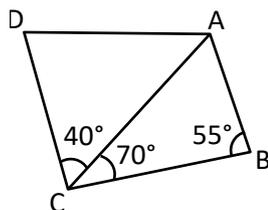
- (A) 60° (B) 120° (C) 30° (D) 80°

Q.2 In the given figure, points P, Q, R and S are respectively the mid points of side AB, side CD, diagonal BD and diagonal AC of quadrilateral ABCD. The quadrilateral PRQS is a [NTSE 2012]



- (A) rectangle (B) rhombus
(C) square (D) parallelogram

Q.3 In the diagram $DA = CB$ what is the measure of $\angle DAC$? [NTSE 2013]

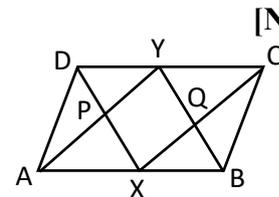


- (A) 70° (B) 100° (C) 95° (D) 125°

Q.4 Each angle of a rectangle is bisected. Let P, Q, R and S be the points of intersection of the pairs of bisectors adjacent to the same side of the rectangle. Then PQRS is a [NSTSE 2014]

- (A) rectangle (B) rhombus
(C) parallelogram with unequal adjacent sides
(D) quadrilateral with no special property

Q.5 X, Y are the mid points of opposite sides AB and DC of a parallelogram ABCD. AY and DX are joined intersecting in P, CX and BY are joined intersecting in Q. The PXQY is [NSTSE 2014]



- (A) Rectangle (B) Rhombus
(C) Parallelogram (D) Square

Q.6 Of all quadrilaterals of a given perimeter, which has the largest area? [NSTSE 2015]

- (A) Square (B) Rectangle
(C) Parallelogram (D) Rhombus

Q.7 ABCD is a parallelogram. The angle bisectors of $\angle A$ and $\angle D$ meet at O. The measure of $\angle AOD$ is _____. [IOM 2016]

- (A) 45° (B) 90°
(C) Depends on the angles A and D
(D) Not able to determine from given data

Q.8 The diagonal of a rectangle is thrice its smaller side. The ratio of its sides is [IOM 2017]

- (A) $\sqrt{2}:1$ (B) $2\sqrt{2}:1$
(C) $3:2$ (D) $\sqrt{3}:1$

Q.9 In a quadrilateral ABCD, $AB \parallel CD$ and $AD = BC = 7$ cm. If $\angle A = 70^\circ$ then the measure of $\angle C$ is [NSTSE 2017]

- (A) 70° (B) 100°
(C) 80° (D) 110°

Q.10 Smallest angle of a triangle is equal to two-third the smallest angle of a quadrilateral. The ratio of the angles of the quadrilateral is 3 : 4 : 5 : 6. Largest angle of the triangle is twice its smallest angle. What is the sum of second largest angle of the triangle and largest angle of the quadrilateral? [NSTSE 2019]

- (A) 160°
- (B) 180°
- (C) 190°
- (D) 170°

Q.11 Which of the following statements is INCORRECT? [NSTSE 2020]

- (A) All rhombuses are parallelograms.
- (B) All squares are parallelograms.
- (C) All rectangles are not squares.
- (D) All squares are trapeziums.

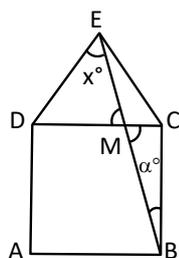
Q.12 A quadrilateral that is not a parallelogram but has exactly two equal opposite angles is [NSTSE 2020]

- (A) A rhombus
- (B) A trapezium
- (C) A square
- (D) A kite

Q.13 Find the measure of largest angle of a quadrilateral if the measures of its interior angles are in the ratio of 3 : 4 : 5 : 6. [IOM 2021]

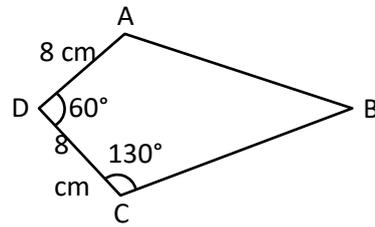
- (A) 60°
- (B) 120°
- (C) 90°
- (D) Can't be determined

Q.14 In the given diagram, equilateral triangle EDC surmounts square ABCD. Find $\angle BED$ represented by x , where $\angle EBC = \alpha^\circ$. [NSTSE 2021]



- (A) 45°
- (B) 60°
- (C) 30°
- (D) None of these

Q.15 In the kite ABCD, $AD = CD = 8$ cm, $\angle ADC = 60^\circ$, $\angle DCB = 130^\circ$ and $AB = CB$. Find $\angle ABC$. [IOM 2021]



- (A) 50°
- (B) 40°
- (C) 60°
- (D) 25°

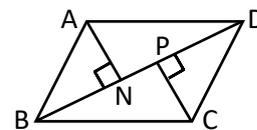
Q.16 In a parallelogram, [NSTSE 2021]

Statement 1: Diagonals bisect each other.

Statement 2: Diagonals divide the parallelogram into two triangles.

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

Q.17 In the figure given below AN and CP are perpendiculars to the diagonal BD of a parallelogram, then which of the following option is correct? [CMO 2022]

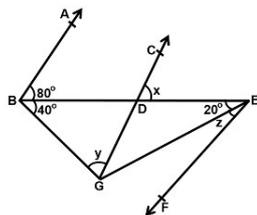


- (A) $AN = CP$
- (B) $AN > CP$
- (C) $AN < CP$
- (D) None of these

Q.18 A metallic sheet is of rectangular shape with measurements 48 cm x 36 cm. From each one of its corners a square of 8 cm is cut off. An open box is made of the remaining sheet. The volume of the box is [CMO 2022]

- (A) 5020 cm³
- (B) 1250 cm³
- (C) 2150 cm³
- (D) 5120 cm³

Q.19 In the given figure (not drawn to scale), if $AB \parallel CG \parallel EF$, then find the value of the following: (i) $2z - x$ (ii) $x + 2y$
[CMO 2022]



- (A) (i) 40° , (ii) 220° (B) (i) 60° , (ii) 200°
 (C) (i) 50° , (ii) 200° (D) (i) 40° , (ii) 200°

Q.20 Draw four rays OA, OB, OC, OD such that $\angle AOB = 58^\circ$, $\angle COD = 64^\circ$. OP bisects $\angle AOB$, OQ bisects $\angle COD$. If OQ is perpendicular to OP, then find the value of $\angle BOC$:
[CMO 2022]
 (A) 29° (B) 50° (C) 51° (D) 48°

ANSWER KEY

EXERCISE-II

MULTIPLE CHOICE QUESTIONS:

Q.1	D	Q.2	B	Q.3	A	Q.4	D	Q.5	B	Q.6	B	Q.7	A
Q.8	C	Q.9	D	Q.10	C	Q.11	A	Q.12	D	Q.13	C	Q.14	A
Q.15	D	Q.16	D	Q.17	D	Q.18	C	Q.19	B	Q.20	D	Q.21	D
Q.22	C	Q.23	D	Q.24	C	Q.25	C	Q.26	B	Q.27	C	Q.28	B
Q.29	C	Q.30	D	Q.31	A	Q.32	A	Q.33	D	Q.34	B	Q.35	B
Q.36	B	Q.37	D	Q.38	A	Q.39	B	Q.40	D	Q.41	C	Q.42	A
Q.43	B	Q.44	B	Q.45	C	Q.46	B	Q.47	A	Q.48	D	Q.49	A
Q.50	B												

EXERCISE-III

TRUE AND FALSE :

Q.1	False	Q.2	True	Q.3	True	Q.4	True	Q.5	False
------------	-------	------------	------	------------	------	------------	------	------------	-------

FILL IN THE BLANKS :

Q.1	60°	Q.2	no	Q.3	yes	Q.4	100°, 80°	Q.5	120°, 60°, 120°
Q.6	yes	Q.7	no	Q.8	no	Q.9	90°, 120°, 60°	Q.10	no

ASSERTION & REASON :

Q.1	A	Q.2	A	Q.3	C	Q.4	A	Q.5	A	Q.6	A
------------	---	------------	---	------------	---	------------	---	------------	---	------------	---

MATCH THE COLUMN:

Q.1	(C)	Q.2	(A)	Q.3	(B)	Q.4	(A)	Q.5	(D)
------------	-----	------------	-----	------------	-----	------------	-----	------------	-----

EXERCISE-IV

VERY SHORT ANSWER TYPE:

Q.1	140°	Q.2	Convex quadrilateral	Q.3	110°
Q.4	(i) No (ii) Yes				

EXERCISE-V

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

1

Series Completion

1.1 NUMBER SERIES

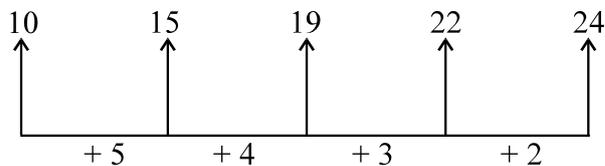
Introduction

A number series is a collection of numbers which follow a particular pattern or rule. The pattern followed by the number in the series remains the same throughout. Each number in a number series is called a term.

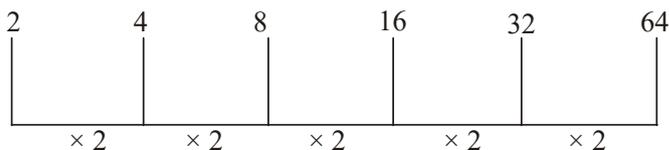
1.2 TYPES OF SERIES

1. **Difference series** : The difference series can be further, classified as follows:

- Number series with a constant difference ; Here the difference between two consecutive numbers is always constant. For example, the numbers of the series 1, 4, 7, 10, 13 are such that the difference between two consecutive terms is constant. Here this difference is 3.
- Number series with increasing /decreasing difference : Here the difference between consecutive terms is not constant. It either decreases or increases, e.g. the series 10, 15, 19, 22, 24

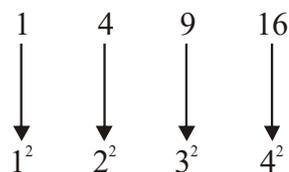


2. **Product series** : Consider the series 2, 4, 8, 16, 32, 64.



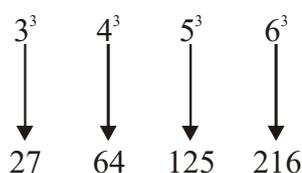
3. **Squares/Cubes series** :

Ex.1 Squares series :

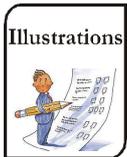


Here the term that follows 16 will be square of 4, i.e. 16.

Ex.2 Cubes series :



4. **Combination series :** This is a type of series where more than one arithmetic operation is performed. Let us take an example. 2, 1, 4, 4, 6, 9, 8, 16
Here two series are being followed alternatively first is even number series (2, 4, 6, 8) and the second is square series (1, 4, 9, 16)
5. **Triangular Pattern Series :** Sometimes, the differences between the consecutive terms of a series, again form a series. The differences between the consecutive terms of the new series so formed, again form a series. This pattern continues till we attain a uniform difference between the consecutive terms of the series.

**Illustration 1 :**

Find the missing term in the series:

4, 11, 30, 67, 128 ?

(A) 164

(B) 219

(C) 216

(D) 218

Solution :

The given series is a triangular pattern series. So, we have :

Series I :	4		11		30		67		128	?
Series II :		7		19		37		61		
Series III :			12		18		24			
Series IV :				6		6				

Clearly in the series III, successive term is increased by 6 So, missing term in series III = $24 + 6 = 30$.

Missing term in series II = $30 + 61 = 91$, missing term in series I = $91 + 128 = 219$.

Thus the missing term is 219. Hence, the answer is (B).

Illustration 2:

2, 7, 16, 29, (.....) 67

(A) 50

(B) 47

(C) 45

(D) 46

Solution :

The pattern is +5, +9,, +21, +25.

Missing number = $29 + 17 = 46$. Hence, the answer is (D)

Illustration 3 :

2, 6, 18, 54, (.....)

(A) 108

(B) 162

(C) 150

(D) 170

Solution :

Each term of the given series is obtained by multiplying its preceding term by 3.

Missing number = $54 \times 3 = 162$. Hence, the answer is (B)

Illustration 4 :

480, 450, 418, 384, (.....)

(A) 364

(B) 348

(C) 312

(D) 318

Solution :

Pattern is -30, -32, -34, -36

Missing number = $384 - 36 = 348$. Hence, the answer is (B)

Illustration 5:

2, 12, 30, 56, 90, 132,

(A) 180 (B) 181 (C) 182 (D) 183

Solution :

This is series of product of two series, as $1 \times 2, 3 \times 4, 5 \times 6, 7 \times 8, 9 \times 10, 11 \times 12$. We can explain this series as product of odd number and even number series.

Missing terms = $13 \times 14 = 182$ Hence, the answer is (C).

1.3 FINDING THE WRONG TERMS IN THE GIVEN SERIES. (NUMBER ODDMAN OUT)

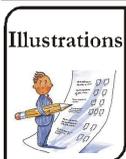
Let us consider some examples to understand the concept of oddman.

1 4 9 16 25 36 63 81

- (a) On observing the terms of the above number series carefully, we notice that all the terms except 63 are perfect squares of natural numbers. 63 is not a square of a natural number. Hence, 63 is the oddman.

- (b) 235 354 424 541 613

This problem is somewhat tricky. The sum of digits of each term except 354 is 10. The sum of digits of 354 is $3 + 5 + 4 = 12$. Hence 354 is the oddman.

**Illustration 6 :****Find the wrong number in the series:**

3, 8, 15, 24, 34, 48, 63

(A) 15 (B) 24 (C) 34 (D) 48 (E) 63

Solution

The difference between consecutive terms of the given series are respectively 5, 7, 9, 11, 13 and 15.

Clearly, 34 is a wrong number and must be replaced by $(24 + 11)$ i.e. 35.

Hence, the answer is (C).

Illustration 7 :**Identify the wrong number in the series :**

69, 55, 26, 13, 5

(A) 5 (B) 13 (C) 26 (D) 55

Solution

Clearly, in the given series, each term is one more than the product of the digits of the preceding term. Thus, $(6 \times 9) + 1 = 55$, $(5 \times 5) + 1 = 26$, $(2 \times 6) + 1 = 13$.

So, 5 is wrong and must be replaced by $(1 \times 3) + 1$ i.e. 4.

Hence, the answer is (A).

1.4 CORRELATION OF THE SERIES [TWO SERIES ARE GIVEN IN WHICH SECOND SERIES FOLLOWS THE PATTERN OF FIRST SERIES]

Here one number series is given. You have to complete this second series by choosing the best from the given alternatives. This series will correlate with the first series.

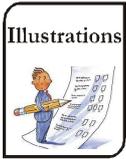
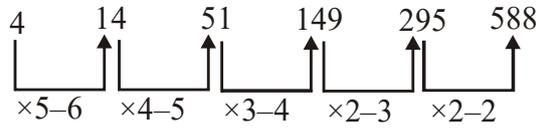


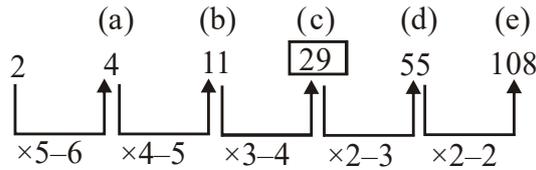
Illustration 8:

4 14 51 149 295 588
 2 (a) (b) (c) (d) (e)
 Which number can replace (c) ?
 (A) 22 (B) 26 (C) 29 (D) 24

Solution :



Same way,

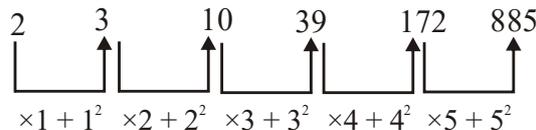


Hence, 29 will replace (C).

Illustration 9:

2 3 10 39 172 885
 3 (a) (b) (c) (d) (e)
 Which number can replace (c) ?
 (A) 15 (B) 18 (C) 39 (D) 24

Solution :



Thus, Answer is $10 \times 3 + 3^2 = 39$

1.5 ALPHABET SERIES

Introduction

In this type of questions, a series of single, pairs or groups of letters or combinations of letters and numerals is given. The terms of the series form a certain pattern as regards the position of the letters in the English alphabet. Identify this pattern and accordingly find the missing term or the wrong term in the given series.

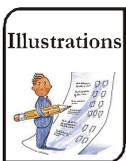


Illustration 10

T, R, P, N, L, ?, ?
 (A) J, G (B) J, H (C) K, H (D) K, I

Solution

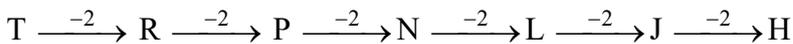
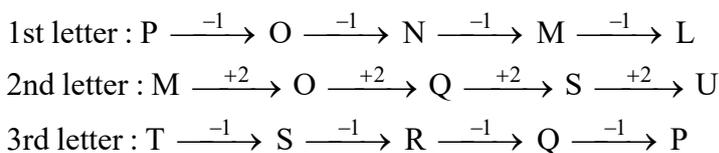


Illustration 11

PMT, OOS, NQR, MSQ, ?
 (A) LUP (B) LVP (C) LVR (D) LWP

Solution



1.6 ALPHA NUMERIC SERIES

Introduction

This type of question is just a jumbled form of questions of Type 1 and Type 2, which you have just read. Here, the terms of the given series are a combination of letters and numerals, which move according to a set pattern. Study the following illustrations.

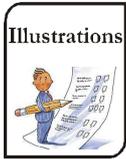


Illustration 12

F3X, H7U, J15R, L31O, ?

(A) M63L (B) N63L (C) N61L (D) N65K

Solution

The first letter of each term is moved two steps forward and the last letter is moved three steps backward to obtain the corresponding letters of the next term. The numbers form the sequence $3 \times 2 + 1 = 7$, $7 \times 2 + 1 = 15$, $15 \times 2 + 1 = 31$, $31 \times 2 + 1 = 63$.

Illustration 13

Find the term which does not fit into the series.

1CV, 5FU, 9IT, 15LS, 17OR

(A) 5FU (B) 15LS (C) 9IT (D) 17OR

Solution :

Comparing digits of all terms,

$1 \xrightarrow{+4} 5 \xrightarrow{+4} 9 \xrightarrow{+6} 15 \xrightarrow{+2} 17$

If 15 is replaced by 13 then all digits follows a pattern i.e. each successive term is increased by 4. Therefore, 15LS is wrong term. Hence the answer is (B)

1.7 CONTINUOUS PATTERN SERIES

Introduction

This type of questions usually consists of a series of small letters which follow a certain pattern. However, some letters are missing from the series. These missing letters are then given in a proper sequence as one of the alternatives. Choose this alternative as the answer.

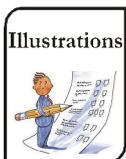


Illustration 14

— stt — tt — tts —

(A) tsst (B) sstt (C) ttst (D) tsts

Solution :

t s t | t s t | t s t | t s t

Hence, the answer is (A).

Illustration 15

a _ bccb _ ca _ cca _ baab _ c

(A) ababc (B) abcaa (C) accab (D) bacaa

Solution

The series is a**abcc**/b**bcaa**/c**cab**/a**abcc**. Thus, the letters moves in a cyclic order and in each group, middle letter occurs only once.

CONCEPT APPLICATION

NUMBER SERIES

- Q.1 Complete the given series
 3 4 6 9 13 18 _____
 (A) 24 (B) 25 (C) 26 (D) 27
- Q.2 Complete the given series
 4 8 16 32 64 _____
 (A) 220 (B) 128 (C) 225 (D) 250
- Q.3 Complete the given series
 729 243 81 27 _____ 3
 (A) 15 (B) 12 (C) 9 (D) 6
- Q.4 Complete the given series
 2 5 11 23 47 95 _____
 (A) 128 (B) 183 (C) 191 (D) 221
- Q.5 Complete the given series
 2 3 5 8 12 17 _____
 (A) 15 (B) 23 (C) 19 (D) 21
- Q.6 Complete the series
 5, 9, 17, 29, 45, _____
 (A) 60 (B) 65 (C) 70 (D) 68
- Q.7 Complete the series
 15, 51, 105, _____
 (A) 501 (B) 51 (C) 15 (D) 150
- Q.8 Complete the series
 3, 7, 15, 31, _____
 (A) 63 (B) 53 (C) 43 (D) 73
- Q.9 Complete the series
 0, 3, 8, 15, _____, 35
 (A) 24 (B) 25 (C) 26 (D) 20
- Q.10 Complete the series
 1, 8, 27, 64, _____, 216
 (A) 127 (B) 125 (C) 124 (D) 128
- Q.11 Complete the series
 1, 3, 6, 10, 15, _____, 28, 36
 (A) 24 (B) 22 (C) 64 (D) 21

- Q.12 Complete the series
90, 84, 86, 80, _____, 76, 78
(A) 87 (B) 82 (C) 77 (D) 89
- Q.13 Complete the series
7, 13, 25, 43, 67, _____
(A) 99 (B) 100 (C) 97 (D) 98
- Q.14 Find out the wrong/incorrect term.
5, 11, 24, 52, 106
(A) 11 (B) 24 (C) 52 (D) 106
- Q.15 Find out the wrong/incorrect term.
7, 9, 16, 25, 41, 66, 105
(A) 41 (B) 66 (C) 16 (D) 105
- Q.16 Complete the given series
1 4 9 16 25 _____
(A) 32 (B) 34 (C) 36 (D) 38
- Q.17 Complete the given series
1 2 6 21 88 _____
(A) 225 (B) 350 (C) 445 (D) 550
- Q.18 Complete the given series
2 3 10 15 26 35 _____
(A) 45 (B) 50 (C) 60 (D) 65
- Q.19 Complete the given series
1 2 2 3 6 5 24 8 120 _____
(A) 12 (B) 15 (C) 35 (D) 60
- Q.20 Complete the given series
4 5 9 18 34 _____ 95
(A) 56 (B) 59 (C) 66 (D) 86
- Q.21 Find the missing number.
4, 16, 36, ?, 100, 144
(A) 72 (B) 68 (C) 81 (D) 64
- Q.22 Find the missing number.
512, 64, 16, 8, 8, 16, ?
(A) 16 (B) 32 (C) 40 (D) 64
- Q.23 Find the missing number.
8, 8, 10, ?, 20, 28
(A) 14 (B) 15 (C) 16 (D) None of these

- Q.24 Find the missing number.
0, 7, 26, ?, 124, 215
(A) 51 (B) 37 (C) 63 (D) 16
- Q.25 Find the missing number.
3, 6, 24, 30, 63, 72, ?, 132
(A) 58 (B) 42 (C) 90 (D) 120
- Q.26 Find the missing number.
0, 6, 20, 42, ?
(A) 64 (B) 72 (C) 80 (D) 84
- Q.27 Find the missing number.
5, 8, 13, 22, 37, ?
(A) 60 (B) 64 (C) 68 (D) 66
- Q.28 Find the missing number.
1, 4, 13, 40, ?
(A) 125 (B) 94 (C) 108 (D) 121
- Q.29 Find the missing number.
8, 11, 15, 22, 33, 51, ?, 127, 203
(A) 80 (B) 53 (C) 58 (D) 69
- Q.30 Find the missing number.
3, 6, 21, 28, 55, 66, ?, 120
(A) 103 (B) 104 (C) 105 (D) 106
- Q.31 Find the missing number.
5, 8, 13, 22, ?
(A) 39 (B) 72 (C) 48 (D) 40
- Q.32 Find the missing number.
17, 17, 17, ?, 17, 51
(A) 17 (B) 19 (C) 24 (D) None
- Q.33 Find the missing number.
Sign: 11 (77) 14
16 (96) 12
Aim: 15 (?) 18
(A) 125 (B) 130 (C) 135 (D) 140
- Q.34 If $a = 10$ (110) 12 and $b = 15$ (185) 13 then what will come in place of '?'. $c = ?$ (158) 14
(A) 15 (B) 20 (C) 12 (D) 8
- Q.35 1, 4, 10, 22, 46 ?
(A) 64 (B) 86 (C) 94 (D) 122

- Q.36 0.5, 0.55, 0.65, 0.8, ?
 (A) 0.9 (B) 0.82 (C) 1 (D) 0.95
- Q.37 4, 9, 25, ?, 121, 169, 289, 361
 (A) 49 (B) 64 (C) 81 (D) 87
- Q.38 1, 1, 4, 8, 9, 27, 16, ?
 (A) 32 (B) 64 (C) 81 (D) 256
- Q.39 Find the missing term.
 0, 6, 24, 60, 230, 210, ?
 (A) 240 (B) 290 (C) 336 (D) 540
- Q.40 Find the missing term.
 10, 15, 30, 45, 90, ?
 (A) 140 (B) 135 (C) 145 (D) 125
- Q.41 Find the missing term.
 1, 4, 2, 8, 6, 24, 22, 88, ?
 (A) 86 (B) 90 (C) 154 (D) 352

LETTER SERIES

- Q.42 U, B, I, P, W, ?
 (A) D (B) F (C) Q (D) Z
- Q.43 H, I, K, N, ?
 (A) O (B) Q (C) R (D) S
- Q.44 Z, ?, T, ?, N, ?, H, ?, B
 (A) W, Q, K, E (B) W, R, K, E (C) X, Q, K, E (D) X, R, K, E
- Q.45 AI, BJ, CK, ?
 (A) DL (B) DM (C) GH (D) LM
- Q.46 A, H, N, S, W, ?
 (A) A (B) Y (C) B (D) Z
- Q.47 AF, EJ, IN, OT, ?
 (A) UX (B) UY (C) UN (D) UZ
- Q.48 LRX, DJP, VBH, NTZ, ?
 (A) ELS (B) FMR (C) GKS (D) FLR
- Q.49 A3P, C5N, E8K, G12G, ?
 (A) I16D (B) I17B (C) I17D (D) J16B

- Q.50 $\frac{A}{5}, \frac{C}{7}, \frac{F}{11}, \frac{J}{19}, ?$
 (A) $\frac{L}{38}$ (B) $\frac{Q}{36}$ (C) $\frac{P}{35}$ (D) $\frac{O}{35}$
- Q.51 $C_3, H_8, O_{15}, ?$
 (A) X_{24} (B) I_{35} (C) T_{26} (D) J_{35}
- Q.52 CK 16 9 JR
 OS 24 19 TX
 KM ? ? PV
 (A) 56, 84 (B) 84, 56 (C) 21, 14 (D) 14, 21
- Q.53 GM 9 0 KT
 PS 0 50 UY
 DI ? ? CP
 (A) 32, 18 (B) 18, 32 (C) 9, 5 (D) 4, 10
- Q.54 K64S, N16R, ?, T9W
 (A) Q16T (B) Q16U (C) R10U (D) P16T
- Q.55 Find the missing term
 A, CD, GHI, ?, UVWXYZ
 (A) LMNO (B) MNOL (C) NOPQ (D) MNOP
- Q.56 Find the missing term
 CX, FU, IR, ?, OL, RI
 (A) LO (B) MN (C) NO (D) OP
- Q.57 Find the missing term
 BF, CH, ?, HO, LT
 (A) DN (B) EL (C) EK (D) EM
- Q.58 DEF, HIJ, MNO, ?
 (A) STU (B) RST (C) RTV (D) SRQ
- Q.59 AYD, BVF, DRH, ?, KGL
 (A) FMI (B) GMK (C) GLJ (D) HLK
- Q.60 PMT, OOS, NQR, MSQ, ?
 (A) LUP (B) LVP (C) LVR (D) LWP
- Q.61 BZA, DYC, FXE, ?, JVI
 (A) HUG (B) HWG (C) UHG (D) WHG
- Q.62 ATTRIBUTION, TTRIBUTIO, RIBUTIO, IBUTI, ?
 (A) IBU (B) UT (C) UTI (D) BUT
- Q.63 ADVENTURE, DVENTURE, DVENTUR, ?, VENTU
 (A) DVENT (B) VENTURE (C) VENTUR (D) DVENTU

- Q.64 C4X, F9U, I16R, ?
 (A) K25P (B) L25P (C) L25O (D) L27P
- Q.65 2A11, 4D13, 12G17, ?
 (A) 36I19 (B) 36J21 (C) 48J21 (D) 48J23
- Q.66 a _ _ bbc _ _ aab _ _ cca _ _ bbcc
 (A) abcbb (B) acba (C) abba (D) caba
- Q.67 _ _ bc _ _ ca _ _ aba _ _ c _ _ ca
 (A) abcab (B) bbbcc (C) ba ba (D) abbcc
- Q.68 Find the missing letters
 _ _ a b a _ _ b a _ a b
 (A) a b b a b (B) a b b b (C) b a a b b (D) b b a b a
- Q.69 Find the missing letters
 _ b a a _ a a b _ a _ a
 (A) a a b b (B) a a b a (C) a b a b (D) b a a b
- Q.70 Find the missing letters
 a _ b b c _ a a b _ c c a _ b b c c
 (A) b a c b (B) a c b a (C) a b b a (D) c a b a
- Q.71 Find the missing letters
 a b b _ b a a _ a _ b a b _ a b
 (A) a b b a (B) a b a b (C) c c a c (D) a a b b
- Q.72 Find the missing letters
 a c _ c a b _ b a c a _ a b a _ a c a c
 (A) a a c b (B) a c b c (C) b a b b (D) b c b b
- Q.73 Find the missing letters
 a b _ b c _ c _ b a _ c
 (A) b a a c (B) a a b b (C) c a a b (D) a a a b
- Q.74 2 3 B _ _ 6 _ _ F G _ _ 5 D _ _ H I
 (A) C, 7, 4, E, 9 (B) D, 8, 6, C, 7 (C) E, 8, 7, D, 9 (D) W, 8, 7, I, 6
- Q.75 C B _ _ D _ _ B A B C C B
 _ _ 1 2 4 3 _ _ ? ? ? ?
 a _ _ a b _ _ c _ _ b _ _ _ _
 (A) 3, 4, 4, 3 (B) 3, 2, 2, 3 (C) 3, 1, 1, 3 (D) 1, 4, 4, 1
- Q.76 b - e - h i k - - - q - t - - - - -
 2 3 5 - 8 9 11 - - - - 18 - - - - - 1
 The last four terms in the letter series are :
 (A) wxya (B) wzxa (C) wxza (D) None of these

ANSWER KEY

CONCEPT APPLICATION

Q.1	A	Q.2	B	Q.3	C	Q.4	C	Q.5	B	Q.6	B	Q.7	A
Q.8	A	Q.9	A	Q.10	B	Q.11	D	Q.12	B	Q.13	C	Q.14	C
Q.15	D	Q.16	C	Q.17	C	Q.18	B	Q.19	A	Q.20	B	Q.21	D
Q.22	D	Q.23	A	Q.24	C	Q.25	D	Q.26	B	Q.27	A	Q.28	D
Q.29	A	Q.30	C	Q.31	A	Q.32	D	Q.33	C	Q.34	C	Q.35	C
Q.36	C	Q.37	A	Q.38	B	Q.39	C	Q.40	B	Q.41	A	Q.42	A
Q.43	C	Q.44	A	Q.45	A	Q.46	D	Q.47	D	Q.48	D	Q.49	B
Q.50	D	Q.51	A	Q.52	C	Q.53	B	Q.54	B	Q.55	D	Q.56	A
Q.57	C	Q.58	A	Q.59	B	Q.60	A	Q.61	B	Q.62	C	Q.63	C
Q.64	C	Q.65	D	Q.66	B	Q.67	A	Q.68	A	Q.69	C	Q.70	B
Q.71	A	Q.72	A	Q.73	C	Q.74	A	Q.75	C	Q.76	C		