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Preeti Agarwal

SCIENCE OLYMPIAD

National Science Olympiad

8

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The Gen X Series

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NATIONAL SCIENCE OLYMPIAD

Exploring the World of Science

Class 8

Preeti Agarwal

V&S PUBLISHERS

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Publisher's Note

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

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

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

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

All the best

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Section 1
Science

1 Force and Pressure

Learning Objectives

- Force
- Forces are due to an Interaction
- Types of Forces
  - Units of force
  - Resultant force
  - Effects of force
- Pressure
- Pressure Exerted by Fluids
- Atmospheric Pressure
  - Variation of atmospheric pressure
  - Standard atmospheric pressure
  - Measuring atmospheric pressure

Force

Force can be defined as the push or pull on an object. It is the influence which can change the state of an object. Its S.I. unit is newton (N).

The direction in which the body is pushed or pulled gives the direction of the force.

Forces are Due to an Interaction

Interaction means mutual action. An interaction of one object with other object results in a force between the two objects.

Interaction between two bodies may or may not involve a direct physical contact.

Types of Forces

There are two types of forces

(1) Contact force

(2) Non-contact force

Contact Forces

Contact force is a force which acts only when the objects are in physical contact with each other.

For example: when you push a car, you are in actual physical contact with the car.

Some typical contact forces are:

(a) Muscular force: The force applied by the muscles of a human or animals is called muscular force Muscular force can be applied only when it is in contact with some other object.

Muscular force is used during walking, running, kicking and lifting certain objects. Animals exert muscular force in ploughing the field or carrying of loads from one place to another.

(b) Frictional force: It is the force exerted by a surface when an object moves across the surface. It can also be defined as the force, which opposes the motion of an object. There are two types of frictional forces:

(i) Kinetic friction (ii) Static friction

(i) Kinetic friction: The frictional force between any two moving surface is called the kinetic friction. There are different types of kinetic friction, such as sliding friction, rolling friction.

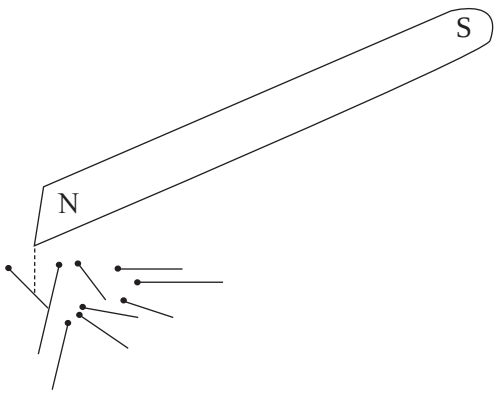
(ii) Static friction: It is the friction that acts between the surfaces of two motionless objects.

The force of friction acts along the two surfaces in contact. The force of friction is due to the roughness on the surface of the bodies in contact. A smooth surface exerts lesser force of friction than a rough surface.

Non–Contact Forces

Non-contact force is the force which can act even without any physical contact between the two objects.

For example: A magnet can pull iron particles from a distance.(Magnetic force)



Alpins are attracted by a magnet even from a distance

Fig:1.1

Some typical non-contact forces are:

(a) Magnetic force: The force exerted by a magnet is called magnetic force. The magnetic force acts from a distance.

(i) A magnet attracts another magnet when unlike poles are brought closer.

(ii) A magnet repels another magnet when the like - poles are brought closer

(iii) A magnet attracts nails and pins made from iron even from some distance.

(b) Electrostatic force:- An electrically charged object exerts force on an uncharged object. Such force is called the electrostatic force. For example, if we rub a plastic comb with our hair and bring the comb near the tiny piece of paper, the piece of paper will either stick to the comb, or will start moving due to the electrostatic force. Similarly, an ebonite rod when rubbed with the woollen cloth, acquires negative charge and attracts the tiny pieces of paper.

(c) Gravitational force:- The force which exists between any two planets, or any two objects with mass in this universe, is called gravitational force. This force is always attractive in nature. All objects on the surface of the earth experience a force of gravity towards the centre of earth, which

is equivalent to the weight of the object. Numerically gravitational force is calculated by:

$$F = G\frac{M_1 \times M_2}{R^2}$$

where M_1 and M_2 are the masses of the objects.

G = Gravitational constant

Units of force: Force is measured in Newton and is denoted by N. Hence 1 Newton force is equivalent to the force required to accelerate one kilogram of mass, at the rate of one meter per second square ($1m/s^2$. Numerically it is given by, $F = m \times a$

where m = mass of the object

a = acceleration.

$1N = 1kg\ ms^{-2}$

Two other units of force which we encounter sometimes are

$1\ dyne = 1g\ cms^{-2} = 10^{-5}\ N$

Kilogram force: The force required to lift a body of mass 1 kg vertically is called one kilogram force. It is denoted by kgf.

Gram force: The force required to lift a body of mass 1 g vertically is called one gram force and denoted by gf

1 kgf = 1000gf

1 kgf = 9.8N ≈ 10N

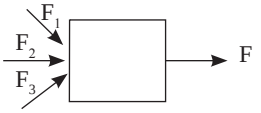
Resultant Force

The vector sum of all the individual forces acting at a point is called resultant force.

Resultant forces considered in following situations:

(i) If the two forces act in the same direction on an object, the net force acting on it is the sum of two forces.

(ii) If the two forces act in the opposite directions on an object, the net force acting on it is the difference between the two forces.



F is the resultant force of F_1, F_2 and F_3 forces

Fig: 1.2

Balanced Forces

"When the resultant of all the forces acting on a body is zero, the forces are said to be balanced forces."

The balanced forces:

- cannot set any stationary body in motion.
- cannot change the speed / velocity of a moving body.
- may change the shape and size of a soft object.

Unbalanced Forces

When the resultant of all the forces acting on a body is not zero, the forces are unbalanced forces. The unbalanced forces can:

- set a stationary object in motion.
- set a moving object at rest.
- change the direction of motion.

In the tug of war, when two teams pull equally hard, the rope does not move in any direction.

A force could be larger or smaller than the other. The strength of a force is usually expressed by the magnitude. We have to also specify the direction in which a force acts. If the direction or the magnitude of the applied force changes, its effect also changes.

Effects of Force

A force acting on a body:

(a) can change the state of motion
(b) can change the direction of a moving object
(c) can stop a moving object
(d) can change the speed of a moving object
(e) can change the size and shape of an object

Pressure

Pressure is defined as the force acting on a unit area.

$$\left[\text{Pressure} = \frac{Force(F)}{Area(A)}\right] \rightarrow P = \frac{F}{A} \rightarrow \text{p} \propto \frac{1}{A}$$

(i) For a given force, smaller is the area of contact, higher is the pressure exerted by it.
(ii) For a given force, larger is the area of contact, lesser is the pressure exerted by it.
(iii) For a fixed area of contact, the pressure exerted increases with an increase in force.

The SI unit of pressure is newton per square metre (N/m^2). This unit is also called pascal (Pa).

So, $\boxed{1\ Pa = 1N/m^2}$

Commonly, the unit 1 atm is taken as the unit of pressure.

1 atm = 76 cm of mercury column
= 760 mm of mercury column

Pressure Exerted by Fluids

Gases and liquids are collectively called as fluids.

Liquids and gases exert pressure on all objects immersed in them and on the walls of the container in which they are stored.

Pressure exerted by liquids

A liquid contained in a vessel exerts pressure on its walls and bottom.

Properties of liquid pressure

1. Liquid pressure increases with depth:

   For example: Pressure acting on an object deep under the sea is much greater than at the sea level. The pressure experienced by deep-sea divers is so great that they have to wear specially designed suits, called diving suits, to protect themselves.

Dams are made stronger and thicker at the base than at the top to withstand the high pressure of water at the base.

2. Pressure exerted by a liquid is equal in all directions at a particular depth.
3. Pressure of a liquid does not depend upon the shape and size of the container.
4. Pascal's law: According to this rule, when pressure is applied on a liquid, it gets transmitted throughout and equally in all directions.

Pressure exerted by gases (or air)

When too much air is blown into the ballon, the air pressure inside the balloon increases, this exerts a force on the inner walls of the balloon and causes it to burst. This shows that air (gases) exerts pressure.

Atmospheric Pressure

Atmospheric pressure is defined as the pressure exerted on an object by the weight of the air above it. The atmospheric pressure is minimum at the sea level.

Variation of atmospheric pressure

(i) The atmospheric pressure changes from place to place and from time to time due to changes in temperature and the quantity of water vapours in the air. The density of moist air is less than that of dry air. Also the density decreases with an increase in temperature, consequently the atmospheric pressure also decreases.

(ii) The atmospheric pressure at a place is due to the weight of the air above it. It is obvious that the pressure will decrease as you go higher up above the sea level. This leads to the rupture of blood vessels in the body, causing bleeding from the nose.

Roughly, the atmospheric pressure falls by one cm of mercury for every hundred metres increase in altitude or height.

Standard atmospheric pressure

Sea level is taken as standard for expressing the atmospheric pressure. The atmospheric pressure at sea level is considered as standard pressure. The value of standard atmospheric pressure is 76 cm or 0.76m of mercury (Hg).

The value of standard atmospheric pressure in N/m^2 is 100,000 = 10^5 pascals.

Measuring atmospheric pressure

The atmospheric pressure is measured by an instrument called simple barometer or mercury barometer.

Another barometer is Aneroid barometer. It does not employ mercury (or any other barometric liquid). It is a direct reading barometer.

Some examples based on effect of area on pressure:

- The foundation of high rise buildings are kept wide. This is to prevent its sinking into the soil.
- Drawing pins, alpins have relatively much larger top and highly pointed and sharpened lower end. This is why these can be easily pressed into softwood board.
- Camel can walk through desert (sandy soil) easily due to broader feet.
- The skiers use flat and long skies to slide on snow. This is because, due to larger area, pressure exerted on the snow will be lesser and the skier can easily slide without sinking into the snow.
- The rear wheels of tractor are made broader. The broad tyres reduce the pressure on the soil and the tractor could move easily through the field.

Did You Know

1. A person weighing 100kg on earth will weigh 38kg on the surface of moon.
2. The force of gravity 100km above the surface of earth will decrease by 3%
3. Friction between the moving parts of a machine can be reduced by lubrication.
4. A sharp knife is more effective in cutting than a blunt knife because the area of contact in sharp knife is lesser than that of a blunt knife.
5. The pressure at the centre of the earth is about 400 billion Pa.
6. The pressure of sunlight is about 3 millions Pa.

Key Points

1. Force is the push or pull on an object.
2. A force of one newton is defined as the force, which produces an acceleration of 1 m/s^2 on an object of mass 1 kg.
3. Muscular and frictional forces are contact forces.
4. Magnetic, electrostatic and gravitational forces are non–contact forces.
5. Pressure is defined as the force acting an a unit area of the surface.
6. The pressure exerted by the atmospheric air at any point on the earth is called atmospheric pressure at that point.
7. Atmospheric pressure decreases with the height.
8. Aneroid barometer is a direct reading instrument which is used for measuring atmospheric pressure.

Multiple Choice Questions

1. Which of these is a contact force?
   (a) Magnetic force
   (b) Frictional force
   (c) Electrostatic force
   (d) Gravitational force
2. The force exerted by the earth on a body is called ———— of the body.
   (a) mass
   (b) weight
   (c) pressure
   (d) force
3. Atmospheric pressure is the pressure exerted by
   (a) solid
   (b) gases in air
   (c) liquid of rivers
   (d) atmosphere
4. Which of these cannot be changed by the force acting on an object?
   (a) mass
   (b) shape
   (c) state of rest
   (d) direction motion
5. Which of the following is TRUE for the pressure exerted by a liquid?
   (a) Pressure is independent of depth of the liquid.
   (b) Pressure is always in the downward direction only.
   (c) Pressure is exerted in all directions but downward pressure is greater than sideways pressure.
   (d) At the same depth, pressure is same in all directions.
6. As pressure is the force applied per unit area, so
   (a) school bags have narrow straps
   (b) pointed nails are easier to hammer in wood
   (c) all cutting tools have blunt cutting edge
   (d) tractors have thin and flat tyres
7. If the force is constant, then pressure is _____ proportional to area.
   (a) inversely
   (b) directly
   (c) not
   (d) none of these
8. If no force acts on a body, it will
   (a) break
   (b) get deformed
   (c) move with increasing speed
   (d) either remain at rest or move with the same speed
9. Let us take a beaker filled with water. We increase the pressure on air in the beaker at its bottom. The pressure is transmitted in
   (a) west direction
   (b) east direction
   (c) eqully in all directions
   (d) south direction
10. A force of 15N acts on an area of $1m^2$. The force is kept the same but the area is reduced to half. What will happen to the pressure?
    (a) Pressure get doubled
    (b) Pressure reduced to half
    (c) Pressure does not change
    (d) Pressure increases by 1.5 times

11. For a force to come into play, the two objects must
    (a) be placed apart
    (b) always move together in same direction
    (c) interact with each other
    (d) all of these
12. Force of friction
    (a) is a contact force
    (b) acts in the direction same or opposite to direction of motion
    (c) is small if surface are smooth
    (d) has all the above mentioned features
13. The study of causes of motion of an object is called
    (a) physics
    (b) dynamics
    (c) kinetics
    (d) mechanics
14. Which of these is NOT true about force?
    (a) It has magnitude.
    (b) It has direction.
    (c) It is scalar.
    (d) It changes the state of motion.
15. What effect does force produce when applied to an object?
    (a) It can change the speed or direction of motion of the object.
    (b) It can change the state of rest or motion of the object.
    (c) It can change the dimension or shape of the object.
    (d) All of these
16. Pressure is measured using
    (a) barometer
    (b) galvanometer
    (c) manometer
    (d) none of these
17. Two forces are acting simultaneously on the football and the football still remains static, i.e., at rest. The force is said to be _____ force.
    (a) constant
    (b) equilibrium
    (c) balanced
    (d) static
18. The value of atmospheric pressure on the surface of the earth at sea level is
    (a) 1.013×10^5 N/m^2
    (b) 1.50×10^5 N/m^2
    (c) 1.013×10^{-5} N/m^2
    (d) 1.50×10^{-5} N/m^2
19. If a set of forces applied on an object move or accelerate the body, then forces are called
    (a) balanced forces
    (b) effective forces
    (c) unbalanced forces
    (d) dynamic forces
20. Muscular force and friction force are
    (a) contact forces
    (b) gravitational forces
    (c) magnetic forces
    (d) distant forces
21. By applying a force of 1N, body of approximately how much mass can we hold in our hand?
    (a) 1000g
    (b) 100g
    (c) 10g
    (d) (0.1)g

22. Electrostatic forces can be
    (a) attractive
    (b) repulsive
    (c) either (a) or (b)
    (d) neither (a) nor (b)
23. Pressure exerted by a block in standing position is ____ than the pressure exerted by the block in lying position.
    (a) less
    (b) more
    (c) equal
    (d) very less
24. The instrument used to measure the atmospheric pressure is
    (a) manometer
    (b) hygrometer
    (c) lactometer
    (d) barometer
25. When we press the bulb of a dropper with its nozzle kept in water, air in the dropper is seen to escape in the form of bubbles. Once we release the pressure on the bulb, water rises up in the dropper. The rise of water in the dropper is due to
    (a) pressure of water
    (b) atmospheric pressure
    (c) gravity
    (d) shape of rubber bulb

Answer Key

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

2 Friction

Learning Objectives

- Force of Friction
- Causes of Friction
- Factors Affecting Friction
- Friction is a Self-adjusting Force
- Types of Friction
- Friction : A Necessary Evil
- Disadvantage of Friction
- Ways to Increase Friction
- Ways to Reduce Friction
- Friction Due to Fluids

Force of Friction

The force acting along the two surfaces in contact which opposes the tendency of motion of one body over the other, is known as force of friction.

The force of friction doesn't depend on area of surface in contact.

Causes of Friction

Friction is due to the following factors:

Due to the Interlocking of Surfaces

When a body (wooden block) is pulled over another, the 'hills' and 'valleys' of the surface in contact interlock with each other and oppose the relative motion between the two bodies. This gives rise to frictional force.

Due to Adhesive Force

Two rough surfaces when pressed together, their surfaces are in contact with each other. The atoms or molecules present at such points of contact attract each other due to electrostatic attraction. These attractions are called as the force of adhesion.

The force of adhesion between the two surfaces give rise to friction.

The Force of Friction Depends on the Following Factors

(i) Nature of the surface in contact: If the surface is rough, there is large interlocking between the surfaces in contact, hence frictional force is larger. For smoother surface, less interlocking takes place, so there is less friction.

(ii) The weight of the object: As we know frictional force (f_e) = μ N (where μ = coefficient of friction and N = normal reaction) since for hacker height normal reaction will be larger so, prochain force will be lower.

Types of Friction

There are three kinds of friction.

(i) Static friction (ii) Sliding friction (iii) Rolling friction.

Static friction

When the applied force is gradually increased, the force of friction also increases at the same rate and the body remains stationary. This force of friction is called static friction (f_s). Since the force of friction adjusts itself to the applied force, so it is also called self adjusting force.

If the applied force is increased further, a stage reaches when the body just begins to move. At this stage force of static friction is maximum $(f_s)_{max}$ This is the limiting value of the static friction, or limiting friction.

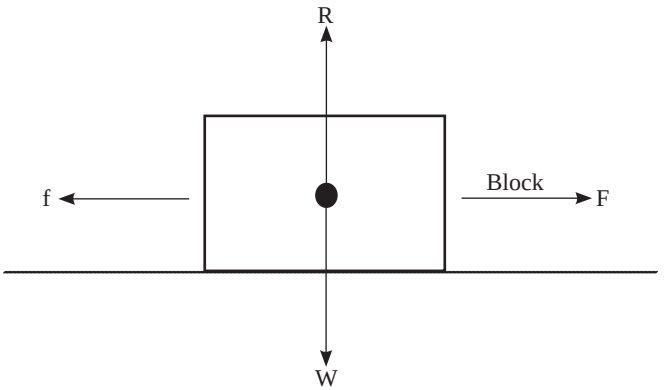


Fig: 2.1 ***Showing that the force of Friction is a self-adjusting force***

Sliding (or kinetic) friction

The frictional force between any two moving surfaces in contact is called kinetic friction. Example: If a boy is sliding on a slider in the garden, the force exerted by the slider on the boy is sliding friction.

The force required to keep a body in motion is less than the force required to start the motion. Therefore, the sliding (or kinetic) friction is less than the static friction.

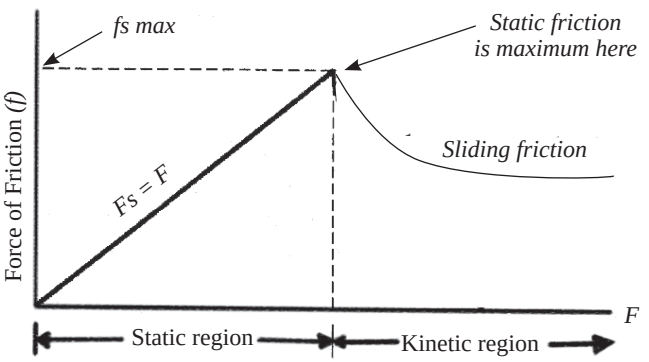


Fig: 2.2 ***Static and Sliding Friction***

Rolling friction

The force of friction existing between the two surfaces in contact when one of them is rolling over the other is called rolling friction. For example: If a wheel is rolling down the slope, the friction between wheel and slope is called the rolling friction.

Rolling friction is much smaller than the sliding friction. That is why all vehicles are mounted on wheels and ball-bearings for rotatory motion. In a ball bearing, the axle rotates on the balls without sliding.

Friction: A Necessary Evil

Friction is useful in many aspects:

(i) Friction between paper and pencil enables us to draw and write on paper.

(ii) Friction between feet and the ground allows movements like walking, running etc.

(iii) Friction between the surface of the road and tyres of vehicles allows the vehicles to move.

(iv) Without friction, nails and screws could not be used to hold things together and knots could not be tied.

(v) Friction between the hands and the object helps us to hold the object easily by providing a grip.

(vi) The surface of the head of a match stick and the sides of the match box are deliberately made rough to increase the friction. Due to increased friction, larger frictional energy heat up the side of the match box because of which the match box lights up easily.

Disadvantages of Friction

(i) Friction causes wear and tear of moving machine parts.

(ii) Friction between various parts of machines lead to a loss of energy. Therefore, friction reduces the efficiency of machines.

Ways to increase friction

(i) Tyres of vehicles have treads and soles of our shoes have grooves to increase friction.

(ii) Roads are made rough to prevent slipping. Even handles of cricket and tennis bats are made of rough materials to get better grip.

(iii) Spikes on the shoes of mountaineers help to get a good grip on ice surface.

Ways to reduce friction

The friction between two surfaces can be reduced by the following methods:

(i) **Polishing :** Polishing makes the surface smooth and hence reduces the friction to a greater extent.

(ii) **Lubrication:** Applying oil or grease between two surfaces reduces the friction.

(iii) **Ball bearings:** Smooth balls are placed between two metal rings such that the ring rotates which provide very little friction.

(iv) **By sprinkling fine powder:** Small quantity of fine powder on a wooden surface or floor etc *reduces* friction. That is why a small quantity of talcum powder is applied on carrom - board. Graphite powder is used in machines to reduce friction.

(v) **By streamlining the body of an object:** Streamline body experience less friction from air or water. Bodies of aeroplanes, rockets, ships, etc., are streamlined. Birds and fish also have streamlined bodies.

Friction Due to Fluids

The frictional force exerted by fluids (liquids and gases) is known as drag force.

When a solid moves in a liquid or a gas, the surface of the solid experiences friction. However, the force of friction between a solid and a liquid surface is less than the two solids. The force of friction between a solid surface and a gas is lesser than the surface of solid and liquid.

The meteors enter the earth's atmosphere at very high speeds. At such speeds the friction due to air is also very large. Due to this, temperature of meteors entering the earth atmosphere rises to a very high level. As a result meteors burn out soon after entering.

To protect spaceships from burning during entry to the earth's atmosphere, they are provided with a heat shield.

Dependence of frictional force on object in liquid

(i) Nature of the fluid
(ii) Shape of the object and
(iii) Speed of object with respect to the fluid.

Did You Know

1. Patterns or grooves on the soles of shoes are made to increase friction. This helps person to walk on the floor without slipping.
2. A boat is more difficult to pull on the beach than on the sea due to more friction between the boat and the beach surface.

Key Points

1. Friction is a property that opposes tendency of motion of an object over another.
2. Adhesion is an attraction between the two surfaces.
3. There are three types of friction - static, sliding and rolling frictions.
4. Static friction > Sliding friction > Rolling friction.
5. The symmetrical shape of a body / object which offers least resistance due to friction is called streamlined shape.
6. The frictional force exerted by fluids is called drag force.

Multiple Choice Questions

1. Which of the following represents frictional force?
   (a) $f_r = \mu N$
   (b) $f_r = 6 \pi nr$
   (c) $f_r = \mu Nr$
   (d) $f_r = \mu$

2. Which of these is true about friction?
   (a) It can stop a moving object.
   (b) It can change the direction of a moving object.
   (c) It can make a moving object faster.
   (d) It can change the shape of an object.

3. Two bodies in contact but not moving with respect to each other can exert
   (a) stable friction
   (b) static friction
   (c) limitinsg friction
   (d) sliding friction

4. Oiling or greasing of moving parts in a machine
   (a) reduces the friction
   (b) changes the friction
   (c) increases the friction
   (d) stops the friction

5. Disadvantage of friction is that
   (a) we can write on paper
   (b) we are able to walk
   (c) we can stop a moving vehicle
   (d) the parts of machine wear and tear

6. A ball moving on a horizontal surface stops because of the
   (a) force of gravity
   (b) force of friction
   (c) atmospheric pressure
   (d) blockage

7. When one object moves over the surface of other object,
   (a) surface of only lower object exerts frictional force on the upper object
   (b) surface of both the objects exert force in the direction opposite to each other
   (c) either (a) or (b) can be possible
   (d) none of these

8. Ball bearings are useful because rolling friction is
   (a) less than sliding friction
   (b) more than sliding friction
   (c) equal to sliding friction
   (d) easier to manage friction

9. The smoother the surface is, _____ will be the friction.
   (a) greater
   (b) lesser
   (c) slippery
   (d) smooth

10. Fluid friction can be reduced by
    (a) streamlining
    (b) ball bearing
    (c) lubrication
    (d) oiling

11. Friction can oppose
    (a) movement
    (b) slip
    (c) speed
    (d) force of gravity

12. Which of the following is correct regarding friction?
    (a) wastes energy
    (b) wears out the rubbing surface
    (c) generates heat
    (d) all of these

13. Friction is minimized by
    (a) polishing and lubrication
    (b) streamlining
    (c) use of wheels and ball bearings
    (d) all of these

14. Frictional force that fluids exert on an object is called
    (a) brag
    (b) blag
    (c) drag
    (d) krag

15. The bodies of aeroplanes, missiles, rockets, cars are streamlined to reduce friction with air. This friction forces is called
    (a) air resistance
    (b) air friction
    (c) drag
    (d) gravitational resistance

16. The force of friction between two bodies in contact is
    (a) parallel to body position
    (b) parallel to contact surface
    (c) perpendicular to contact surface
    (d) inclined at 45° to contact surface

17. Friction due to water and air can be reduced by suitably designing the shape of the objects. This is called
    (a) ball - setting
    (b) frictional adjustment
    (c) streamlining
    (d) figure correction

18. Method of increasing friction is by
    (a) using lubricant
    (b) providing grooves on sole of shoes
    (c) polishing the surfaces
    (d) using ball bearing

19. Sprinkling of powder on the carromboard ____ friction.
    (a) decreases
    (b) increases
    (c) does not affect
    (d) none of these

20. The force of friction that exists between the surfaces in contact when one body slides over the surface of other body is called ____ friction.
    (a) rolling
    (b) static
    (c) sliding
    (d) moving

21. Which of these frictions is the least in magnitude?
    (a) static friction
    (b) sliding friction
    (c) rolling friction
    (d) all are equal

22. Which of these frictions is largest in magnitude in comparison to other frictions?
    (a) rolling
    (b) sliding
    (c) static
    (d) all are equal

23. Which of these statements is NOT correct?
    (a) A ball moving on a horizontal surface stops due to force of friction.
    (b) Force of friction helps us to walk on ground.
    (c) Wheels are spherical in shape as rolling friction is less than sliding friction.
    (d) Tyres have grooves to reduce the friction.

24. What type of friction does not allow two surfaces to slide upon one another?
    (a) fluid friction
    (b) static friction
    (c) sliding friction
    (d) drag

25. When two bodies are in contact, friction opposes the relative motion between
    (a) the upper surface
    (b) the lower surface
    (c) both the surfaces in contact
    (d) none of these

Answer Key

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

3 Light

Learning Objectives

- Reflection of Light
- Laws of Reflection
- Regular and Irregular or Diffused Reflection
- Real and Virtual Images
- Formation of Images by a Plane Mirror
- Ray Diagram for the Formation of Image by a Plane Mirror
- Reflected Light can be Reflected Again
- Multiple Images
- Kaleidoscope
- Periscope
- Sunlight - White or Coloured (Dispersion of Light)
- The Human Eye - What is Inside our Eye
- Working of the Human Eye
- Persistence of Vision
- Defects of the Eye - Myopia
  - Hypermetropia
- Care of the Eye
- Visually Challenged Persons can Read and Write
- The Braille System

Light is an electromagnetic wave and form of energy which enables us to see things around us. The objects which emit light are known as source of light or luminous objects, like sun. Those objects which can't produce light of its own are called non–luminous object e.g. *Moon, earth* etc.

Reflection of Light

When the light ray is incident on the surface of an object, it is reflected, transmitted, or absorbed. When it falls on the polished surface, it reverts back in the same medium. This phenomenon is known as reflection of light. In other words "Bouncing back of the light after striking a polished surface is called reflection of light."

Silver metal is the best reflector of light, as it reflects all of the light falling on it.

Incident ray of light: The ray of light which falls on an object is called incident ray of light.

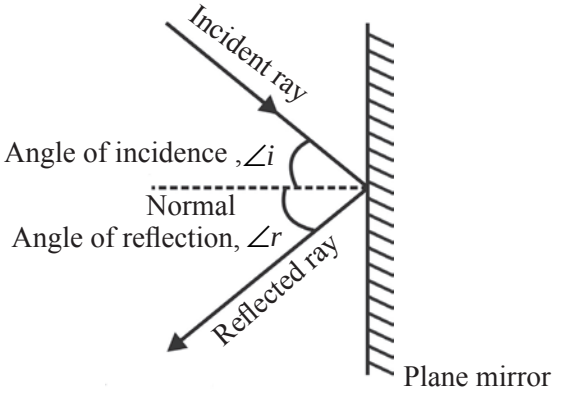


Fig: 3.1 ***Reflection of light through a plane mirror***

Reflected Ray: The ray of light which bounces back in its own medium from the surface of an object is called reflected ray.

Angle of Incidence: The angle between the incident ray and the normal at the point of incidence is called the angle of incidence. It is denoted by ∠ i.

Angle of Reflection: The angle between the reflected ray and the normal at the point of incidence is called the angle of reflection. It is denoted by ∠ r.

Laws of Reflection

There are two laws of reflection:

(i) Angle of reflection (∠ r) is equal to the angle of incidence (∠ i).

(ii) Incident ray, reflected ray and normal at the point of incidence all lie in the same plane.

Regular and Irregular or Diffused Reflection

Depending upon the nature of the reflecting surface, there are two types of reflections.

Regular Reflection

When a parallel beam of light falls on a smooth and highly polished surface, then the reflected beam is also parallel and directed in a fixed direction. Such reflection of light is called regular reflection.

The glare of regular reflected light beam is dazzling. Search lights and automobile head light are the examples of regular reflection of light.

Diffused Reflection

When a parallel beam of light falls on a rough surface, and the reflected light is not parallel but spreads over a wide area. Such reflection of light is called irregular or diffused reflection.

Light reflected from the wooden table, newspaper etc. are the examples of diffused reflection of light.

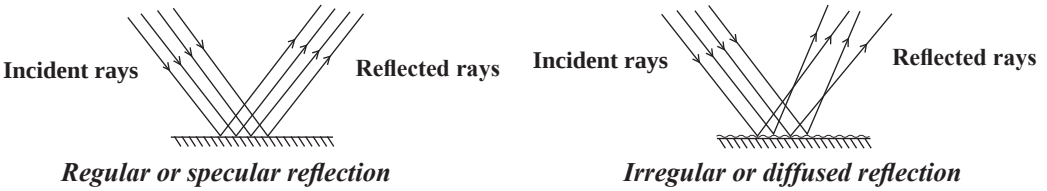


Fig: 3.2

Real and Virtual Image

The image that can be obtained on the screen is called real image. A real image is formed when reflected light ray coming from an object actually meets at a point. Real image can be formed with the help of concave mirror and convex lens if the object is placed at its focus or beyond the focus.

The image that cannot be obtained on the screen is called virtual image. When the reflected rays of light coming from an object appears to meet at a point, a virtual image is formed. The images formed by a plane mirror are always virtual.

A concave mirror and convex lens form a virtual image when the object is placed at a distance, less than its focal length.

A convex mirror and concave lens forms a virtual image of the object placed before it.

Formation of Images by a Plane Mirror

In case of a plane mirror, the distance of object and image formed are equal but are on the opposite side of the mirror. When an object is placed in front of a plane mirror, the right side of the object appears to be left and the left side appears to be right. This phenomenon is called lateral inversion.

The word AMBULANCE on the hospital van is always written in the form of its mirror image. This is done because, we will be able to see the hospital van coming behind us in rear view mirror of a car. and thus can give pass to the van.

Uses of plane mirror:

(a) It is used as a viewing mirror in our house.

(b) It is used in the shop of the barber, jeweller etc.

(c) For making kaleidoscope and periscope.

Ray Diagram for the Formation of Image by a Plane Mirror

To construct a ray diagram for the formation of an image follow the following rules:

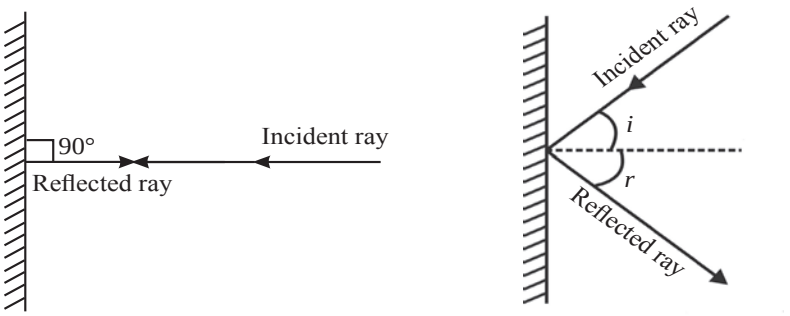


Fig: 3.3 ***Reflection of rays from a plane mirror***

- A ray of light falling on a plane mirror at 90° (perpendicular) gets reflected back from the mirror by the same path.
- A ray of light falling on a plane mirror at any angle gets reflected from the mirror such that the angle of incidence is equal to the angle of reflection.

Image of a point Object in a Plane Mirror

Suppose a point object O is placed in front of a plane mirror MM′. Consider two rays of light OA and OB falling on the mirror at points A and B respectively. These rays after suffering reflection get reflected along AC and BD, respectively. The reflected ray appear to come point I. The point I is the image of the point object O.

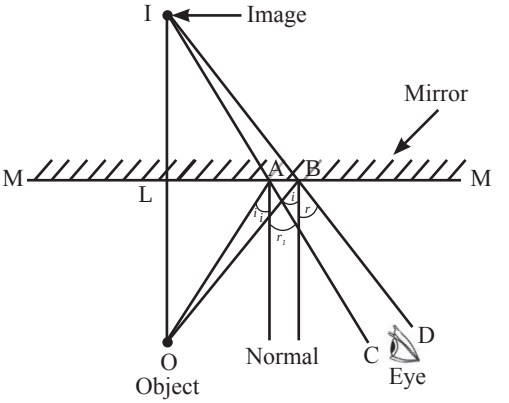


Fig: 3.4 ***Image of a point object in a plane mirror***

Image of an Extended Object in a Plane Mirror

Consider a candle OO′ placed in front of a mirror MM′.

- Rays OA, OB, start from the top of the candle get reflected after striking the mirror.
- The reflected rays AE and BF appear to come from the point I. The point I is the image of the top of the candle.
- Rays O′C and O′D start form the lowest point of the candle get reflected after striking the mirror.
- The reflected rays, CG and DH appear to come from point I′. The point I′ is the image of the foot of the candle.
- Thus the II' is the image of the object OO′ (the candle).

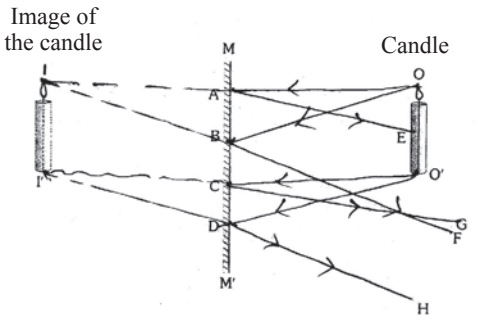


Fig: 3.5 ***Image of an Extended Object in a Plane Mirror***

Note: **(i) The image in a plane mirror is:** virtual, of the same size as the object, laterally inverted, formed as far behind the mirror as the object is in front.

(ii) Reflected Light can be Reflected Again: When two mirrors are placed inclined at an angle to each other, many images of the object placed before them are seen. This is because the image formed in one mirror acts as the object for the other.

Multiple images

The number of images seen depends upon the angle at which the two mirrors are placed and can be determined by the formula:

$$n = \frac{360}{\theta} - 1$$

Where n = number of images formed.

θ = angle between the two mirrors. (in degrees)

1. **When the two mirrors are placed at right angles to each other :** When the object is placed in front of two plane mirrors placed at right angles to each other, three images are formed:

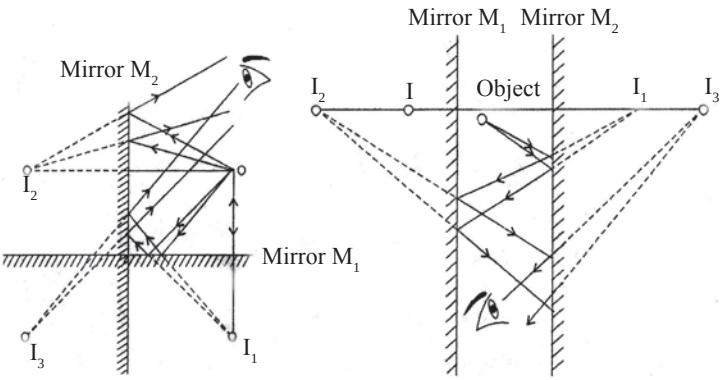
   (i) The image I_1 of the object O is due to mirror 1.

   (ii) The image I_2 of the object O is due to mirror 2.

   (iii) The third image I_3 may be considered to the image of I_2 in the image of the mirror 2 or the image of I_2 in the image of the mirror 1.

   The image I_3 is an overlap of two images. Thus the image I_3 is brighter than both I_1 and I_2.

2. **When the two plane mirrors are placed parallel to each other:** Consider and object (O) placed in between the two plane mirrors held parallel to each other. The image of the object in mirror M_2 is formed at I_1 as for behind the mirror as the object in front of it. The image I_1 acts as object for mirror M_1 and its image is formed at I_2. The image I_2 when acts as the object for mirror M_2 and the corresponding image is formed at I_3.



(a) Formation of multiple images by two mirrors at right angles to each other

(b) Formation of images when two plane mirrors are placed parallel to each other

Fig: 3.6