



HAMDARD

IMTIHANI

THE MOST POP

ACCORDING TO THE NEW SYLLABUS AND
INTERMEDIATE AND SECONDARY EDUCATION
D.G.KHAN, SARGODHA, BAHAWALPUR

THE MOST POPULAR BOOK DUE TO STANDARD
COMPREHENSIVE AND TO THE POINT MATTER

HAMDARD

IMTIHANI

PHYC

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1.1

Physical and Non-Physical Quantities

Q.1 Describe physical and non-physical quantities.

Ans. Physical Quantities: All measurable quantities are called physical quantities.

Example

- length of an object using a ruler.
- time duration of an event using a clock.
- the temperature (the degree of hotness) of somebody using a thermometer.

Non-physical quantities:

All the quantities which are not measured are called non physical quantities.

- Non-physical quantities mostly help understand and analysis of human behaviour, emotions and social interactions.

Quick Quiz: Complete the following

Table 1.1			
Sr.No.	Feature	Physical Quantity	Non-Physical Quantity
1.	Measurement	Yes	No
2.	Instrument used		
3.	Numerical value and unit		
4.	Examples	1. 2.	1. 2.

Ans.

These units are called derived units.

Derivation:

Area = length $\times$ breadth

= metre $\times$ metre

= square metre

= metre² or m²

Speed = Distance/Time = metre/second = ms⁻¹

A few derived units with specific names and symbols are given in Table 1.3.

Table 1.3			
Sr. No.	Physical quantity	Unit	Symbol
1.	Area	square metre	m ²
2.	Volume	cubic metre	m ³
3.	Speed	metre per second	ms ⁻¹
4.	Force	newton	N
5.	Pressure	pascal	Pa
6.	Electric charge	coulomb	C
7.	Plane angle	radian	rad

Q.6 Explain SI prefixes. Derived examples of meaning of prefixes.

Ans. Prefixes: Prefixes are the words or symbols added before SI unit and stand for the multiples or the sub multiples of that unit.

1.5

Length Measuring Instruments

Q.8. What are length measuring instruments? Explain it.

Ans. Measuring Instruments: Measuring instruments are used to measure various physical quantities.

Examples: Length, Mass, Time, Volume etc.

Metre Rule: Length is generally measured using a metre rule in the laboratory. The smallest division on a metre scale is 1 mm.

Uses of Metre Rule: Metre rule is commonly used in the laboratories to measure length of an object or distance between two points.

Least Count of Metre Rule: The smallest measurement that can be taken with a metre rule is 1mm. One millimetre is known as least count of the metre rule. Least count is the smallest measurement that can be taken accurately with an instrument.

Measure the Length of an Object: To measure the length of an object, the metre ruler is placed in such a way that its zero coincides one edge of the object and then the reading in front of the other edge is the length of the object.

Common Source of Error: One common source of error comes from the angle at which an instrument is read. Metre ruler should either be tipped on its edge or read when the person's eye is directly above the ruler at point B. If the metre ruler is read from an angle, such as from point A or C, the object will appear to be of different length. This is known as parallax error.

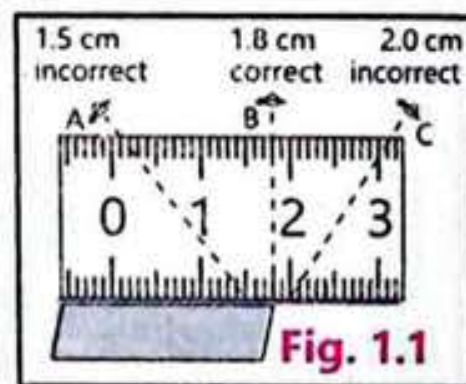


Fig. 1.1

Q.11. What is the function of Micrometre Screw Gauge? How it is used.

Ans. Screw Gauge: It is used to measure very small lengths correct upto 0.01 mm such as diameter of a wire or the thickness of a metal sheet.

Construction: It has two scales.

- (a) The main scale on the sleeve, which has markings of 0.5 mm each.
- (b) The circular scale on the thimble, which has 50 divisions. Some instruments may have main scale markings of 1mm and 100 divisions on the thimble.

Pitch of the Screw Gauge: When the thimble makes one complete turn, the spindle moves 0.5 mm (1 scale division) on the main scale which is called pitch of the screw gauge. Thus, its least count is,

$$\text{Least count} = 0.5\text{mm}/50 = 0.01 \text{ mm}$$

Q.12 Describe the method checking for zero Error.

Ans. Zero error: To find the zero error, close the gap between the spindle and the stud of the screw gauge by rotating the ratchet in the clockwise direction. If zero of circular scale not coincides with the index line, then the zero error will be present in the instrument.

No zero error: If the zero of the circular scale coincides with horizontal line, there is no zero error (Fig 1.6 a).

Explanation: If it is not exactly in front of the horizontal line of the main scale on joining the anvil and spindle then there is a zero error

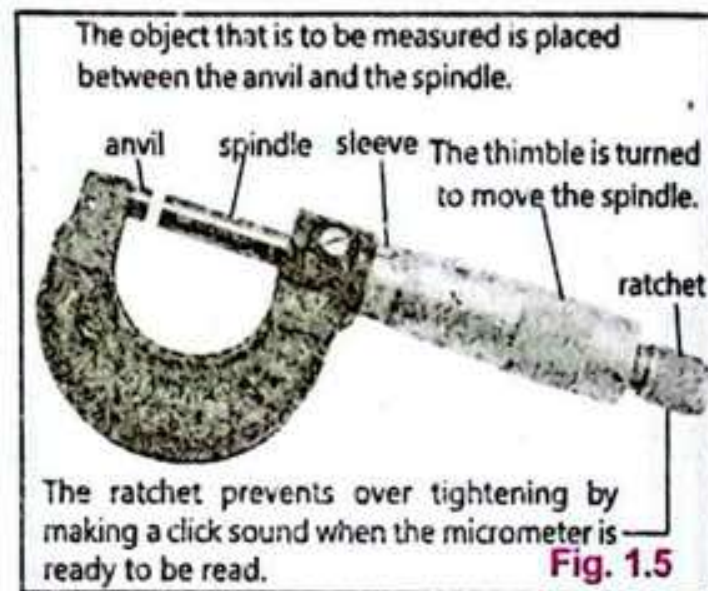


Fig. 1.5



represents one tenth ($1/10$) of a second. Thus, one tenth of a second is the least count of this stopwatch.

Working: While using, a knob present on the top of the device is pressed. This results in the starting of the watch. The same knob is again pushed to stop it. After noting the reading, the same knob is again pressed to bring back the needles to the zero position. Now-a-days, electronic/digital watches (Fig. 1.11) are also available which can measure one hundredth part of a second.



Fig. 1.11

Digital Stopwatch

1.8

Measuring Cylinder

Q.16. What is measuring cylinder? How it can be used?

- Ans. Measuring Cylinder:** A measuring cylinder is a glass or transparent plastic, with a scale divided in cubic centimeters (cm^3 or cc) or millimetres (mL) marked on it.

Use: It is used to find the volume of liquids and non-dissolvable solids.

Explanation:

Levels of Liquids in Cylinder: The level of liquids in the cylinder is marked to find the volume. In order to read the volume correctly, the cylinder must be placed on a horizontal surface and the eye shall be kept in level with meniscus of water surface as shown in Fig. 1.12. The meniscus is the top level of the liquid surface. Water in the cylinder curves downward and its surface is called concave surface. The reading is taken corresponding to the bottom edge of the surface. The mercury in the cylinder curves upward. Its surface is convex and the reading is taken corresponding to the top edge. The cylinder can be used to find the volume of solids



Fig. 1.12

Measuring cylinder

Measure Length of Straight Line calibrated in millimeter: The end point of the line lies between 10.3cm and 10.4 cm marks. By convention, if the end of the line does not touch or cross the midpoint of the smallest division, the reading is confined to the previous division. In case the end of the line seems to be touching or have crossed the midpoint, the reading is extended to the next division. Thus in this example the maximum uncertainty is ± 0.05 cm. It is, in fact, equivalent to an uncertainty of 0.1 cm equal to the least count of the instrument divided into two parts, half above and half below the recorded reading.

The uncertainty or accuracy in the value of a measured quantity can be indicated conveniently by using significant figures.

1.11

Significant Figures

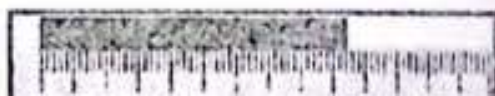
Q.20. What are significant figures? Which rules are helpful in identifying significant figures?

Ans. Definition: All the accurately known digits and first doubtful digit in an expression are called significant figures.

It reflects the precision of a measured value of a physical quantity.

Explanation: We can count number of candies in a jar and know it exactly by counting but we cannot measure the height of the jar exactly. All measurements include uncertainties depending upon the refinement of the instrument which is used for measurement.

It is important to reflect the degree of uncertainty in a measurement by recording the observation in significant



1.13

Rounding off the Digits

Q.22. How decimal numbers are rounded off? Explain with example.

Ans. When rounding off numbers to a certain number of significant figures, do so to the nearest value.

(i) If the last digit is less than 5 then it is simply dropped. This decreases the number of significant digits in the figure.

For example: 1.943 is rounded to 1.94 (3 significant figures).

(ii) If the last digit is greater than 5, the digit on the left is increased by one. This also decreases the number of significant digits in the figure.

For example. 1.47 is rounded to two significant digits is 1.5.

(iii) If the last digit is 5, then it is rounded to get nearest even number.

For example: 1.35 is rounded to 1.4 and 1.45 is also rounded to 1.4.

Sometimes logic is applied to decide the fate of the digit. If we round to 2 significant figures $4.452 \times 10^2 \text{m}$, the answer should be $4.5 \times 10^2 \text{m}$, since $4.452 \times 10^2 \text{m}$ is more closer to $4.5 \times 10^2 \text{m}$ than $4.4 \times 10^2 \text{m}$.

Conceptual Long Questions

1. Justify and illustrate the use of measuring cylinder to measure volume [including both measurement of volume of liquid and determining the volume of a solid by displacement can method].

Ans. Justification for using measuring cylinders:

$$\begin{aligned}
 \text{(a)} \quad & 5.123 \times 10^4 \text{ m} + 3.28 \times 10^5 \text{ m} \\
 &= 5.123 \times 10^4 \text{ m} + 32.8 \times 10^4 \text{ m} \\
 &= (5.123 + 32.8) 10^4 \text{ m} \\
 &= 37.923 \times 10^4 \text{ m} \\
 &= 3.7923 \times 10^5 \text{ m}
 \end{aligned}$$

$$\begin{aligned}
 \text{(b)} \quad & 2.57 \times 10^{-2} \text{ mm} - 3.43 \times 10^{-3} \text{ mm} \\
 &= 2.57 \times 10^{-2} \text{ mm} - 0.343 \times 10^{-2} \text{ mm} \\
 &= (2.57 - 0.343) \times 10^{-2} \text{ mm} \\
 &= 2.227 \times 10^{-2} \text{ mm} \\
 &= 2.227 \times 10^{-2} \times 10^{-3} \text{ m} \\
 &= 2.227 \times 10^{-5} \text{ m}
 \end{aligned}$$

Example 1.2:

Find the value of each of the following quantities:

$$\text{(a)} \quad (4 \times 10^3 \text{ kg}) (6 \times 10^6 \text{ m}) \qquad \text{(b)} \quad \frac{6 \times 10^6 \text{ m}^3}{2 \times 10^{-2} \text{ m}^2}$$

Solution

$$\begin{aligned}
 \text{(a)} \quad & (4 \times 10^3 \text{ kg}) (6 \times 10^6 \text{ m}) \\
 &= (4 \times 6) \times 10^{3+6} \text{ kg m} \\
 &= 24 \times 10^9 \text{ kg m} = 2.4 \times 10^{10} \text{ kg m}
 \end{aligned}$$

$$\begin{aligned}
 \text{(b)} \quad & \frac{6 \times 10^6 \text{ m}^3}{2 \times 10^{-2} \text{ m}^2} \\
 &= \frac{6}{2} \times 10^{6-(-2)} \text{ m}^{3-2} = 3 \times 10^8 \text{ m}
 \end{aligned}$$

ACTIVITIES

Activity 1.1:

The teacher should facilitate this activity and initiate discussion as per direction.

One student should measure the length of a writing board with his hand. The same should be repeated by four or five students. Are all the measurements

Activity 1.7:

The teacher should facilitate the groups to take a metallic ball or a pendulum bob. Measure its diameter and then volume by placing it in between two wooden blocks alongside a ruler. Then use measuring cylinder and comment on the result of this two onset activities.

- i. Measure the ball's diameter using two wooden blocks and a ruler calculate the volume using the formula

$$V = \frac{4}{3} \pi r^3$$

- ii. Submerge the ball in a measuring cylinder filled with water. Record the volume of water displaced as the balls volume.
- iii. **Compare:** Discuss any differences between the calculated and displaced volumes, considering possible errors like measurement inaccuracies or water adhesion.

Quick Quiz

- The negative exponents have values less than.
(a) zero (b) one (c) two (d) three
- The Symbol of second is:
(a) s (b) sec (c) second (d) sd"
- Which prefix is correct?
(a) mm (b) km (c) ms (d) All of these"
- Symbol of length is

11. Who invented vernier callipers?

Ans. Vernier callipers were invented by a French Scientist Pierre Vernier in 1631.

12. How did Ancient scientists estimate the volume of grains?

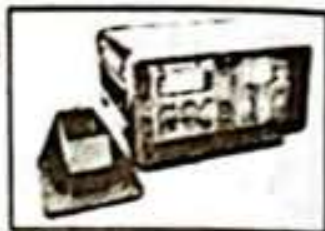
Ans. Ancient Chinese used to estimate the volume of grains by sounding their vessels containers.

13. What is an example of an old measurement still in use despite the adoption of SI units?

Ans. Despite the use of SI in most countries, the old measure is still in use, such as printers type is measured in point. One point is $1/72$ of an inch equivalent to 0.35mm.

14. What is the shortest time interval that an electronic timer can measure?

Ans. An electronic timer can measure time intervals as short as one-ten thousands ($1/10,000$) of a second.



FOR YOUR INFORMATION

The negative exponents have values less than one. For example, $1 \times 10^{-2} = 0.01$

DO YOU KNOW

The kilogram is the only base unit that has a prefix.

Objective Type Questions

Additional MCQ's

25. Which of the following is not a length measuring instrument?
(a) Vernier calliper (b) Screw gauge (c) Stop watch (d) Measuring tape
26. Which of the following instruments is commonly used to measure the mass of a small object in a laboratory?
(a) Beam Balance (b) Measuring Tape (c) Vernier Callipers (d) Stop watch
27. Which of the following is not a mass measuring instrument?
(a) Spring Balance (b) Beam Balance
(c) Electronic Balance (d) vernier callipers
28. What is the advantage of using a digital stopwatch?
(a) It is more accurate (b) It is easier to read
(c) It is more precise (d) All of the above
29. Why is measuring cylinder used in a laboratory?
(a) To measure the length of objects (b) To measure the volume of liquids
(c) To measure the mass of objects (d) To measure the temperature of objects

1.11**Significant Figures**

30. The number of significant figure in 0.00580km is:
(a) 5 (b) 4 (c) 3 (d) 2
31. The number of significant figure in 100.8s is:
(a) 2 (b) 3 (c) 4 (d) 5
32. In the value 210.0g the number of significant figure is/are:
(a) 1 (b) 2 (c) 3 (d) 4

quantities such as length, breadth, thickness, mass, volume, density, time, temperature etc.

3. Describe use of SI measurements.

Ans. Use of SI measurements helps all scientists to share and compare their observations and results easily.

4. Define international system of units.

Ans. The international committee on weights and measures in 1961 recommended the use of a system consisting of seven base units known as international system of units abbreviated as SI.

5. Describe examples that explain the meaning of prefixes.

$$\begin{array}{ll} \text{Ans. i. } 5000 \text{ mm} = \frac{5000}{1000} \text{ m} = 5 \text{ m} & \text{ii. } 50000 \text{ cm} = \frac{50000}{100} \text{ m} = 500 \text{ m} \\ \text{iii. } 3000 \text{ g} = \frac{3000}{1000} \text{ kg} = 3 \text{ kg} & \text{iv. } 2000 \mu\text{s} = 2000 \times 10^{-6} \text{ s} = 2 \times 10^{-3} \end{array}$$

6. Describe method to write numbers using scientific method.

Ans. To write numbers using scientific notation, move the decimal point until only one non-zero digit remains on the left. Then count the number of places through which the decimal point is moved and use this number as the power or exponents of 10.

7. Write the name of two measuring instruments.

Ans. Metre rule, measuring tape.

8. Which smallest measurement can be taken metre rule?

unpredictable.

For Example: changes in temperature, pressure, humidity, voltage, etc.

25. How random errors can be reduced?

Ans. The effect of random errors can be reduced using several or multiple readings and then taking their average or mean value. Similarly, for the measuring time period of oscillating pendulum, the time of several oscillation, say 30 oscillations is noted and then mean or average value of one oscillation is determined.

26. Define significant figures.

Ans. In any measurement, the accurately known digits and the first doubtful digit are known-as significant figures.

27. What is precesion? Define.

Ans. Precesion refers to the consistency or repeatability of measurement.

28. Define accuracy.

Ans. Accuracy refers to how close a measurement is to the true or accepted value.

Conceptual Short Questions

1. How can errors in measurement be minimized?

Ans. (i) Use well calibrated instruments.

(ii) Take multiple readings and find the average.

(iii) Avoid parallax errors by aligning the eye properly with scale.

(iv) Ensure environmental conditions are stable.

2. Describe the process of measuring the diameter of a wire using screw gauge.

Exercise Questions (Solved)

A Multiple Choice Questions

Tick (✓) the correct answer:

- 1.1 The instrument that is most suitable for measuring the thickness of a few sheets of cardboard is a:

(a) metre rule	(b) Measuring tape
(c) Vernier callipers	(d) micrometer screw gauge
- 1.2 One femto metre is equal to:

(a) 10^{-9}m	(b) 10^{-15}m	(c) 10^9m	(d) 10^{15}m
-----------------------	------------------------	--------------------	-----------------------
- 1.3 A light year is a unit of:

(a) light	(b) time	(c) distance	(d) speed
-----------	----------	--------------	-----------
- 1.4 Which one is a non-physical quantity?

(a) distance	(b) density	(c) colour	(d) temperature
--------------	-------------	------------	-----------------
- 1.5 When using a measuring cylinder, one precaution to take is to:

(a) Check for the zero error
(b) Look at the meniscus from below the level of the water surface
(c) Take several readings by looking from more than one direction
(d) Position the eye in line with the bottom of the meniscus
- 1.6 Volume of water consumed by you per day is estimated in:

(a) millilitre	(b) litre	(c) kilogram	(d) cubic metre
----------------	-----------	--------------	-----------------

1.8 What is meant by: a. 5 pm b. 15 ns c. 6 μm d. 5 fs

Ans: These terms represent specific quantities along with their respective units of measurement.

a. 5pm (pm a unit for length)

- 1 picometer = 10^{-12} meter.
- 5pm means a length of picometer, which is extremely small, often used in atomic as subatomic measurements.

b. 15ns

- ns stands for a nano second (a unit of time).
- 1 nano second, 10^{-9} second (one billionth of a second.)
- 15ns means a duration of 15 nano second, commonly used in electronics and computing to measure signal or data processing times.

c. 6 μm

- μm stands for micro meter (or micron), a unit of length.
- 1 micrometer = 10^{-6} meters (one millionth of meter).
- 6 μm represents a length of 6 micrometers, often used to describe the size of microorganisms or fine particles.

d. 5fs

- fs stands for femto second, (a unit of time).
- 1 femtosecond, 10^{-15} seconds (One quadrillionth of a second)
- 5fs indicates a duration of 5 femto secondes, commonly used in ultrafast laser physics and time resolved spectroscopy.

Reason: Coins are light weight and grams are the standard unit for measuring such small masses.

(f) Mass of your school bag:

Unit: kilogram (kg)

Reason: A school bag is heavier than a coin and kilograms are used to measure such weights.

(g) Duration of your class period:

Unit: minute (m)

Reason: Class periods typical last for several minutes, making minutes the suitable unit.

(h) Volume of petrol filled in the tank of a car:

Unit: Litre (L)

Reason: Fuel volume is commonly measured in litres for vehicles.

(i) Time to boil one litre milk:

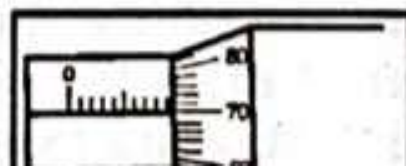
Unit: Minute (min) or second (s)

Reason: The boiling process is a relatively short duration activity, so minutes or seconds are appropriate.

1.2 Why might a standard system of measurement be helpful to a tailor?

Ans: A standard system of measurement is helpful for a tailor because it ensure accuracy, consistency and clear communication when creating ensures.

1.3 The minimum main scale reading of a micrometer screw gauge is 1 mm and there are 100 divisions on the circular scale. When thimble is rotated once, 1 mm is its



a. Number of seconds in a day:

$$86,400 \text{ s} = 8.64 \times 10^4 \text{ s}$$

b. Number of seconds in a week:

$$604,800 \text{ s} = 6.048 \times 10^5 \text{ s}$$

c. Number of seconds in a month:

$$2,592,000 \text{ s} = 2.592 \times 10^6 \text{ s}$$

1.3 Solve the following addition or subtraction. State your answers in scientific notation.

a. $4 \times 10^{-4} \text{ kg} + 3 \times 10^{-5} \text{ kg}$

b. $5.4 \times 10^{-6} \text{ m} - 3.2 \times 10^{-5} \text{ m}$

Ans: a. $4 \times 10^{-4} \text{ kg} + 3 \times 10^{-5} \text{ kg}$

To add both terms must have the same power of 10

Rewrite 4×10^{-4} with the same exponent as 3×10^{-5}

$$4 \times 10^{-4} = 40 \times 10^{-5}$$

Now, add the coefficients

$$40 \times 10^{-5} \text{ kg} + 3 \times 10^{-5} \text{ kg} = (40 + 3) \times 10^{-5} \text{ kg} = 43 \times 10^{-5} \text{ kg}$$

$$43 \times 10^{-5} \text{ kg} = 4.3 \times 10^{-4} \text{ kg} \text{ Ans.}$$

b. $5.4 \times 10^{-6} \text{ m} - 3.2 \times 10^{-5} \text{ m}$

Rewrite 5.4×10^{-6} with the same exponent as 3.2×10^{-5} :

$$5.4 \times 10^{-6} \text{ m} = 0.54 \times 10^{-5} \text{ m}$$

Now, subtract the coefficients

$$0.54 \times 10^{-5} \text{ m} - 3.2 \times 10^{-5} \text{ m} = (0.54 - 3.2) \times 10^{-5} \text{ m} = -2.66 \times 10^{-5} \text{ m}$$

$$5.4 \times 10^{-6} \text{ m} - 3.2 \times 10^{-5} \text{ m} = -2.66 \times 10^{-5} \text{ m} \text{ Ans.}$$

1.4 Solve the following multiplication or division. State your answers in scientific notation.

a. $(5 \times 10^4 \text{ m}) \times (3 \times 10^{-3} \text{ m})$

b. $6 \times 10^8 \text{ kg}$

b. $580 \times 10^2 \text{ g}$

Sol. $580 \times 10^2 \text{ g} = 5.8 \times 10^2 \times 10^2 \text{ g} = 5.8 \times 10^{2+2} \text{ g}$
 $= 5.8 \times 10^4 \text{ g} = 58 \times 10^3 \text{ g} = 58 \text{ kg} \quad \because 1 \text{ kg} = 10^3 \text{ g}$

c. $45 \times 10^{-4} \text{ s}$

Sol. $45 \times 10^{-4} \text{ s}$

$$45 \times 10^{-4} \text{ s} = 4.5 \times 10^{-3} \text{ s}$$

$$4.5 \times 10^{-3} \text{ s} = 4.5 \text{ ms}$$

Final Answer: a. 0.5 km b. 58 kg c. 4.5 ms

1.9 Light year is a unit of distance used in Astronomy. It is the distance covered by light in one year. Taking the speed of light as $3.0 \times 10^8 \text{ ms}^{-1}$, calculate the distance.

Sol. Given data:

Speed of light = $3.0 \times 10^8 \text{ m/s}$

Convert 1 year to seconds

$$1 \text{ year} = 365 \times 24 \times 60 \times 60 \text{ seconds} = 31536000 \text{ seconds} = 3.15 \times 10^7 \text{ seconds}$$

Calculate distance:

$$\text{Distance} = (3.0 \times 10^8 \text{ m/s}) \times 3.15 \times 10^7 \text{ seconds}$$

Multiply the values

$$\text{Distance} = 3 \times 10^8 \times 3.15 \times 10^7 \text{ m}$$

$$\text{Distance} = 9.45 \times 10^{15} \text{ m}$$

Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

Introduction

Q. Define mechanics and its branches.

Ans. Mechanics: Mechanics is the branch of physics that deals with the motion of objects and the forces that change it.

Mechanics is divided into two branches. 1. Kinematics 2. Dynamics

Kinematics: Kinematics is the study of motion of objects without referring to forces. In our everyday life, we observe many objects in motion. For example, cars, buses, bicycles, motorcycles moving on the roads, aeroplanes flying through air, water flowing in canals or some object falling from the table to the ground.

Dynamics: Dynamics deals with forces and their effect on the motion of objects.

2.1

Scalars and vectors

Q.1. Define scalars and vectors. Also give examples of them.

OR Differentiate between scalars and vectors quantities.

Ans.

2.2

Rest and Motion

Q.4. Define rest and motion with examples. Discuss the state of rest or motion of a body is relative.

Ans. Rest: A body is said to be at rest if it does not change its position with respect to its surroundings.

Examples:

- (1) A book, placed on the table is an example of rest. Because it does not change its position.
- (2) Trees and street lights around the roads are the examples of rest. Both do not change their positions.



Fig. 2.5 (a)

Meaning of surroundings: Surrounding are the places in neighbourhood of any object, where various objects are present.

Motion: A body is said to be in motion, if it changes its position with respect to its surroundings.

Examples: (i) A bus moving on a road is an example of motion.
(ii) A running boy in the street is an example of motion.

State of rest or motion of a body is relative: The state of rest or motion of a body is always relative.



Fig. 2.5 (b)

Explanation: A person standing in the compartment of a moving train is at rest with respect to the other passengers in the compartment but he is in motion with respect to an observer standing on the platform of a railway station.

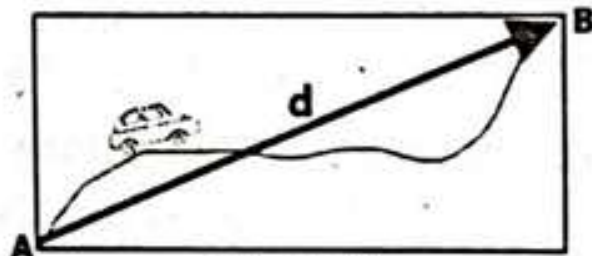
2. It can be found out by given formula $S = v \times t$	2. It can be found out by given formula $d = v \times t$
3. It is a scalar quantity because it needs only magnitude to describe.	3. It is a vector quantity because it needs magnitude and direction to describe.
4. Let a person be travelling from Lahore to Multan in a car. On reaching Multan, he reads the speedometer and notices that he has travelled a distance of 320km. It is the distance travelled by that person. Obviously, it is not the shortest distance from Lahore to Multan, as the car took many turns in the way. He did not travel along a straight line.	4. Suppose a car travels from a position A to B. The displacement d is the straight line AB directed from A to B as indicated by the arrow head. 
5. Unit: Its unit is meter	5. Unit: Its unit is meter

Fig. 2.11

The curved line is the actual path (distance) and the displacement is the straight line AB.

2.5

Speed and Velocity

Q.8. Define speed. Give examples. Write its formula and unit.

Ans. Definition: The distance covered in unit time is known as speed.

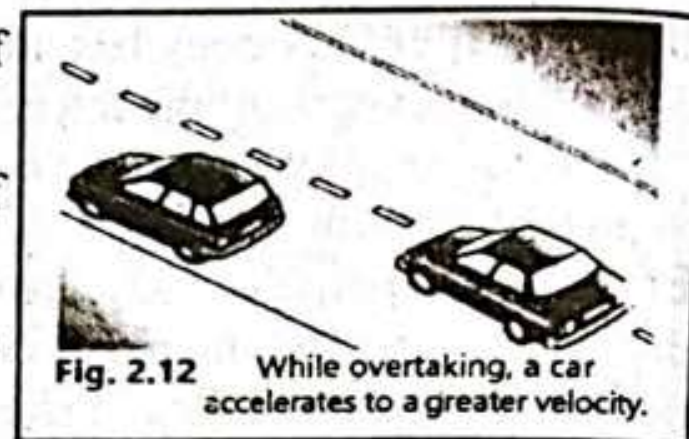
Unit time: It may be a sec, an hour, a day and a year.

either in its magnitude or direction or both. The change in the velocity of a body causes acceleration in it.

Acceleration of a moving object is in the direction of velocity if its velocity is increasing.

Acceleration of the object is opposite to the direction of velocity if its velocity is decreasing.

Formula: Acceleration can be found out by given formula.



$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

$$\text{Acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{Time taken}} = a = \frac{v_f - v_i}{t}$$

Here a is the acceleration, v_i is the initial velocity, v_f is the final velocity and t is the time taken.

Unit: SI unit of acceleration is metre per second per second or ms^{-2} .

Q.13. Explain variable and uniform acceleration. Also define positive and negative acceleration. Give examples.

Ans. Variable acceleration: A body has variable acceleration if it has equal changes in velocity in unequal intervals of time however short the interval may be.

Explanation: In equation $a = \frac{v_f - v_i}{t}$, a is the average acceleration of a body during

(i) Distance-time graph when object is at rest:

Now consider another case.

Time t (min)	0	1	2	3	4	5
Distance S (km)	1.2	1.2	1.2	1.2	1.2	1.2

Graph line is horizontal in this case (Fig. 2.17). It shows that the distance covered by the car does not change with change in time. It means that the car is not moving; it is at rest.

Speed of the object: A horizontal line parallel to time axis on a distance - time graph shows that speed of the object is zero.

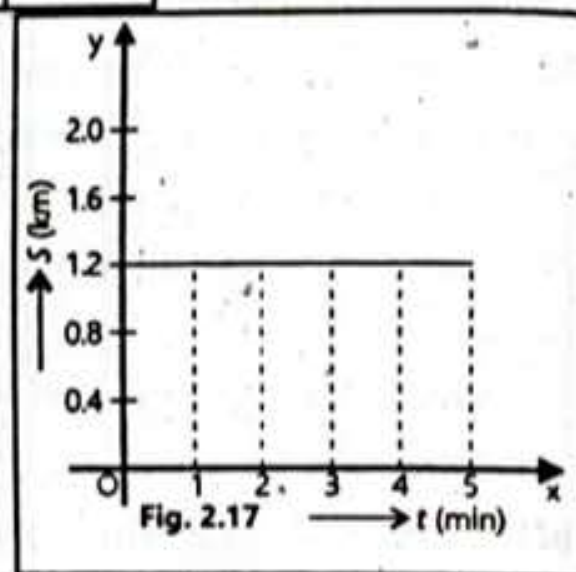
(ii) Distance-time graph when object is moving with constant speed:

Let a car be moving in a straight line on a motorway. Suppose that we measure its distance from starting point after every one minute, and record it in the table given below.

Time t (min)	0	1	2	3	4	5
Distance S (km)	0	1.2	2.4	3.6	4.8	6.0

Follow the steps given below to draw a graph on a centimetre graph paper:

- Take time t along x-axis and distance S along y-axis.
- Select suitable scales (1 minute = 1 cm) along x-axis and (1.2 km = 1 cm) along y-axis. The graph paper shown here is not to the scale.



$$\text{Slope} = \frac{S_2 - S_1}{t_2 - t_1} = \frac{S}{t}$$

From Eq. (2.1), $\frac{S}{t} = \tan \theta = \text{slop of graph line.}$

Fig. shows that $\frac{S}{t} = \tan \theta = \text{slop of graph line.}$

2.9 Speed - Time Graph

Q.17. Explain speed time graph for the following condition:

- (i) When the object is moving with uniform acceleration.
- (ii) When the object is moving with constant speed.
- (iii) When the object is at rest.

Ans. Speed-time graph: In a speed-time graph, time is taken along x-axis and speed is taken along y-axis. **OR**

The graph between speed v versus time t . This is called speed-time graph.

- (i) **When the object is moving with uniform acceleration.**

Suppose the speed of the same car after every one second and record it in the Table below.

Time t (S)	0	1	2	3	4	5
Speed v (ms^{-1})	0	8	16	24	32	40

Take t along x-axis and v along y - axis. Scale

$v \uparrow$

2.11

Area Under Speed - Time Graph

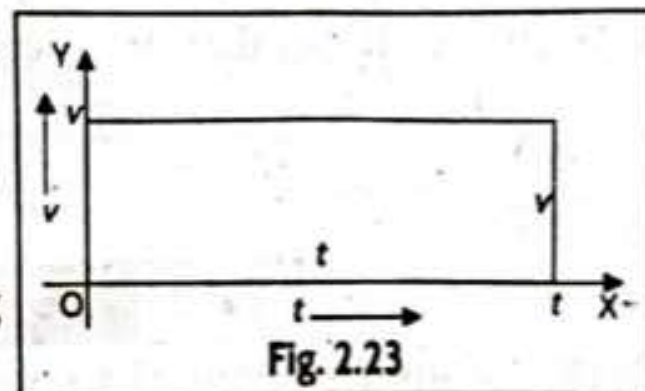
Q.19: Explain area under speed - time graph by using examples.

Ans. Definition: The area under the speed-time graph up to the time axis is numerically equal to the distance covered by the object.

The distance moved by an object can also be determined by using its speed time graph.

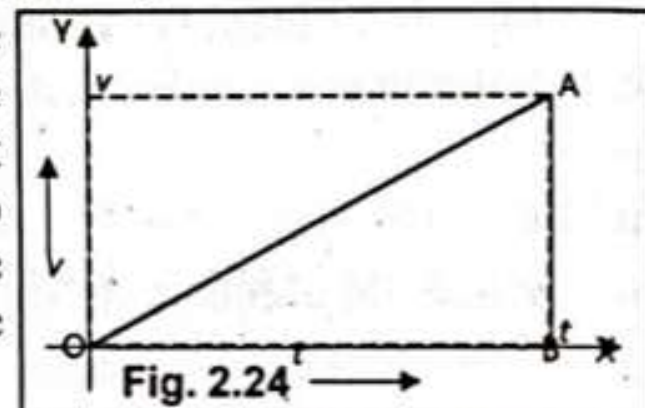
Axis of speed: In speed time graph, speed v is taken along y -axis.

Axis of time: In speed - time graph, time t is taken along x -axis.



Example No 1: Fig 2.23 shown that the object is moving with constant speed v . For a time - interval t , the distance covered by the object as given by is $v \times t$.

This distance can also be found by calculating the area under the speed-time graph. The area under the graph for time interval t is the area of rectangle of sides t and v . This area is shown shaded in fig and is equal to $v \times t$. Thus, area under speed-time graph up to the time axis is numerically equal to the distance covered by the object in time t .



Example No 2: Fig 2.24 shows that the speed of the object increases uniformly from 0 to v in time t . The average speed is given by

the x-axis and y-axis. If the object is moving with constant acceleration in both directions, the equations of motion for each direction are as follows.

In the x-direction

$$x = x_0 + vx_0t + \frac{1}{2} axt^2$$

In the y-direction

$$y = y_0 + vy_0t + \frac{1}{2} ayt^2$$

2. Explain the concept of relative velocity and derive the formula for the relative velocity of two objects moving in the same or opposite directions. How does this concept apply in various frames of reference?

Ans. Relative velocity refers to the velocity of one object as observed from another object. The relative velocity depends on the direction and magnitude of the velocities of the two objects.

If two objects are moving in the same direction, the relative velocity v_{rel} is velocities.

$$v_{rel} = |v_1 - v_2|$$

$$v_{rel} = |v_1 + v_2|$$

3. Derive the equations of motion for uniformly accelerated motion starting from the definition of acceleration?

$$v_f = \frac{252 \times 10^3 \text{ m}}{60 \times 60 \text{ s}} = 70 \text{ m s}^{-1}$$

Time taken = $t = 20 \text{ s}$

Average acceleration = $a_{av} = ?$

Using, $a_{av} = \frac{v_f - v_i}{t}$

Putting the values

$$a_{av} = \frac{70 \text{ ms}^{-1} - 0}{20 \text{ s}}$$

$$a_{av} = 3.5 \text{ ms}^{-2}$$

Thus, the average acceleration of the plane is 3.5 ms^{-2} .

Example 2.5 An iron bob is dropped from the top of a tower. It reaches the ground in 4 seconds. Find

- the height of the tower,
- the velocity of the ball as it strikes the ground.

Solution:

For freely falling body,

Initial velocity = $v_i = 0 \text{ ms}^{-1}$

Acceleration = $a = 10 \text{ ms}^{-2}$

Mini Exercise

The distance time-graph shows the motion of three cyclists.

(a) What does each line on the graph represent?

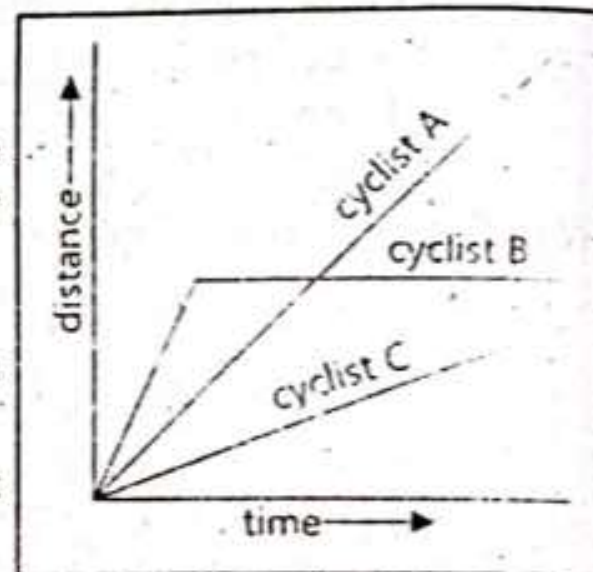
Ans. Each line represents the motion of a cyclist. The slope of the line indicates the cyclist's speed and the higher the slope, the faster the cyclist.

(b) Which cyclist travelled the most distance?

Ans. Cyclist A traveled the most distance because their line reaches farther on the distance axis.

(c) Which cyclist travelled at the greatest speed? The lowest speed At constant speed.

Ans. Cyclist A has the greatest speed because their line is the steepest. Cyclist C has the lowest speed because their line is the flattest. Cyclist B travels at a constant speed, as their line is straight and does not curve.



Objective Type Questions

Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques (Knowledge, Understanding, Application, Analytical & Conceptual)

2.6

Acceleration

23. The rate of change of velocity with time is:
 (a) Acceleration (b) Velocity (c) Speed (d) Distance
24. The unit of acceleration is:
 (a) ms^{-1} (b) ms^{-2} (c) Nm (d) kgm^{-1}
25. The unit of acceleration is:
 (a) kmh^{-2} (b) kmh^{-1} (c) ms^{-1} (d) kms^{-1}
26. Negative acceleration is also called:
 (a) Displacement (b) Retardation (c) Deceleration (d) Both (b) and (c)

2.7

Graphical analysis of motion

27. The point where the two axis intersect each other is known as:
 (a) Graph (b) Variable (c) Origin (d) Slope
28. Slope of distance time graph gives:
 (a) Force (b) Displacement (c) Distance (d) Speed

2.12

Solving problems for motion under gravity

29. $v_f^2 - v_i^2 =$ _____

(a) at

(b) $2as$

(c) v_{avg}

(d) $\frac{\Delta v}{v_i}$

9. If a car accelerates from rest and reaches a velocity of 30 m/s in 10 seconds what is its average acceleration?
- (a) 3 m/s^2 (b) 0.3 m/s^2 (c) 30 m/s^2 (d) 300 m/s^2
10. A ball is thrown horizontally from the top of a tower. Which of the following statement is true?
- (a) The ball's horizontal velocity remains constant while falling
(b) The ball's vertical velocity remains constant
(c) The ball accelerates horizontally at the same rate as vertically
(d) The ball's vertical motion is independent of its horizontal motion
11. Displacement is a vector quantity. Which of the following is true about displacement?
- (a) It is always equal to the distance travelled.
(b) It is the shortest path between the initial and final positions.
(c) It can never be zero.
(d) It is always greater than the distance travelled.
12. A car Travels 100 meters north, then 100 meters east what is the magnitude of its displacement?
- (a) 100 m (b) 200 m (c) 141.4 m (d) 0 m
13. An object moves with constant acceleration. Which of the following statement is true?
- (a) The velocity of the object increases at a constant rate.

8. What is head to tail rule in addition of vectors? OR state head to tail rule in addition of vectors by graphical method?

Ans. Addition of vectors by graphical Method:

Head to tail rule: To add these vectors, we apply a rule called head-to-tail rule, which states that: To add a number of vectors, redraw their representative lines such that the head of one coincides with the tail of the other. The resultant vector is given by a single vector which is directed from the tail of the first vector to the head of the last vector.

2.2

Rest and motion

9. Define rest with example.

Ans. Rest: A body is said to be at rest if it does not change its position with respect to its surroundings.

Examples:

- (i) A book; placed on the table is an example of rest. Because it does not change its position.
- (ii) Trees and streetlights around the roads are the examples of rest. Both do not change their positions.

10. Define motion with example.

Ans. Motion: A body is said to be in motion, if it changes its position with respect to its surroundings.

Examples:

- (ii) The motion of dust or smoke particles in the air is also random motion.
- (iii) Zig zag motion of the molecules of gases and liquids is called random. It is also called Brownian motion. This movement is also shown in figure.

2.4**Distance and Displacement**

20. Define Distance.

Ans. Distance:

- (i) The distance is the length of actual path of the motion.
- (ii) It can be found out by given formula $S = v \times t$
- (iii) It is a scalar quantity because it needs only magnitude to describe.
- (iv) Its unit is meter (m).

21. Define Displacement.

Ans. Displacement:

- (i) Displacement is the shortest distance between two points which has magnitude and direction.
- (ii) It can be found out by given formula $d = v \times t$
- (iii) It is a vector quantity because it needs magnitude and direction to describe.
- (iv) Its unit is meter (m).

2.5**Speed and Velocity**

22. Define speed. Its unit and its formula.

Ans. Definition: The distance covered in unit time is known as speed.

Unit time: It may be a sec, an hour, a day and a year.

2.6

Acceleration

29. Define acceleration. Its formula and unit.

Ans. Acceleration: Acceleration is defined as the rate of change of velocity of a body.

Reason of acceleration: In many cases the velocity of a body changes due to a change either in its magnitude or direction or both. The change in the velocity of a body causes acceleration in it.

Example No 1: Acceleration of a moving object is in the direction of velocity if its velocity is increasing.

Example No 2: Acceleration of the object is opposite to the direction of velocity if its velocity is decreasing.

Formula: Acceleration can be found out by given formula.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{time taken}}$$

$$\text{Acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{time taken}} = a = \frac{v_f - v_i}{t}$$

Here a is the acceleration, v_i is the initial velocity, v_f is the final velocity and t is the time taken.

30. What is meant by deceleration?

OR What is retardation?

Ans. Negative Acceleration, is called deceleration or retardation.

44. Define gravitation acceleration. Write its value.

Ans. Gravitational acceleration: The acceleration of a freely falling bodies is called gravitational acceleration. It is denoted by g .

Value of g : On the surface of the Earth, the value of g is approximately 10ms^{-2} .

45. Write three eq of motion for bodies moving under gravity.

Ans. 1. $v_f = v_i + gt$ **2.** $S = v_i t + \frac{1}{2}gt^2$ **3.** $2gS = v_f^2 - v_i^2$

46. What was Albert Einstein proposed?

Ans. In 1905, famous scientist Albert Einstein proposed his revolutionary theory of special relativity which changed many of the basic concepts of physics.

47. Write a short note on speed of light.

Ans. Speed of light is a universal constant. Its value is approximately $3 \times 10^8\text{ms}^{-1}$. Speed of light remains the same for all motions.

48. Describe universal speed limit.

Ans. Any object with mass cannot achieve speeds equal to or greater than that of light. this is known as universal speed limit.

Conceptual Short Questions

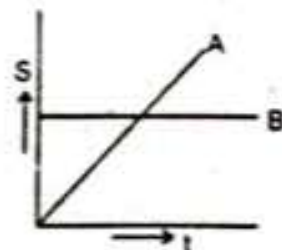
1. Why distance is a scalar quantity and displacement is a vector quantity?

Ans. Distance is a scalar quantity because it only measures the magnitude while displacement is a vector quantity because it measures both magnitude and direction.

2. Why speed is a scalar quantity and velocity is a vector quantity?

2.6 The displacement time graphs of two objects A and B are shown in the figure. Point out the true statement from the following:

- (a) The velocity of A is greater than B.
- (b) The velocity of A is less than B.
- (c) The velocity of A is equal to that of B.
- (d) The graph gives no information in this regard.



2.7 The area under the speed-time graph is numerically equal to:

- (a) velocity
- (b) uniform velocity
- (c) acceleration
- (d) distance covered

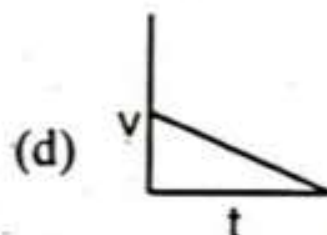
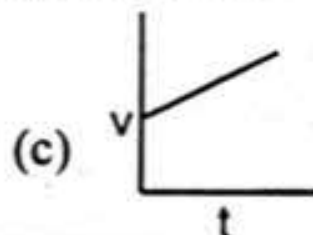
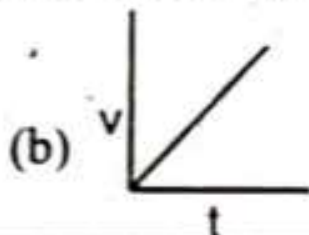
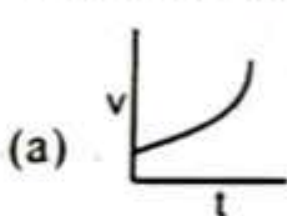
2.8 Gradient of the speed-time graph is equal to:

- (a) speed
- (b) velocity
- (c) acceleration
- (d) distance covered

2.9 Gradient of the distance-time graph is equal to the:

- (a) speed
- (b) velocity
- (c) distance covered
- (d) acceleration

2.10 A car accelerates uniformly from 80.5 kmh^{-1} at $t = 0$ to 113 kmh^{-1} at $t = 9\text{s}$. Which graph best describes the motion of the car?



ANSWERS:

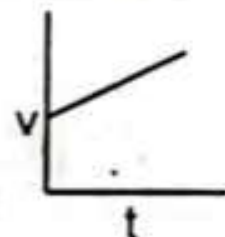
1. equal to or less than one 2. rest 3. 5m 4. 400 m 5. 2 s

6. The velocity of A is greater than B. 7. distance covered

8. acceleration

9. speed

10.



C Constructed Response Questions

2.1 Distance and displacement may or may not be equal in magnitude. Explain this statement.

Ans. Distance and displacement may differ because distance is the total path traveled, while displacement is the shortest path between the start and end points, with direction. They are equal only if the motion is along a straight line in one direction.

2.2 When a bullet is fired, its velocity with which it leaves the barrel is called the muzzle velocity of the gun. The muzzle velocity of one gun with a longer barrel is lesser than that of another gun with a shorter barrel. In which gun is the acceleration of the bullet larger? Explain your answer.

Ans. The gun with the shorter barrel has a larger acceleration of the bullet.

Reason. This is because the bullet in the shorter barrel achieves a higher muzzle velocity. Over a shorter distance, implying a greater rate of change of velocity (acceleration) within that shorter distance, as acceleration is proportional to velocity change divided by the distance traveled.

2.3 For a complete trip, average velocity was calculated. Its value came out to be positive. Is it possible that its instantaneous velocity at any time during the trip had the negative value? Give justification of your answer.

Ans. Yes, average velocity depends on total displacement while instantaneous velocity

(ii) **Speed:** The distance covered in unit time is known as speed.

Velocity: The rate of change in displacement of a body with time is called velocity.

2.3 Describe different types of motion. Also give examples.

Ans. For answer see Q. 5, 6

2.4 Explain the difference between distance and displacement.

Ans. For answer see Q.7

2.5 What do gradients of distance-time graph and speed-time graph represent?

Explain it by drawing diagrams.

Ans. For answer see Q. 16, 18

2.6 Prove that the area under speed-time graph is equal to the distance covered by an object.

Ans. For answer see Q. 19

2.7 How equations of motion can be applied to the bodies moving under the action of gravity?

Ans. For answer see Q. 20, 21

E Numerical Problems

2.1 Draw the representative lines of the following vectors.

(a) A velocity of 400 ms^{-1} making an angle of 60° with x-axis.

Time = $t = 5s$

Required: Final velocity = $v_f = ?$

Formula: By the use of first equation of motion.

$$v_f = v_i + at$$

Solution:

$$\text{as } v_f = v_i + at$$

$$v_f = 5 \text{ ms}^{-1} + 1.5 \text{ ms}^{-2} \times 5s$$

$$v_f = 12.5 \text{ ms}^{-1}$$

Result: The velocity of car after 5 second is 12.5 ms^{-1}

2.5 A motorcycle initially travelling at 18 km h^{-1} accelerates at constant rate of 2 ms^{-2} . How far will the motorcycle go in 10 seconds?

Data:

$$\text{Initial velocity} = v_i = 18 \text{ kmh}^{-1} = \frac{18 \times 1000 \text{ ms}^{-1}}{3600} = 5 \text{ ms}^{-1}$$

$$\text{Acceleration} = a = 2 \text{ ms}^{-2}$$

$$\text{time} = t = 10 \text{ seconds}$$

Required:

$$\text{Distance} = S = ?$$

Formula:

$$\text{By second eq of motion: } S = v_i t + \frac{1}{2} at^2$$

Solution:

Result: (a) A stone take 3s to reach the ground.

(b) The velocity of stone just before hiting the ground is 30ms^{-1}

2.8 A car travels 10 km with an average velocity of 20 ms^{-1} . Then it travels in the same direction through a diversion at an average velocity of 4m s^{-1} for the next 0.8 km. Determine the average velocity of the car for the total journey.

Soluion:

Step-I: Calculate the time taken for the first part of the journey:

$$\text{Distance} = 10\text{ km} = 10000\text{ m}$$

$$\text{Average velocity} = 20\text{ ms}^{-1}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Average velocity}}$$

$$\begin{aligned}\text{Time} &= \frac{10000\text{m}}{20\text{ms}^{-1}} \\ &= 500\text{ s}\end{aligned}$$

Step-II: Calculate the time taken for the second part of the journey:

$$\text{Distance} = 0.8\text{ km} = 800\text{ m}$$

$$\text{Average velocity} = 4\text{ms}^{-1}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Average velocity}}$$

$$\text{Time} = \frac{800\text{m}}{4\text{ms}^{-1}} = 200\text{ s}$$

CHAPTER 3

Dynamics

Student Learning Outcomes

After completing this chapter, students will be able to:

- Illustrate that mass is a measure of the quantity of matter in an object
- Explain that the mass of an object resists change from its state of rest or motion (inertia)
- Describe universal gravitation and gravity. State Newton's Law of gravitation. (Include problems related to gravitation.)
- Define and calculate weight [weight is the force exerted on an object having mass by a planet's gravity and use $w = mg$]
- Define and calculate gravitational field strength [This includes being able to state that a gravitational field is a region in which a mass experiences a force due to gravitational attraction. Students should be able to define gravitational field strength (g) as force per unit mass use the equation gravitational field strength = weight/mass $g = w/m$ (and know that this is equivalent to the acceleration of free fall)]
- Justify and illustrate that use of mechanical and electronic balances to measure mass [understanding the internal workings of the electronic balance is not required; just how to practically use the instrument in appropriate situations]

Force acting on us:

- Some forces of gravity acting downward,
- The force of friction which helps us to walk on the ground and many others.

Types of forces: There are two major types of forces.

(1) Contact forces (2) Non-contact forces.

Q.2. Explain contact force and its examples.**Ans. Contact force:**

- A contact force is a force that acts at the point of contact between two objects
- Applied forces (push, pull and twist) are contact forces.

Examples: Some examples of contact forces are given below

(i) Friction (ii) Drag (iii) Thrust (iv) Normal force
(v) Air Resistance (vi) Tension Force (vii) Elastic Force

- (i) **Friction:** It is the force that resists motion when the surface of one object comes in contact with the surface of another.
- (ii) **Drag:** The drag force is the resistant force caused by the motion of a body through a fluid. It acts opposite to the relative motion of any object moving with respect to surrounding fluid.
- (iii) **Thrust:** It is an upward force exerted by a liquid on an object immersed in it. When we try to immerse an object in water, we feel an upward force exerted on the object. This force increases as we push the object deeper into the water. A ship can float in the sea due to this force which balances the weight of the ship.

$$F = \frac{G m_1 m_2}{r^2}$$

- It is the weakest one among all four fundamental forces.
- It is a long-range force.
- In a way this force extends to infinite distance.

(2) Electromagnetic force:

- It is the force that causes the interaction between electrically charged particles.
- Electrostatic and magnetic forces come under this category.
- These are long range forces.

Electromagnetic fields:

- The areas in which these forces act are called electromagnetic fields.
- Electromagnetic forces are stronger than gravitational and weak nuclear forces.

(3) Strong nuclear forces:

It holds the atomic nuclei together by binding the protons and neutrons in the nucleus over coming repulsive electromagnetic force between positively charged protons. It is also a short-range force with the order of 10^{-14} m. If the distance between nucleons increases beyond this range, this force ceases to act.



Fig. 3.5
A moving magnet produces electric current

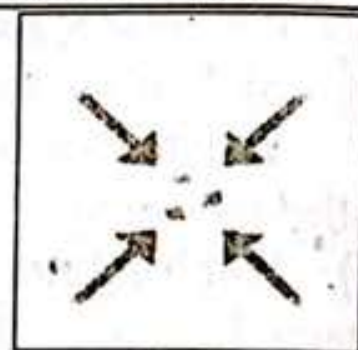


Fig. 3.6
The binding force of protons and neutrons in the nucleus

Force: Force is an agency which changes or tends to change the state of rest or of uniform motion of a body.

In simple words, we can say that force causes acceleration.

Q.8. Write a note on Inertia. OR Explain Inertia.

Ans. Inertia: The property of a body to maintain its state of rest or of uniform motion in a straight line is called inertia.

Inertia Depends upon mass: The mass of an object is a measure of its inertia. The greater the mass of an object, the greater is its inertia.

Example: A net force is required to change the velocity of objects. For instance, a net force may cause a bicycle to pick up speed quickly. But when the same force is applied to a truck, any change in the motion may not be observed. We say that the truck has more inertia than a bicycle.

Q.9. State Newton's second law of motion. Also explain its derivation.

Ans. Newton's second law can be stated as:

Statement: "If a net external force acts upon a body, it accelerates the body in the direction of force. The magnitude of acceleration is directly proportional to the magnitude of force and is inversely proportional to the mass of the body."

Explanation: If a net force of magnitude F acts on a body of mass m and produces an acceleration of magnitude a , then the second law can be written mathematically as.

Derivation:

$$a \propto F$$

$$\text{and } a \propto \frac{1}{m}$$

following.

(1) Relativistic Mechanics : (2) Quantum Mechanics

(1) Relativistic Mechanics: It is concerned with the motion of bodies having a speed close to that of light so that the behaviour is described by the theory of relativity rather than Newtonian mechanics.

(2) Quantum Mechanics: It is the field of physics, that explains how extremely small objects simultaneously have the characteristics of both particles (matter) and waves. Physicists call this the wave - particle duality.

Conclusion: The conclusion is that Newton's laws of motion are not exact for all types of motion, but provide a good approximation, unless an object is small enough or moving close to the speed of light.

3.6

Mass and Weight

Q.12. Explain Mass and weight?

Ans. Mass: The characteristic of a body which determines the magnitude of acceleration produced when a certain force acts upon it is known as mass of the body.

Example: The weight of the object is 5kg, it is not true. Infact, 5kg is the mass of the object.

- Mass is a scalar quantity.
- It remains the same everywhere.
- The SI unit of mass is kilogram (kg).
- It is denoted by 'm'.
- Mass is measured by an ordinary balance.

Weight: The weight of an object is equal to the force with which the Earth attracts the body towards its centre.

3.8

Friction

Q.14. Define friction and dissipative effect of friction with examples?

Ans. Friction: Friction is force that tends to prevent the bodies from sliding over each other.

Dissipative Effect of Friction: Friction is a dissipative force such as the friction force between solids or the drag force in motions through fluid.

Role of energy: Energy is wasted in doing work against friction. The lost energy appears in the forms of heat.

Example No 1: A very common example of energy dissipation is the rubbing of hands, when we rub our hands, heat is generated due to friction and our hands become warm.

Example No 2: Temperature of machines rises due to friction that can cause many problems.

Example No 3: Tyres of vehicles wear out after being too hot due to friction between tyres and road.

Example No 4: Shooting of stars seen in the sky at night also happen due to friction of air.

These are actually asteroids that enter the Earth's atmosphere. As they are moving, air resistance causes generation of heat. Their temperature becomes so high that they start burning and ultimately disintegrate.

Q.15. Explain sliding friction and its categories.

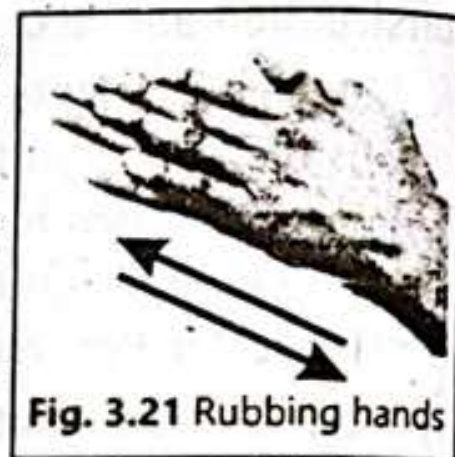


Fig. 3.21 Rubbing hands

and ships also face friction while moving through air or water. If the front of a vehicle is flat, it faces more resistance by air or water. Therefore, the bodies moving through air or water are streamlined to minimize air or water friction.

Streamline flow: The air passes smoothly over the slanting surface of vehicle. This type of flow of air is known as streamline flow.

3.9

Momentum and Impulse

Q. 19. What is momentum and impulse? Derive the relation between momentum and impulse.

Ans. Momentum: Momentum of a body is the quantity of motion it possess due to its mass and velocity.

Formula: The momentum of a body is given by the product of its mass (m) and velocity (v).

$$P = mv$$

Unit: The unit of momentum is kg ms^{-1} . It can also be written as (Ns).

Vector quantity: Momentum is a vector quantity because it needs magnitude, unit and direction for its description.

Impulse: Impulse is defined as $F \times \Delta t$ or $m \Delta v$ equal to the total change in momentum.

Therefore, $\text{Impulse} = F \times \Delta t = m \Delta v$

Dividing by Δt ,

$$F = \frac{m(\Delta v)}{\Delta t}$$

Where $m(\Delta v)$ is the change in momentum Δp .

$$\text{Acceleration} = a = 2\text{ms}^{-2}$$

$$\text{Force} = F = ?$$

By Newton's second law of motion

$$F = ma$$

So, $F = 10\text{kg} \times 2\text{ms}^{-2}$

$$F = 20\text{N}$$

Thus, the force acting on the block is 20N.

Example 3.2: A force of 7500N is used to move a truck of mass 3000kg. Find the acceleration produced in the truck. How long will it take to accelerate the truck from 36kmh^{-1} to 72kmh^{-1} speed?

Solution:

$$\text{Mass of truck} = m = 3000\text{kg}$$

$$\text{Force applied} = F = 7500\text{N}$$

$$\text{Acceleration} = a = ?$$

$$\text{Initial speed} = v_i = 36\text{kmh}^{-1}$$

$$v_i = \frac{36 \times 1000\text{m}}{60 \times 60\text{s}} = 10\text{ms}^{-1}$$

$$\text{Final speed} = v_f = 72\text{kmh}^{-1}$$

$$v_f = \frac{72 \times 1000\text{m}}{60 \times 60\text{s}} = 20\text{ms}^{-1}$$

By Newton's second Law

Velocity of first ball = $v_1 = 5\text{ms}^{-1}$
before collision

Mass of second ball = $m_2 = 2\text{kg}$

Velocity of second ball = $v_2 = 0$

Velocity of both the balls after collision = $v = ?$

Total mass of balls after collision = $m_1 + m_2$

By law of conservation of momentum,

Total momentum before collision = Total momentum after collision

$$m_1v_1 + m_2v_2 = (m_1 + m_2)v$$

$$3\text{kg} \times 5\text{ms}^{-1} + 0 = (3\text{kg} + 2\text{kg})v$$

$$15\text{kgms}^{-1} = 5\text{kg} \times v$$

$$v = 3\text{ms}^{-1}$$

Thus, The velocity with which both the balls will move after collision is 3ms^{-1} .

Quick Quiz

- Newton's was born in:
(a) January 4, 1643 (b) January 5, 1643 (c) January 6, 1643 (d) January 7, 1643
- The weight of 100g mass is:
(a) 1N (b) 1.5N (c) 2N (d) 3N

ANSWERS:

1. (a) 2. (a)

Mini Exercise

5. The force between two objects which are not in physical contact is:
 - (a) Contact
 - (b) Friction
 - (c) Non contact
 - (d) Drag
6. An apple falling down from a tree is an example of:
 - (a) Gravitational force
 - (b) Magnetic force
 - (c) Elastic force
 - (d) Weak and strong force
7. What is the value of G if $F = G \frac{m_1 m_2}{r^2}$?
 - (a) $6.67 \times 10^{10} \text{ Nm}^2 \text{ kg}^{-2}$
 - (b) $6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$
 - (c) $6.67 \times 10^{-10} \text{ Nm}^2 \text{ kg}^{-2}$
 - (d) $6.67 \times 10^9 \text{ Nm}^2 \text{ kg}^{-2}$
8. A Pakistani Scientist Dr. Abdus Salam along with Sheldon Glashow and Steven Weinberg were awarded in:
 - (a) 1980
 - (b) 1981
 - (c) 1970
 - (d) 1979
9. Which force is responsible for the disintegration of nucleus?
 - (a) Strong nuclear force
 - (b) Electromagnetic force
 - (c) Gravitational force
 - (d) Weak nuclear force
10. Newton was born in:
 - (a) January 5, 1643
 - (b) January 6, 1643
 - (c) January 4, 1643
 - (d) January 3, 1643
11. The property of a body to maintain its state of rest or in a straight line is called:
 - (a) Force
 - (b) Inertia
 - (c) Momentum
 - (d) Impulse
12. Inertia depends upon:
 - (a) Mass
 - (b) Velocity
 - (c) Displacement
 - (d) Time
13. 1 Newton = ?
 - (a) 1 kgms^{-2}
 - (b) 1 kgms
 - (c) $1 \text{ kgm}^{-1}\text{s}^{-1}$
 - (d) $1 \text{ kg}^{-1}\text{m}^{-1}\text{s}^{-1}$

4. A ball is dropped from a height. Neglecting air resistance, its acceleration is:
 (a) Increasing (b) Decreasing (c) Constant (d) Zero
5. Two objects of different masses are dropped from the same height in a vacuum. They will:
 (a) Hit the ground at the same time
 (b) Hit the ground at the times due to different masses
 (c) Acceleration differently (d) None of these above
6. If the net force acting on an object is doubled, its acceleration will:
 (a) Remain constant (b) Be halved (c) Doubled
 (d) Depend on its velocity
7. A person standing in an elevator feels lighter when the elevator is:
 (a) Accelerating downward (b) Accelerating upward
 (c) Moving at constant speed upward (d) At rest
8. The force that keeps an object moving in a circular path is called:
 (a) Centrifugal force (b) Gravitational force (c) Normal force (d) Centripetal force
9. Which of the following quantities is a measure of inertia?
 (a) Weight (b) Mass (c) Velocity (d) Acceleration
10. A book resting on a table does not fall because:
 (a) Gravity acts upward
 (b) The table exerts a downward force equal to the book's weight
 (c) The net force on the book is zero
 (d) There is no force acting on the book
11. What is the direction of the net force on an object moving in a circular path?



with the surface of another.

7. What is drag force?

Ans. Drag: The drag force is the resistance force caused by the motion of a body through a fluid. It acts opposite to the relative motion of any object moving with respect to surrounding fluid.

8. Which is force of thrust?

Ans. It is an upward force exerted by a liquid on an object immersed in it. When we try to immerse an object in water, we feel an upward force exerted on the object. This force increases as we push the object deeper into the water. A ship can float in the sea due to this force which balances the weight of the ship.

9. Define normal force.

Ans. It is the force exerted by the surface on an object lying on it. This force acts outward and perpendicular to the surface. It is also called the support force upon the object.

10. What is air resistance?

Ans. It is the resistance (opposition) offered by air when an object falls through it.

11. What is tension force?

Ans. It is the force experienced by a rope when a person or load pulls it.

12. Define elastic force with example.

Ans. It is a force that brings certain materials back to their original shape after being deformed. Examples are rubber bands, springs, trampoline etc.

13. Define action-at-a-distance.

Ans. The non-contact forces can work from a distance. That is why these are sometimes called as action-at-a-distance.

1 kg. $1 \text{ N} = 1 \text{ kgm}^{-2}$

31. State Newton's third law of motion.

Ans. For every action there is always an equal and opposite reaction.

32. Define relativistics velocities.

Ans. The problems arise when we deal with the motion of elementary particles having velocities close to that of light. These velocities are known as relatives velocities. For example, mass of objects starts increasing, length of object appearing shorter and time duration of events becomes longer.

33. Differentiate between mass and weight.

Ans. Mass: The characteristic of a body which determines the magnitude of acceleration produced when a certain force acts upon it is known as mass of the body. Mass is a scalar quantity denoted by 'm'. It remains the same everywhere. Practically, mass is measured by an ordinary balance. The SI unit of mass is kilogram (kg).

Weight: The weight of an object is equal to the force with which the Earth attracts the body towards its centre. By Newton's law, $F = ma$, the weight of a body 'w' will be given by $w = mg$, where g is the gravitational acceleration. As the value of g varies from place to place and also with altitude, therefore, the value of weight does not remain the same everywhere.

34. What is balances scales? Write its types.

Ans. Balance scales are commonly used to compare masses of objects or to weigh objects by balancing them with standard weights.

35. Define mechanical platform balances.

and m_2 are two masses distance r apart and G is constant of gravitation. Its value is $6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$.

50. State Newton's law of Gravitation.

Ans. Statement: "Every particles in the universe attracts every other particles with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their center.

Mathematically: $F = G \frac{m_1 m_2}{r^2}$

51. State law of inertia.

Ans. "An object will remain at rest, or continue to move in a straight line at a constant speed, unless acted upon by an external force."

52. Prove $F = ma$?

Ans. Statement: If a net force of magnitude ' F ' acts on a body of mass ' m ' and produce an acceleration of magnitude ' a ', then second law can be written mathematically as:

Derviation: and

$$a \propto F$$

$$a \propto \frac{1}{m}$$

So $a \propto \frac{F}{m}$ or $a (\text{constant}) \frac{F}{m}$

the value of constant will be 1:

- 3.2** An object will continue its motion with constant acceleration until:
- the resultant force on it begins to decrease.
 - the resultant force on it is zero.
 - the resultant force on it begins to increase.
 - the resultant force is at right angle to its tangential velocity.
- 3.3** Which of the following is a non-contact force?
- Friction
 - Air resistance
 - Electrostatic force
 - Tension in the string
- 3.4** A ball with initial momentum p hits a solid wall and bounces back with the same velocity. Its momentum p' after collision will be:
- $p' = p$
 - $p' = -p$
 - $p' = 2p$
 - $p' = -2p$
- 3.5** A particle of mass m is moving with velocity v collides with another particle of the same mass at rest. The velocity of the first particle after collision is:
- v
 - $-v$
 - 0
 - $-1/2$
- 3.6** Conservation of linear momentum is equivalent to:
- Newton's first law of motion
 - Newton's second law of motion
 - Newton's third law of motion
 - None of these
- 3.7.** An object with a mass of 5kg moves at constant velocity of 10ms^{-1} . A constant force then acts for 5 seconds on the object and gives it a velocity of 2ms^{-1} in the opposite direction. The force acting on the object is:
- 5N
 - -10N
 - -12N
 - -15N
- 3.8.** A large force acts on an object for a very short interval of time. In this case, it is easy to determine:

the 80kg skater applies an equal and opposite force on the 60kg skater.

Calcualtion: since there are no external force, momentum is conserved.

$$m_1v_1 + m_2v_2 = 0$$

Mass of the first skater = $m_1 = 60\text{kg}$

Mass of the second skater = $m_2 = 80\text{kg}$

Velocity of the first skater = $v_1 = 4\text{ms}^{-1}$

Required:

Velocity of the second skater = $v_2 = ?$

Formula: $m_1v_1 + m_2v_2 = 0$

Solution: By using $m_1v_1 + m_2v_2 = 0$

$$60\text{kg} \times 4\text{ms}^{-1} + 80\text{kg} \times v_2 = 0$$

$$240\text{kgms}^{-1} + 80v_2 = 0$$

$$v_2 = -\frac{240\text{kgms}^{-1}}{80\text{kg}}$$

$$v_2 = -3\text{ms}^{-1}$$

Result: The velocity of the 80kg skater is 3ms^{-1} (The negative sign indicates that the second skater moves in the opposite direction to the first skater)

3.2 Inflatable air bags are installed in the vehicles as safety equipment. In terms of momentum, what is the advantage of air bags over seat belts?

Ans. Airbags, compared to seatbelts, offer a significant advantage by increasing the time over which the occupant's momentum changes during a collision. This result in a

The tyre surface is designed to maximize friction. The tread pattern (the grooves and ridges on the tyre) increases the contact area between the tyre and the road, providing more grip. The rubber compound itself is formulated to have a high coefficient of friction with various road surfaces (asphalt, concrete, etc.) A worn tyre has less tread, has less tread, reducing the contact area and thus the friction. Wet or icy roads also reduce friction because a layer of water or ice reduces the direct contact between the tyre and the road surface.

When brakes are applied, the braking system acts on the wheels, creating a torque that tyre to slow the wheels' rotation. This action, however, depends on the friction between the tyres and the road. The braking force is the force that slows the vehicle down. This force is directly proportional to the friction force between the tyres and the road. If the friction is low (e.g on ice), the braking force will be reduced, leading to a longer stopping distance. The maximum breaking force is limited by the maximum static friction force between the tyres and the road. If the braking force exceeds the maximum static friction force, the tyres will skid (kinetic friction takes over, which is less than static friction), and the braking force will decrease.

E Numerical Problems

- 3.1. A 10 kg block is placed on a smooth horizontal surface. A horizontal force of 5N is applied to the block. Find:

Result: Thus, The force to increase the velocity is 1600N.

3.4. A 5g bullet is fired by a gun. The bullet moves with a velocity of 300 ms^{-1} . If the mass of the gun is 10 kg, find the recoil speed of the gun.

Data: Mass of the bullet = $m_b = 5\text{g} = 0.005\text{kg}$

Mass of the gun = $m_g = 10\text{kg}$

Velocity of the bullet = $v_b = 300\text{ms}^{-1}$

Required:

Velocity of the gun = $v_g = ?$

Formula:

$$m_b v_b + m_g v_g = 0.$$

Solution:

Total Initial momentum before fired = Total Final momentum after fired

$$0 = m_b v_b + m_g v_g$$

then, $m_g v_g = -m_b v_b$

$$v_g = -\frac{m_b v_b}{m}$$

$$v_g = \frac{0.005\text{kg} \times 300\text{ms}^{-1}}{10\text{kg}}$$

$$v_g = -\frac{1.5}{10} \text{ ms}^{-1}$$

$$v_g = -0.15\text{ms}^{-1}$$

Result: The common velocity of the two bogies after they become coupled is 1.03ms^{-1} .

- 3.7.** A cyclist weighing 55 kg rides a bicycle of mass 15 kg. He starts from rest and applies a force of 90 N for 8 seconds. Then he continues at a constant speed for another 8 seconds. Calculate the total distance travelled by the cyclist.

Data:

$$\text{Cyclist mass} = m_1 = 55 \text{ kg}$$

$$\text{Bicycle's mass} = m_2 = 15 \text{ kg}$$

$$\begin{aligned}\text{Total mass} &= m_1 + m_2 \\ &= 55 + 15 = 70\text{kg}\end{aligned}$$

$$\text{Initial velocity} = v_i = 0 \text{ ms}^{-1}$$

$$\text{Force} = F = 90\text{N}$$

$$\text{Time} = t = 8\text{s}$$

Required:

$$\text{Total distance} = d = ?$$

Formula:

$$d_1 = v_i t + \frac{1}{2} at^2$$

$$d_2 = v \times t$$

Solution: First, we calculate the acceleration using Newton's second law

$$F = ma$$

$$a = \frac{F}{m}$$

$$90\text{N}$$

$$I = 0.4\text{kg}(4\text{ms}^{-1} - (-6)\text{ms}^{-1})$$

$$I = 0.4\text{kg}(4 + 6\text{ms}^{-1})$$

$$I = 0.4\text{kg}(10\text{ms}^{-1})$$

$$I = 4\text{Ns}$$

$$\text{Impulse} = 4\text{Ns}$$

Since the impulse is positive, the direction of the impulse is upward.

3.9. Two balls of masses 0.2 kg and 0.4 kg are moving towards each other with velocities 20ms^{-1} and 5ms^{-1} respectively. After collision, the velocity of 0.2kg ball becomes 6ms^{-1} . What will be the velocity of 0.4 kg ball?

Data:

$$\text{Mass of 1}^{\text{st}} \text{ ball} = m_1 = 0.2\text{kg}$$

$$\text{Velocity of 1}^{\text{st}} \text{ ball before collision} = v_1 = 20\text{ms}^{-1}$$

$$\text{Mass of 2}^{\text{nd}} \text{ ball} = m_2 = 0.4\text{kg}$$

$$\text{Velocity of 2}^{\text{nd}} \text{ ball before collision} = v_2 = -5\text{ms}^{-1}$$

(Since it is moving toward ball 1, we take the velocity as negative)

$$\text{Velocity of 1}^{\text{st}} \text{ ball after collision} = v_1' = 6\text{ms}^{-1}$$

Required:

$$\text{Velocity of 2}^{\text{nd}} \text{ ball after collision} = v_2' = ?$$

Formula:

4.1

Like and Unlike Parallel Forces

Q 1. What are types of parallel forces? Also give examples.

Ans. There are two types of parallel forces.

1. Like parallel forces
2. Unlike parallel forces

1. **Like parallel forces:** If the parallel forces are acting in the same direction, they are called like parallel forces.

2. **Unlike parallel forces:** If their directions are opposite to one another, they are called unlike parallel forces.

Example: Three forces F_1 , F_2 and F_3 are shown in Fig. 4.1 acting on a rigid body at different points. Here, the forces F_1 and F_2 are like parallel forces but F_2 and F_3 are unlike parallel forces.

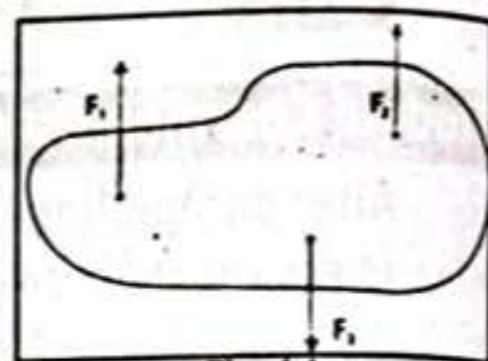


Fig. 4.1

4.2

Addition of Forces

Q.2: How forces can be added by head to tail rule?

Ans. We have already learnt about vectors and their representation. Remember that the resultant is the same for any order of addition of vectors. As forces are vectors, so forces can also be added by head to tail rule.

To determine the resultant of two or more forces acting in a plane, the following example will explain its method.

Example: Let us add three force vectors F_1 , F_2 and F_3 having

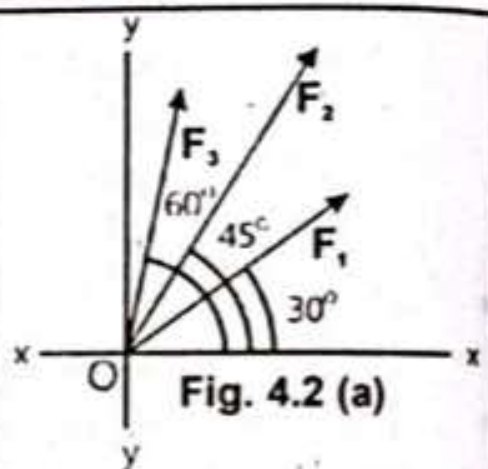


Fig. 4.2 (a)

the same body, they form a couple.

Explanation: A couple is a special type of torque. We observe at many situations in our daily life, when two equal and opposite parallel forces produce torque.

Example 1: While opening or closing a water tap, turning key in the lock, opening the lid of a jar.

Example 2: Turning steering wheel of a motor car, we apply a pair of equal forces in opposite directions. The torque produced in this way is known as couple.

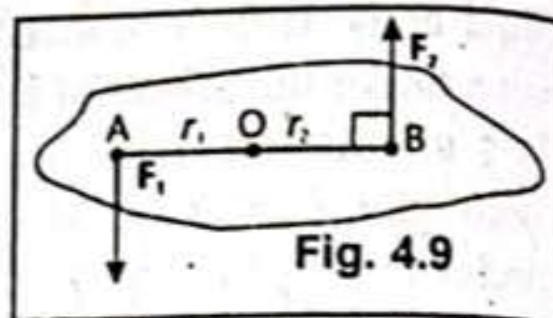


Fig. 4.9

4.4

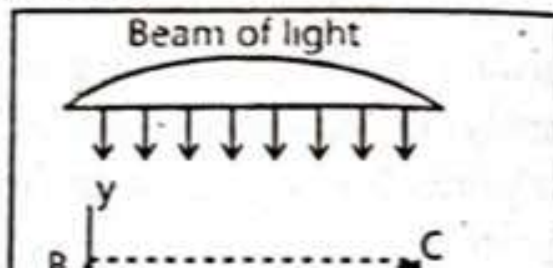
Resolution of Vectors

Q.6: Define resolution of force. How can a force be resolved into its perpendicular components?

Ans. Resolution of a force: To divide a force into its components is known as resolution of a force.

Explanation: By head-to-tail rule, two or more vectors can be added to give a resultant vector. Its reverse process is also possible, i.e. a given vector can be divided into two or more parts. These parts are called as components of the given vector. If these components are added up, their resultant is equal to the given vector.

Perpendicular or rectangular components: A force is resolved into two components which are perpendicular to each other. These are called its perpendicular or rectangular components of the force.



- **Unit of Moments:** SI unit of moments is: Newton - metre (Nm).

Applications:

1. **Seasaws:** To balance a seasaw, the moments on either side of the pivot must be equal.
2. **Levers:** Tools like crowbars and scissors rely on the principle of moments to make work easier.
3. **Structural Engineering:** Ensuring stability of bridges and buildings.
4. **Rotational Mechanics:** In understanding and designing rotating machinery.
If the moments are unbalanced, the object will rotate in the direction of the larger moment.

4.7**Centre of Gravity and Centre of mass**

Q.9: Define centre of gravity. Also explain it.

Ans. Centre of Gravity: "Centre of gravity is that point where total weight of the body appears to be acting."

- If a body supported at its centre of gravity, it stays there without rotation.

Explanation:

An object is composed of a large number of small particles. Each particle is acted upon by the gravitational force directed towards the centre of the Earth. As the object is small as compared to the Earth, the value of g can be taken as uniform over all particles. Therefore, each particle experiences the same force mg . Since all these forces are parallel and act in the same direction, so their resultant as shown in will be equal to the sum of all these forces i.e.,

Resultant of force = Σmg where Σ means the "sum of".

(i) Static equilibrium (ii) Dynamic equilibrium

(i) **Static Equilibrium:** A body at rest is in static equilibrium.

Example: 1. An example of static equilibrium is a book lying on the table. Only two forces are acting on it. One is its weight $w=mg$ acting downward and the other is F_n the normal force that the table exerts upward on the book. Since the book is at rest so it has zero acceleration. Therefore, the sum of all the forces acting on the book should be zero, so that the book is said to be in equilibrium. Hence

$$F_n - w = 0$$

$$\text{or } F_n = w$$

This means that forces can act on a body without accelerating it, provided these forces balance each other.

2. An electric bulb hanging from the ceiling of a room, a man holding a box, a beam held horizontal against a wall with the help of a rope and a hanging weight, are all examples of static equilibrium.

(ii) **Dynamic Equilibrium:** A boy moving with uniform velocity is in dynamic equilibrium.

Example: A good example of dynamic equilibrium is a paratrooper (Fig. 4.19). In a few second after the free fall, the parachute opens and a little later, the paratrooper starts descending with a uniform velocity.

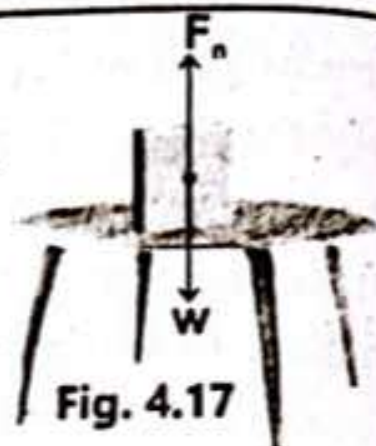


Fig. 4.17

Book is in static equilibrium

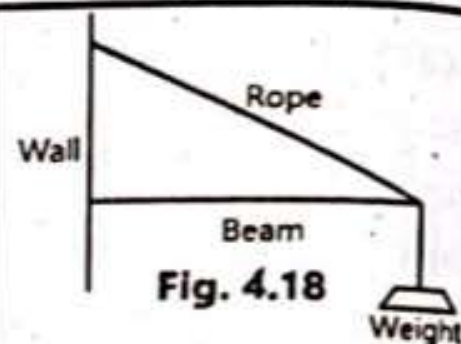


Fig. 4.18

A beam projected from a wall is also in static equilibrium



4.10

States of Equilibrium

Q.16: There are how many states of equilibrium. Define and explain them with examples.

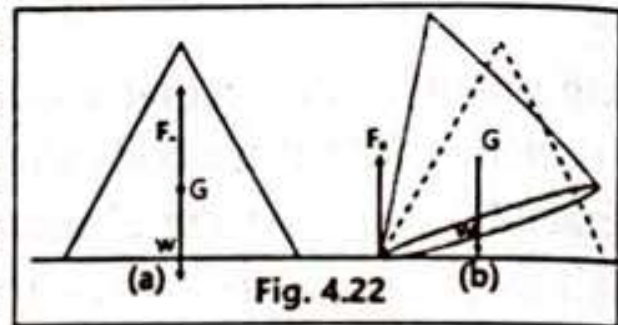
Ans. States of equilibrium: An object is balanced when its centre of mass and its point of support lie on the same vertical line. Then forces on each side are balanced, and the object is said to be in equilibrium. There are three states of equilibrium in connection with stability of the balanced bodies.

(i) Stable equilibrium (ii) Neutral equilibrium (iii) Unstable equilibrium

i. Stable Equilibrium: A body is said to be in a state of stable equilibrium, if after a slight tilt, it comes back to its original position.

Explanation: Stable equilibrium occurs when the torques arising from the rotation (tilt) of the object compel the body back towards its equilibrium position.

Example: The cone shown in Fig. 4.22 (a) is in the state of stable equilibrium. Its weight w acting downward at the centre of gravity G and the reaction of the floor F_n acting upward, lie on the same vertical line. Since these forces are equal and in opposite direction, so they balance each other and both the conditions of equilibrium are satisfied.



As you try to push over the cone slightly, its centre of gravity is raised but it still remains above the base of the cone. The weight w and the normal force F_n do not remain in the same line but act like two unlike parallel forces. The cone does not remain in

The kids learn from these toys about stable systems and how they return to their state of initial rest position after being disturbed. Educational games on the basis of balancing toys have also been developed for the kids.

Q.19: Write a note on Rotational motion versus translational motion?

Ans. counterparts of velocity, acceleration, force and momentum in translational motion are angular velocity, angular acceleration, moment of force (torque) and angular momentum respectively in rotational motion. It suggests that the torque plays the same role in the rotational motion that is played by the force in the translational motion. Therefore, we are justified to predict that analogous to Newton's first law of motion, a rotating object will continue to do so with constant angular velocity unless acted upon by a resultant moment (torque). However, if a resultant torque is applied to rotating object, it will accelerate depending on the direction of the torque relative to the axis of rotation.

This fundamental principle enhances our understanding how objects move and interact with their environment whether in linear or rotational motion scenarios.

Q.20: Explain motion in a circle.

Ans. When a body is moving along a circular path its velocity at any point is directed along the tangent drawn at that point. Shows that the direction of tangent at each point on a circle is different, therefore, the velocity of an object moving with uniform speed in a circle is changing constantly. Hence, a force perpendicular to the direction of motion is always required to keep the object moving with uniform speed in a circular path.

It should be noted that F is essentially perpendicular to v . For an instance"; if it is

$$F_c = m \cdot \frac{v^2}{r} = \frac{mv^2}{r}$$

Key points:

- The direction of centripetal force is towards the centre.
 - Without this force, the object would move tangentially due to inertia.
2. Explain the concept of work, energy and power. Derive the work-energy theorem?

Ans. Work is done when a force is applied to an object and the object moves in the direction of the force.

$$W = F \cdot d \cos \theta$$

Energy: Energy is the capacity to do work.

- **Kinetic energy:** Energy of motion: $K.E = \frac{1}{2} mv^2$
- **Potential energy:** $P.E = mgh$

Power: Power is the rate at which work is done. $P = \frac{W}{t}$

Work-Energy theorem:

The net work done on an object is equal to its change in kinetic energy.

$$W_{\text{net}} = \Delta K.E = \frac{1}{2} m(v_f^2 - v_i^2)$$

Proof: Using Newton's second law.

$$F = ma \quad \text{and} \quad a = \frac{v_f^2 - v_i^2}{2s}$$

Example 4.5: A picture is suspended by means of two vertical strings as shown in Fig. 4.21. The weight of the picture is 5N, and it is acting at its centre of gravity. Find the tension T_1 & T_2 in the two strings.

Solution:

$$\text{Total upward force} = T_1 + T_2$$

$$\text{Total downward force} = w = 5\text{N}$$

$$\text{Tensions in the strings, } T_1 = ?, T_2 = ?$$

$$\text{Since, there is no horizontal force, so } \Sigma F_x = 0$$

$$\text{Putting } \Sigma F_x = 0 \text{ and } \Sigma F_y = 0$$

$$T_1 + T_2 - w = 0 \dots\dots\dots (i)$$

Apply $\Sigma \tau = 0$, selecting point B as point of rotation. Here torque τ_1 of T_1 is negative whereas torque τ_2 of w is positive about point B. T_2 produces zero torque as it passes through the point of rotation. Hence, $\tau_2 - \tau_1 = 0$

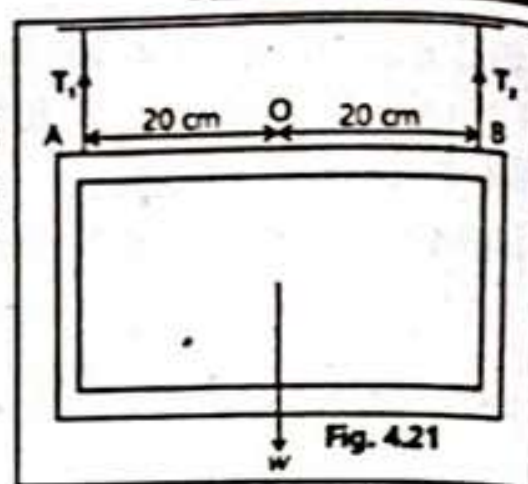
$$\text{or } w \times BO - T_1 \times AB = 0$$

Putting the values,

$$w \times 0.2\text{m} - T_1 \times 0.4\text{m} = 0$$

$$5\text{N} \times 0.2\text{m} - T_1 \times 0.4\text{m} = 0$$

$$T_1 = \frac{5\text{N} \times 0.2\text{m}}{0.4\text{m}} = 2.5\text{N}$$



4. $\sin 90^\circ =$ _____
(a) 1.0 (b) 0 (c) $\frac{1}{\sqrt{2}}$ (d) $\frac{\sqrt{3}}{2}$
5. $\tan 60^\circ =$ _____
(a) 0 (b) $\sqrt{3}$ (c) $\frac{1}{2}$ (d) 1.0
6. $\sin 45^\circ =$ _____
(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{1}{2}$ (c) 0 (d) $\frac{1}{\sqrt{2}}$
7. How many ratios trigonometric have?
(a) five (b) six (c) seven (d) eight
8. $\cos 45^\circ =$ _____
(a) $\frac{1}{\sqrt{2}}$ (b) 1.0 (c) 0 (d) $\frac{\sqrt{3}}{2}$
9. $\tan 0^\circ =$ _____
(a) 1.0 (b) 0 (c) $\frac{1}{2}$ (d) $\frac{1}{\sqrt{2}}$
10. Which is an application of principle of moments?
(a) Seasaw (b) Levers (c) Bamboo stick (d) All of these

4. Unlike parallel forces acting _____ in direction.
 (a) Same (b) opposite (c) different (d) None

4.3
Turning Effect of a Force

5. Turning effect of force is called:
 (a) torque (b) momentum (c) velocity (d) force
6. During rotation the particles of rigid body rotate alongs _____.
 (a) centre (b) fixed circles (c) line of action (d) their direction
7. The line along which the force acts is called:
 (a) line of action (b) moment arm (c) torque (d) axis of rotation
8. A couple is a special type of _____.
 (a) torque (b) force (c) acceleration (d) velocity
9. While turning a vehicle _____ is applied on the steering wheel.
 (a) force (b) couple (c) pressure (d) momentum
10. Product of force and moment arm is called:
 (a) moment of force (b) torque (c) both a & b (d) None
11. Moment of force is applied in the working of _____.
 (a) running car (b) cycling (c) bottle opener (d) pushing
12. Torque of force is zero when the line of action of force passes through the _____.
 (a) centre (b) bottom (c) axis of rotation (d) top
13. In anticlockwise direction torque is _____.
 (a) negative (b) positive (c) neutral (d) none
14. In clockwise rotation torque is _____.

33. Example of dynamic equilibrium is ____
(a) running man (b) moving (c) paratrooper (d) all of these

4.9

Conditions of Equilibrium

34. There are ____ conditions of equilibrium.
(a) two (b) three (c) four (d) five
35. 1st condition of equilibrium satisfies when ____.
(a) $\Sigma F = 0$ (b) $\Sigma \tau = 0$ (c) $\Sigma F \neq 0$ (d) $\Sigma \tau \neq 0$
36. Second condition of equilibrium satisfies when:
(a) $\Sigma F = 0$ (b) $\Sigma \tau \neq 0$ (c) $\Sigma F \neq 0$ (d) $\Sigma \tau = 0$

4.10

States of Equilibrium

37. There are ____ states of equilibrium.
(a) two (b) three (c) four (d) five
38. An object is balanced when its centre of mass and its point of intersection lie on ____ vertical line.
(a) different (b) opposite (c) same (d) none
39. If a body returns back to its original position after tilt it is in:
(a) unstable equilibrium (b) stable equilibrium
(c) neutral equilibrium (d) none of these
40. If a body does not come back to its original position after tilt it is in ____ equilibrium.
(a) stable (b) unstable (c) neutral (d) static
41. If a body comes to rest in its new position after disturbance then it is in

6. What happens to the stability of an object when its centre of gravity is lowered?
- (a) It becomes less stable (b) It becomes more stable
(c) It remains the same (d) It becomes unstable
7. Which of the following is not a counterpart of a quantity in translational motion in rotational motion?
- (a) velocity (b) acceleration (c) momentum (d) energy
8. Which of the following is not a source of a centripetal force?
- (a) gravity (b) friction (c) tension (d) electrical force
9. What happens to the centripetal force if the radius of the circular path is increased while keeping the speed constant?
- (a) The centripetal force increases (b) the centripetal force decreases
(c) centripetal force remains same (d) the centripetal force becomes zero
10. What is the key principle behind resolving a force into its components?
- (a) the principle of superposition
(b) the law of conservation of momentum
(c) Newton's third law (d) the Pythagorean theorem
11. What is a component of a vector?
- (a) the direction of the vector (b) the magnitude of the vector
(c) the effective value of the vector in a specific direction
(d) the change in vector over time.

Moment of Force

11. What is moment of force or torque?

Ans. Moment of a force or torque is defined as the product of the force and the moment arm. i.e. $\tau = F \times \ell$

12. When does torque of force zero?

Ans. The torque of a force is zero when the line of action of force passes through the axis of rotation, because its moment arm becomes zero.

13. What is the unit of torque?

Ans. SI unit of torque is newton metre (Nm).

4.4**Resolution of Vectors**

14. What are the components of the vector?

Ans. A vector can be divided into two or more parts. These parts are then called as components of the given vector.

15. What is resolution of force?

Ans. To divide a force into its components is known as resolution of a force.

16. What are perpendicular or rectangular components of the force?

Ans. A force is resolved into two components which are perpendicular to each other. These are called its perpendicular or rectangular components of the force.

17. What is component of a vector?

Ans. A component of a vector is its effective value in a given direction.

3. What are factors that determine the turning effect of a force?

Ans. The turning effect of force depends on:

- (a) The magnitude of the force.
- (b) The moment arm of the force.

4. How can we increase the turning effect of a force on a door?

Ans. We can increase the turning effect by:

- * Increasing the force applied.
- * Pushing the door farther the away from the hinge.

5. Why can the centre of gravity of an object be outside of the object itself?

Ans. In objects with complex shapes, like a bowl, the centre of gravity can lie outside the material, as the mass distribution is uneven.

6. What is the difference between centre of gravity and the centre of mass?

Ans. The centre of gravity is the point where the force of gravity acts on an object, while the centre of mass is the point where the mass of an object is concentrated.

7. Explain how to determine the centre of gravity of an irregularly shaped object?

Ans. The centre of gravity can be found by suspending the object from different points and drawing vertical lines from each point of suspension. The intersection of these lines will be the centre of gravity.

8. How many types of forces are responsible for translational and rotational motion?

Ans. External forces are responsible for both translational and rotational motion.

9. Why is a paratrooper an example of dynamic equilibrium?

- 4.7. In stable equilibrium the centre of gravity of the body lies:
 (a) at the highest position (b) at the lowest position
 (c) at any position (d) outside the body
- 4.8. The centre of mass of a body:
 (a) lies always inside the body (b) lies always outside the body
 (c) lies always on the surface of the body (d) may lie within, outside or on the surface
- 4.9. A cylinder resting on its circular base is in:
 (a) stable equilibrium (b) unstable equilibrium
 (c) neutral equilibrium (d) none of these three
- 4.10. Centripetal force is given by:
 (a) rF (b) $rF\cos\theta$ (c) $\frac{mv^2}{r}$ (d) $\frac{mv}{r^2}$

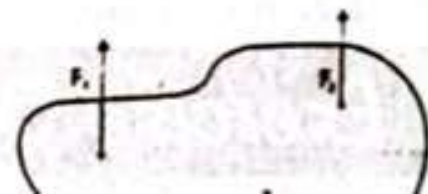
ANSWERS:

1. between 1 N and 7 N 2. $F \sin 60^\circ$ 3. torque 4. $\Sigma F = 0$ and $\Sigma \tau = 0$
 5. loses 6. principle of moments 7. at the lowest position
 8. may lie within, outside or on the surface 9. stable equilibrium 10. $\frac{mv^2}{r}$

B Short Answer Questions

4.1. Define like and unlike parallel forces.

Ans. Like parallel forces: If the parallel forces are acting in the same direction, these are called like parallel forces. Three forces F_1 , F_2 and F_3 are shown in figure acting on a rigid



tangential to the circular path. Since the angle between the radius (force direction) and the tangent (velocity direction) is 90° , the force is perpendicular to velocity.

© Constructed Response Questions

4.1. A car travels at the same speed around two curves with different radii, For which radius the car experiences more centripetal force? Prove your answer.

Ans. The car experiences more centripetal force on the curve with the smaller radius.

Proof. Centripetal force $F_c = \frac{mv^2}{r}$. For constant speed (v) and mass (m), F_c is inversely proportional to the radius (r). Smaller radius means larger (F_c).

4.2. A ripe mango does not normally fall from the tree. But when the branch of tree is shaken, the mango falls down easily. Can you tell the reason?

Ans. The shaking provides an external force that overcomes the weak attachment of the mango to the branch, causing it to detach and fall due to gravity.

4.3. Discuss the concepts of stability and centre of gravity in relation to objects toppling over. Provide an example where an object's centre of gravity affects its stability, and explain how altering its base of support can influence stability.

Ans. Stability depends upon the object's centre of gravity and base of support. If the centre of gravity is low and within the base, the object is more stable.

For example: A tall narrow glass is less stable than a wide-bottomed bowl because its higher centre of gravity is more likely to move outside the base when tilted.

Balanced at the centre of gravity (CG), i.e, 50 cm from each end

Suppose $r_1 = 40\text{cm} = 0.4\text{m}$

$r_2 = 30\text{cm} = 0.3\text{m}$

$w_2 = 4\text{N}$

Required: $w_1 = w = ?$

Solution:

so, Torque due to $w_1 = 0.4 \times w$

(It is counter clockwise torque)

and Torque due to $w_2 = 0.3\text{m} \times 4\text{N}$

Torque due to $w_2 = 1.2\text{ Nm}$

It is clockwise torque

Since the system is in equilibrium, so clockwise torque = counter clockwise torque

$1.2\text{Nm} = (0.4\text{m}) w$

$$\Rightarrow w = \frac{1.2}{0.4} \text{N}$$

$$w = 3\text{N}$$

- 4.4. A see-saw is balanced with two children sitting near either end. Child A weighs 30N and sits 2 m from the pivot, while child B weighs 40N and sits 1.5 metres from the pivot. Calculate the total moment on each side and determine if the see-saw is in equilibrium.**

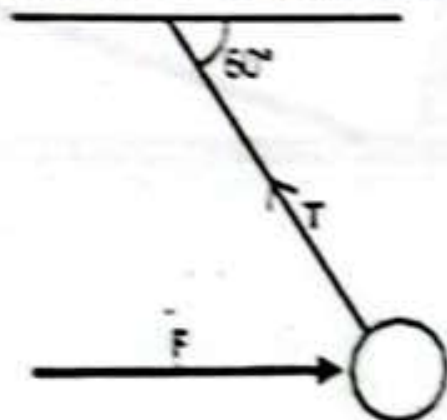
$$F = \frac{150 \text{ Nm}}{0.3 \text{ m}}$$

$$F = \boxed{500 \text{ N}}$$

Result:

Thus, 500 N force should be applied on the spanner.

- 4.7. A 5N Ball hanging from a rope is pulled to the right by a horizontal force F . The rope makes an angle of 60° with the ceiling as shown in the given figure. Determine the magnitude of force F and tension T in the string.**



Data:

$$w = 5 \text{ N}$$

$$\theta = 60^\circ$$

Required:

$$F = ?, T = ?$$

Formula:

In the horizontal direction:

Required: $r_2 = ?$

Solution: For a body in equilibrium: Clockwise moments = Anticlockwise moments

$$F_1 r_1 = F_2 r_2$$

$$m_1 g r_1 = m_2 g r_2$$

$$r_2 = \frac{m_1 g r_1}{m_2 g}$$

$$r_2 = \frac{(30\text{kg})(10\text{ms}^{-2})(1.6\text{m})}{(40\text{kg})(10\text{ms}^{-2})}$$

$$r_2 = \frac{480}{400} \text{ m}$$

$$r_2 = 1.2 \text{ m}$$

Result: The other girl may sit about 1.2m away from the axis.

4.10. Find the tension in each string as shown in the given figure, if the block weight 150N.

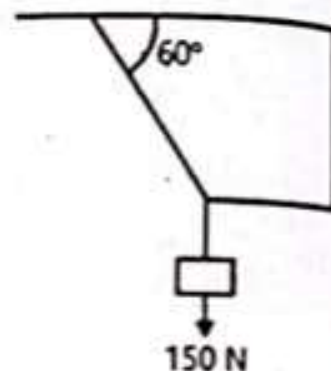
Data:

$$w = 150 \text{ N}$$

Angle of string with ceiling = 60°

Required: T_2 (vertical string) = ?

T_1 (inclined string) = ?



Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

Introduction

Work: Work is said to be done when a force acts on an object and moves it through some distance.

Energy: Energy is closely associated with that of work, when work is done by one system on another, energy is transferred between the two systems.



Fig. 5.1



Fig. 5.2

5.1

Work

Q.1. Define and explain work.

Ans. Definition: Work is defined as the product of magnitude of force and the distance covered in the direction of force

Essential element of work: Force and distance are two essential elements of work.

Explanation:

When someone does work, energy of the body has to be spent. In fact, energy is transferred to the body on which work is done. In other words, the energy is transferred from one system to another.

For example: when you do work pushing a swing, Chemical energy in your body is transferred to the swing and appears as energy of the motion of the swing.

Unit: Like work, energy is a scalar quantity. Its SI unit is joule (J).

Joule: When one joule work is done on a body, the amount of energy spent is one joule.

Name the forms of energy: There are many forms of energy. Electrical energy, chemical energy, nuclear energy, heat energy and light energy are some well-known forms which we shall study later on.

Basic form of energy: There are two basic forms of energy.

- (i) Kinetic energy (ii) Potential energy

Mechanical Energy: The combination of these two types of energies is called 'Mechanical energy'.
OR

It is the energy associated with the motion or position of an object, and it is typically measured in joule (J).

Q.5. What is kinetic energy and also derived their formula.

Ans. Kinetic energy (K.E): The kinetic energy of a body is the energy that a body possesses by virtue of its motion.

Examples: Running water, moving wind.

Explanation: To find out how much kinetic energy a moving body possesses, an opposite force can be applied on the body to stop its motion. Then the work done by the force will be equal to the kinetic energy of the body. i.e. Kinetic energy (E_k) = Work done (W)

Waste energy: This energy does not remain available for doing some useful work and may be called waste energy.

Example: Let a body of mass m be at rest at a point A above the height h from the ground. (As shown in fig. 5.12). Its total energy P.E is mgh .

$$E_p = mgh \text{ and } E_k = 0$$

Then the body is allowed to drop to point B at a height x from the ground. The body loses potential energy and gains kinetic energy as it gets speed while falling down. Assuming air resistance negligible.

$$E_p = mg(h - x)$$

The loss of potential will appear as the gain in kinetic energy, hence at point B.

$$E_k = mgx$$

Total energy at B.

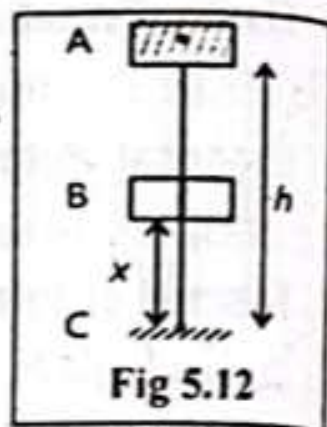
$$E = mg(h - x) + mgx$$

$$E = mgh$$

Just before hitting the ground at point 'C' the whole of potential energy is changed into kinetic energy.

$$\text{Thus, } E_p = 0 \text{ and } E_k = mgh$$

Thus, total energy remains the same as mgh . On hitting the ground this energy is dissipated as heat and sound in the environment.



5.4

Sources of Energy

Q.8. Write some sources of energy.

Ans. Sources of energy: Energy can be defined as the ability of the body to do work.

1. **Fossil fuel energy:** Fossil fuel energy comes out from burning of oil, coal and

Q.11. What is geothermal energy? Briefly explain.

Ans. Geothermal energy: In some parts of the world, hot rocks are present in the semi molten form deep under the surface of Earth. They are heated by energy released due to decay of radioactive elements. The temperature of these rocks is about 250°C . This energy is known as geothermal energy.

Use: They are used to run electric generators.

Use of heat rocks: To make use of the heat of the rocks, two holes are drilled upto the rocks. Cold water is pumped down through one of the holes. It is heated up by the hot rocks and starts boiling.

Hot spring: Steam is produced that comes out through the other hole. The steam runs the generator which produces electricity.

Where there is water already present over the hot rocks, it comes out of the surface of the Earth in the form of hot springs and geysers.

Q.12. What is wind energy and Also write its use.

Ans. Wind: Wind has been used as a source of energy for centuries.

Uses:

- Windmills used to draw water from the well to grind grains into the flour.
- Wind generators make electricity in the same way as steam generators in power stations.

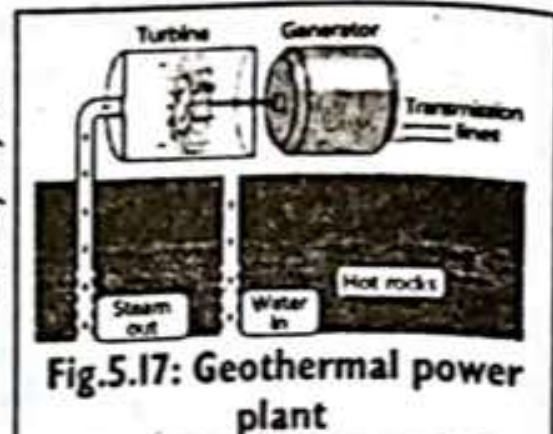


Fig.5.17: Geothermal power plant



Fig. 5.18



As the need for energy is increasing day by day, there is need to develop other non-traditional renewable energy sources.

5.6 The Advantages and Disadvantages of Methods of Energy Production

Q.17. Gives the advantages and the disadvantages of methods of energy production.

Ans: Advantages:

- (a) The production of hydroelectric power is more economical and pollution free
- (b) The solar power, wind, tidal, and wave power need more initial cost but they do not produce pollution and are also economical as well.

Disadvantages: Power generation by fossil fuels and nuclear fuel adds to the pollution of environment. Burning of fossil fuels produce smoke, carbon dioxide gas and heat (Fig. 5.22). They enhance direct pollution to atmosphere. Wind mills are very noisy. Some people think that wind turbines spoil the beauty of landscape.

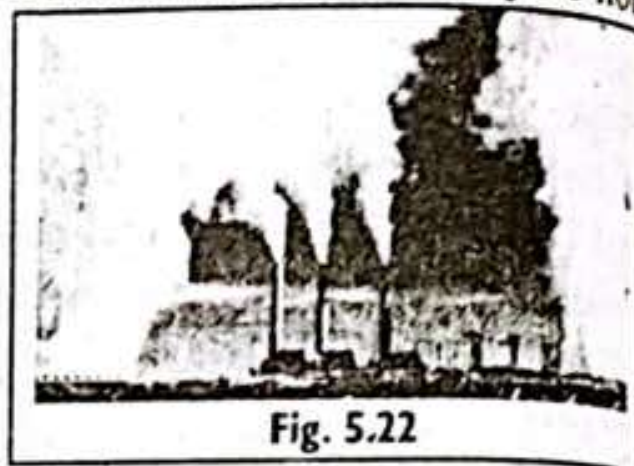


Fig. 5.22

Nuclear Power Generators: Nuclear power generators are also run by steam produced by nuclear heat energy. Heat itself is a form of pollution. Moreover, there is always danger of leakage of the radioactive radiation which is harmful to living bodies. People living around nuclear plants are always at risk.

Nuclear Waste: The disposal of nuclear waste is another problem for the nuclear power generation. However, any form of waste energy ends up as thermal energy that goes to the environment.

Thermal Pollution: Thermal pollution is increasing day by day causing global warming.

Q.20. Write a note on perpetual energy machine.

Ans. Perpetual Energy Machine: It is a hypothetical machine that can do work indefinitely, without any external source of energy. A perpetual machine would have to generate more energy than it consumes, effectively producing energy from nothing which is impossible. In any real mechanical system, some energy is always lost as heat due to friction between moving parts and air resistance etc. Thus, making it impossible for a machine to keep moving without an external source of energy. Infact, it is a consequence of the principle of conservation of energy that a perpetual energy machine is not workable.

Conceptual Long Questions

1. What do you know about the efficiency of a machine? Gives its procedure of calculation, why there is a limit set by the efficiency of a machine?

Ans. Efficiency of a Machine: Efficiency of a machine is a ratio of the output work or energy to the input work or energy. It is measured how effectively a machine converts the input energy into useful work. In other words, efficiency indicates how well a machine utilizes the energy provided it.

Calculation : The efficiency of a machine is calculated using the following formula

$$\text{Efficiency } (\eta) = (\text{Output Work/Input work}) \times 100$$

$$\eta = (\text{output Energy/Input Energy}) \times 100$$

The efficiency is usually expressed by a percentage.

2. **Second law of thermodynamics:** The second law states that the total entropy (a measure of disorder or randomness) of a closed system always increases over time. This means that energy cannot be converted from one form to another with 100% efficiency.
3. **Input Energy Required:** A perpetual motion machine would require an initial input of energy to start operating. However once the machine is running, there would be no external source of energy to sustain it.
- **In Conclusion:** In Conclusion, a perpetual motion machine is impossible according to the laws of physics, specifically the law of conservation of energy and the second law of thermodynamics.

Examples

Example 5.1: A person does 200 J of work in pushing a carton through a distance of 5 metres. How much force is applied by him?

Solution: Work done $W = 200 \text{ J}$

Distance $S = 5 \text{ m}$

Force $F = ?$

Using formula $W = F \times S$ or $F = \frac{W}{S}$

Putting the values, we get

$$F = \frac{200 \text{ J}}{5} = 40 \text{ N}$$

Quick Quiz

1. The energy in the stretched bow is:
(a) Kinetic energy (b) Elastic P.E. (c) Potential energy (d) Chemical energy
2. The work done by the single beat of human heart is:
(a) 0.5J (b) 1J (c) 1.5J (d) 2J
3. The energy content of the nuclear bomb dropped on Hiroshima, Japan, in the second World War was:
(a) $8.0 \times 10^{11}\text{J}$ (b) $8.0 \times 10^{-13}\text{J}$ (c) $8.0 \times 10^{-11}\text{J}$ (d) $8.0 \times 10^{13}\text{J}$
4. The energy output of a power station in one year is:
(a) 10^{14}J (b) 10^{12}J (c) 10^{16}J (d) 10^{-16}J
5. Before electricity was discovered, one of the primary function's of fossil fuels was to provide:
(a) air (b) light (c) water (d) heat
6. Solar powered car which won the World Solar challenge race in Darwin Australia was in:
(a) 1993 (b) 1994 (c) 1995 (d) 1996
7. More than _____ of Icelanders use geothermal energy to warm their homes.
(a) 60% (b) 70% (c) 80% (d) 85%
8. The train is changing _____ every moment in the roller coaster.
(a) Potential energy (b) Kinetic energy (c) sound energy (d) Electrical energy
9. How many people died from direct exposure by nuclear accident in Russia?
(a) 30 (b) 31 (c) 40 (d) 50
10. Burning of fossil fuels releases how much CO_2 into the atmosphere every

2. If the direction of motion of the force is perpendicular to the direction of motion of the body then work done will be:
(a) Maximum (b) Minimum (c) zero (d) none of above
3. Formula of work done is:
(a) $W = F \times S$ (b) $W = F \times t$ (c) $W = \frac{F}{S}$ (d) $W = \frac{t}{F}$
4. SI unit of work done is:
(a) Weber (b) Newton (c) Ns (d) Joule (J)
5. One joule is equal to:
(a) $\frac{1N}{1m}$ (b) $1N \times 1m$ (c) $\frac{1m}{1N}$ (d) $\frac{1N^2}{1m^2}$

5.2

Energy

6. One horse power is equal to:
(a) 740W (b) 746W (c) 750W (d) 756W
7. An ability to do work:
(a) work (b) combustion (c) energy (d) efficiency
8. SI unit of energy is:
(a) Newton (b) Joule (c) Weber (d) Newton second
9. Energy has _____ basic forms.
(a) Two (b) Three (c) Four (d) Five
10. The combination of kinetic and potential energy is called:

31. Which is the biggest source of energy?
(a) Dam (b) Sun (c) Tumels (d) Solar
32. Solar cells is also known as calculators:
(a) Solar Panels (b) Solar Calculators
(c) Photo volatic cells (d) Electric generator
33. Pakistan also run nuclear power stations at:
(a) Karachi (b) Chashma (c) Lahore (d) Both (a) and (b)
34. Salter's Duck has _____ parts:
(a) Two (b) Three (c) Four (d) Five
35. The dirt which is left over after staining dirty water is called:
(a) Digestor (b) Biofuel (c) Sewage (d) Biomass

5.5

Renewable and Non - Renewable sources

36. The resources of energy which are replaced by new ones after their use are called:
(a) Dung (b) Biomass
(c) Renewable energy (d) Non - renewable
37. Which of the following are renewable resources?
(a) Wave energy (b) Tidal energy (c) solar energy (d) All of these
38. Which of the following is non-renewable resources?
(a) Fossil fuels (b) Tidal energy
(c) solar energy (d) Geothermal energy

10. Which of the following is the example of kinetic energy?
(a) A book lying on a table (b) A wall standing still
(c) A car moving on a straight road (d) A person holding a heavy bag
11. The example of P.E:
(a) A car moving on a straight road (b) A book lying on a table
(c) A person holding a heavy bag (d) Water stored behind a dam
12. A ball is lifted from the ground to a height of 10m. What happens to its potential Energy?
(a) It decreases (b) It remains the same
(c) It increases (d) It becomes zero
13. What is the efficiency of a machine that converts 80% of the input energy into useful work?
(a) 20% (b) 50% (c) 80% (d) 100%
14. What is the maximum possible efficiency of any machine?
(a) 50 (b) 80 (c) 20 (d) 100

ANSWERS:

- | | | | | | | |
|--------|--------|---------|---------|---------|---------|---------|
| 1. (b) | 2. (c) | 3. (a) | 4. (a) | 5. (a) | 6. (b) | 7. (a) |
| 8. (a) | 9. (a) | 10. (c) | 11. (d) | 12. (c) | 13. (c) | 14. (d) |

Additional Short Question

15. Why are renewable sources of energy are important?

Ans. Renewable sources of energy are important because they are sustainable, non-polluting and can help to reduce our reliance on the non-renewable sources.

5.6**The Advantages and disadvantages of methods of Energy production**

16. Why are nuclear power plants considered a reliable sources of energy, and what are the risks associated with them?

Ans. Nuclear power plants are considered reliable because they can operate continuously and produce a large amount of electricity with low operating costs. However they also pose risks such as nuclear accidents radioactive waste disposal.

17. What is the main disadvantage of thermal power plants?

Ans. The main disadvantage of thermal power plants is that they produce air pollution and greenhouse gases.

18. Why are nuclear power plants consider a reliable source of energy a safety risk also.

Ans. Nuclear power plants are consider a safety risk because they can experience accidents, such as meltdowns, which can release radioactive materials into the environment.

Reliable source of energy: Because they can operate continuously and are not dependent of weather condition.

19. What is the main disadvantage of the nuclear power plants.

Ans. The main disadvantage of nuclear power plants are they produce radioactive waste, which can be hazardous to human health and the environment.

because the rate of doing work and if the time taken to do work decreases the rate of doing work increases.

9. Can the efficiency of a machine be greater than 1?

Ans. No, the efficiency of a machine cannot be greater than 1. This is because the output energy of a machine cannot be greater than the input energy. The maximum efficiency of a machine is 1, which means that all the input energy is converted into useful output energy.

10. What happens to the energy of an object when it is converted from one form to another?

Ans. When energy is converted from one form to another, the total energy of the object remains the same. However, the form of energy changes. For example a car brakes its kinetic energy change into heat energy but the total energy of the car same.

11. Can energy be created or destroyed?

Ans. No, energy cannot be created or destroyed only converted from one form to another form, this is known as the law of conservation of energy, which states that the total energy of an isolated system remains constant over time.

Exercise Questions (Solved)

A Multiple Choice Questions

Tick (✓) the correct answer:

5.1. Work done is maximum when the angle between the force F and the displacement d is:

5.5. Define work and its SI unit.

Ans. Work: Work is defined as the product of magnitude of force and the distance covered in the direction of force.

SI unit of work is Joule (J).

Joule: One joule work is done when a force of one newton acting on a body moves it through a distance of one metre in its own direction.

5.6. What is the potential energy of a body of mass m when it is raised through a height h .

Ans. The potential energy (E_p) of a body of mass " m " raised to a height " h " is given by:

$$P.E. = mgh$$

Where g is the gravitational accelerations

5.7. Find an expression for the kinetic energy of a moving body.

Ans. Kinetic energy (E_k) is the energy of an object possesses due to its motion. The kinetic energy of a moving body depends on its mass and velocity.

$$\text{Formula: } E_k = \frac{1}{2} mv^2$$

5.8. Define efficiency of a working system. Why a system cannot have 100% efficiency?

Ans. Efficiency is the ratio of useful output energy to the total input energy, expressed as a percentage.

A system cannot have 100% efficiency due to energy losses from friction, heat and other inefficiencies.

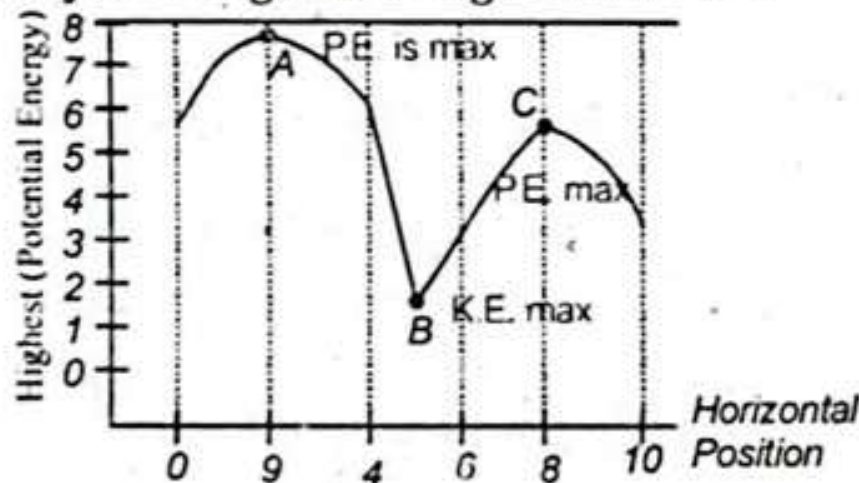
distance is covered. Since there is no displacement, there is no work being done, despite the effort exerted.

5.8. A cyclist goes downhill from the top of a steep hill without pedalling and takes it to the top of the next hill.

- (i) Draw a diagram of what happened.
- (ii) Analyse this event in terms of potential and kinetic energy.

Label your diagram using these terms.

Ans. (i)



- (ii) At the top of the first hill (Point A), potential energy is high and kinetic energy is zero. As the cyclist descends to the bottom (point B), Potential energy converts to kinetic energy climbing to record hill (point C), kinetic energy is converted back into potential energy, slowing the cyclist.

5.9. Is timber or wood renewable source of heat energy? Comment.

Ans. Yes, timber or wood are renewable sources of heat energy.

Reason: Wood is a biomass fuel that can be replenished naturally over time by growing more trees. As long as the rate of tree planting and growth exceeds the rate of wood harvesting wood renewable energy source.

5.5. A ball of mass 160 g is thrown vertically upward. The ball reaches a height of 20 m. Find the potential energy gained by the ball at this height.

Data:

$$m = 160 \text{ g} = 0.16 \text{ kg}$$

$$\text{Acceleration due to gravity (g)} = 10 \text{ ms}^{-2}$$

$$\text{Height} = h = 20 \text{ m}$$

Required: Potential energy = ?

Solution: P.E = mgh

$$\text{P.E} = (0.16 \text{ kg}) (10 \text{ ms}^{-2}) (20 \text{ m})$$

$$\text{P.E} = 32 \text{ J}$$

Result: The potential energy gained by the ball at height is 32 J.

5.7. A girl is swinging on a swing. At the lowest point of her swing, she is 1.2 m from the ground, and at the highest point she is 2.0 m from the ground. What is her maximum velocity and where?

Data: At the highest point, the girl's

5.6. A 0.14 kg ball is thrown vertically upward with an initial velocity of 35 ms^{-1} . Find the maximum height reached by the ball.

Data:

$$\text{Initial velocity } v_i = 35 \text{ m/s}$$

$$\text{Final velocity} = v_f = 0 \text{ ms}^{-1}$$

$$\text{Mass} = m = 0.14 \text{ kg}$$

Acceleration due to gravity = $a = -10 \text{ m/s}^2$
(negative because it is in upward motion)

Required: Maximum height = $S = ?$

$$\text{Solution: } 2aS = v_f^2 - v_i^2$$

$$2(-10 \text{ ms}^{-2}) S = (0)^2 - (35 \text{ ms}^{-1})^2$$

$$(-20 \text{ ms}^{-2}) S = -1225 \text{ m}^2 \text{ s}^{-2}$$

$$S = \frac{1225}{20} \text{ m}$$

$$S = 61.25 \text{ m}$$

Result: The maximum height is 61.25 m

5.8. A person pushes a lawn mower with a force of 50 N making an angle of 45° with the horizontal. If the mower is moved through a distance of 20 m, how much work

5.12. A 40 kg boy runs up-stair 10 m high in 8 s. What power he developed.

Data:

$$m = 40 \text{ kg}$$

$$h = 10 \text{ m}$$

$$t = 8 \text{ s}$$

$$g = 10 \text{ ms}^{-2}$$

Required:

$$P = ?$$

Solution:

First we find work done

$$W = mgh$$

$$W = 40 \text{ kg} \times 10 \text{ ms}^{-2} \times 10 \text{ m}$$

$$W = 4000 \text{ J}$$

Now we find power

$$\text{Power} = \frac{\text{Work done}}{\text{Time}}$$

$$P = \frac{4000 \text{ J}}{8 \text{ s}} = 500 \text{ watt}$$

Result: He developed (500 Watt) power

5.13. A force F acts through a distance L on a body. The force is then increased to $2F$ that further acts through $2L$. Sketch a force displacement graph and calculate the total work done.

Data:

Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

Introduction

The main contents included in this chapter are: (i) Deformation of solids due to some applied force (ii) Density and pressure.

6.1

Deformation of solids

Q 1. Briefly explain the following:

Deforming force, elasticity, elastic limit

Ans. Deforming Force:

An external force applied on an object can change its size or shape. Such a force is known as deforming force.

Example: An appropriate force applied to a spring can increase its length called extension or cause compression thus reducing its length. If the force is removed, the spring will restore its original size and shape. Similarly stretched rubber strip or band comes to its original shape and size on removing the applied force.

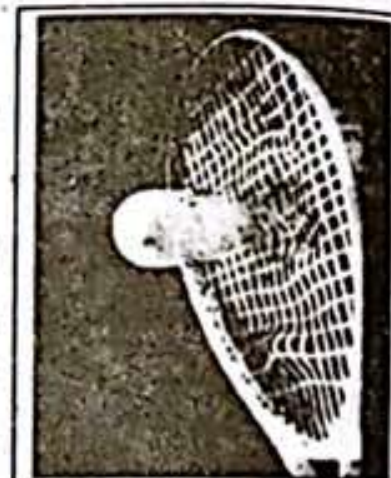


Fig. 6.1

6.3

Density

Q.4: What is density and how it is measured?

Ans. Density: Density of a substance is defined as its mass per unit volume.

Formula:
$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Unit: The SI unit of density is kg m^{-3} . Other unit also in use is g cm^{-3} .

Explanation:

If we take equal volumes of different substances and weigh them by a balance, you will find that each of them has a different mass. You know that all substances are composed of molecules. The molecules of different substances are different in size and mass. The inter-molecular spacing is also different. The molecules of different substances are different in size and mass. The inter-molecular spacing is also different.

The mass of equal volume of various substances actually is the mass of the total number of molecules present in that volume. Naturally, the substance whose molecules are densely packed and also which are heavy will weigh more than others.

Importance of density: The architects and engineers take special care of the density of the building material to be used in designing and constructing roads, bridges and buildings. The density of building material is essential for estimating the strength required in foundations and supporting pillars.

Density Measurement:

Density of a substance can be determined by measuring its mass and volume. The

Or $P = \rho gh \dots\dots\dots(6.4)$

$$P = \frac{F}{A} = \frac{\rho Ahg}{A}$$

Equation 6.4 shows that pressure in a liquid increase with depth. The value of pressure depends on the depth and density of the liquid.

6.6

Atmospheric Pressure

Q.7: Write a note on atmospheric pressure and also discuss variation with height?

Ans. Atmospheric pressure: The atmosphere exerts pressure on the surface of the Earth and on everything on the Earth. This pressure is called atmospheric pressure.

Explanation: The Earth is surrounded by a layer of air which we call atmosphere. We know that air is a mixture of gases. Their molecules are always in motion. They collide with one another and with all other objects coming in their way. Thus, they exert force on the objects. This force per unit area is the atmospheric pressure. Since the molecules of air have random motion, therefore atmospheric pressure acts equally in all directions.

Atmospheric pressure extends:

Atmospheric pressure extends up to a height of about 100 kilometres. The density of air is not the same in the atmosphere. It decreases continuously with altitude.

We live at the bottom of Earth's atmosphere which is a fluid that exerts pressure on our bodies.

Sea level pressure: The value of atmospheric pressure is about 1.013×10^5 Pa. This value is referred to as standard atmospheric pressure. It is an enormous pressure which can crush anything. We do not feel it because practically all the bodies have air inside

6.9

Pascal's Law

Q.10: What is Pascal's law? Explain Pascal's law and write some applications of Pascal's law in daily life.

Ans. Pascal's Law: When pressure is applied at one point in an enclosed fluid, it is transmitted equally to all parts of fluid without loss.

Explanation with examples:

1. Inflate a balloon: When we inflate a balloon, we blow air in it with a certain pressure but the balloon blows uniformly from all sides. It means that the pressure applied at its mouth has been transmitted uniformly in all directions.

2. Motorbike Tyre: When a motorbike tyre is inflated, air pressure is applied at one point but the tyre is uniformly inflated from all sides. This indicates that pressure is transmitted to each part of the tyre.

Activity: Let us perform a very interesting activity with a liquid. Take water in a flask with piston and having a few side tubes fixed at different positions. If such flask is not available we can join a syringe at the mouth of a pet bottle. For side tubes, bendable transparent drinking straws can be glued on the holes punched on sides of the bottle.

You will observe that the level of water in all the side tubes is the same. This is because a liquid seeks its own level and rises

Some Typical Pressures

Location	Pressure (Pa)
Sun's centre	2×10^8
Earth's centre	2×10^7
Deepest ocean trench	1.1×10^8
A motor tyre	2×10^5
Standard atmospheric	1.013×10^5
Blood pressure	1.6×10^4
On mount Everest	4×10^4
On mars	7×10^2



Conceptual Long Questions

Q.1. Why do small insects like water striders walk on water? Explain the role of surface tension in this phenomenon and discuss its applications in everyday life.

Ans. Water striders, also known as pond skaters or water skaters are small insects that can walk on water due to the phenomenon of surface tension. Surface tension is a property of liquid. That causes them to behave as if they have an elastic skin at their surface.

⇒ **Role of surface tension:**

Surface tension is responsible for allowing water strider to walk on water in several ways.

1. **High surface tension:** Water has a high surface tension, which allows it to support the weight of small insects like water strides.
2. **Elastic skin:** The surface tension of water creates an elastic skin that can deform and recover when an object, like a water strider, applies pressure to it.
3. **Hydrophobic legs:** Water striders have hydrophobic (water-repelling) legs, which reduce the surface energy between the legs and the water. This allows the water strider to generate a large upward force, enabling it to walk on water.

⇒ **Application in everyday life:**

Surface tension plays a crucial role in various everyday phenomena and application:

1. **Soap and detergents:** Surface tension is responsible for the formation of soap and

the pressure exerted by this force on the bigger piston? How much weight can be lifted by the other piston?

Solution:

Let the areas of cross-sections of the pistons be A_1 , and A_2 , and their radii be r_1 and r_2 respectively.

Putting the values of, $r_1 = \frac{5}{2} \text{ cm} = 2.5 \times 10^{-2} \text{ m}$, $r_2 = \frac{25}{2} \text{ cm} = 12.5 \times 10^{-2} \text{ m}$

$$A_1 = \pi r_1^2 \quad \text{and} \quad A_2 = \pi r_2^2$$

Force on the smaller piston = $F_1 = 160 \text{ N}$. Its pressure on the piston is:

$$P = \frac{F_1}{A_1} = \frac{F_1}{\pi r_1^2}$$

If the weight lifted by the bigger piston is w , then according to the Pascal's law.

$$\frac{F_1}{A_1} = \frac{w}{A_2}$$

$$\text{or } w = \frac{F_1 A_2}{A_1} = \frac{F_1 \pi r_2^2}{\pi r_1^2} = \frac{F_1 \times r_2^2}{r_1^2}$$

by Putting the values

$$w = 160 \text{ N} \times (12.5 \times 10^{-2} \text{ m})^2 / (2.5 \times 10^{-2} \text{ m})^2 = 4000 \text{ N} = 4 \text{ kN}$$

So, we can lift 4000 N weight by applying a force of 160 N on smaller piston.

or interact with the liquid. Make sure these substance don't over flow the water.

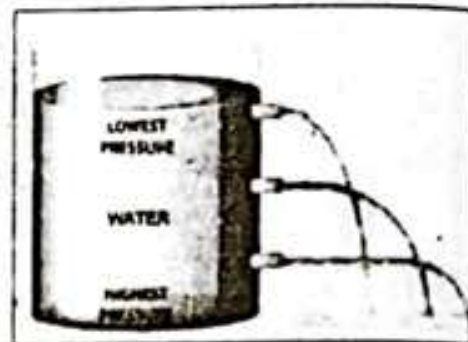
- (v) The water level will rise when the substance displaces an amount of liquid equivalent to its volume. Allow the substance to settle at the bottom of the cylinder.
- (vi) Once the substances has settled, observe the final water level in the cylinder. Note down the final volume which represents the volume of the water plus the volume of the added substances.
- (vii) The volume of substance is equal to difference between the final volume and the initial volume of substance = Final volume - Initial volume.

Conclusions: This practical activity demonstrates the principle of displacement. By measuring the rise in liquid level when an insoluble substance is added, you can calculate the volume of the substance.

Activity 6.3:

Teacher should help the students to perform this activity and initiate discussion as per instructions.

- (i) Make three small holes at different heights in the side of a container.
- (ii) Fill the container with water.
- (iii) Observe the water streams flowing out of the holes. It is initially normal to the surface.
- (iv) Which one of the streams hits the ground at larger distance?
- (v) At which position the liquid has more pressure?



We shall observe that the stream from each hole, initially flows out normal to

- Cold water
- Tongs or gloves

Procedure:

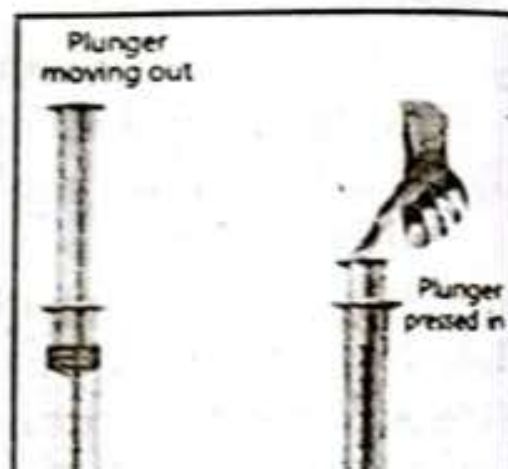
- Place the tin can on the stove and fill it with water. Boil the water until steam is coming out of the top of the can. The water inside the can should be fully vaporized.
- Once the can is full of steam, carefully remove it from the heat source using tongs or gloves. Quickly seal the top of the can tightly with the cork or an airtight lid. This step is important as it traps the steam inside the can.
- After sealing the can, immediately submerge the can into a container of cold water. Make sure the water completely cover the can.
- After submerging the can in cold water, watch what happens. The can will suddenly crumple and collapse.

Conclusion: The tin can crumples because the internal pressure inside the can decrease sharply when the steam condenses into water after being exposed to cold water.

Activity 6.6:

The teacher should facilitate the groups to follow the instructions given below.

- Fill a syringe with water and insert its nozzle into a thin plastic tube.
- Press the syringe to fill the tube with water.
- Half fill the second syringe with water and insert its nozzle to the other end of the tube.
- Press one plunger in through some distance.



Objective Type Questions

Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques (Knowledge, Understanding, Application, Analytical & Conceptual)

6.1

Deformation of solids

6.2

Hooke's Law

- Which of the following is a cause of the deformation of solids?
(a) Temperature change (b) External force
(c) Change in density (d) All of above
- What is Hooke's law?
(a) $F = ma$ (b) $F = kx$ (c) $E = mc^2$ (d) $P = IV$
- What is the unit of spring constant K ?
(a) N/m (b) kg/m (c) m/N (d) Ns/m
- A 50 N force stretches a spring by 0.1m. What is the spring constant?
(a) 100 N/m (b) 500 N/m (c) 1000 N/m (d) 5000 N/m
- Which of the following devices uses Hooke's law to measure weight?

27. In an open manometer, what is compared to measure the pressure of gas?
- (a) Atmospheric pressure (b) Absolute zero
(c) Gravitational force (d) Gas flow rate

6.9

Pascal's Law

28. Which of the following devices works based on Pascal's law?
(a) Hydraulic press (b) Bicycle pump (c) Venturi meter (d) Thermometer
29. What is formula for pressure according to Pascal's law?
(a) $P = F/A$ (b) $P = V/T$ (c) $P = mg$ (d) $P = A/F$
30. Which of the following best describes the applications of Pascal's law?
(a) It applies only gases. (b) It applies only to solids.
(c) It applies to both liquid and solids (d) It applies only in vacuum
31. Which of the following is NOT an applications of Pascal's Law?
(a) Hydraulic pressure (b) Syringes
(c) Air plane wing design (d) Hydraulic brake
32. What is the primary function of hydraulic brakes?
(a) To increase the vehicle speed (b) To reduce the vehicle fuel
(c) To slow down or stop a vehicle (d) To maintain a constant speed
33. Which principle does a hydraulic brakes system operate on?
(a) Bernoulli's principle (b) Pascal's law
(c) Archimedes principle (d) Newton's Laws
34. Which of the following component is NOT part of a hydraulic brake system?

Additional Short Question

**Short Answer Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)**

1. What are the three main states of matter?

Ans. Solid, liquid and gaseous states are the three states of matter. These states are due to attractive forces that exists between the atoms and molecules.

2. What is the main reason for the existence of different states of matter?

Ans. The main reason for the existence of different states of matter due to attractive forces that exists between the atoms and molecules.

6.1

Deformation of solids

3. Define deforming force with an example.

Ans. An external force applied on object can change its size or shape. Such a force is known as deforming force. For example, an appropriate force applied to a spring can increase its length called extension or cause compression thus reducing its length. If the force is removed, the spring will restore its original size and shape.

4. Define elasticity.

Ans. An object is said to be elastic, if after removal of the deforming force, it restores to its original size and shape. This property of the material is known as elasticity.

5. What are inelastic materials?

Ans. Some materials such as clay dough or plasticine do not return to their original shape after the removal of the deforming force. They are known as inelastic materials.

Example: Chopper: Pressure in the edge of the blade of a chopper is made very sharp. When we apply force on the handle of the chopper to cut an object, the pressure on the object, at the contact surface, due to its small area becomes very high and the object is easily cut (Fig. 6.7).



20. Write the formula and SI unit of pressure.

Ans. Formula: $P = F/A$.

SI-Unit: The SI unit of pressure is Nm^{-2} and also is called pascal (Pa).

21. What is the pressure at a depth of 10m in water?

Ans. The pressure at a depth of 10m in water approximately 98100Pa.

22. Why do football and hockey boots have stud on their soles?

Ans. Sports boots for football and hockey have studs on their soles. They reduce the area in contact between your feet and the ground. This increases the pressure and your feet grip the surface more firmly.

6.6

Atmospheric Pressure

23. What is atmosphere?

Ans. The Earth is surrounded by a layer of air which we call atmosphere.

24. Define atmospheric pressure.

Ans. The atmosphere exerts pressure on the surface of Earth and on everything on the Earth. This pressure is called atmospheric pressure.

47. Which law explains the working of hydraulic brakes?

Ans. Pascal's law Explains the working of hydraulic brakes.

48. What fluid is used in hydraulic brakes?

Ans. Brake fluid, which is typically a type of hydraulic fluid such as DOT fluid or mineral oil.

49. Name the main components of hydraulic brake system.

Ans. The main components include the brake lever, master cylinder, brake fluid, brakes lines and brake pads.

50. Can hydraulic brakes be used in bicycles?

Ans. Yes, hydraulic brakes are commonly used in high performance bicycles providing better stopping power and control.

Conceptual Short Questions

1. What happens to a material when it reaches its elastic limit?

Ans. When material reaches its elastic limit. It begins to deform permanently.

2. What physical property does Hooke's Law help to determine?

Ans. Hooke's Law helps to determine the stiffness of a material or spring.

3. What is the role of Hooke's law in earthquake-resistant buildings?

Ans. It helps design materials and structures that can absorb stress and deform elastically during earthquake.

4. Why do denser materials sink in fluids?

Ans. Because their weight is greater than the buoyant force exerted by the fluid.

5. Why does oil float on water?

- into soft surfaces and minimizing damage to the ground. Pressure is inversely proportional to area. A larger area results in lower pressure for the same force (weight).

6.2. Why animals like deer who run fast have a small area of the foot?

Ans. Animals like deer that run fast have small feet to minimize the surface area in contact with the ground. This reduces friction, allowing for faster and more efficient movement. A smaller area means less surface area for friction to act up and increase speed.

6.3. Why is it painful to walk bare footed on pebbles?

Ans. Walking bare foot on pebbles is painful because the small, rounded surface of the pebbles concentrate pressure on soles of feet, causing discomfort and pain.

6.4. State Pascal's law. Give an application of Pascal's law.

Ans. Pascal law: When pressure is applied at one point in an enclosed fluid, it is transmitted equally to all parts of liquid without loss.

Applications: (i) Hydraulic brakes (ii) Hydraulic press
(iii) Water pumps

6.5. State what do you mean by elasticity of a solid.

Ans. Elasticity of a solid refers to its ability to return to its original shape or size after an external force, which caused deformation, is removed.

6.6. What is Hooke's law? Does an object remain elastic beyond elastic limit? Give reason.

Ans. Hooke's Law: The force required to stretch or compress a spring by a distance is proportional to that distance.

deep lake?

Ans. The water pressure one meter below the surface of swimming pool and a very large and deep lake is the same. This is because water pressure depends only on depth, not on the volume or size of the body of water.

6.5. What will happen to the pressure in all parts of a confined liquid if pressure is increase in one part? Give an example in your daily life by where such principle is applied.

Ans. According to Pascal's law, if pressure is increased in one part of a confined liquid, the pressure will increase equally in all parts of the liquids.

Example: Hydraulic brake in vehicles, where pressure applied to brake pedal is transmitted equally to all four brakes.

6.6. If some air remains trapped within the top of the mercury column of the barometer which is supposed to be vacuum, how would it affect the height of the mercury column?

Ans. Trapped air in the barometer will reduce the height of mercury column as the air will exert pressure and oppose the weight of the mercury.

6.7. How does the long neck is not a problem to a giraffe while raising its neck suddenly?

Ans. The giraffe's long neck has thick walls in its blood vessels, and a specialized circulatory system that maintains sufficient blood pressure to the brain even when the neck is raised suddenly.



6.8. The end of glass tube used in a simple barometer is not properly sealed, some

$$\begin{aligned}
 \text{Volume} &= V = 5 \text{ L} \\
 &= 5 \times 1000 \text{ cm}^3 \quad \because \{1 \text{ L} = 1000 \text{ cm}^3\} \\
 &= 5 \times 10^3 (10^{-2})^3 \text{ m}^3 \\
 &= 5 \times 10^3 \times 10^{-6} \text{ m}^3 \\
 &= 5 \times 10^{-3} \text{ m}^3
 \end{aligned}$$

To Find:

$$\text{Density} = \rho = ?$$

Solution:

$$\text{Density } (\rho) = \frac{\text{Mass}}{\text{Volume}}$$

$$\rho = \frac{4.5 \text{ kg}}{5 \times 10^{-3} \text{ m}^3}$$

$$\rho = 0.9 \times 10^3 \text{ kg m}^{-3}$$

Result: Its density is $0.9 \times 10^3 \text{ kg m}^{-3}$

6.3 When a solid of mass 60 g is lowered into a measuring cylinder, the level of water rises from 40 cm^3 to 44 cm^3 . Calculate the density of the solid.

Data: Mass of the solid = $m = 60 \text{ g} = 0.06 \text{ kg}$

$$\text{Initial water level} = 40 \text{ cm}^3$$

$$\text{Final water level} = 44 \text{ cm}^3$$

$$\begin{aligned}
 \text{Volume of the solid} &= \text{Final} - \text{Initial} = 44 \text{ cm}^3 - 40 \text{ cm}^3 = 4 \text{ cm}^3 \\
 &= 4 \times (0.01 \text{ m})^3 = 4 \times 10^{-6} \text{ m}^3
 \end{aligned}$$

To Find:

$$\text{Density } (\rho) = ?$$

Solutions:

Solution:

so

$$\rho_{\text{Hg}} g h_{\text{Hg}} = \rho_{\text{water}} g h_{\text{water}}$$

$$h_{\text{water}} = \frac{\rho_{\text{Hg}} g h_{\text{Hg}}}{\rho_{\text{water}} g}$$

$$h_{\text{water}} = \frac{(13.6 \times 10^3 \text{ kgm}^{-3})(10 \text{ ms}^{-2})}{(1000 \text{ kgm}^{-3})(10 \text{ ms}^{-2})} \times h_{\text{Hg}}$$

$$h_{\text{water}} = 13.6 \times h_{\text{Hg}}$$

Height of mercury column is 0.760m

$$h_{\text{water}} = 13.6 \times 0.760 \text{ m} = 10.3 \text{ m}$$

Result:

If a column of mercury of 1m height is replaced by water of density 1000 kgm^{-3} , the height of the water column would be approximately 10.3 m to match the same pressure.

6.7 Suppose in the hydraulic brake system of a car, the force exerted normally on its piston of cross-sectional area of 5 cm^2 is 500 N. What will be the pressure transferred to the brake oil? What will be the force on the second piston of area of cross-section 20 cm^2 ?

Data: $F_1 = 500 \text{ N}$

$$A_1 = 5 \text{ cm}^2 = 5 \times 10^{-4} \text{ m}^2$$

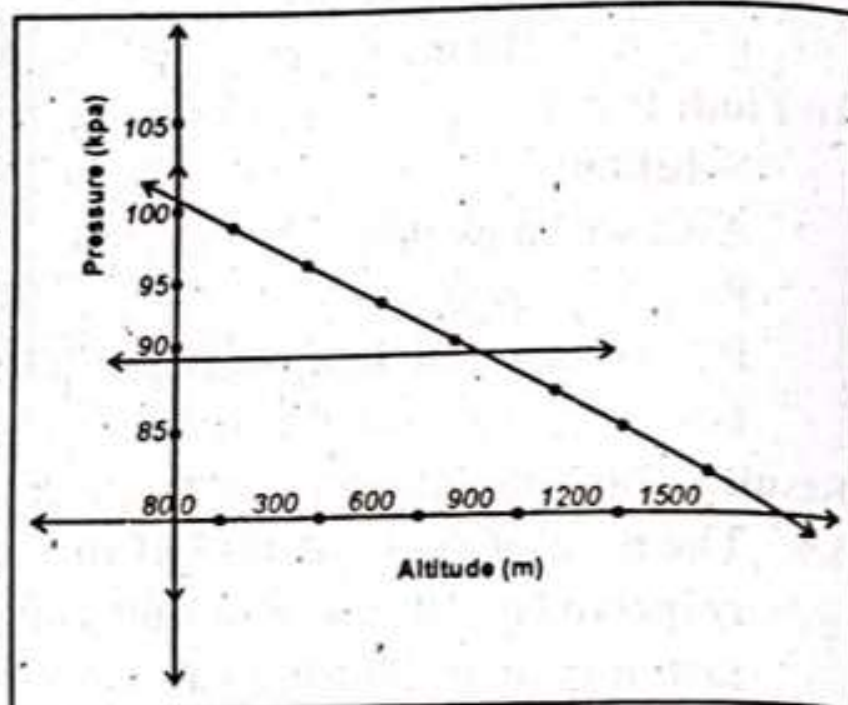
$$A_2 = 20 \text{ cm}^2 = 20 \times 10^{-4} \text{ m}^2$$

To Find:

Pressure = ? (Pressure transferred to the brake oil)

Ans.

- (a) To find the air pressure at sea level (Altitude = 0), extend the line of best fit to the y-axis (where altitude is 0) so y-intercept represents the pressure at sea level which is $101 \text{ kPa} = 1.01 \times 10^2 \text{ kPa} = 1.01 \times 10^5 \text{ Pa}$.
- (b) To find the Altitude at which the air pressure is 90 kPa , draw a horizontal line across the graph at 90 kPa along y-axis. The point where this line intersect the line to best fit represents the altitude, which is $1020 \text{ m} = 1.02 \text{ km}$.



6.11. If the pressure in a hydraulic press is increased by an additional 10 N cm^{-2} , how much extra load will the output platform support if its cross-sectional area is 50 cm^2 ?

Data:

$$P = 10 \text{ N cm}^{-2}$$

$$A = 50 \text{ cm}^2$$

To Find: Extra Load = $F = ?$

Solution: As we know that,

$$P = \frac{F}{A}$$

$$F = P \times A$$

in motion. Their motion may be vibrational, rotational or linear.

Intermolecular Force: There exists a mutual force of attraction between the molecules known as intermolecular force. This force depends upon the distance between the molecules. It decreases with increasing distance between them.

Kinetic Molecular Model of Matter: The molecules possess kinetic energy due to motion and potential energy due to force of attraction. When a substance is heated, its temperature rises and its molecular motion becomes more vigorous which increases the kinetic energy of the molecules. Thus, the temperature of the substance depends upon the average kinetic energy of its molecules.

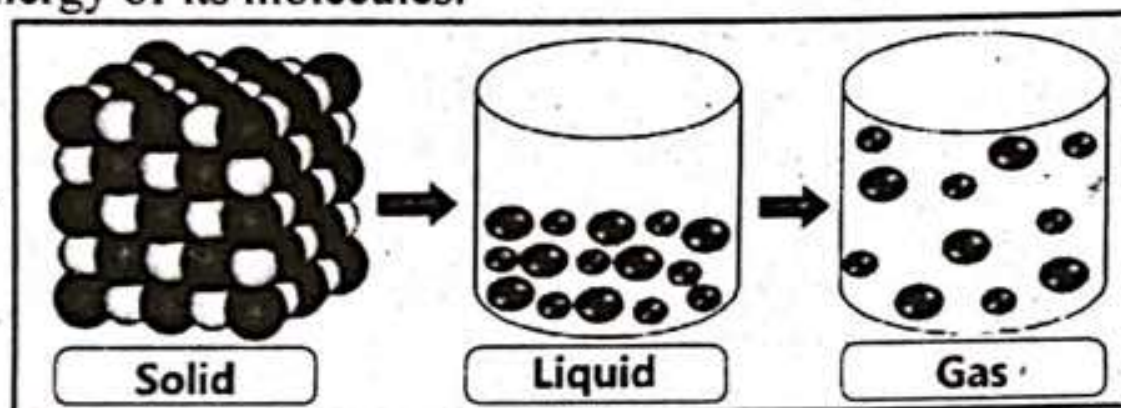


Fig. 7.1

Properties of Matter: Most of the properties of solids, liquids and gases can be explained on the basis of kinetic molecular theory of matter.

In case of Solids: In case of solids, the inter-molecular forces are so strong that they keep the molecules bound. So, the molecules are held at fixed positions but still they show vibrational motion about their fixed points (Fig. 7.2). This is why the solids have a



Explanation: Our sense of touch can tell us whether an object is hot or cold. It gives an idea about the object's temperature but we cannot measure the actual temperature of the body just by touching it. For the exact measurement of the hotness of a substance we require an instrument called a thermometer.

Thermometers use some property of a substance, which changes appreciably with the change of temperature.

Basic thermometric properties of liquid: Some basic thermometric properties for a material suitable to construct a thermometer are the following.

1. It is a good conductor of heat.
2. It gives quick response to temperature changes.
3. It has uniform thermal expansion.
4. It has high boiling point.
5. It has low freezing point.
6. It has large expansivity (low specific heat capacity)
7. It does not wet glass
8. It does not vapourize.
9. It is visible.

Q.6. State and explain liquid-in-glass Thermometer.

Ans. Definition: The liquids expand on heating. So, expansion in the volume of a liquid can be used for the measurement of temperature. This is known as liquid-in-glass thermometer.

Mercury: One such liquid which is commonly used in thermometers is mercury.

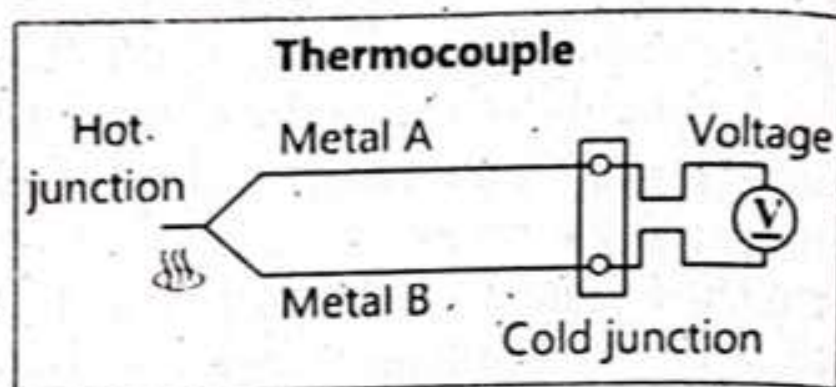
Construction: It is made of glass. It has a bulb at one end filled with mercury.

Explanation: When the temperature rises, the mercury expands and moves up through the narrow capillary tube in the form of a mercury thread. The position of the end of thread

electric current between two junctions of two wires of different materials due to difference of temperatures at the junctions.

Construction: This type of thermometer consists of two wires of different materials such as copper and iron. Their ends are joined together to form two junctions.

Working: If the two junctions are at different temperatures, a small current flows through



across them. This current is due to the potential difference produced across the two functions as the two wires have different resistance to the flow of current. The greater is the difference of temperatures the greater is the potential difference or voltage produced across the junctions. If one end of the junction is kept at a fixed lower temperature, say by placing it in an ice bath at 0°C for reference, the temperature of other junction at a higher temperature can be measured using a millivolt meter by a calibrated scale on it.

Practical use of thermocouple thermometer: This type of thermometer is particularly useful for very high temperatures and also rapidly changing temperature as there is only a small mass of metal (the junction) to heat up.

7.4

Sensitivity, Range and Linearity of Thermometers

Q.10. Explain Sensitivity, Range and Linearity of Thermometers and explain with example.

Ans. A thermometer is evaluated by its three key characteristics that are sensitivity, range and linearity. The sensitivity of a thermometer is the ability of the thermometer to respond to a small change in temperature. The range of a thermometer is the range of temperatures over which it can be used. The linearity of a thermometer is the ability of the thermometer to give a linear response to a change in temperature.

- **Particle Arrangement:** Particles are tightly packed in a fixed and regular arrangement.
- **Forces:** Strong intermolecular or interatomic forces dominate holding particles in place.
- **Distance:** Minimal distance between particles $\sim 10^{-10}$ m for atoms in a crystal lattice.
- **Motion:** Particles vibrate about fixed positions with limited freedom.
- **Properties:** Solids have definite shape and volume due to restricted particle motion and strong cohesive forces.

Liquids:

- **Particle Arrangement:** Particles are close together but not in a fixed arrangement.
- **Forces:** Moderate forces allow particles to slide past one another.
- **Distance:** Slightly larger distances than in solids ($\sim 10^{-10}$ to 10^{-9} m)
- **Motion:** Particles exhibit random motion and have higher kinetic energy compared to solids.
- **Properties:** Liquids take the shape of their container but have a fixed volume due to limited compressibility.

Gases

- **Particle Arrangement:** Particles are widely spaced and move independently.
- **Forces:** Negligible intermolecular forces under normal conditions.
- **Distance:** Large distances between particles ($\sim 10^{-9}$ to 10^{-6} m).
- **Motion:** Particles move freely in all directions with high kinetic energy, leading to

- ii. Each group places a spoon in the hot water and stir it.
- iii. Students touch the outer each of the spoon and observe that it becomes warm.

Explanation:

- i. Heat flows from the hot water to the spoon because the water's temperature is higher.
- ii. The spoon gets hotter due to conduction where heat travels through the metal a good conductor.
- iii. This demonstrates how heat moves from a hotter object to a cooler one.

Point to Ponder!

Q. Could we make mercury thermometer if the expansion of glass were greater than mercury?

Ans. No because if the glass, expanded more than mercury, the mercury would move downward instead of upward, making thermometer inaccurate. This would prevent it from correctly measuring temperature because the glass would increase the space more quickly than the mercury could expand.

Brains Teaser!

a) Why the walls of the thermometer bulb are thin?

Ans. The walls of a thermometer are thin to allow faster for quick heat transfer, providing quicker and accurate temperature readings.

b) Why the inner bore must be narrow?

Ans. The inner bore must be narrow to ensure structural integrity, strength and precise measurements for specific designs or applications.

Objective Type Questions**Additional MCQ's**

7.4
Sensitivity, Range and Linearity of Thermometers
7.5
Structure of a Liquid-in-Glass Thermometer

24. A thermometer is evaluated by its key characteristics, which is correct?
 (a) Sensitivity (b) Range (c) Linearity (d) All of these
25. Which refers to the span of the thermometer?
 (a) Range (b) Sensitivity (c) Linearity (d) Thermocouple
26. Which refers to direct proportional relationship between the temperature and scale reading across entire range of measurement?
 (a) Linearity (b) Range (c) Sensitivity (d) Thermocouple
27. Which factor increases the average kinetic energy of a particle in a substances:
 (a) Decreasing the temperature (b) Increasing the temperature
 (c) Decreasing the volume (d) Increasing the pressure
28. What is the freezing point of water on the Fahrenheit scale?
 (a) 0°F (b) 32°F (c) 100°F (d) 212°F
29. What is SI unit of Heat?
 (a) Joule (b) Calorie (c) Watt (d) Kelvin
30. Which process does not require a medium for heat transfer?
 (a) Conduction (b) Convection
 (c) Radiation (d) All require a medium
31. Plasma differs from gases because:
 (a) Plasma has a definite shape (b) Plasma is made up of charged particles
 (c) Plasma particles are tightly packed (d) Plasma has no kinetic energy

continuously. This causes the gas molecules to move faster. The collisions between atoms and molecules of the gas become so strong that they tear off the atoms. Atoms lose their electrons and become positive ions. This ionic state of matter is called plasma. Plasma is also formed in gas discharge tubes when electric current passes through these tubes.

4. How "Plasma" the fourth state of matter is formed?

Ans. At very high temperature, the matter assumes the state of ions and electrons. This state is called plasma.

Formation of Plasma: The kinetic energy of gas molecules goes on increasing if a gas is heated continuously. This causes the gas molecules to move faster and faster. The collisions between atoms and molecules of the gas become so strong that they tear off the atoms. Atoms lose their electrons and become positive ions. The ionic state of matter is called plasma.

5. Describe importance of plasma.

Ans. Plasma is highly conducting state of matter. It allows electric current to pass through it.

7.2 + 7.3

Temperature and Heat + Thermometers

6. Define Temperature.

Ans. Temperature can be defined as a physical quantity which determines the direction of flow of thermal energy.

7. Define Heat.

Ans. Heat is the energy which is transferred from one object to another due to difference of temperature between the two bodies.

8. What is internal energy?

22. Define Linearity.

Ans. This refers to a direct proportional relationship between the temperature and scale reading across entire range of measurement.

23. What is meant by good linearity?

Ans. A good linear thermometer should measure equal increments on the scale corresponding to equal changes in the temperature. It means markings on the scale should be evenly spaced over the whole range.

24. What is meant by high linearity?

Ans. High linearity means more consistent and proportional scale readings over the entire range to ensure accuracy of measurement.

25. Why is linearity important for a thermometer?

Ans. Linearity ensures that equal temperature intervals correspond to equal changes in the length at height of the liquid column making the thermometer easy to read.

Conceptual Short Questions

Q.1. Why is mercury commonly used in thermometers?

Ans. Mercury is used because it:

- Expands uniformly with temperature
- It is visible due to shiny appearance.
- Does not stick to the glass.
- Has a wide temperature range (-39°C to 356°C).

Q.2. What is the function of bulb in a liquid in glass thermometer?

Ans. The bulb stores the liquid and allows it to expand or contract based on temperature changes.

Q.3. How does the particle theory of matter explain the diffusion of gases?

ANSWERS:

1. Vibrate about their mean positions
2. Random motion
3. degree of hotness or coldness.
4. the energy in transit
5. +273
6. -40
7. Expand linearly
8. it wets the glass tube
9. non-linear expansion
10. quickly responds to temperature changes
11. Thermocouple thermometer

B Short Answer Questions

7.1. Why solids have a fixed volume and shape according to particle theory of matter?

Ans. Solids have fixed volume and shape because their constituent particles are tightly packed and held together by strong forces allowing only vibration in place without movement.

Strong interparticle forces hold these particles in fixed positions, preventing them from moving freely. This rigid structure maintains a constant volume and shape.

7.2. What are the reasons that gases have neither a fixed volume nor a fixed shape?

Ans. Gases have neither a fixed volume nor a fixed shape because their particles are far apart, move freely and have high energy allowing them to fill any container. This lack of strong interactions allows the gas to expand or compress to match the volume and shape of its container.

7.3. Compare the spacing of molecules in the solid, liquid and gaseous state.

Ans. The spacing of molecules is:

Solid: Very close together, tightly packed.

Liquid: Closer together than in gases, but more loosely packed than in solids.

plasma is a high-energy state of matter where atoms or molecules are ionized, and particles have kinetic energy.

7.2. Why is mercury usually preferred to alcohol as a thermometric liquid?

Ans. Mercury is preferred to alcohol as a thermometric liquid because it has a higher coefficient of expansion, making it more sensitive to temperature changes. Additionally, mercury has a higher boiling point, allowing it to measure higher temperatures.

7.3. Why is water not suitable for use in thermometers. Without calculations, guess what is equivalent temperature of 373K on Celsius and Fahrenheit scales?

Ans. Water is not suitable for use in thermometers because it freezes at 0°C and boils at 100°C , limiting its temperature range. Additionally, water's coefficient of expansion is relatively low, making it less sensitive to temperature changes. The equivalent temperature of 373K on Celsius scale is 100°C and 212°F on Fahrenheit scale.

7.4. Mention two ways in which the design of a liquid in glass thermometer may be altered to increase its sensitivity.

Ans. Two ways to increase the sensitivity of a liquid-in-glass thermometer are:

- (1) using a liquid with a higher coefficient of expansion,
- (2) increasing the length of the thermometer's stem, allowing for more precise temperature readings.

E Numerical Problems

7.1 The temperature of a normal human body on Fahrenheit scale is 98.6°F . Convert it into Celsius scale and kelvin scale.

Solution: Step I:

Sol. Data:

$$T_F = 98.6^{\circ}\text{F}$$

$$T_C = ?$$

$$T_K = ?$$

The formula to convert Fahrenheit (T_F) to Celsius (T_C) is:

$$T_C = \frac{5}{9}(T_F - 32)$$

Putting above value.

$$T_C = \frac{5}{9}(98.6 - 32)$$

$$T_C = \frac{5}{9}(66.6) = 37^{\circ}\text{C}$$

Step II:

Again

$$\frac{-4}{5} C = 32$$

$$C = -40$$

So the temperature at which the Celsius and Fahrenheit reading are the same is -40°C (or -40°F)

7.3 Convert 5°F to Celsius and Kelvin scale.

Sol. Data:

Given: $T_F = 5^{\circ}\text{F}$

$$T_C = ?$$

$$T_K = ?$$

Sol. To convert 5°F to Celsius and Kelvin we will use the following formulas.

To convert Fahrenheit (T_F) to Celsius (T_C) is:

$$T_C = \frac{5}{9}(T_F - 32)$$

By putting above value

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

$$T_C = -15^{\circ}\text{C}$$

CHAPTER 8**Magnetism****Student Learning Outcomes**

After completing this chapter, students will be able to:

- Describe the forces between magnetic poles and between magnets and magnetic materials [Including the use of the terms north pole (N pole) south pole (S pole), attraction and repulsion, magnetised and unmagnetised]
- Describe induced magnetism
- Differentiate between temporary and permanent magnets.
- Describe magnetic fields [as a region in which a magnetic pole experiences a force]
- State that the direction of the magnetic field at a point is the direction of the force on the N pole of a magnet at that point
- State that the relative strength of a magnetic field is represented by the spacing of the magnetic field lines
- Describe uses of permanent magnets and electromagnets
- Explain qualitatively in terms of the domain theory of magnetism how materials can be magnetised and demagnetise [stroking method, heating, orienting in north-south direction and striking, use of a solenoid]
- Differentiate between ferromagnetic, paramagnetic and diamagnetic materials [by

8.4

Temporary and Permanent Magnets

Q.4. What are temporary and Permanent Magnets?

Ans. Temporary Magnets: Temporary magnets are the magnets that work in the presence of a magnetic field of permanent magnets. Once the magnetic field vanishes, they lose their magnetic properties. Electromagnets are also good examples.

Examples: Usually, soft iron is used to make temporary magnets. Paper clips; office pins and iron nails can easily be made temporary magnets.

Permanent Magnets: Permanent magnets retain their magnetic properties forever. These are either found in nature or artificially made by placing objects made of steel and some special alloys in a strong magnetic field for a sufficient time.

Four Main Types: There are many types of permanent magnetic materials. For example cobalt, alnico and ferrite.

8.5

Magnetic Fields

Q.5. What is magnetic fields? And how the magnetic lines of force is produce?

Ans. Magnetic field: A magnetic field is the region around a magnet where an other magnetic object experiences a force on it.

Explanation: When a magnet attracts a certain magnetic material, it exerts some force to do so. Similarly, when it attracts or repels a magnetic pole of another magnet, it exerts a force on it. This force can be observed up to a certain distance from the magnet.



Q.8. Write some applications of permanent magnets.

Ans. 1. A.C generator:

Principle: AC is made to pass through the coil between the poles of permanent magnet, it starts rotating.

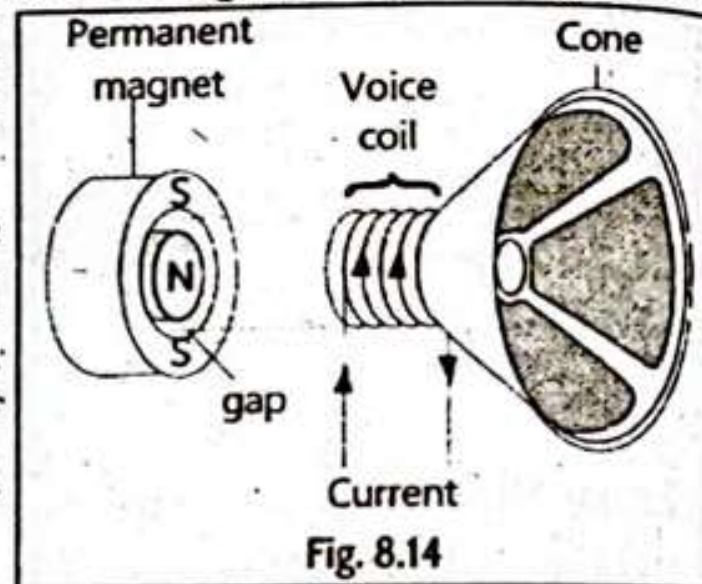
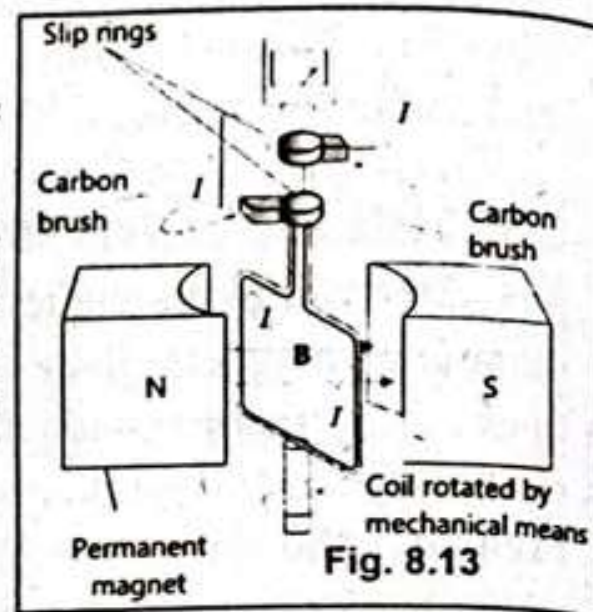
Working: When a coil is rotated between the poles of a permanent magnet, the magnetic field through the coil changes and an emf is induced between the ends of the coil. On connecting these ends to an external circuit, an alternating current (AC) flows through the circuit.

2. Electric motor:

Electric motor is the reverse process of electric generator.

3. Moving Coil Loudspeaker. Working: AC interacts with the magnetic field to generate a varying force that pushes and pulls on the voice coil and the attached cone. The cone vibrates back and forth to produce sound in the air.

Explanation: A voice coil attached to the cone of the speaker is slipped over one pole (N) of the radial permanent magnet as shown in fig.8.14. From a microphone or some other sound signals in the form of varying (AC) current passes through the voice coil that is inserted in the gap of permanent magnet.



2. Electromagnetic Cranes:

Huge Electromagnets: Huge electromagnets are used in cranes at scrapyards, steel works and on ships. These are so powerful that they can lift iron and steel objects such as cars.

Working: After moving the heavy objects to the required position, the objects are released by just switching OFF the current of the electromagnet.

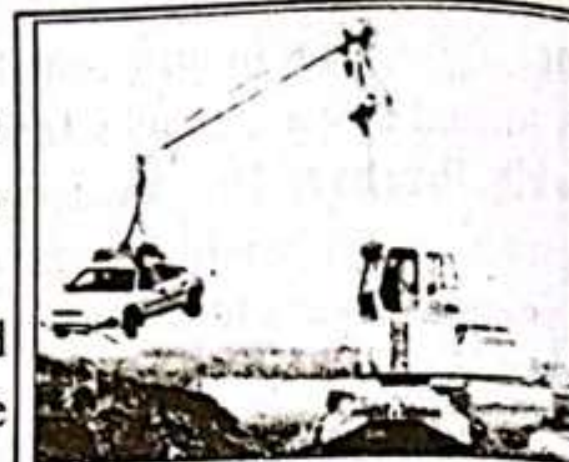


Fig. 8.18

8.8

Domain Theory of Magnetism

Q.13. Define and explain domain theory of magnetism.

Ans. Magnetic Domain: The materials in which large group of atoms of the order of 10^{16} have their electron spin naturally aligned parallel to each other are called ferromagnetic materials. These groups are called magnetic domains.

Explanation: It is observed that the magnetic field of a bar magnet is like the field produced by a solenoid (long coil of wire) carrying current (fig. 8.19 a & b).

Suggest: It suggests that all magnetic effects are due to moving charges. In case of solenoid, charges are moving in the wire. The motion responsible for the magnetism in it is that of electrons within the atoms of the material.

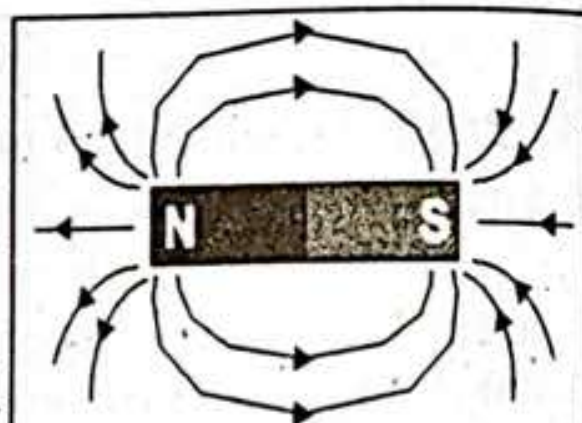
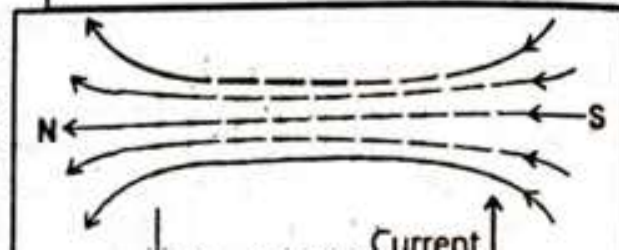


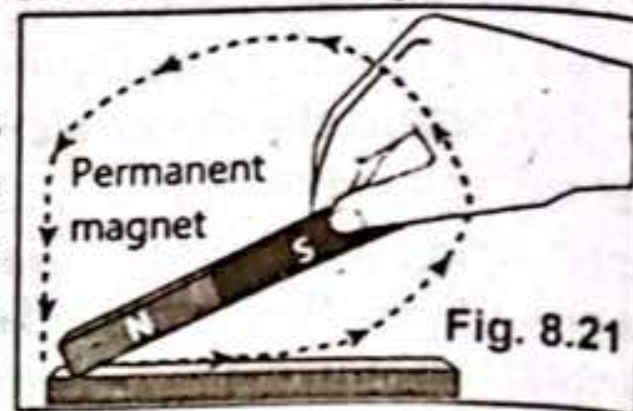
Fig. 8.19 (a)



1. Stroking: In this method, magnetism is induced in a steel bar by using the magnetic field of a permanent magnet. The steel bar can be stroked in two ways.

(a) Single-Touch Method:

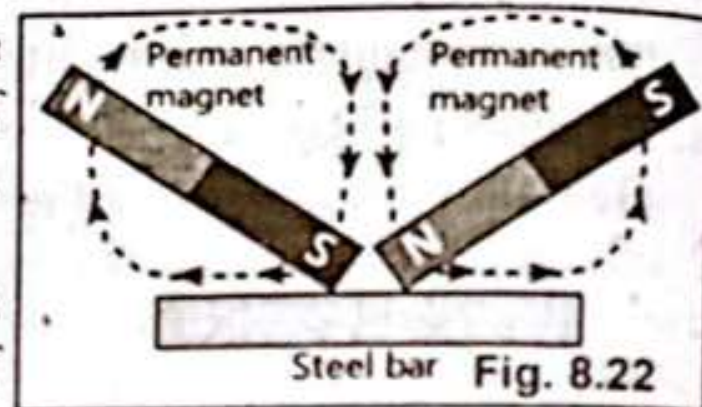
Working: A steel bar is placed on a horizontal surface. It is stroked from one end to the other several times in the same direction using the same pole (say N) of the permanent magnet. Every time the magnet is lifted up sufficiently high on reaching the other end of the bar.



(b) Double-Touch Method:

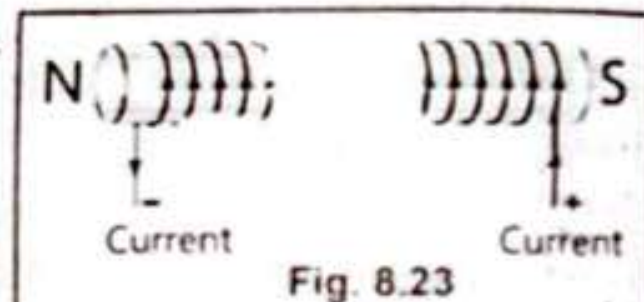
Working: In this method, stroking is done from the centre of the steel bar onwards with the unlike poles of two permanent magnets at the same time (Fig.8.22). This method is more efficient than the first one.

Explanation: In both the cases, the poles produced at the ends of magnetized steel bar after stroking are of the opposite polarity to that of the stroking pole.



2. Making a magnet using solenoid

Working: In this method, a steel bar to be magnetized is placed inside a solenoid (long coil of wire) as shown in Fig. 8.23. The solenoid should have several hundred turns of insulated copper wire. When direct current is passed through the solenoid, the steel bar becomes a



Electronic devices can be protected from strong magnetic effects by enclosing them in the boxes made of soft iron.

8.11

Soft Iron as Magnetic Shield

Q.18. What is the purpose of using soft iron in the in electromagnets? Explain how its high magnetic permeability helps in these application.

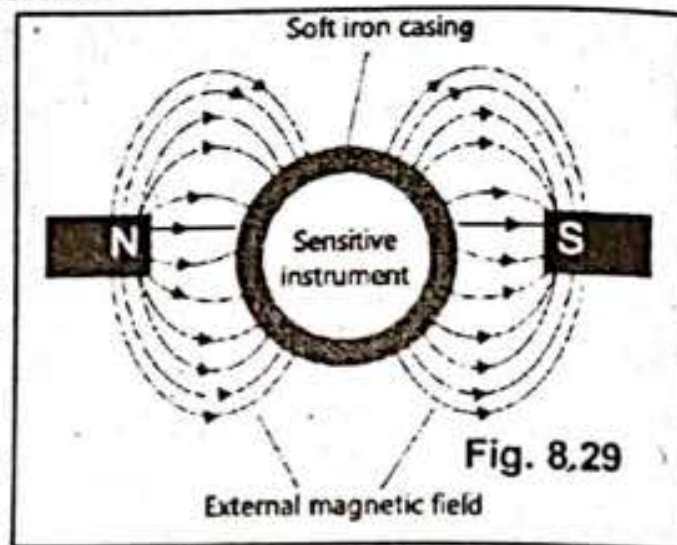
Ans. **Magnetic permeability of soft iron:** Soft iron has high magnetic permeability. The permeability is the ability of a material to allow the magnetic flux or lines of force through it when the material is placed inside a magnetic field.

Explanation: If a sensitive magnetic device is enclosed in a casing of soft iron, the magnetic flux gets established in the soft iron rather than the device. Thus, the device is shielded from external magnetic field.

Working: A soft iron casing (shell) is placed inside a magnetic field produced by opposite poles of two bar magnets. Since the magnetic permeability of the iron shell is higher than that of air, so the magnetic flux is established in the soft iron. As a result, the device is protected from the magnetic field. Usually, the casing is made with rounded corners to facilitate the magnetic field line up easily.

Example: When a piece of soft iron is put into a magnetic field, it generates a magnetic field due to magnetization.

Use of Soft Iron: Soft iron is generally used in the cores of transformers and electromagnets because of its high permeability. In case of an electromagnet, the core of



2. Analyse applications of magnet in recording technology and illustrate electronic devices need to be kept safe from the strong magnetic fields.

Ans. Magnets play a crucial role in recording technology. Here are some applications.

Magnetic tapes: Magnetic tapes are used to record audio and video signals. The tape is coated with a magnetic material that can be magnetized to represent the recorded signal.

Hard disk drivers: Hard disk drivers use magnetic disks to store data. The disks are coated with a magnetic material and the data is recorded by magnetizing the material.

Magnetic Resonance Imaging: MRI machines use strong magnetic fields to create images of the body.

Electronic devices that need to be kept safe from strong magnetic fields:

Credit cards: Credit cards have a magnetic strip that can be damaged by strong magnetic fields.

Smart phones: Smart phones have magnetic sensors that can be affected by strong magnetic fields.

Laptop have hard disk drivers that can be damaged

Keep devices safe: Keep them away from strong magnetic fields, such as those produced by MRI machines or strong magnets.

Avoid placing devices near magnetic fields for extended periods.

3. State the soft magnetic material such as a soft iron can be used to provide shielding from magnetic field.

Ans. Soft magnetic materials, such as soft iron, can be used to provide shielding from magnetic fields.

iii. What do you observe? Describe briefly.

Aim: To observe the magnetic field of a magnet using iron filings.

Materials:

- Iron Filings
- Magnet
- Card paper or glass sheet
- Plastic sheet (Optional)

Procedure:

- i. Place iron filings scattered on the top of a card paper or glass sheet.
- ii. Move a magnet beneath the paper, card, glass or plastic sheet.
- iii. Observe the pattern formed by the iron filings.

Observation and Results: When the magnet is moved beneath the paper; card, glass or plastic sheet, the iron filings align themselves in a pattern, forming lines that emerge from the north pole and enter the south pole of the magnet.

Conclusion: The pattern formed by the iron filings represents the magnetic field lines of the magnet. The magnetic field is strongest near the poles of the magnet and weakest near the center.

Activity 8.3

The teacher should facilitate each group to perform this activity as per instructions.

- i. Take a magnetic compass. Put it on a table and see which end of its needle points north. The N-pole of the needle is usually coloured red.
- ii. Place a bar magnet on the table. Bring the compass near to its N-pole. In which

- iii. Try to hang steel nails at the other end of the bar magnet to form a similar chain.
- iv. Remove the chain of iron nails by pulling the topmost nail. Does the similar chain collapse?
- v. Remove the chain of steel nails in the same way. Does this collapse?
You will observe that the chain of iron nails immediately collapse but the steel nails remain attached to each other for some time. This shows that the magnetism induced in the iron nails is temporary while that in the steel nails is permanent.

Aim: To compare the temporary and the permanent magnetization of iron and steel nails.

Materials:

- Bar magnet
- Stand with clamp
- Iron nails
- Steel nails

Procedure:

- i. Clamp the bar magnet horizontally on the stand.
- ii. Touch the head of an iron nail to one end of the magnet and observe.
- iii. Continue adding iron nails to form a chain.
- iv. Attempt to form a similar chain using steel nails.
- v. Remove the chain of the iron nails by pulling the topmost nail and observe.
- vi. Remove the chain of the steel nails in the same way and observe.

Observations and Results:

- i. The iron nails form a chain due to temporary magnetization.
- ii. The steel nails also form a chain, but it remains attached for some time due to

4. The end of the magnet that points north is known as:
(a) North magnetic pole (b) South magnetic pole
(c) Identification of Magnet (d) Magnetic End
5. If the north pole of one is placed near the south pole of other, the poles will attract, we can say that:
(a) Like poles repel and unlike pole attract
(b) Unlike pole repel and like pole attract (c) both (a) and (b) (d) none of these
6. Which material can be made a magnet:
(a) Like poles (b) Unlike poles (c) Magnetic poles (d) Steel and iron
7. How many main types of permanent magnet's?
(a) Three (b) Seven (c) Six (d) Four
8. Electromagnets are also good examples of:
(a) Temporary magnets (b) Permanent magnets
(c) Magnetic field (d) Electromagnets
9. The pattern of a magnetic field around a bar magnet can be seen _____ by a simple experiment.
(a) with very difficulty (b) with very hard
(c) with very easy (d) with very normal
10. The lines that correspond to the path of the filings these lines are:
(a) Poles lines of force (b) Parallel lines
(c) Distance lines of force (d) Magnetic lines of force
11. Electric motor is the _____ process of electric generator.
(a) Forward (b) Reverse (c) Previous (d) Both a and c

Conceptual MCQ's

1. Which force act between two magnetic poles?
(a) Electric Force (b) Magnetic Force
(c) Gravitational Force (d) Fractional Force
2. Which of the following material is a natural magnet?
(a) Iron (b) Copper (c) Lode stone (d) Aluminium
3. What is the direction of the magnetic field lines around a bar magnet?
(a) From north pole to south pole (b) From south to north pole
(c) Clockwise (d) Counterclockwise
4. What is the term for the region around a magnet where the magnetic force can be detected?
(a) Magnet Field (b) Electric Field
(c) Gravitational Field (d) Frictional Field
5. Which of the following is the characteristics of a magnetic field?
(a) It is a scalar quantity (b) It is a vector quantity
(c) It is constant quantity (d) It is a variable quantity
6. What is the unit of measurement of magnetic field strength?
(a) Tesla (b) Ampere (c) Volt (d) Ohm
7. Which of the following material is ferromagnetic?
(a) Copper (b) Aluminum (c) Iron (d) Glass
8. What is the term for the process of a magnetizing a material?

8. Where the field lines appear?

Ans. The field lines originated from the north pole and end on south pole.

9. Why points x-called neutral point?

Ans. Because the field due to one magnets cancel out that due to other magnets. Therefore point x-called neutral point.

10. If we increase the number of cells in the battery or increase the number of turns of coil, so what we will observe?

Ans. We observe that the strength of the magnetic field in each case increase. This will be indicated by the more number of clips held by the nail.

11. When a circuit is breaks?

Ans. A circuit breaker is designed to pass a certain maximum current through it safely. If the current becomes excessive, it switches OFF the circuit. Thus, electric appliances are protected from burning. Inside a circuit breaker, the current flows along a copper strip, through the iron armature and coil of electromagnet. The electromagnet attracts the armature. If the current is large enough, the armature is detached from the copper strip and the circuit breaks.

12. Why steel is used to make a permanent magnet?

Ans. Steel is not so easily oriented to change order. It requires very strong external field, but once, oriented, retains the alignment. That is why steel is used to make permanent magnet.

13. Can a magnet demagnetize by storing it near another magnet.

Ans. Yes, a magnet can be demagnetized by storing it near another magnet. The opposing magnetic field can cause the magnetic domains to become randomly aligned, resulting in a loss of magnetic field.

14. What is the effect of alternating current on a magnet?

5. What are temporary magnets?

Ans. Temporary magnets are made of soft metals and only exhibit magnetic properties when near a permanent magnet or an electric magnet.

6. What are some applications of magnets?

Ans. Magnets are used in many electronic devices, such as TVs, speakers and radios. They are also used in computers to store data on hard disks, and in generators to convert mechanical energy to electrical energy.

7. What is meant by diamagnetism?

Ans. Diamagnetism is a fragile type of magnetism generated by a change in the electrons orbital motion due to an enforced magnetic field. When the source of the induced magnetic field is removed the magnetization of the given material is disappear.

8. What is a permanent magnet?

Ans. A permanent magnet is a material made from a magnetized substance and generates its own magnetic fields. A familiar example is a magnet used to stick notes on metal objects.

9. What is an electromagnet?

Ans. An electromagnet is composed of a coil of wire that behaves like a magnet when an electric current flows through it.

Exercise Questions (Solved)

A Multiple Choice Questions

Tick (✓) the correct answer:

8.1 Which one of the following is not a magnetic material?

(a) Cobalt

(b) Iron

(c) Aluminium

(d) Nickel

- 8.7 Differentiate between paramagnetic and diamagnetic materials.

Ans: Paramagnetic materials: Paramagnetic materials are weakly attracted to external magnetic fields due to unpaired electrons.

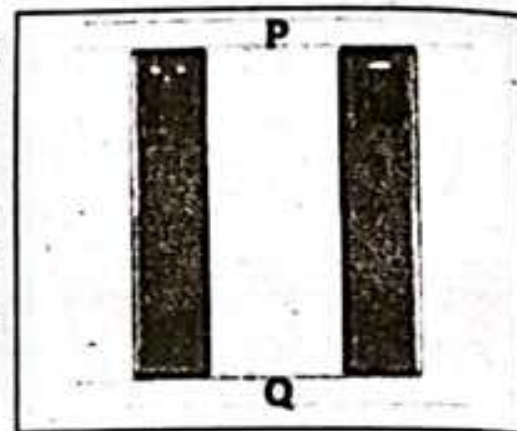
Diamagnetic materials: Diamagnetic materials are weakly repelled due to paired electrons and induced opposing magnetic moments.

C Constructed Response Questions

- 8.1 Two bar magnets are stored in a wooden box. Label the poles of the magnets and identify P and Q objects.

Ans. To store the magnets safely, we should keep the P object (N-pole) of one magnet near the Q-object (S-pole) of the other magnet.

Reason: This is because opposite poles attract each other and this arrangement will help prevent the magnets from attracting other metal objects for each other.



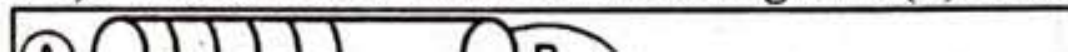
Magnet 1: P(N-pole) Q(S-pole)

Magnet 2: P(N-pole) Q(S-pole)

- 8.2 A steel bar has to be magnetised by placing it inside a solenoid such that end A of a bar becomes N-pole and end B becomes S-pole. Draw circuit diagram of solenoid showing steel bar inside it.

Ans. End A (N-pole): Current flow from (+) terminal of battery to end A.

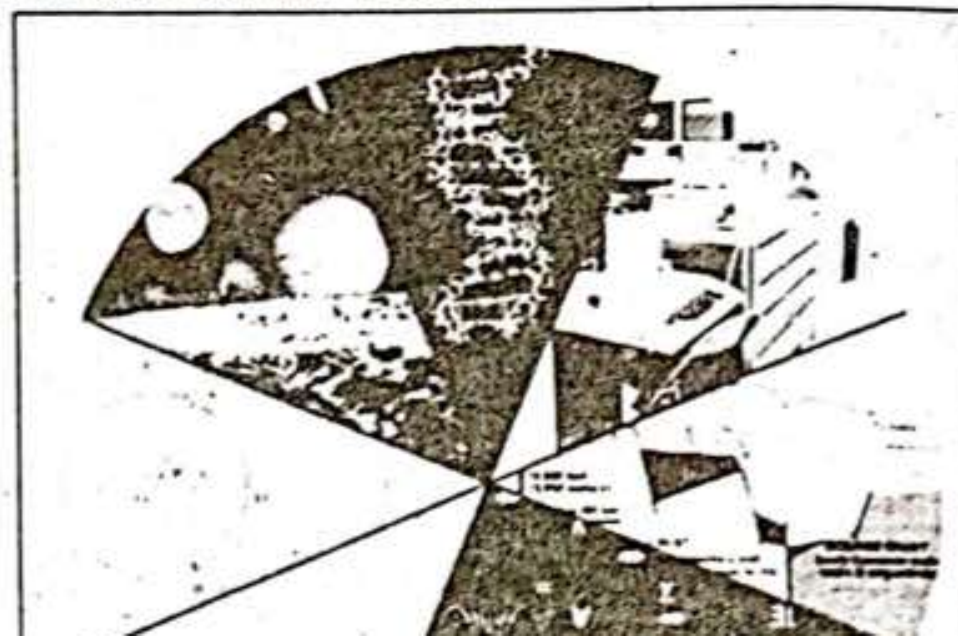
End B (S-pole): Current flow from End B to negative (–) terminal of battery.



CHAPTER 9**Nature of Science****Student Learning Outcomes**

After completing this chapter, students will be able to:

- Describe physics as the study of matter, energy, space, time and their mutual connections and interactions
- Explain with examples that physics has many sub-fields, and in today's world involves interdisciplinary fields. (Students should be able to distinguish in terms of the broad subject matter that is studied between the fields:
- Biophysics
- Astronomy
- Astrophysics
- Cosmology
- Thermal Physics
- Optics
- Classical Mechanics
- Quantum Mechanics
- Relativistic Mechanics
- Nuclear Physics



Fundamental concept:

Physics explores how these fundamental concepts are inter-connected.

Theory of relativity:

For example, the theory of relativity explains how space and time are not absolute quantities but are related to each other. It describes the relationship between space and time and how they are influenced by gravity and speed, for example, the bending of light around massive objects like stars.

Quantum mechanics:

Another branch of physics, the quantum mechanic, explains the behaviour of particles at the atomic and subatomic levels. It is how the physics has applied its principles to wide variety of phenomena, from everyday occurrences such as related to motion and heat to the extreme conditions found in the universe.

9.2**Branches of Physics****Q.2. Explain different branches of physics.**

Ans. Due to expanding scope of research in Physics, it is usually divided into following branches:

1. Mechanics:

It is a study of motion and the physical effects which influence motion. It is based on Newton's laws of motion



methods that are applicable across a wide range of disciplines. Some of these are:

1. Biophysics 2. Medical Physics 3. Astrophysics
4. Geophysics 5. Climate Physics 6. Computation Physics

1. Biophysics:

Some biological systems and processes are described using the principles and technique of physics under this field of study.

Examples:

Include the mechanics of biological structures, physical properties of cells, tissues and organs.

2. Medical Physics:

It applies physical principles to develop techniques and technologies for health diagnosis and treatment. The examples include imaging techniques, such as X-rays; ultra sound, MRI and CT scan and also radiation therapy for cancer treatment.

3. Astrophysics:

It deals with the physical properties and processes of celestial bodies and phenomena. For example, the interaction between the matter and energy in space to understand the universe as a whole.



DNA Structure



Magnetic Resonance Imaging (MRI)



Study of celestial bodies

5. Record, organize and analyze gathered data, plotting and interpreting graphs to reach at a conclusion which is called a theory.
6. Repeated tests of the theory to wide range of similar issues then lead towards the formulation of a law.

Q.6. Describes the main stages of scientific method with examples.

Ans. Some key stages are elaborated here:

1. Observation:

The first step in scientific method is to make observations of natural processes and to collect the data about them. This may be done either by ordinary observations or by obtaining the results from different experiments. For example, it is our common observation that shadow of an opaque object is formed when it is placed in the path of light coming from the Sun or a lamp (Fig.9.1).



Fig. 9.1

2. Hypothesis:

On the basis of the data collected through observations or experimentation, we can develop a hypothesis. This is done in order to test its logical results, i.e., it is assumed that nature will act in a particular way under certain specific circumstances. From the above example, we assume that shadows of opaque objects are formed when they come in the path of light because light travels in a straight line.

3. Experiment:

Experiment is an organized repeatable process which is used to test the truth of a hypothesis.

Examples:

- i. A civil engineer designs a bridge that can withstand strong winds, earthquakes, intense weather conditions and heavy traffic.
- ii. A software engineer designs a user friendly application of a smartphone.
- iii. An aviation engineer looks for lighter material which can withstand sudden and severe disturbances and extreme weather conditions during the flight of an aeroplane.

Though the science, technology and engineering fields seem distinct but they often work together. Scientific discoveries lead to new technologies and engineers rely on scientific knowledge for our benefits and comforts. They are the potent for change in the outlook of mankind in shaping life style and influencing our way of thinking.

Objective Type Questions

Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques (Knowledge, Understanding, Application, Analytical & Conceptual)

1. _____ is important and basic part of Physical Sciences.
(a) Physics (b) Chemistry (c) Geology (d) all of these

24. In scientific method, if predictions that can be tested and potentially proven false is known as:
(a) Hypothesis (b) Falsifiability (c) Observations (d) Prediction
25. After the careful analysis of a theory we can make:
(a) Hypothesis (b) Observation (c) Prediction (d) Experiment
26. If test result do not agree, hypothesis is:
(a) Rejected (b) Changed (c) Accepted (d) Both (a) and (b)
27. In which century, Albert Einstein declared that mass and energy, the two concerns of Physics, are forms of each other?
(a) 18th (b) 19th (c) 20th (d) 21st

ANSWERS:

- | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (c) | 3. (b) | 4. (a) | 5. (a) | 6. (c) | 7. (b) |
| 8. (d) | 9. (b) | 10. (d) | 11. (b) | 12. (a) | 13. (c) | 14. (a) |
| 15. (d) | 16. (d) | 17. (a) | 18. (c) | 19. (b) | 20. (d) | 21. (b) |
| 22. (c) | 23. (c) | 24. (b) | 25. (c) | 26. (d) | 27. (c) | |

Conceptual MCQ's

1. Mechanics is based on:
(a) Newton's law of motion (b) Gravitation
(c) Both (a) and (b) (d) Heat energy
2. Artificial Intelligence involved which fields?
(a) Computer science (b) Mathematical logic (c) Neuroscience (d) All of these
3. Successful verification of an assumption with the help of experimentation, it becomes.

3. What is the theory of relativity?

Ans. Relativity is a theory formulated by Albert Einstein, which states that space and time are relative and all motion must be relative to a frame of reference.

4. Define quantum mechanics.

Ans. The quantum mechanics is the branch of Physics which explains the behavior of particles at the atomic and subatomic levels.

9.2**Branches of Physics**

5. Define Mechanics.

Ans. It is a study of motion and the physical effects which influence motion. It is based on Newton's laws of motion and gravitation and is often called classical mechanics.

6. Define acoustics.

Ans. It deals with the nature and physical aspects of audible sound energy. The wide range of applications of sound properties are studied in the field of acoustics.

7. Differentiate between Quantum mechanics and Relativistic Mechanics.

Ans.	Quantum Mechanics	Relativistic Mechanics
	It explains the behaviour of particles at the atomic and subatomic level.	It explain how space and time are not absolute quantities but related to observer. It describes the relationship between them and how they are influenced by gravity and speed.

8. Differentiate between Nuclear Physics and Particle Physics.

Ans.	Nuclear Physics	Particle Physics
	It is the study of the properties	It is the study of subatomic particles and

nucleus over coming repulsive electromagnetic force between positively charged protons. It is also a short-range force with the order of 10^{-14}m .

5. How different fields collaborate to enhance the development of Artificial Intelligence?

Ans. "Artificial Intelligence" the development involves computer science, mathematical logic, neuroscience etc. The collaboration across these fields enhanced the development of intelligence systems and their applications.

Exercise Questions (Solved)

A Multiple Choice Questions

Tick (✓) the correct answer:

- 9.1. Physics is a branch of:
(a) social science (b) life science
(c) physical science (d) biological science
- 9.2. Which branch of science plays vital role in technology and engineering?
(a) Biology (b) Chemistry (c) Geology (d) Physics
- 9.3. Automobile technology is based on:
(a) acoustics (b) electromagnetism (c) optics (d) thermodynamics
- 9.4. A user friendly software application of smart phone use:
(a) laser technology (b) information technology
(c) medical technology (d) electronic technology
- 9.5. The working of refrigeration and air conditioning involves:

The requirement of falsifiability ensures that theories are not based on vague, non-specific or untestable claims.

Importance: It distinguishes scientific theories from false or pretended beliefs that cannot be experimentally tested.

C Constructed Response Questions

9.1 Is the theory of science an ultimate truth? Describe briefly.

Ans. No, the theory of science is not the ultimate truth. Scientific theories are based on current evidence and understanding, but they are subject to revision or replacement as new data or better explanations emerge as new discoveries are made, and theories are refined to better explain observations and phenomena.

9.2 Do you think that the existing laws of nature may need a change in future? Describe briefly.

Ans. Yes, the laws of nature may need to be revised in the future. Current laws are based on existing evidence, but new discoveries could reveal situations where these laws don't fully apply, as seen with quantum mechanics and general relativity. Science is an evolving field and our understanding may change over time.

9.3 Describe three jobs that need the use of scientific knowledge.

Ans. 1. Medical Scientist: Conducts research to improve health care develop new treatments, and understand diseases.

2. Environmental Scientist: Studies the environment and works on solutions to protect natural resources and address issues like pollution and climate change.

Time Allowed: 1:45 Hrs
Subjective Type (Part I)
Max. Marks: 48
(2 × 5 = 10)
Q.2: Write short answers to any five (05) questions:

- (i) What is measurement? Name its two parts.
- (ii) Write the name of 3 base quantities and 3 derived quantities.
- (iii) Why a standard unit is needed to measure a quantity correctly?
- (iv) Differentiate between scalar and vector quantities.
- (v) What are distance-time graph and speed-time graph?
- (vi) What kind of changes in motion may be produced by a force?
- (vii) State Newton's second law of motion. Also define the unit of force.
- (viii) When someone jumps from a small boat onto the river bank, why does the jumper often fall into the water? Explain

Q.3: Write short answers to any five (05) questions:
(2 × 5 = 10)

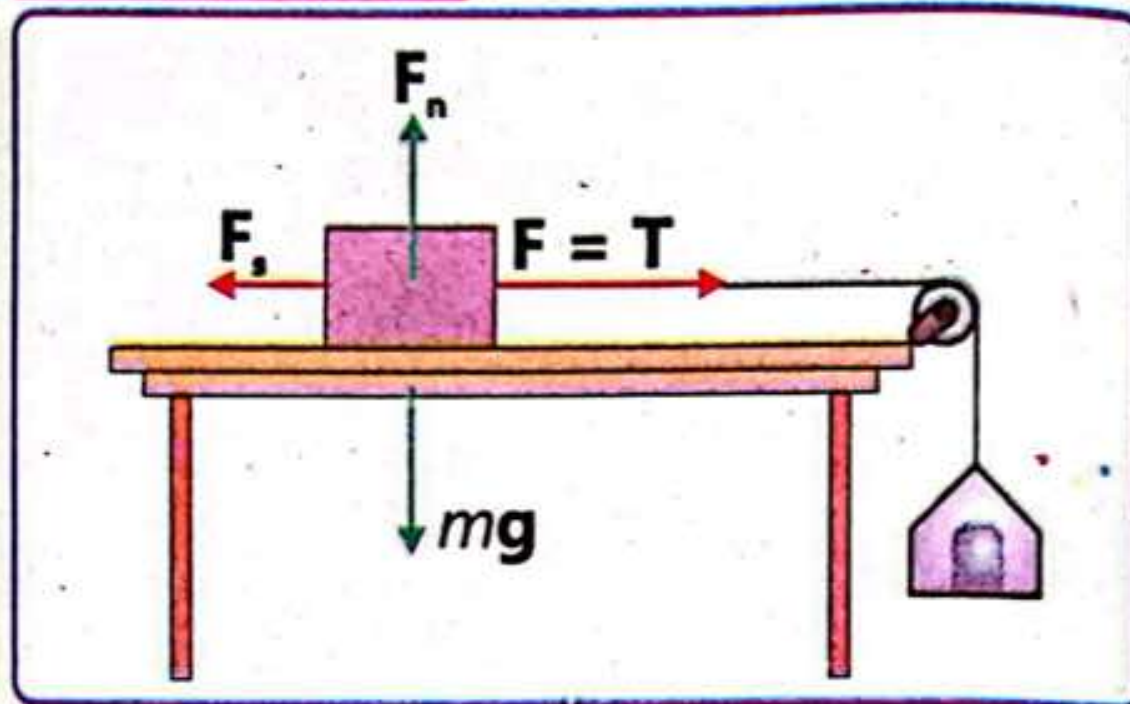
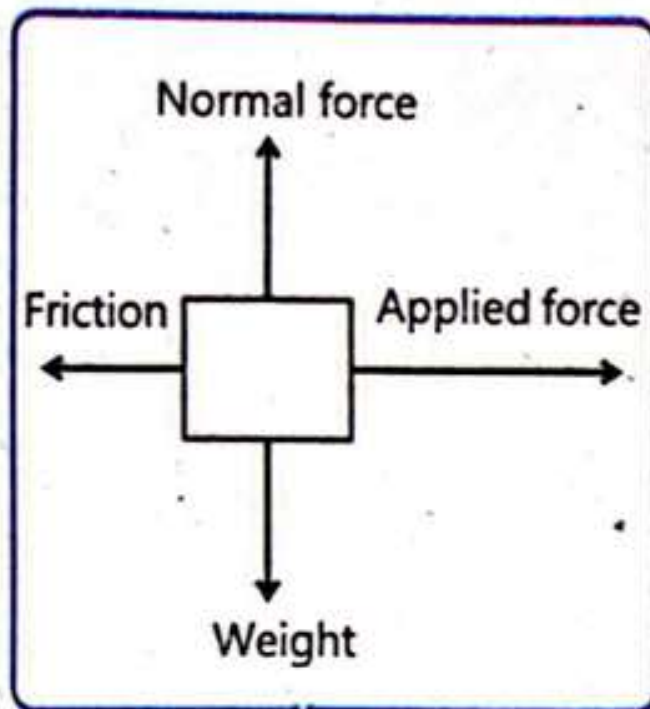
- (i) What are rectangular components of a vector and their values?
- (ii) Give an example of the body which is moving but it is yet in equilibrium.
- (iii) Define neutral equilibrium and give its two examples.
- (iv) A slow-moving car may have more kinetic energy than a fast-moving motorcycle. How is this possible?
- (v) Differentiate between kinetic energy and potential energy.
- (vi) A man rowing boat upstream is at rest to the shore. Is he doing work?
- (vii) Distinguish between force and pressure.
- (viii) State the basic principle used in the hydraulic brake system of the automobile.

Q.4: Write short answers to any five (05) questions:
(2 × 5 = 10)

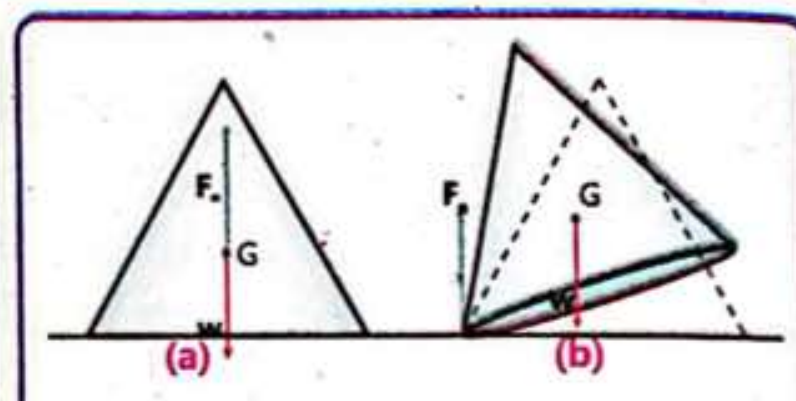
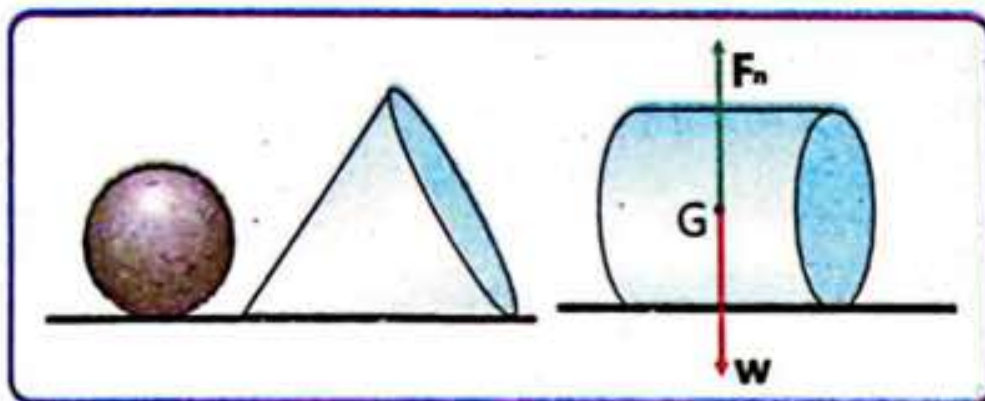
- (i) State the main scales used for the measurement of temperature.
- (ii) What does determine the direction of heat flow?
- (iii) What is thermometer? Enlist some basic thermometric properties

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CHAPTER 3

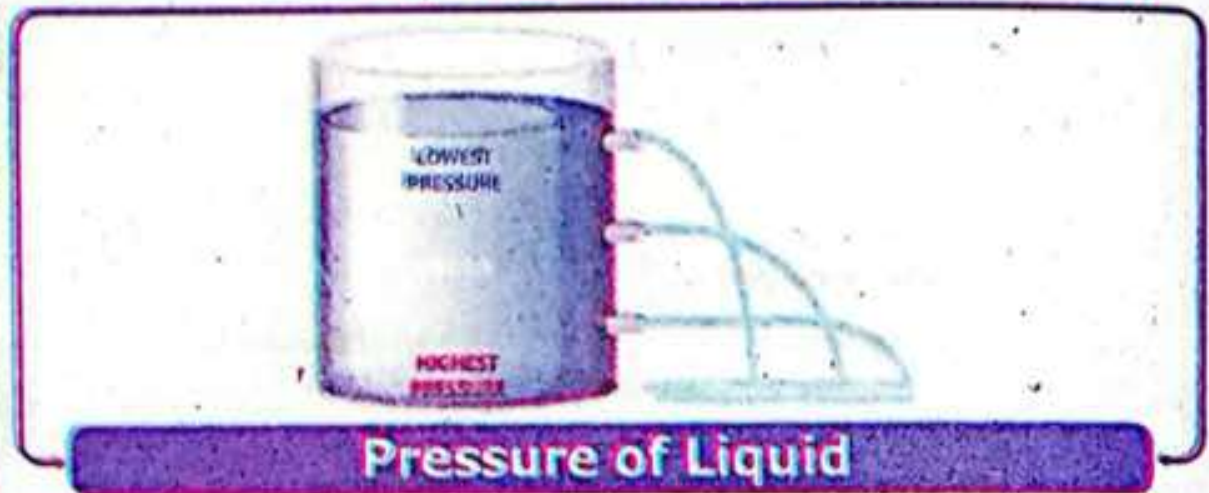
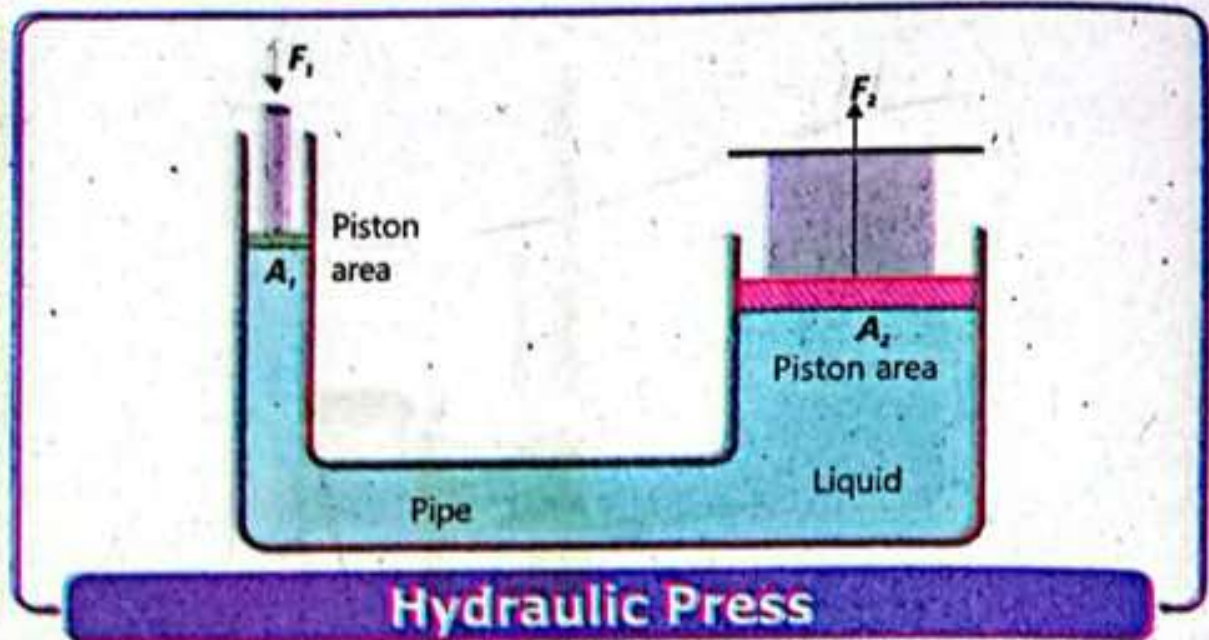
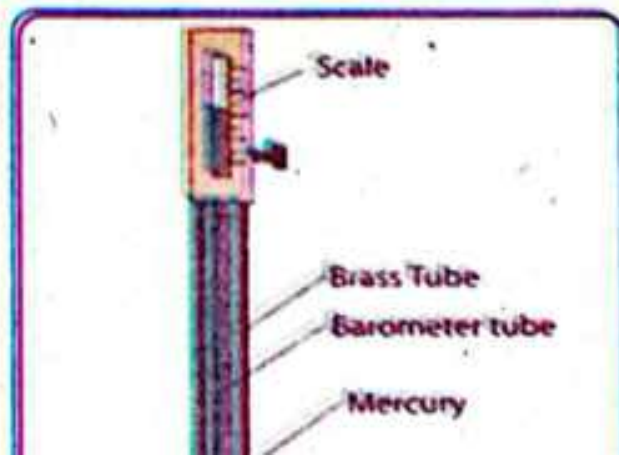
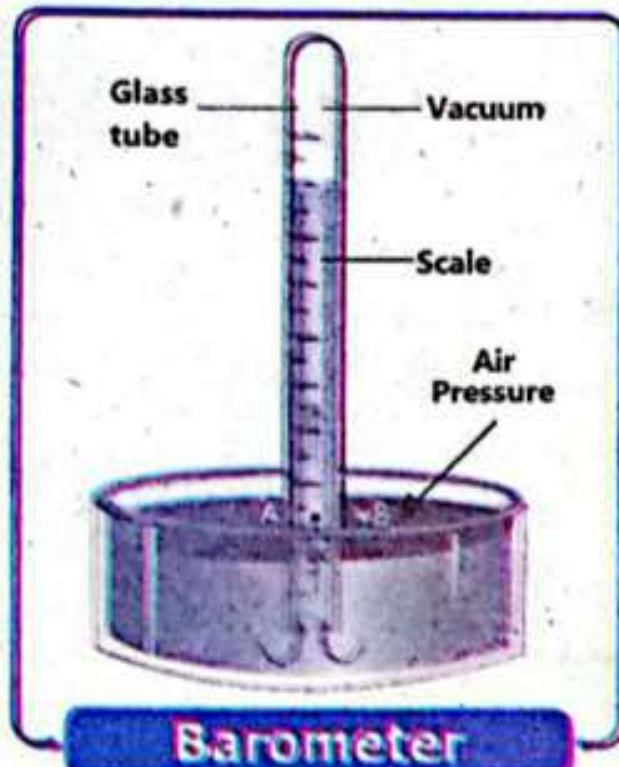


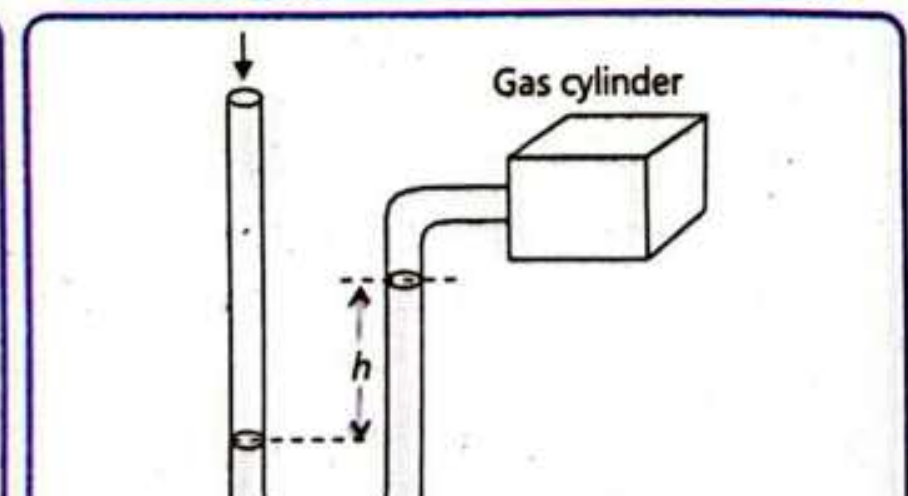
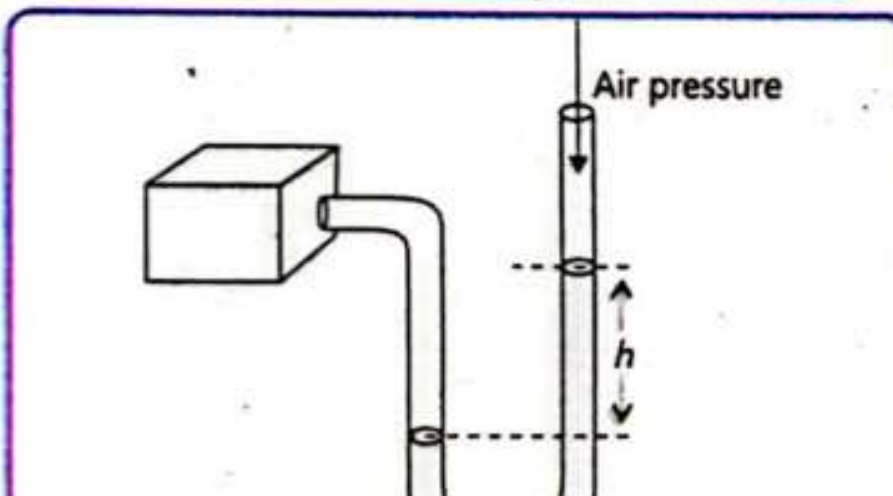
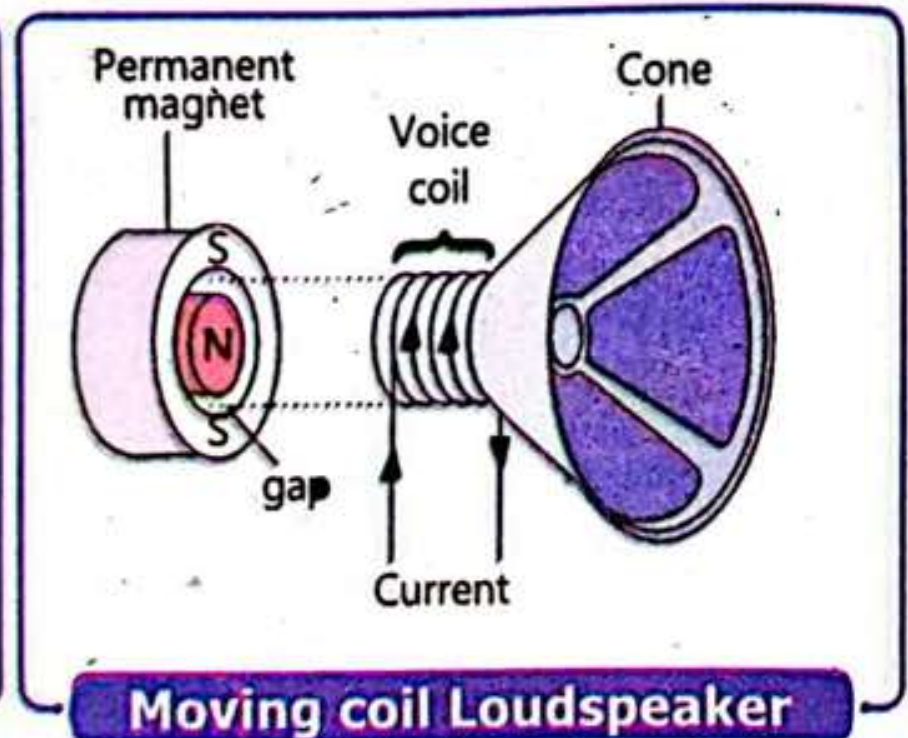
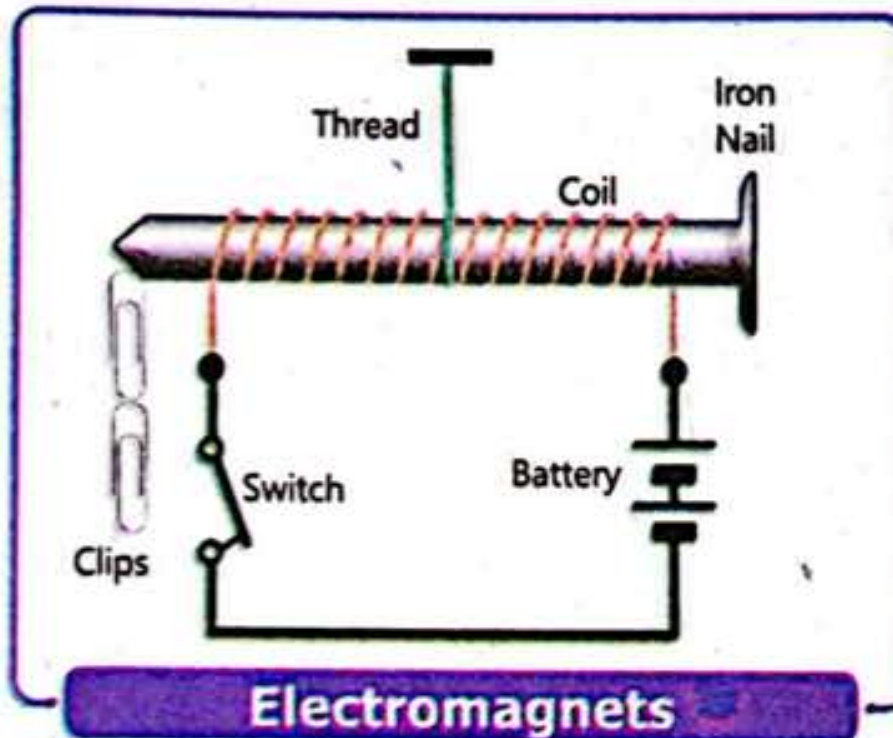
CHAPTER 4



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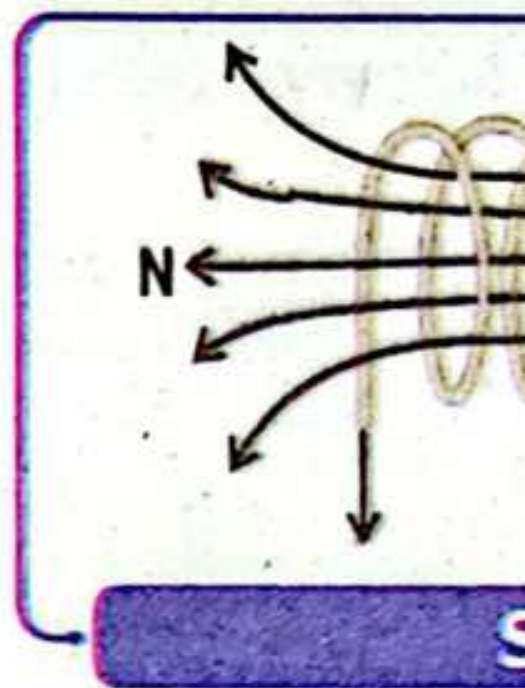
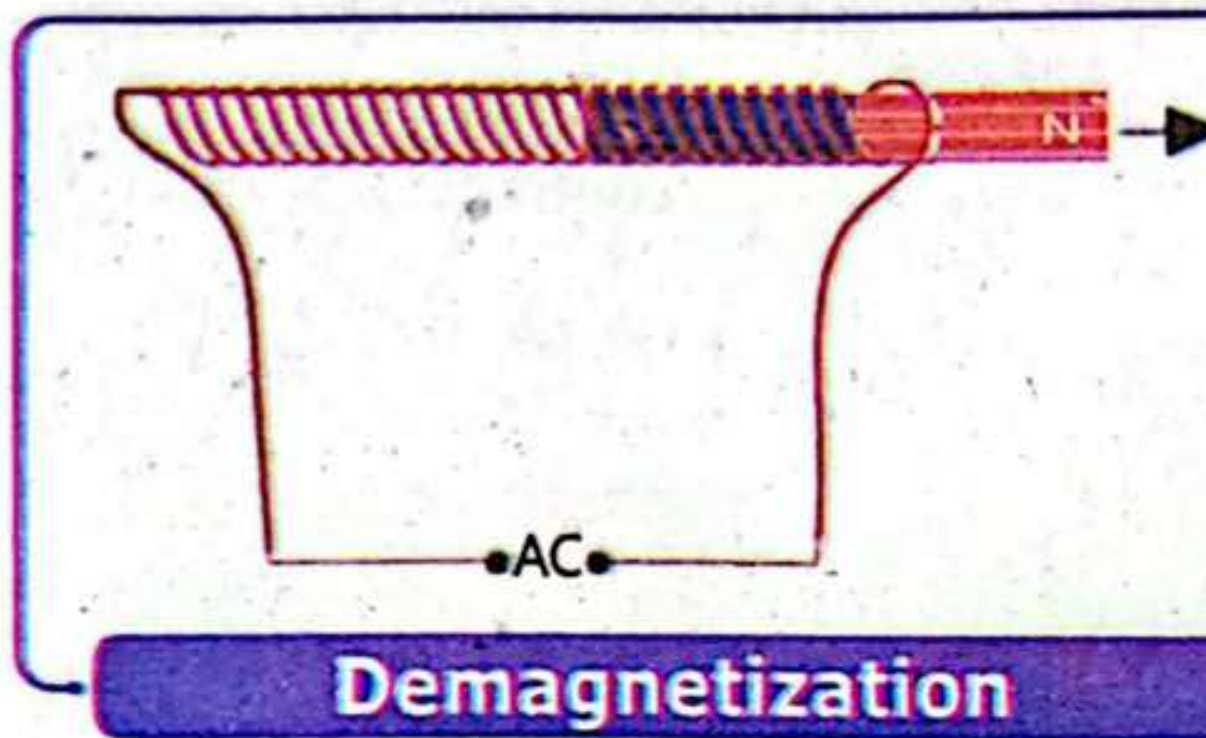
CHAPTER 6



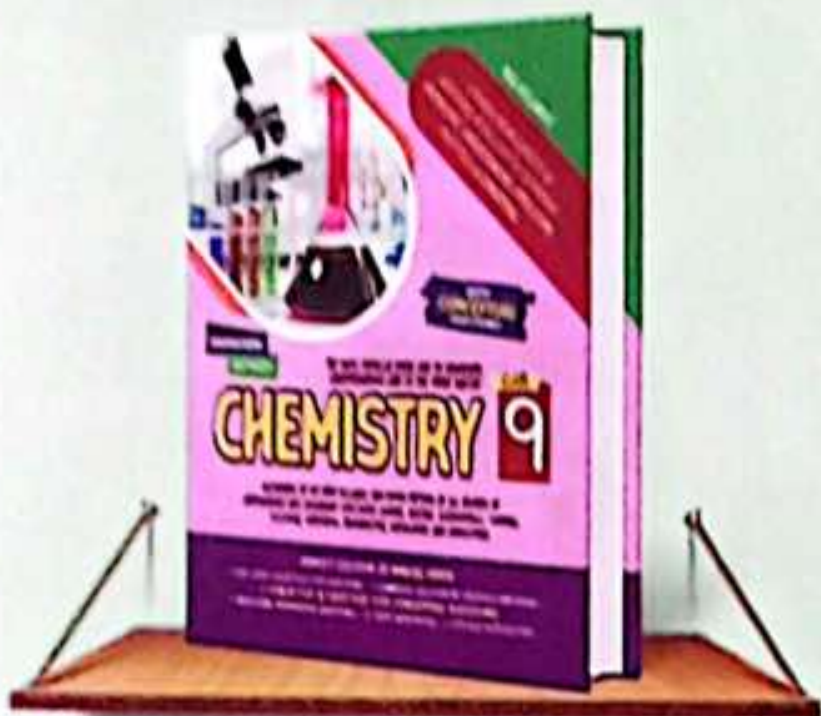
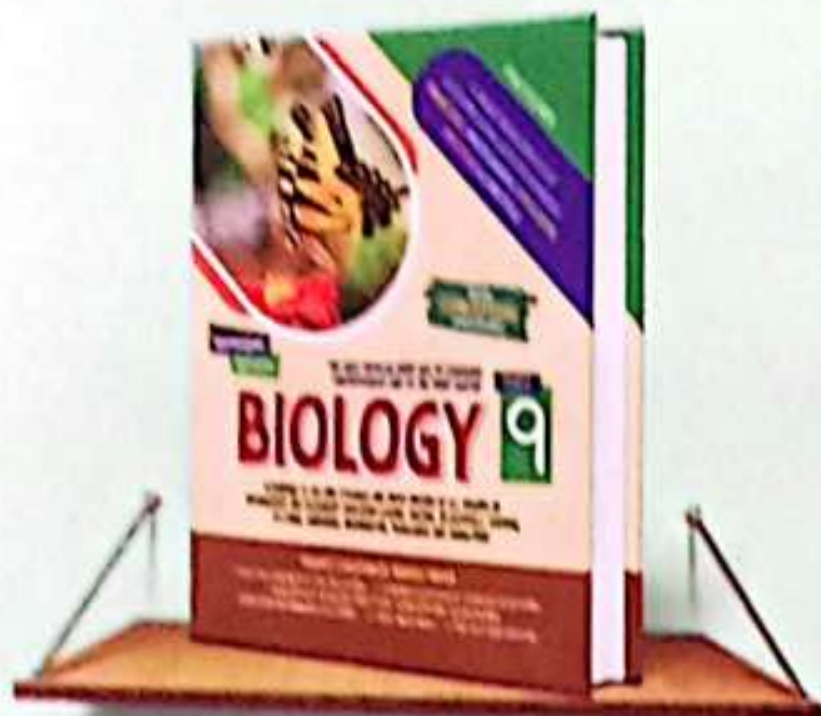


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