5

"A body in motion tends to stay in motion unless acted on by an outside force." – Isaac Newton

Measurement of Length and Motion

The Big Question

Imagine trying to build a treehouse without knowing how long the wood pieces are, or planning a trip without knowing how far you need to travel or how fast you're going. How do we describe how big things are, how far they move, or how quickly they get there? This chapter will unlock the fundamental concepts of measurement, showing us how to quantify the world around us and understand the unseen forces of motion!

Meet EeeBee.AI

Hello, young scientists! I'm EeeBee, your AI buddy. Let's dive into how we measure distance and observe objects moving, from tiny ants to giant rockets!

Still curious? Talk to me by scanning the QR code.

Learning Outcomes

By the end of this chapter, students will be able to:

- Understand the importance of measuring length in daily life and science.
- Learn standard units of length like millimeters, centimeters, meters, and kilometers.
- Identify types of motion: linear, circular, and oscillatory.
- Analyze motion using examples, focusing on time and distance measurements.

From Last Year's Notebook

Measurement (History and Units of Measurement)

Science Around You

Measurement and motion are everywhere in our daily lives. From tracking your steps on a smartwatch and timing your run, to understanding how a car travels and how quickly a ball falls, these concepts are fundamental. Mastering them helps us understand sports, design safer vehicles, and even explore the vastness of space.

NCF Curricular Goals and Competencies

This chapter aligns with the following curricular goals and competencies:

CG-4 (C 4.1, 4.2, and 4.3): Applies scientific methods to measure length and observe different types of motion in daily life. **CG-5 (C 5.1):** Develops analytical skills by relating measurements and motion to broader physical concepts.

Measurement of Length and Motion

Mind Map

Measurement of Length

The process of determining the distance between two points.

❖ **SI Unit of Measuring Length:** Meter (m)

❖ **Units of Length and Their Relationship with Other Units:**

- ✓ 1 Kilometer = 1000 Meters
- ✓ 1 Meter = 100 Centimeters
- ✓ 1 Meter = 1000 Millimeters
- ✓ 1 Centimeter = 10 Millimeters

Non-Standard Units of Measuring Length:

- ✓ • Foot Span • Arm Length
- ✓ • Cubits • Handspan

Relationship with Standard Units:

- ✓ • 1 Foot = 12 Inches
- ✓ • 1 Yard = 3 Feet
- ✓ • 1 Inch = 2.54 Centimeters
- ✓ • 1 Fathom = 6 Feet

Motion and Its Types

The process of determining the distance between two points.

❖ **Types of Motion:**

❖ **Rectilinear Motion:** Movement along a straight line

- ✓ Example: Car moving on a straight road

❖ **Circular Motion:** Movement along a circular path

- ✓ Example: Earth's orbit around the Sun

❖ **Rotational Motion:** Motion around an axis

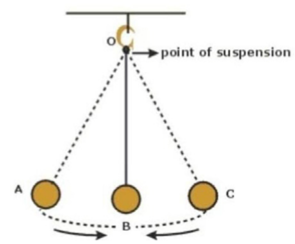
- ✓ Example: Spinning top, Earth's rotation

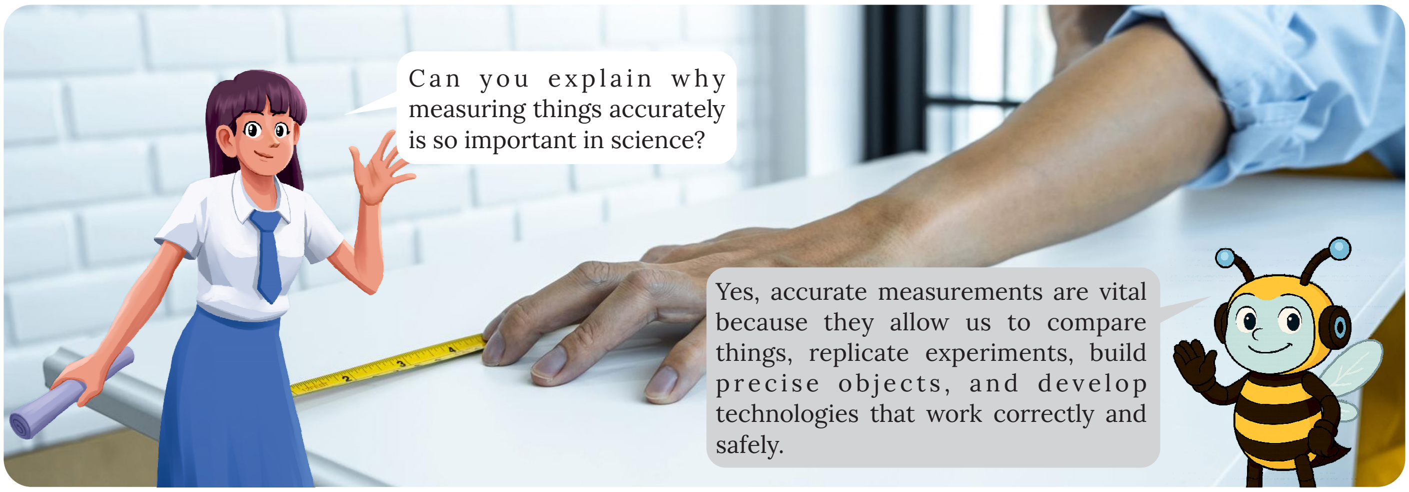
❖ **Oscillatory Motion:** Repetitive back-and-forth movement

- ✓ Example: Pendulum swing

❖ **Periodic Motion:** Motion that repeats at regular intervals

- ✓ Example: A rocking chair, A bouncing ball





In Focus

- Measurement of Length
- Motion and its Types

Introduction

Measurement is a fundamental aspect of understanding the physical world, allowing us to quantify and analyze various phenomena. Length, as a basic physical quantity, is essential for defining the size and distance of objects, while motion involves the study of how objects change position over time. In this chapter, we explore the tools and techniques used for accurate measurement of length, ranging from simple scales to advanced instruments like vernier calipers.

From History's Pages

The invention of tools like the sundial and water clock allowed early societies to measure time and motion. During the Scientific Revolution, pioneers like Galileo and Newton formalized the understanding of motion through laws and mathematical principles. The advent of the metric system in the 18th century brought a universal standard for length measurement, eventually adopted globally for precision and consistency. Today, advanced technologies like lasers and atomic clocks provide unparalleled accuracy in measuring both length and motion.

Measurement of Length

Measurement of length is one of the fundamental aspects of science and daily life, enabling us to quantify distances and dimensions. It plays a crucial role in fields like construction, engineering, trade, and navigation. Early methods relied on arbitrary units like body parts, but the need for consistency led to standardized systems. The development of precise tools and global standards, such as the metric system, revolutionized measurement practices.

Measuring lengths and distances is an essential part of daily life, as it is required for various tasks and professions. For instance, a tailor measures the length of fabric to stitch garments such as shirts, pants, skirts, and kurtas, while a carpenter determines dimensions to create furniture with precision. This highlights the long-standing human need for measurement and the development of various methods to fulfill it. Measurement is defined as the process of determining an unknown quantity by comparing it to a known, fixed quantity. Since it is not always possible to estimate quantities by sight alone, accurate measurement requires a standard unit of measurement.

Types of Measuring Length

Standard Units of Measuring Length

Standard units are universally accepted and consistent units used for accurate and reliable measurement. These units are defined and maintained by international agreements and are part of standardized systems like the metric system. For example, the meter (m) is the standard unit of length in the **International System of Units (SI)**. Subdivisions of the meter, such as centimeters (cm) and millimeters (mm), or larger multiples like kilometers (km), are used depending on the context.

Key Features of Standard Units:

- Universally accepted and consistent across the globe.
- Ensures accuracy and reliability in measurements.
- Examples: Meter (m), centimeter (cm), millimeter (mm), kilometer (km).t
- Tools for measurement: Ruler, measuring tape, Vernier caliper, and micrometer.

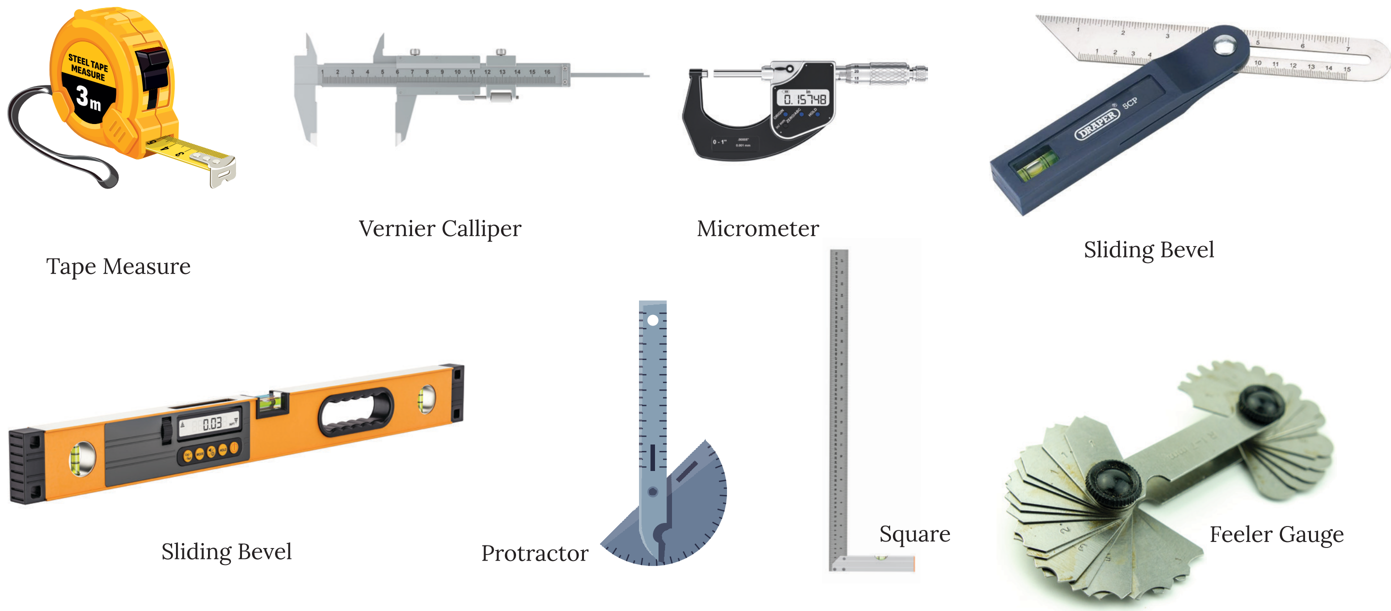


Fig. 5.1 Standard Units of Measuring Length

Units of Length and Their Relationship with Other Units

Unit Name	Symbol	Relation with Other Units
Millimetre	mm	1 mm = 0.001 m
Centimetre	cm	1 cm = 0.01 m
Decimetre	dm	1 dm = 0.1 m
Metre	m	1 m = 100 cm = 10 dm = 0.001 km
Kilometre	km	1 km = 1000 m

Keywords

International System of Units (SI) : It is the modern form of the metric system and the standard for measuring physical quantities globally. It is based on seven base units, such as the meter for length and the kilogram for mass. SI units ensure uniformity and accuracy in science, industry, and daily life.

Non-Standard Units of Measuring Length

Non-standard units are informal and vary depending on the individual or culture. These include units like a handspan, footstep, arm's length, or rope, which were commonly used in ancient times for everyday measurements. While they are convenient for rough estimations, they lack consistency and precision, as they depend on the person using them.

Key Features of Non-Standard Units:

- Informal and inconsistent across individuals or regions.
- Useful for quick, approximate measurements in informal settings.
- Examples: Hand span, cubit, foot sapn, Arm length.
- Not suitable for scientific or technical purposes due to lack of standardization.

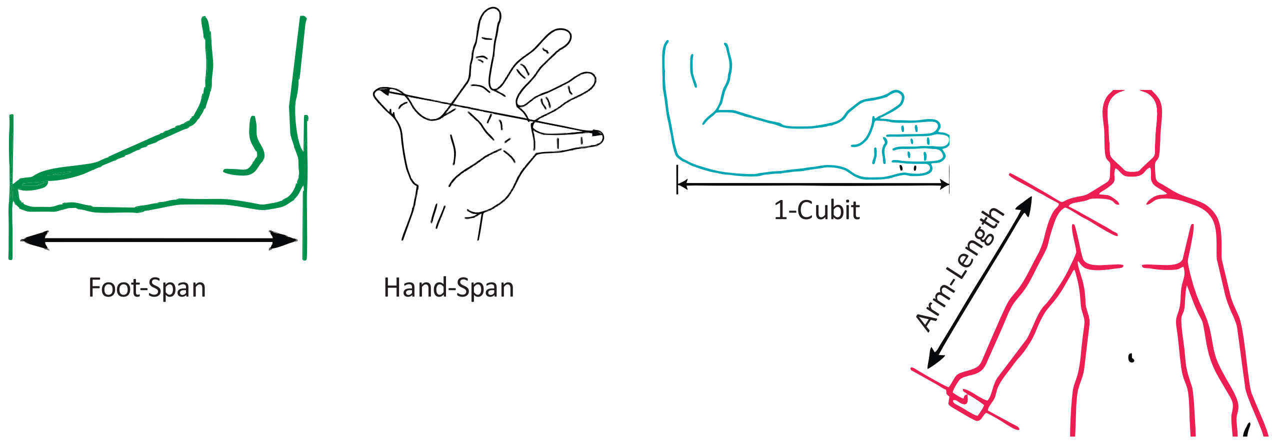


Fig. 5.2 Non-Standard Units of Measuring Length

Comparison of Standard and Non-Standard Units

Aspect	Standard Units	Non-Standard Units
Definition	Fixed, globally recognized measures	Variable, based on personal or cultural references
Accuracy	High precision and reliability	Low precision, subjective
Examples	Meter, centimeter, kilometer	Handspan, footstep, cubit
Usage	Science, industry, and trade	Informal or approximate needs
Tools	Rulers, measuring tapes, calipers	None or basic tools (e.g., rope)

Tools for Measuring Length

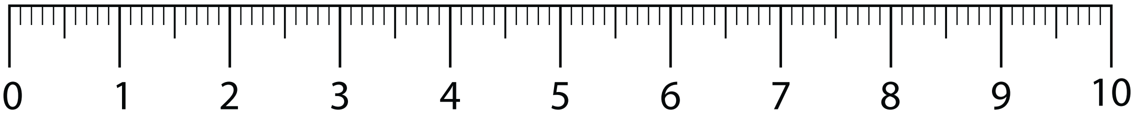
Overview of Tools

Different tools are used based on the type of measurement—straight or curved, small or large objects. The main tools are:

Tool	Length Available	Material	Use
Centimetre Scale	15 cm, 30 cm, 100 cm	Plastic, Wood, Metal	Small, straight objects
Metre Rod	1 m	Plastic, Wood, Metal	Classroom, furniture measurements
Measuring Tape	1 m to 50 m	Cloth, Plastic, Metal	Tailoring, engineering, curved lines

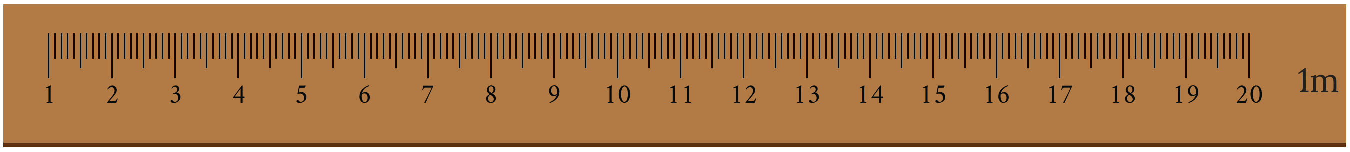
Centimetre Scale

- Length: Available in 15 cm, 30 cm, or 100 cm scales.
- Divisions: 1 cm is divided into 10 millimetres (mm).
- Use: Suitable for small, straight objects like notebooks or pencils.



Metre Rod

- Length: Typically 1 metre long.
- Divisions: Divided into 100 equal parts, each representing 1 cm.
- Use: Ideal for classroom demonstrations or measuring furniture.



Measuring Tape

- Material: Made of cloth, plastic, or metal, making it flexible.
- Lengths: Comes in 1 m, 2 m, 5 m, 10 m, and 50 m options.
- Use: Commonly used by tailors, engineers, and architects for both straight and curved surfaces.

Correct Way of Measuring Length

To measure length accurately, follow proper steps and techniques.

Fig. 5.3 Measuring Tape

Steps for Using a Scale

- **Placement:** Place the scale flat along the length of the object. Ensure it is parallel to the object being measured.
- **Zero Alignment:** Align the zero mark of the scale with one end of the object.
- **Measurement:** Read the mark on the scale where the other end of the object aligns.
- **Eye Position:** Maintain the eye exactly above the reading point to avoid parallax error.

Tips for Broken Scales

If the zero mark is broken or unclear, use a visible mark (e.g., "1 cm") as the starting point and subtract it from the final reading.

Step	Correct Method	Incorrect Method
Placement	Parallel to the object	Slanted or not aligned
Zero Alignment	Zero mark at the starting point	Random starting point
Eye Position	Perpendicular to the scale	Slanted or at an angle, causing errors

Example of Measuring Length

- Suppose the length of an object starts at the 1 cm mark and ends at the 6 cm mark.
- **Calculation:** Length = Final Reading - Initial Reading = 6 cm - 1 cm = 5 cm.
- **Result:** The length of the object is 5 cm.

Measuring Curved Lines

Measuring Tape is used for curved lines due to its flexibility. It can measure objects such as pipes, circular tables, or fabric.

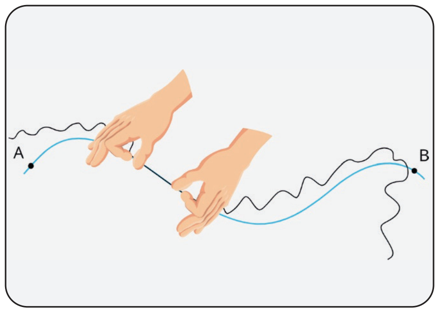


Fig. 5.4 Measuring Curved Lines

Steps for Using Measuring Tape:

- Wrap the tape around the curved object.
- Note the point where the tape overlaps or completes the measurement.
- Record the total length as displayed on the tape.

Describing Positions

The position of an object is often defined in relation to a fixed point or object. This fixed point is called a reference point. It helps us describe where an object is located relative to a known position. For instance, when we say "A car is parked 500 meters away from the grocery store," the grocery store serves as the reference point. Reference points simplify understanding locations and distances in both daily life and larger contexts such as navigation.

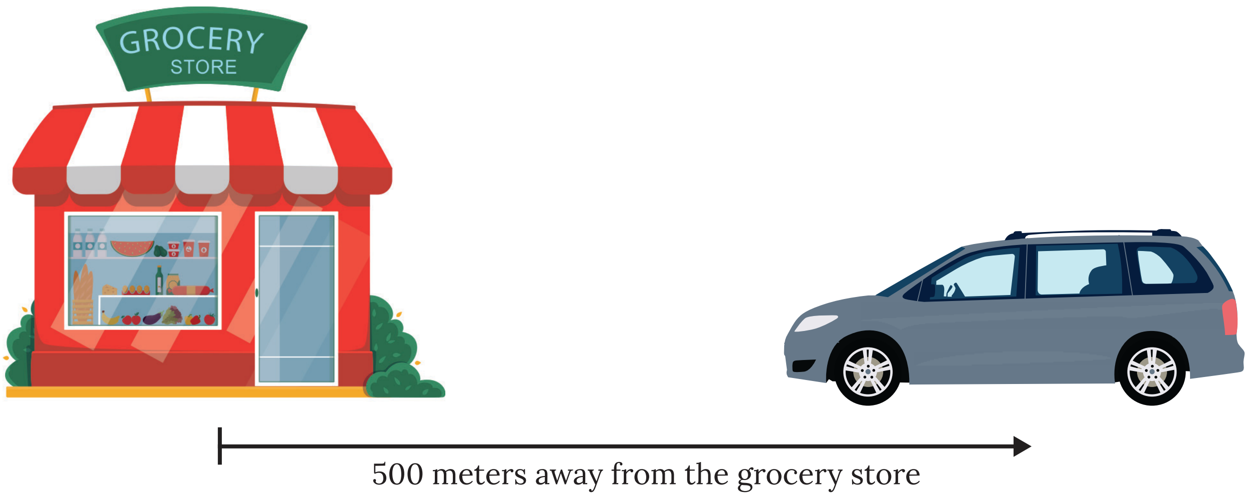


Fig. 5.5 Describing Positions

Kilometre Stones

Kilometre stones are physical markers placed along roads or highways. These stones provide key information for navigation and positioning:

Features of Kilometre Stones:

- Indicate the distance in kilometres from a starting point (usually a city or road's origin).
- Help travelers, drivers, and tourists determine how far they are from their destination.
- Typically found with city names and their respective distances etched on them.

Practical Use:

- Used on highways like NH-44 to indicate distances between key cities or towns, making navigation easier.

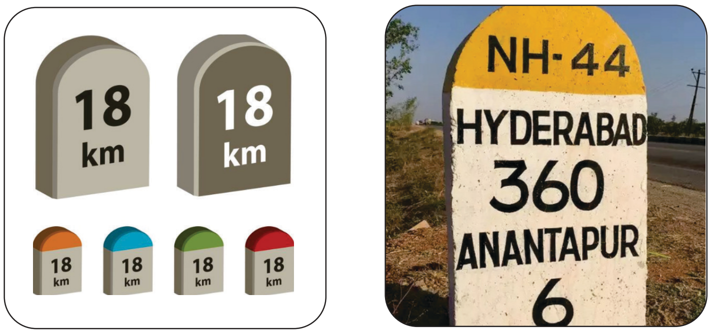


Fig. 5.6 Kilometre Stones

Fact Flash

Did you know that the "foot" as a unit of length historically varied widely, often based on the actual length of a king's foot? This led to inconsistencies until standardized systems were developed! Also, the modern definition of a meter is based on the speed of light, making it an incredibly precise and universal standard!

Common Misconceptions

× **Misconception:** All rulers start measuring from the very edge.

✓ **Correction:** Some rulers have a small gap before the "0" mark to ensure accuracy when measuring from an object's true edge. Always align with the designated "0."

× **Misconception:** A "foot" is always exactly 12 inches.

✓ **Correction:** While 12 inches is the standard in the imperial system, historical "feet" varied. The modern inch itself is defined in terms of the metric system (exactly 25.4 mm).

Science Around You

Measurement of length helps us determine the distance between two points and is essential in both science and daily life. While early humans used non-standard units like handspans, the need for consistency led to the use of standard units. Today, the meter (m) is the SI unit of length, ensuring measurements are the same worldwide.

Activity

Estimating and Measuring Length: The Everyday Object Challenge

Objective: To practice estimating lengths and then accurately measuring them using standard tools.

- **Materials:** A ruler, a measuring tape, various common household objects e.g., a pencil, a book, a phone, a spoon.
- **Procedure:**
  - **Choose Objects:** Select 5-7 different objects of varying lengths.
  - **Estimate:** For each object, first estimate its length to the nearest centimeter (cm) or inch (in) and record your estimation.

  Measure:
  - For smaller objects (like a pencil or phone), use the ruler. Align one end of the object with the "0" mark and read the measurement at the other end.
  - For larger objects (like a book or door width), use the measuring tape. Extend the tape, align the "0" mark, and read the measurement.
- **Observation:** Note how close your estimations were to the actual measurements and reflect on how practice improves estimation skills.

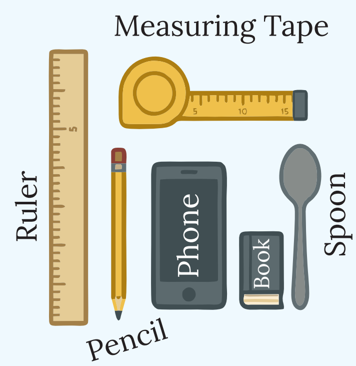


Fig. 5.7 Materials Required

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Multiple Choice Questions:

Remembering

1. What is the SI base unit of length?
   (a) Centimeter ☐ (b) Inch ☐ (c) Meter ☐ (d) Kilometer ☐

Understanding

2. Why did humans move from using handspans to standard units for length?
   (a) Handspans were too small ☐
   (b) To ensure consistency in trade and communication ☐
   (c) They ran out of hands ☐ (d) Only royalty could use handspans ☐
3. Which of the following tools would be most appropriate for measuring the length of a room?
   (a) A 15 cm ruler ☐ (b) A small school protractor ☐
   (c) A long measuring tape ☐ (d) A weighing scale ☐

Short Answer Question:

Analyzing

4. Identify two standard units of length and compare them with two non-standard units once used in history.
5. Explain length in the context of physics and show why accurate measurement is important in construction.

Long Answer Question:

Evaluating

6. Explain the evolution of length measurement from ancient times to the modern era, highlighting the shift from non-standard to standard units. Describe three different tools used to measure length for various scales (small, medium, large) and discuss the importance of selecting the appropriate tool for accurate measurement.

Motion and its Types

Motion is the change in the position of an object with respect to time and its surroundings. It is one of the most important ideas in science because it explains how things move and why. Motion can be seen all around us—when a ball rolls, a bird flies, or the Earth orbits the Sun. Depending on the path of movement, motion can be straight (linear), round (circular), or back-and-forth (oscillatory).

Motion may be uniform, when an object moves at the same speed in a straight line, or non-uniform, when the speed or direction keeps changing. To understand motion, we use terms like displacement, speed, velocity, and acceleration. These help us compare and measure how objects move.

The study of motion is guided by Newton's Laws of Motion, which link force, mass, and movement. Instruments like rulers, stopwatches, and motion sensors help us measure it correctly. Motion is not just about vehicles or machines—it is also in our daily lives: walking, running, breathing, and even the random movement of particles in air and water, called **Brownian motion**.

From the tiniest particles to the largest planets, motion governs the universe. Without understanding it, we could not build safe transport, launch rockets, or even play sports. Motion is everywhere—it keeps life and the world moving!

Keywords

Brownian motion: It is the random, irregular movement of tiny particles in a fluid, caused by collisions with fast-moving molecules of the fluid.

Types of Motion

Objects in motion can follow different paths and exhibit various types of motion depending on their nature and the forces acting on them. Motion is broadly classified into the following types:

Linear or Rectilinear Motion

Definition: An object is said to be in linear motion if it moves along a straight line in one direction.

Examples:

- A bicycle moving on a straight road.
- A car driving along a highway.
- An apple falling from a tree.

Key Characteristics:

- The path of the motion is straight.

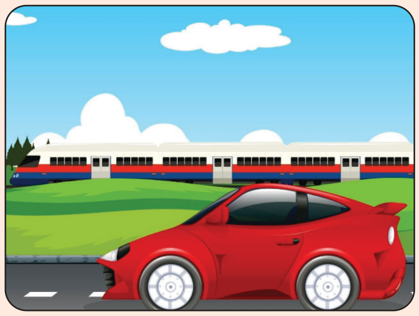


Fig. 5.8 Linear Motion

Curvilinear or Random Motion

Definition: Motion that occurs along a curved path or changes direction in an irregular manner is called curvilinear or random motion.

Examples:

- A train moving along a curved track.
- The flight of a butterfly in a garden.

Key Characteristics:

- The path is curved or irregular.

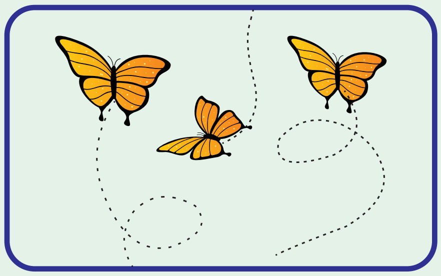


Fig. 5.9 Curvilinear Motion

Circular Motion

Definition: An object is in circular motion when it moves around a fixed point in a circular path. The **axis of rotation** lies outside the body.

Examples:

- The moon orbiting the Earth.

Key Characteristics:

- The motion follows a circular **trajectory.**

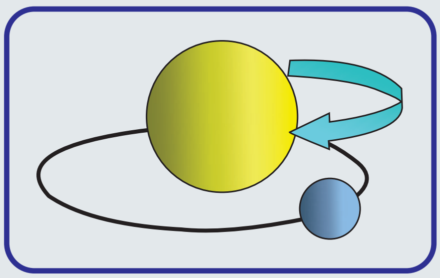


Fig. 5.10 Circular Motion

Keywords

Axis of Rotation: The axis of rotation is an imaginary line around which an object spins or rotates.
Trajectory: A trajectory is the path that a moving object follows through space. It is usually curved due to forces like gravity and air resistance.

Rotational Motion

Definition: Rotational motion occurs when an object spins around a fixed axis inside the body

Examples:

- The rotation of a fan.
- The movement of car tires.
- A giant wheel at an amusement park.

Key Characteristics:

- The object spins while maintaining its position.

Fig. 5.11 Rotational Motion

Oscillatory Motion

Definition: Motion that involves an object moving back and forth about its mean position is called oscillatory motion.

Examples:

- The pendulum of a clock.

Key Characteristics:

- Repetitive back-and-forth movement.

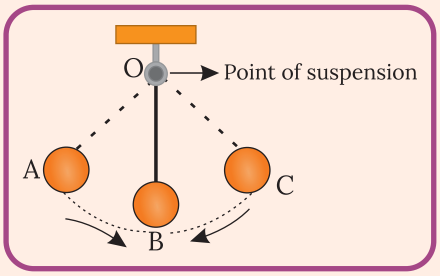


Fig. 5.12 Oscillatory Motion

Fact Flash

Did you know that even when you're standing still, you're actually moving incredibly fast? You're rotating with the Earth at approximately 1,670 kilometers per hour (at the equator) and orbiting the Sun at about 107,000 kilometers per hour! Also, a typical sneeze travels at about 160 kilometers per hour, showcasing a very brief, but rapid, motion!

Common Misconceptions

× **Misconception:** Heavier objects fall faster than lighter objects.

✓ **Correction:** In a vacuum (without air resistance), all objects fall at the same rate, regardless of their mass, due to gravity.

× **Misconception:** Motion requires a constant force.

✓ **Correction:** An object in motion will stay in motion at a constant velocity unless acted upon by an external force (Newton's First Law).

Science Around You

Motion is a basic concept in physics that explains how objects change position over time. Everything in the universe is constantly moving, from tiny atoms to massive galaxies. Motion helps us understand events like a ball rolling, a car driving, or planets orbiting the sun. Newton's laws of motion explain how forces affect movement, such as why objects speed up, slow down, or follow curved paths. These principles are used in building vehicles, launching rockets, and analyzing sports, making motion essential in science and daily life.

Activity

Observing Different Types of Motion: The Toy Car Race

Objective: To observe and identify different types of motion using simple toys.

- **Materials:** A toy car, a ramp a string with a small weight tied to one end (pendulum), a spinning top or coin.
- **Procedure:**
  - **Linear Motion (Straight Line):** Push the toy car across a flat, smooth floor in a straight line. Observe its path.
  - **Curvilinear Motion (Curved Path):** Gently push the toy car in a curved path or make it go around a circular object. Observe its path.
  - **Oscillatory/Periodic Motion:** Hang the string with the weight (pendulum) from a fixed point. Pull it to one side and release. Observe its swinging motion.
  - **Rotational Motion:** Spin the top or a coin on a flat surface. Observe its spinning motion around an axis.
- **Observation:** Note how each object moves and classify its motion based on the path it takes (straight, curved, back-and-forth, spinning).

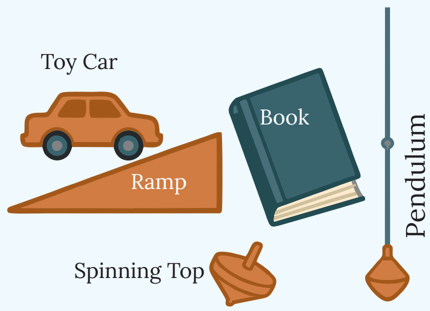


Fig. 5.13 Materials Required

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Remembering

Multiple Choice Questions:

1. Which type of motion is shown by a car moving in a straight road?
   (a) Rotational motion ☐ (b) Oscillatory motion ☐
   (c) Rectilinear motion ☐ (d) Circular motion ☐

Understanding

2. Which of the following is an example of rotational motion?
   (a) A child sliding down a slide ☐ (b) The Earth spinning on its axis ☐
   (c) A car moving on a straight road ☐ (d) A boy running in the park ☐
3. Which of the following is an example of rotational motion?
   (a) A car driving on a straight road ☐ (b) A swing moving back and forth ☐
   (c) A spinning ceiling fan ☐ (d) A ball falling from a height ☐

Applying

Short Answer Question:

4. Observe a ceiling fan in your classroom. Identify the type of motion it shows and explain how it is different from the motion of a car moving straight on a road.
5. A pendulum in a clock swings back and forth. Explain the type of motion and how it is an example of periodic motion.

Evaluating

Long Answer Question:

6. Explain the concept of motion and its significance in the physical world. Describe three different types of motion with real-world examples for each, and discuss how understanding motion principles is vital in the design and operation of everyday technologies like bicycles or elevators.

SUMMARY

Measurement of length and motion are fundamental concepts in science, forming the basis of our understanding of the physical world. These principles help us quantify distances, dimensions, and the behavior of objects in motion, playing an essential role in daily life and advanced scientific applications.

Measurement of Length

The measurement of length refers to determining the distance between two points. Early methods relied on non-standard units like handspans, cubits, and footsteps, which were inconsistent and subjective. Over time, standard units, such as the meter in the International System of Units (SI), replaced these informal methods to ensure precision and consistency. Tools like rulers, measuring tapes, Vernier calipers, and micrometers allow accurate length measurement for diverse purposes, from tailoring to scientific research.

Advancements in measurement techniques, including laser-based methods, have enabled highly precise length measurements, supporting innovations in technology, engineering, and global standardization.

Motion and Its Types

Motion is the change in an object's position over time relative to its surroundings. It is a universal phenomenon observed in all natural and man-made systems. Motion is categorized into various types based on the path, nature, and periodicity of movement:

- **Linear or Rectilinear Motion:** Movement along a straight line, such as a car driving on a road or a stone falling vertically.
- **Curvilinear or Random Motion:** Movement along a curved or unpredictable path, like a thrown ball or the erratic flight of a butterfly.
- **Circular Motion:** Movement along a circular path, as seen in the rotation of a fan blade or the Earth's orbit around the Sun.
- **Rotational Motion:** Movement of an object around a fixed axis, such as a spinning wheel or the rotation of the Earth on its axis.
- **Oscillatory Motion:** Repetitive back-and-forth movement within a fixed range, like a pendulum or a swing.
- **Vibratory Motion:** Rapid back-and-forth motion within a small range, such as the vibration of a guitar string or a mobile phone.
- **Periodic Motion:** Motion that repeats at regular intervals, such as the ticking of a clock or the revolution of planets.
- **Non-Periodic Motion:** Motion that does not repeat at regular intervals, like the movement of clouds or leaves falling from a tree.

Example Based Questions

Multiple Choice Questions

1. A student measures the length of a table using a ruler but starts from the 2 cm mark instead of zero. He records the table's length as 120 cm. What is the actual length of the table?

   (a) 118 cm

   (b) 122 cm

   (c) 120 cm

   (d) 119 cm

   Answer: (a) 118 cm

   Explanation: If measurement starts from 2 cm instead of 0, the error is (2 cm). Actual length = 120 − 2 = 118 cm. This shows the importance of proper measurement technique.

2. Which of the following is an example of oscillatory motion?

   (a) A bus moving on a straight road

   (b) The Earth revolving around the Sun

   (c) The pendulum of a wall clock

   (d) A boy running in a park

   Answer: (c) The pendulum of a wall clock

   Explanation: Oscillatory motion is repeated to and fro movement about a fixed point. A pendulum swings back and forth, making it a clear example.

3. The SI unit of length is:

   (a) Centimeter (b) Kilometer

   (c) Metre (d) Foot

   Answer: (c) Metre

   Explanation: The standard international (SI) unit of length is the metre (m). Other units like cm or km are smaller or larger multiples of the metre.

Short Answer Questions

4. A child uses a measuring tape to measure the length of a rope and finds it to be 3.2 m. Convert this into centimeters.

   Answer:

   1 metre = 100 cm.

   So, 3.2 m = 3.2 × 100 = 320 cm.

   This example shows how conversion between different metric units is applied in daily life.

5. Give one example each of linear motion and circular motion from your daily life.

   Answer: **Linear motion:** A train moving on straight railway tracks.

   Circular motion: A ceiling fan rotating about its axis.

   These examples help students connect abstract motion types to real-world situations.

6. A bus starts from rest and moves on a straight road. Explain whether the motion is uniform or non-uniform.

   Answer: The bus gradually increases its speed after starting from rest. Since its speed changes with time, the motion is non-uniform motion.

   In uniform motion, speed remains constant, but here the speed varies.

Long Answer Questions

7. Ramesh measures the length of a cricket pitch. He walks along the pitch using his foot as a unit of measurement and counts 22 steps. His friend uses a measuring tape and finds the pitch length to be 20.12 m. Why is there a difference? Which method is more reliable, and why?

   Answer: The difference arises because Ramesh used a non-standard unit (his foot). The length of a foot can vary from person to person, which causes inaccuracy. His friend used a measuring tape, which is a standardized instrument marked in SI units (metres and centimetres). The method with a measuring tape is more reliable because:

   - It gives the same result for everyone.
   - It avoids personal variation in measurement.
   - It is based on internationally accepted SI units.

Gap Analyzer™
Complete Chapter Test

EXERCISE

A. Choose the correct answer.

1. What is the SI unit of length?
   - (a) Kilometer ☐ (b) Meter ☐
   - (c) Centimeter ☐ (d) Millimeter ☐
2. Which of the following is an example of uniform motion?
   - (a) A car slowing down at a turn ☐ (b) A train moving at a constant speed ☐
   - (c) A ball rolling on uneven ground ☐ (d) A person running at varying speeds ☐
3. What device is commonly used to measure the length of small objects accurately?
   - (a) Measuring tape ☐ (b) Vernier caliper ☐
   - (c) Stopwatch ☐ (d) Spring balance ☐
4. Which of the following represents periodic motion?
   - (a) A car on a straight road ☐ (b) A child on a swing ☐
   - (c) A leaf floating in water ☐ (d) A stone rolling downhill ☐
5. Which type of motion does the Earth exhibit when it revolves around the Sun?
   - (a) Rotational motion ☐ (b) Circular motion ☐
   - (c) Linear motion ☐ (d) Oscillatory motion ☐

B. Fill in the blanks.

1. The length of an object is measured using a _________ or a measuring tape.
2. Objects that move back and forth repeatedly exhibit _________ motion.
3. The movement of a fan's blades is an example of _________ motion.
4. To measure very long distances, we use units like _________ or kilometers.
5. Instruments like a vernier caliper are used to measure the _________ dimensions of small objects.

C. Write True or False.

1. The SI unit of length is the centimeter. _________
2. A train moving at a constant speed is an example of non-uniform motion. _________
3. Periodic motion occurs at regular intervals of time. _________
4. Linear motion occurs when an object moves along a straight path. _________
5. Rotational motion is when an object moves back and forth repeatedly. _________

D. Define the following terms.

1. Length
2. Motion
3. Uniform Motion
4. Periodic Motion
5. Circular Motion

E. Match the columns.

	Column A		Column B
1.	Measuring tape	(a)	Back and forth motion
2.	Rotational motion	(b)	Constant speed motion
3.	Oscillatory motion	(c)	Spinning fan blades
4.	Uniform motion	(d)	Straight-line measurement
5.	Non-uniform motion	(e)	Varying speed motion

F. Assertion and Reason

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

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.
(e) Both A and R are false.

1. **Assertion (A):** It is difficult to measure the length of a curved line directly with a ruler.
   Reason (R): A ruler is designed to measure only straight distances.
2. **Assertion (A):** A ceiling fan exhibits circular motion.
   Reason (R): All parts of the fan move along a circular path around a fixed center.
3. **Assertion (A):** The motion of a butterfly is an example of random motion.
   Reason (R): Random motion has a constant speed and direction.

G. Give reasons for the following statements.

1. Measuring instruments are essential for accurate length measurements.
2. Motion is classified into different types based on how objects move.
3. Circular motion is important in understanding the motion of planets.
4. Periodic motion is observed in natural phenomena like pendulums.
5. Different units are used to measure length for objects of varying sizes.

H. Answer in brief.

1. Why is the SI unit of length important in measurement?
2. What is the difference between uniform and non-uniform motion?
3. Describe an example of periodic motion in daily life.
4. How is a vernier caliper used for precise measurements?
5. What type of motion do the wheels of a moving bicycle exhibit?

I. Answer in detail.

1. Explain the importance of standard units in the measurement of length.
2. Describe the differences between uniform motion and non-uniform motion with examples.
3. What are the various types of motion? Explain with examples.
4. Discuss the methods used to measure the length of different objects, from small to very large.
5. Compare and contrast periodic motion and rotational motion with examples.

SKILL-BASED PRACTICE

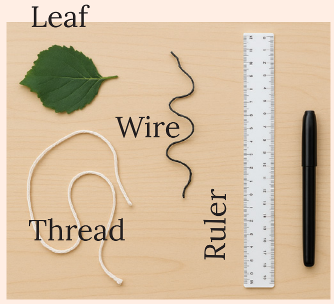
Activity Time

STEM

Measuring Irregular Shapes

Materials Needed:

- Several irregularly shaped objects (e.g., a leaf, a twisted piece of wire, a piece of string), A ruler or meter stick, A piece of thread, Marker pen



Materials Required

Activity Steps:

1. **Object 1 (Leaf):** Place the thread along the longest curve of the leaf. Mark the start and end points on the thread. Then, straighten the thread and measure its length with the ruler.
2. **Object 2 (Twisted Wire):** Carefully untwist the wire to make it as straight as possible without breaking it. Then, measure its total length using the ruler.
3. **Object 3 (String):** Tie a knot at one end of the string. Measure a specific length (e.g., 20 cm) from the knot and make another mark. Now, try to estimate how many times this 20 cm length fits around another object (e.g., a water bottle) to measure its circumference.

Questions to Answer:

- Which method was most effective for measuring the leaf's length? Why?
- What challenges did you face when measuring the twisted wire?
- How can you use a thread and ruler to measure the circumference of your wrist?
- What does this activity teach you about measuring objects that are not perfectly straight?

Skills Covered: Practical Measurement Skills, Problem-Solving, Adaptability of Tools, Precision

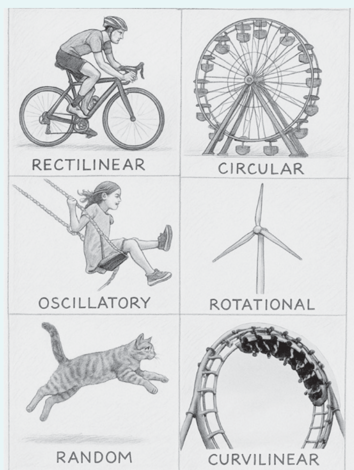
Creativity

Art

"Motion in Art" Collage

Task: Create a collage using pictures from magazines, newspapers, or printouts that show at least five types of motion (e.g., rectilinear, circular, oscillatory, rotational, random, curvilinear). Label each type clearly.

Materials: Chart paper/cardboard, Old magazines/newspapers/ printouts, Scissors & glue stick, Colourful markers or pens,



Types of Motion in Art

Questions to Answer:

- Which type of motion was easiest to find?
- Did you find an object showing more than one type of motion?
- How does art help us understand motion?

Skills Covered: Visual Representation of Concepts, Classification Skills, Observation

Motion Analysis

Group Activity

Investigating Speed and Distance

Activity Instructions: Work in a group of 3-4 students.

1. **Setup:** Find a clear, flat area (e.g., a hallway or playground). Mark a start line and a finish line 10 meters apart (use a measuring tape to ensure accuracy).
2. **Experiment 1 (Walking):** One student walks from the start to the finish line at a steady pace. Another student uses a stopwatch to measure the time taken.
3. **Experiment 2 (Running):** The same student runs from the start to the finish line. Measure and record time. Repeat 3 times and record average time.
4. **Calculations:** For both walking and running, calculate the average speed using the formula: Speed = Distance / Time.

Questions to Answer:

- What was the average time taken for walking 10 meters? What about running 10 meters?
- Calculate the average speed for walking and running.
- Compare the speeds. Why was the running speed higher than the walking speed?

Skills Covered: Measurement (Time & Length), Calculation (Speed), Analysis & Comparison

The School Sports Day

Case Study

During the annual school sports day, students eagerly take part in a wide range of athletic events, each designed to showcase their physical abilities and competitive spirit. These events vary from track races to field competitions, offering something for every student to enjoy and excel in. Two of the most exciting and commonly observed events are the 100-meter sprint and the discus throw.

In the 100-meter race, the participants, who are sprinters, line up side by side at the starting line. Once the starting signal is given—usually a whistle or a starter pistol—they run as fast as possible in a straight path towards the finish line.

In the discus throw, the athlete begins by standing in a designated circular area. Before releasing the discus, the athlete spins around one or more times to build up momentum. This spinning motion helps to increase the force with which the discus will be thrown. After gaining enough speed and proper positioning, the athlete releases the discus into the air. The discus then travels along a curved, parabolic trajectory due to the force of the throw and the influence of gravity and air resistance. This event highlights strength, technique, and control.

School Sports Day

Guiding Questions:

1. What type of motion is exhibited by the runners in the 100-meter race?
2. When the athlete spins before throwing the discus, what type of motion is that?
3. Once the discus is released and flies through the air, what type of motion does it show?

Skills Covered: Identifying Types of Motion, Observation Skills, Classification, Calculation of Speed

Satellite-Based Tolling Systems

Source Based Question

In recent developments, India is preparing to roll out a new Global Navigation Satellite System (GNSS)—based toll collection technology on its highways. This satellite system measures how far vehicles travel using GPS and GAGAN, enabling tolls to be calculated based on the actual distance driven rather than stopping at toll booths. Vehicles will have On-Board Units (OBUs) that communicate with satellites, tracking their motion continuously and deducting toll charges automatically. This method uses precise measurement of a vehicle's movement through space and time, offering a real-world example of how motion can be quantified.

THE ECONOMIC TIMES News

No highway fee up to 20 kms for vehicles with global navigation satellite system

New Delhi: Motorists using vehicles with a functional Global Navigation Satellite System (GNSS) will be allowed to travel toll-free on highways and expressways up to 20 kilometres daily with effect from Tuesday, according to a government notification. The Ministry of Road Transport and Highways amended the National Highways Fee (Determination of Rates and Collection) Rules, 2008, which has come to effect from Tuesday.

Image Credit : Economics Times

(First Published: Sep. 10, 2024, The Economic Times)

Guiding Questions & Tasks: Measurement of Motion

1. **Understanding Motion**
   a. What is being measured by the satellite system in the example above?
   b. Why is measuring the distance a vehicle travels important in this context?
2. **Measuring Tools & Units**
   a. What two tools or systems are mentioned that help measure the vehicle's motion?
   b. If a car travels 150 kilometers according to the system, which unit is being used, and why is it suitable for students to learn?
3. **Motion in Everyday Life**
   a. How does this GNSS system capture motion differently than a stop-watch and measuring tape might?
   b. Can you think of another example (besides tolls) where measuring motion or distance without direct contact is helpful?

Skills Covered: Measurement Skills, Speed Calculation, Application of Physics Principles