5
Chapter

Measurement of Length and Motion

We'll cover the following key points:

- Measurement of Length
- Motion and its Types

Hi, I'm EeeBee

Do you Remember:

Fundamental concept in previous class.

In class 4th we learnt

- Measurement of Length

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.

Guidelines for Teachers

Educators can introduce measurement by highlighting its importance in science and daily life, demonstrating tools like rulers and meter sticks, and emphasizing accuracy. For motion, interactive activities such as observing objects, recording distances, and discussing motion types can be used. Hands-on practice and discussions foster critical thinking, helping students connect theory to real-world applications.

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.

Introduction

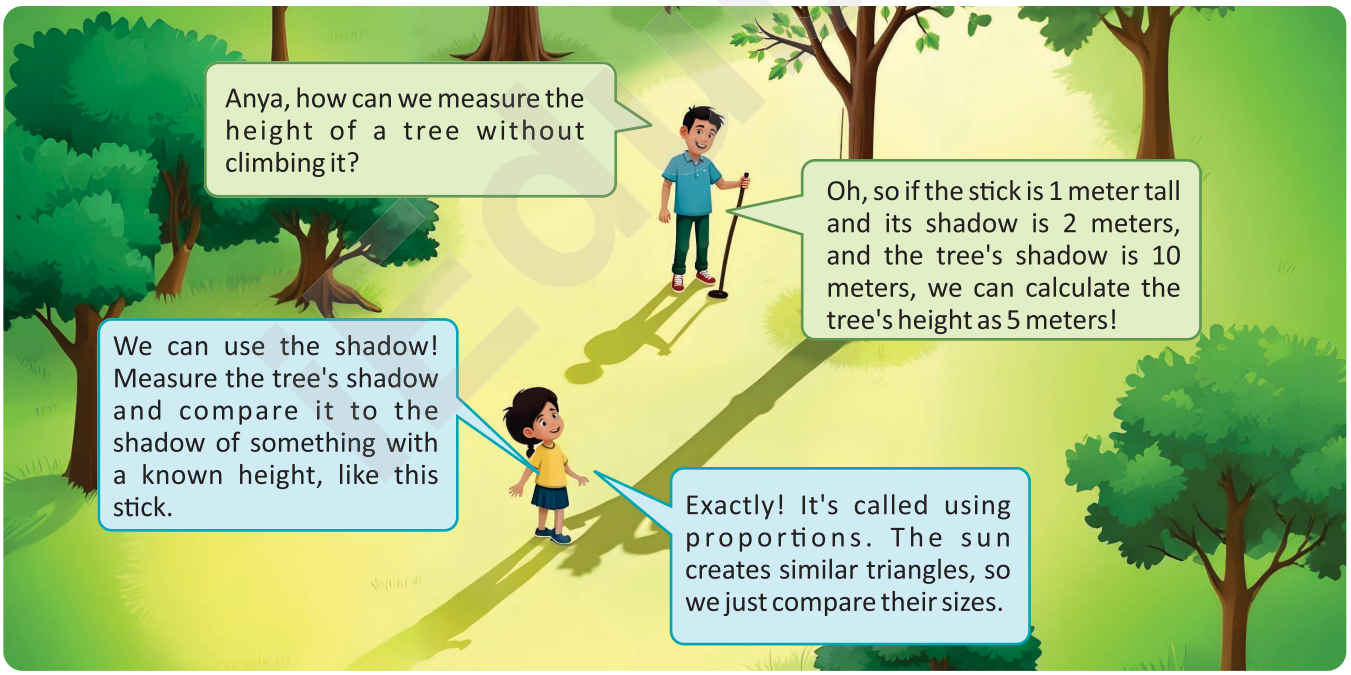
Measurement is a fundamental aspect of understanding the physical world, allowing us to quantify and analyze various phenomena. Length, as a basic physical quantity, is essential for defining the size and distance of objects, while motion involves the study of how objects change position over time. In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

In History...

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

Ravi and Anya are in a park, measuring the height of a tree using a shadow.



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).
- Tools for measurement: Ruler, measuring tape, Vernier caliper, and micrometer.

Tape Measure

Vernier Calliper

Micrometer

Square

Sliding Bevel

Laser Tape Measure

Spirit Level

Protractor

Feeler Gauge

Units of Length and Their Relationship with Other Units

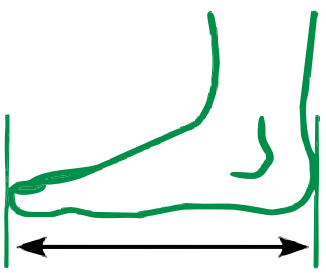
Unit Name	Symbol	Relation with Other Units
Millimetre	mm	1 mm = 0.001 m
Centimetre	cm	1 cm = 0.01 m
Decimetre	dm	1 dm = 0.1 m
Metre	m	1 m = 100 cm = 10 dm = 0.001 km
Kilometre	km	1 km = 1000 m

Non-Standard Units of Measuring Length

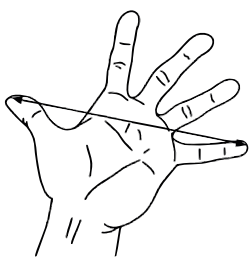
Non-standard units are informal and vary depending on the individual or culture. These include units like a handspan, footstep, arm's length, or rope, which were commonly used in ancient times for everyday measurements. While they are convenient for rough estimations, they lack consistency and precision,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

Key Features of Non-Standard Units:

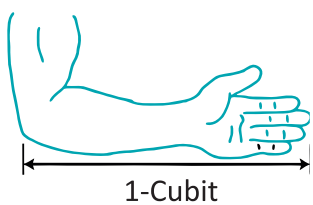
- Informal and inconsistent across individuals or regions.
- Useful for quick, approximate measurements in informal settings.
- Examples: Hand span, cubit, foot sapn, Arm length.
- Not suitable for scientific or technical purposes due to lack of standardization.

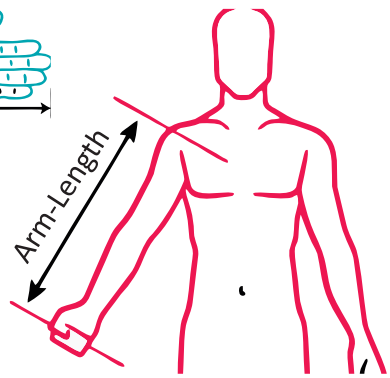


Foot-Span



Hand-Span





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:

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.

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

Correct Way of Measuring Length

To measure length accurately, certain steps and techniques must be followed:

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.

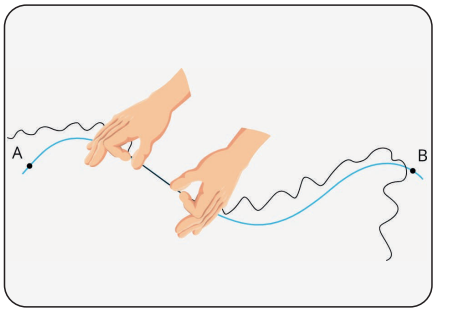
Step	Correct Method	Incorrect Method
Placement	Parallel to the object	Slanted or not aligned
Zero Alignment	Zero mark at the starting point	Random starting point
Eye Position	Perpendicular to the scale	Slanted or at an angle, causing errors

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.

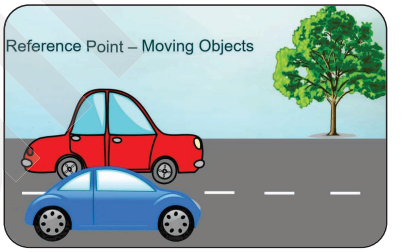


Steps for Using Measuring Tape:

- 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.



Kilometre Stones

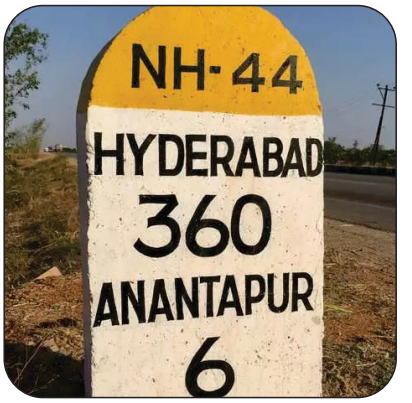
Kilometre stones are physical markers placed along roads or highways. These stones provide key information for navigation and positioning:

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.



Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Apply Concept in Context

Apply

- How many millimetres are there in 5 centimetres?
- Give examples of objects or items commonly measured using millimetres and centimetres.
- Aarav needs to solve a set of unit conversion problems for his assignment. Help him with the following conversions:

a)1.5 m to mm (b) 45,000 cm to m (c) 125 km to m (d) 0.75 kg to grams

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking, Analytical thinking

Examine Further

Analyse

- How do people with limited mobility measure long distances, such as the length of a large hall?
- What methods can be used to measure the height of a tall building or a mountain without directly climbing it?

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking, Research, Analytical thinking

Self-Assessment Questions

Evaluate

- What is the tool used to measure the height of a tall object, such as a flagpole?
- Explain the significance of the zero mark on a measuring tool.

Skills Covered : Evaluative thinking

Creative Insight

Create

Perform the following activity to explore measurement techniques:

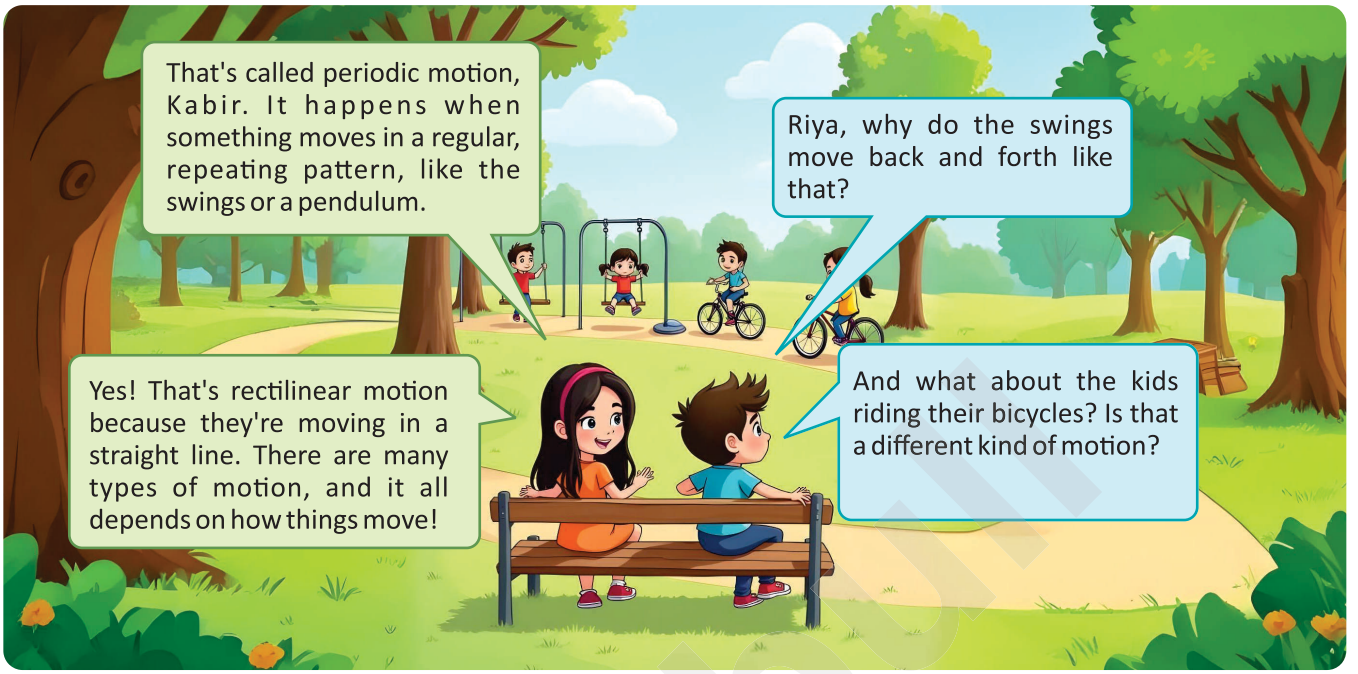
- Use a ruler to measure the length and width of your desk. Then use your smartphone or another device to measure the same dimensions using its built-in measurement feature.
- Compare the values obtained with both methods. Record any differences and try to justify why they might occur.
- Share your findings with a group and discuss the accuracy and reliability of the two measurement methods.

Skills Covered: Creativity, Critical and logical thinking, Brainstorming, Applicative thinking, Collaboration, Communication, Analytical thinking

Bloom's Taxonomy

Motion and its Types

Riya and Kabir are in a park, watching kids play on swings and bicycles.



Motion is the change in position of an object with respect to time and its surroundings. It is a fundamental concept in physics that describes how objects move in various ways, influenced by forces acting on them. Motion can occur in different forms, such as linear, circular, or oscillatory, depending on the path and nature of movement. Understanding motion is crucial in daily life, as it governs everything from the movement of celestial bodies to the functioning of machines. It is classified into various types based on the path and behavior of the moving object, helping us analyze and describe different physical phenomena effectively.

Types of Motion

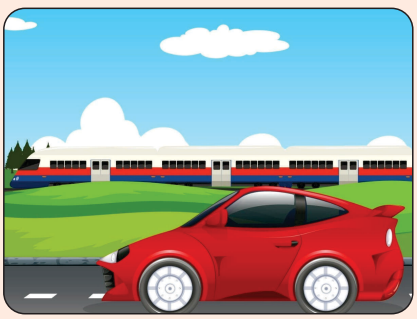
Objects in motion can follow different paths and exhibit various types of motion depending on their nature and the forces acting on them. Motion is broadly classified into the following types:

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.

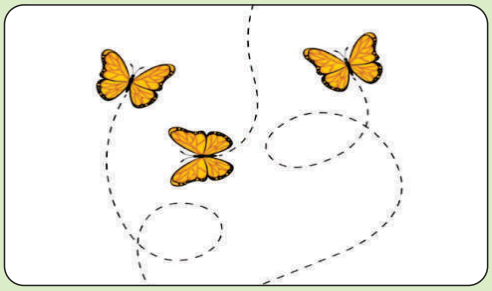


Key Characteristics:

- The path of the motion is straight.

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:

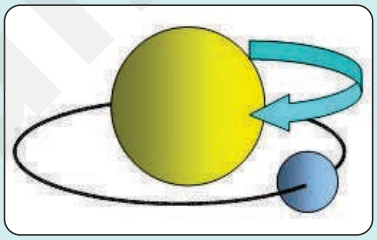
- A train moving along a curved track.
- The flight of a butterfly in a garden.

Key Characteristics:

- The path is curved or irregular.

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.

Rotational Motion

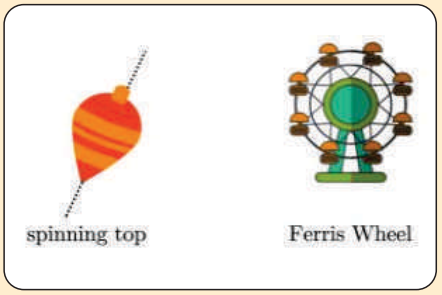
Definition: Rotational motion occurs when an object spins around a fixed axis inside the body

Examples:

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

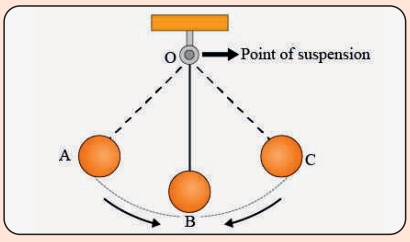
Key Characteristics:

- The object spins while maintaining its position.



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.

SCAN TO ACCESS

Take a Task

Watch Remedial

Bloom's Taxonomy

Let's recall what we know

Apply Concept in Real-Life Context

Apply

- Can an object be in motion and at rest simultaneously? Explain with an example.
- Identify the type of motion shown by the hands of a clock.

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Examine Further

Analyse

- Have you noticed why a pendulum eventually stops swinging if left unattended? Explain your observation.
- Imagine an athlete running on a circular track. Is the athlete exhibiting rotational or circular motion? Justify your answer.

Skills Covered: Critical and logical thinking, Brainstorming, Applicative thinking

Self-Assessment Questions

Evaluate

- Define oscillatory motion and give two examples from daily life.
- List three examples of periodic motion and explain why they are periodic.
- What is the difference between circular motion and rotational motion?

Skills Covered : Evaluative thinking

Creative Insight

Create

Explain how the movement of a car on a busy road can involve multiple types of motion.

Perform the following activity to support your answer:

- Observe the motion of a toy car on a flat surface and measure the distance it travels in a straight line using a scale or tape.
- Now, place an obstacle to change its direction, and observe how the motion becomes curved.
- Record the time it takes for the car to move in both straight and curved paths.

Write your observations and conclusions in tabular format and explain how the type of motion changes with the setup.

Skills Covered: Creativity, Critical and logical thinking, Brainstorming, Applicative thinking, Collaboration, Analytical thinking

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

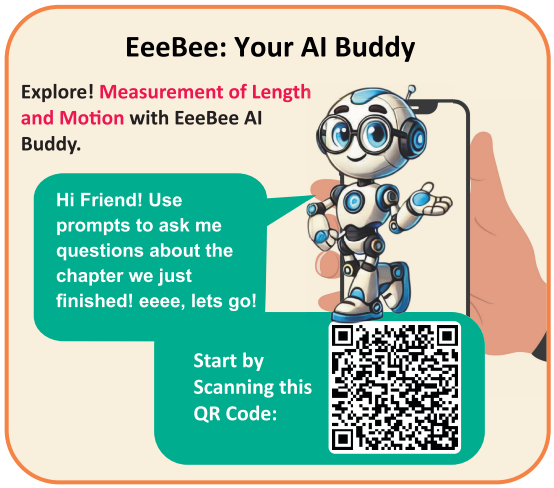
The measurement of length refers to determining the distance between two points. Early methods relied on non-standard units like handspans, cubits, and footsteps, which were inconsistent and subjective. Over time, standard units, such as the meter in the International System of Units (SI), replaced these 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.



EXERCISE

That turn curiosity into confidence—let's begin!

Gap Analyzer™
Take a Test

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. 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.

G. 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?

H. Answer in detail.

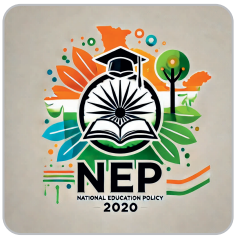
1. Explain the importance of standard units in the measurement of length.
2. Describe the differences between uniform motion and non-uniform motion with examples.
3. What are the various types of motion? Explain with examples.
4. Discuss the methods used to measure the length of different objects, from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

NEP Corner

Know about NEP 2020

More Play, Less Pressure!

The policy encourages bagless days and internships even for school students, so you learn through fun and hands-on experience.



Skill-based Activity

Curious Minds at Work

STEM

Observe your surroundings and identify an object whose length can be measured using a non-standard unit (e.g., handspan, footstep). Write a question about how the accuracy of the measurement can be improved using standard units. Using the scientific method, describe the steps you would take to answer your question.

Skills Covered: Critical and logical thinking, Brainstorming, Analytical thinking, Problem-solving, Curiosity, Observation, Decision-making skills

Flavors of Motion

Art

Identify and sketch an object in motion that you observe in your surroundings (e.g., a swinging pendulum or a moving car). Write a short description of the type of motion (rectilinear, circular, or periodic) it exhibits and explain why. Present your work to the class.

Skills Covered: Creativity, Critical and logical thinking, Applicative thinkin

Diversity in Motion

Group Activity

In groups, investigate examples of different types of motion observed in your local surroundings. Create a chart categorizing these motions as rectilinear, circular, or periodic and present it to the class.

Skills Covered: Critical and logical thinking, Brainstorming, Teamwork, Communication, Applicative thinking, Decision-making skills

Technology in Focus

Case to Investigate

Explore and research how scientists use advanced tools like laser rulers or motion sensors to measure length and analyze motion in scientific experiments. Write a short report on your findings.

Skills Covered: Critical and logical thinking, Brainstorming, Research, Applicative thinking

Sustainability Spotlight

Aligning with SDGs

Research a technological advancement that improves the accuracy of measuring length or motion in environmental studies (e.g., satellite-based systems for tracking animal movement). Highlight its key features and how it aligns with sustainable development goals. Present your findings to the class.

Aligned with: SDG 9 – Industry, Innovation, and Infrastructure, SDG 13 – Climate Action

Skills Covered: Critical and logical thinking, Brainstorming, Research, Problem-solving, Ethics

Mapping Motion

Integrated Learning

Using the Internet, create a map of India showing the railway routes of high-speed trains. Explain how the rectilinear motion of these trains depends on the straight tracks and the challenges involved in maintaining such motion.

Integrated Learning: Geography

Skills Covered: Critical and logical thinking, Brainstorming, Analytical thinking, Applicative thinking